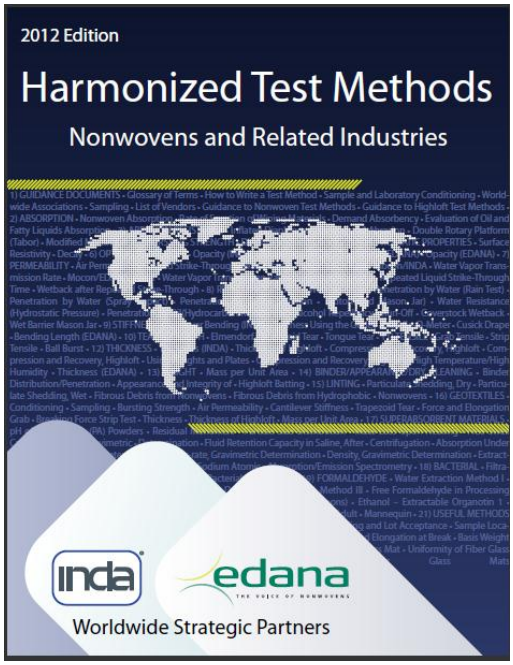
HARMONIZED TEST METHODS
NONWOVENS AND RELATED INDUSTRIES
2012



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2012 Edition

Harmonized Test Methods

Nonwovens and Related Industries

INDA and EDANA are pleased to answer the industry needs by publishing the 2012 edition of our Harmonized Test Methods Manual for the nonwoven and related industry. This 2012 edition contains the most complete collection of up-to-date industry related test methods.

This edition features a new, intuitive numbering system. We have retained the WSP (World Strategic Partners) which indicates it has been reviewed and approved by INDA and EDANA's joint task force of members. It also indicates the partnership and cooperation between INDA and EDANA in developing this document to help you do business throughout the world. In this edition we have expanded several testing areas: Permeability, stiffness, superabsorbent materials and other useful methods including new methods in filtration, hygiene, absorption, retention and physical characteristics.

We think you will find this edition the most useful and easy to use we have ever issued. The manual is in a user friendly interactive format, by simply clicking on the test method name in the table of contents you will be directed directly to the page which starts with this method.

Both EDANA and INDA want to thank all those who work to make this third edition possible and we give a special thanks to Carl Palenske of Palenske Consulting for his tireless efforts in reformatting and guiding us.

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GUIDANCE DOCUMENT: WSP 001.0.R3 (12)

Standard Terminology Relating to the Nonwoven Industry and EDANA and INDA's Standard Test Methods

The number in parentheses indicates the year of the last revision

1. Scope

This standard is a compilation of terminology gathered by members of INDA and its standing committees.

These are common terms used in the nonwoven industry and their definitions may be unique to the industry.

Some of these terms are used in EDANA and INDA's Standard Test Methods, in which case the test method number will be included after the definition. Some of the newer definitions have a word in parentheses after the term which indicates it's origin. i.e. (TAPPI) or (Flushability)

2. Referenced Documents

INDA's Nonwoven Glossary

3. Terminology

Alphabetical listing of terms used regarding the nonwoven industry.

Aa

Abrasion
The wearing or grinding away of any part of the fabric by mechanical action. WSP 020.1.R3 (12); WSP 020.2.R3 (12) WSP 020.4.R3 (12); WSP 020.5.R3 (12).

Abrasion cycle
When abrasion testing, one or more movements of the abradant across a fabric surface can be one abrasion cycle. The abrasion cycle is dependent on the programmed motions of the abrasion machine. It may consist of one back-and-forth unidirectional movement, as in rotary platform test method, or a combination of both directions in the inflated diaphragm test method and in the oscillatory cylinder abrasion method, an abrasion cycle consists of one circular movement of the specimen. WSP 020.2.R3 (12); WSP 020.4.R3 (12); WSP 020.5.R3 (12).

Abrasion cycle (Martindale*)*
On completion of all the translational abrasion tracings, a lissajous figure is formed comprising 16 rubs, which is 16 revolutions of the two outer drives and 15 revolutions of the inner drive. This is one cycle of the Martindale abrasion testing equipment. WSP 020.5.R3 (12).

Reference number
WSP 001.0.R3 (12) A

Current edition approved WSP 001.0.R3 (12)
Originally published as WSP 1.0 in 2005
Last approved as WSP 1.0 in 2008

Abrasion resistance
The ability of a surface to resist wear by friction.

Abrasion rubs (Martindale)
One revolution of the two outer drives of the Martindale abrasion equipment. WSP 020.5.R3 (12).

Absorbent hygiene product (AHP)
For the purpose of this method, all disposable products designed to absorb body fluids, such as baby diapers, feminine hygiene products or adult incontinence management devices. WSP 404.0.R1 (12)

Absorption before leakage
Mass of synthetic urine that the product can absorb under specific conditions before it leaks. WSP 354.0.R2 (12).

Absorption
A process in which one material (the absorbent) takes in or absorbs another (the absorbate). The liquid or gas is absorbed into a porous substance and retained.

Accumulator
A temporary storage device used in a fabric production line that enables the line to continue producing fabric while the full wound-up roll of fabric is doffed and replaced by an empty wind-up roll. In operation, the fabric is festooned over two parallel series of rollers of which the top series is elevated and stationary and the bottom series is counterbalanced and able to move up and down. This accumulator is positioned between the production line output and the fabric wind-up. During doffing, when no fabric is being wound up and the roll is removed, the bottom series of rollers starts to drop towards the floor, thereby taking up output from the production unit. (See J-Box as an example of another system.)

Accuracy
The degree of agreement between the true value of a testing attribute and the average value when using a given test method. WSP 002.0.R3 (12)

Acetate fibers
A manufactured fiber in which the fiber-forming substance is cellulose acetate (Federal Trade Commission (FTC) definition). Acetate fibers are derived by treating pure cellulose, which has been extracted from vegetable matter and generally wood pulp or cotton linters, with acetic anhydride. The resulting product is dissolved in acetone and extruded into filaments and the acetone evaporated. Acetate fibers are moderately strong, generally soft and lustrous like rayon. Acetate staple and filament fibers are more commonly used in weaving operations supplying end-markets such as lingerie, blouses, dresses, men's ties and other apparel. Acetate consumption by the nonwoven industry is relatively low.

Acetone
Colorless liquid used as an organic solvent.

Acid groups
Carboxylic acid group WSP 270.2.R3 (12).

Acquisition and distribution layer, also referred to as sub-layer
A nonwoven wicking layer under the top sheet (or face fabric) of an absorbent product, which speeds the transport and distribution of fluids throughout the absorbent core.

Actinic degradation
Deterioration of physical and aesthetic properties of fibers and fabrics due to exposure to light.

Activated carbon
A form of carbon capable of removing certain gases from air or impurities from water. Carbon is obtained from certain materials, generally of vegetable origin, and activated to produce a porous structure with a large surface area and adsorptive properties.

Additives
Chemicals added or incorporated into materials to give them different functional or aesthetic properties, such as flame retardancy and softness.

Adhesion
The force that holds different materials together at their interface.

Adhesive migration
The movement of adhesive in a fabric during drying or curing, to give it a non-uniform distribution within the web usually increasing to the outer layers.

Adsorbent
It is the material to which a molecule is attached and retained.

Adsorption
The attraction and adhesion of gaseous or liquid molecules to the surface of a solid. The strength of the bond depends on the van der Waal forces between two molecules.

Aerobic Process (Flushability)
A biochemical process or condition occurring in the presence of dissolved oxygen.

Aerosol
Small particles, solid, semi-solid or liquid suspended in the air. The diameter of the particles may vary from 100 microns down to 0.02 microns. Examples are dust, smoke and fog.

Aesthetics
Properties of fabrics perceived by touch, sight, smell and sound. Examples are hand, drape, texture, rustle, color and odor.

Afterglow
The flameless, ember-like burning of a material after the external ignition source is removed.

After treatment (Finishing)
Chemical or mechanical processes carried out after a web has been formed and bonded to enhance functional or aesthetic properties. Examples are embossing, crêping, softening, printing and dyeing. The term also includes slitting to narrower widths and rewinding to desired roll lengths.

Agar plate
Petri dish containing sterile agar nutrient medium. WSP 302.0.R4 (12)

Agglomeration
A cluster of particles or fibers.

Aging
Process in which products are exposed to environmental conditions, that simulate real use or accelerated use, for the purpose of determining their effect on the functional and aesthetic properties of the products.

Air filter
A device for removing contaminants from an air stream.

Air forming
See Air laid.

Air laid nonwoven
Forming a web by dispersing fibers into an air stream and condensing them from the air stream on to a moving screen by means of pressure or a vacuum

Air laid pulp
An air laid nonwoven that is produced with fluff, wood pulp. The web can be bonded with resin and/or thermal plastic resins dispersed within the pulp.

Air laid web
A web of fibers produced by the air laid process.

Air laying, Air laid process
A nonwoven web forming process that disperses fibers into a fast moving air stream and condenses them onto a moving screen by means of pressure or vacuum.

Air permeability
The rate at which air flows through a fabric. WSP 070.1.R3 (12).

Aliquot
The exact portion of a larger volume of liquid to be used for testing. WSP 160.2.R4 (12), 404.0.R1 (12).

Amorphous
Not crystalline. A random, rather than regular, arrangement of chains of molecules within regions of a polymer or fiber.

Anaerobic Process (Flushability)
A biochemical process which occurs in the absence of dissolved oxygen.

Anionic compound
A chemical carrying a negative electrical charge.

Anisotropic
Not having the same physical properties in every direction. In the plane of a fabric, it is related to a non-random distribution of fibers.

Anti-felting agents
Products that minimize matting of textile materials.

Antifoaming agent
An additive that minimizes the formation of bubbles within or on the surface of a liquid by reducing the surface forces that support the bubble's structure. See Surface Tension.

Antioxidant
An additive that retards the deterioration of a material's functional and aesthetic properties resulting from its reaction with the oxygen in air.

Anti-soiling properties
The ability of a textile to resist the deposition of dirt, making it easy to remove the dirt. Anti-staining is a similar ability for oil or water bound stains.

Anti-stat
An additive that reduces the accumulation or assists the dissipation of electrical charges that arise during the processing of fibers, fabrics and films, and during the use of products.

Arachne machine
A machine that stitchbonds a nonwoven using a knitting stitch.

Aramid fiber
A synthetic fiber made from a long chain of synthetic polyamide molecules. There are two main fiber types: polyamide 6, usually marketed under the Perlon name and polyamide 6.6 (often referred to as 66) referred to as Nylon. Other types of polyamide fibers have developed, but volumes are low. The numbers indicate how many carbon atoms are in each basic molecule of which the polyamide is made. Aramids were the first synthetic fibers developed: polyamide 6 in Germany and polyamide 6.6 in the United States. The main physical properties of aramid fibers are high strength, abrasion resistance, good elasticity and resistance to many solvents.

ASHRAE
The acronym for American Society of Heating, Refrigeration and Air Conditioning Engineers. Most air and liquid filter manufacturers in the United States use the ASHRAE test methods. Filter producers and consumers in many countries around the world follow the ASHRAE procedures.

Asphalt overlay
A type of geotextile fabric used in the resurfacing of older roads. In the process, the old layer of road has a layer of tar sprayed on the surface and then the nonwoven asphalt overlay is put on top of the surface while it is still tacky. Subsequently, a new asphalt surface is layered on top. The nonwoven's purpose is to prevent water from seeping from below the surface to degrade the surface and to spread the load of cars and trucks to a wider area.

ASTM
The acronym for American Society for Testing and Materials International.

Automated mason jar end point detector
Is an apparatus with an electronic sensing unit with (5) timers capable of automatically detecting any saline solution penetrating through any 1 of 5 specimens by the use of metal grids. WSP 080.5.R4 (12).

Bb

BLC
See Barrier Leg Cuff.

Back coating
An adhesive type substance applied to the back side of a fabric for the purpose of locking pile yarn into a carpet backing, or bonding a secondary backing to the primary backing, increasing fabric body or stiffness, or imparting flame retardancy to the fabric.

Background
The number of particles present in the test system which did not originate from the specimen being tested. WSP 160.2.R4 (12)

Backing
A web or other material that supports and reinforces the back of a product such as carpeting or wallpaper.

Back sheet
The exterior surface of a baby or adult diaper – generally made of film. The current trend is to improve absorbent products' aesthetics by adding a nonwoven material to cover the film, giving the outside of the product a cloth-like hand.

Bacterial filtration efficiency (BFE)
The filtration efficiency of a filter medium is dependent upon the size of the challenge particles, the flow rate of the air stream passing through the filter, and the surface properties of the particles (e.g. either moist or dry). WSP 300.0.R4 (12)
Other terms related to BFE can be found in WSP 301.0.R4 (12); WSP 302.0.R4 (12)

Bacteriostat
Chemical additive that limits or prevents the growth of bacteria.

Bag (bag of nonwoven)
The bag has the dimensions of (60 x 40) mm^2 to (60 x 85) mm^2 and made of non-apertured heat-sealable nonwoven. WSP 240.2.R3 (12); WSP 241.2.R3 (12)

Bale
A compressed and bound package of fiber – the common shipping package for fibers.

Bale breaker
Opening equipment used to break open compressed bales of fiber into separated fiber clumps in preparation for carding.

Barrier leg cuff
The raised cuff, which is generally a hydrophobic cover stock, used in baby or adult diapers and designed to contain body waste in the core area.

Basis weight
The weight of a unit area of fabric. Examples are ounces per square yard and grams per square meter.

Batt
A collection of fibers assembled into a sheet suitable for needlepunching bonding by some method. The term is synonymous with web.

Batting
A soft, bulky assembly of fibers usually used for filling, formed by carding, garnetting, air laying or other means. Layered carded webs are sometimes called a batt. WSP 120.4.R4 (12); WSP 120.5.(R4 (12); WSP 150.1.R4 (12); WSP 150.2.R4 (12).

Batting integrity
The ability of a textile filling material to resist distortion or change when subjected to multiple home launderings or drycleanings. WSP 150.2.R4 (12).

Beam
In the context of the spunlaid technology, the term refers to the large beam that contains the fiber spinning dies. In textiles, the term refers to a large spool containing many separate fibers wound parallel to one another for use in warp knitting or weaving.

Beater
The machine that does most of the fiber separation and cleaning in the processes of picking and opening that occur before the fiber is made into a web.

Bending length
A measure of the interaction between fabric weight and fabric stiffness as shown by the way in which a fabric bends under its own weight. Bending length reflects the stiffness of a fabric when bent in one plane under the force of gravity and is one component of drape. WSP 90.1.R4 (12); WSP 90.5.R4 (12).

Bias
Is a constant or systemic error that is always present in test results. WSP 002.0.R3 (12).

Bicomponent (bico) fibers
Fibers made of two different polymers extruded into one filament (core within a sheath or side by side are examples). One type of bicomponent fiber is produced using two polymers so chosen that one component softens at a lower temperature to act as a binder while the other component maintains the web's structural integrity. A second type of bicomponent fiber is splittable and with some form of mechanical energy applied, such as the hydroentangled technology, will separate into finer denier fibers.

Binder
An adhesive substance used to bind a web of fibers together or bond one web to another. The adhesive can be in a solid form (powder, film or fiber), foam, or in liquid form (emulsion, dispersion, solution) to bond the constituent elements or enhance their adhesion.

Binder content
The weight of adhesive used to bond the fibers of a web together – usually expressed in dry weight as percent of the fabric weight.

Binder fiber
Fibers with lower melting points than other fibers with a higher softening point or non-melting fibers. Upon the application of heat and pressure, these fibers soften and adhere to other fibers in the

web, thereby acting as a binder. Some binder fibers can be bicomponent. A solvent (e.g. water) can activate some binder fibers, which may not be thermoplastic.

Biodegradable
The ability of a substance to be broken down by bacteria.
Biodegradation (Flushability)
The chemical breakdown of materials by living organisms in the environment. The process depends on naturally occurring microorganisms, such as bacteria and fungi, which break down molecules for growth. For a material to be considered completely biodegradable the parent material must disappear, substantial production of carbon dioxide (aerobic conditions) or methane (anaerobic conditions) must occur and there must be an absence of persistent metabolites (substances produced by biological processes).

Biologically-Mediated Disintegration (Biodisintegration) (Flushability)
The biological breakdown of a product into smaller (but not molecular) pieces. Disintegration is assessed by the weight loss of a product on various sieve sizes under specific environmental conditions.

Bleaching
Chemical treatment with compounds that release chlorine or oxygen to increase the whiteness of fibers and fabrics.

Blend
A combination of two or more fiber types in making yarn or fabrics.

Boardy
The quality of stiffness in describing the hand of a fabric.

Bonding patterns
With most nonwoven materials the bonding patterns have two sides: The **face side** is the side that has the heated pattern roll applied with pressure. The **anvil side** is the side that rolls over a smooth steel roll while pressure is being applied. WSP 090.1.R4 (12).

Bonding
The process of combining a fibrous web into a nonwoven fabric by means of resins (e.g. adhesives or solvent) or physical (e.g. mechanical entanglement or thermal adherence). The bonding may be all over or restricted to predetermined, discrete sites.

Bond strength
Amount of force needed to separate layers in a laminated structure or to break the fiber-to-fiber bonds in a nonwoven.

Breaking force
The maximum force applied to a material carried to rupture. (Compare breaking point, breaking strength. Syn. force-at-break). Materials that are brittle usually rupture at the maximum force. Materials that are ductile usually experience a maximum force before rupturing. WSP 110.1.R4 (12); WSP 110.4.R4 (12).

Breaking length
The length of a strip of fabric or film whose weight is equal to the force needed to break it. It is calculated by dividing the force needed to break by the basis weight.

Brightness
As applied to white and near white nonwovens, has come to be associated with the numerical value of their reflectance to light in the blue and violet portions of the spectrum. WSP 060.2.R3 (12).

Bristles
Fibers with thickness greater than about 100 microns (500 mils).

Brownian movement
The random movement of small particles or aerosols suspended in a fluid caused by molecular bombardment and fluctuations about the particle.

Brushing
A finishing process where a system of spinning brushes with wire bristles lightly touch a fabric and raise a light nap. This brushing process is more commonly used to finish woven and knitted materials.

Bulking
Processes that develop greater fullness, volume and crimp in yarns and fabrics.

Burning rate
The speed at which a fabric burns. This can be expressed as the amount of fabric affected per unit time, in terms of distance or area traveled by flame, afterglow or char.

Bursting distension
(distension at burst) Expansion of a test specimen at the bursting pressure. It is expressed either as height at burst or as volume at burst. WSP 030.1.R3 (12); WSP 030.2.R3 (12).

Bursting pressure
(pressure at burst): Maximum pressure applied to a test specimen clamped over an underlying diaphragm until the test specimen ruptures. WSP 030.1.R3 (12); WSP 030.2.R3 (12).

Bursting strength
(strength at burst): (a) Pressure obtained by subtracting the diaphragm pressure from the mean bursting pressure. WSP 030.1.R3 (12); WSP 030.2.R3 (12). (b) The force needed to rupture a material by distending it with force or pressure WSP 030.1.R3 (12); WSP 030.2.R3 (12); WSP 110.5.R4 (12).

Cc

Calender
A machine used to bond sheets of fabric or film to each other or to create surface features on these sheets. It consists essentially of two or more heavy cylinders that impart heat and/or pressure to the sheets that are passed between them. The rollers can be mirror-smooth, embossed with a pattern or porous.

Calender bonding
Thermally bonding a web of loose fibers by passing them through the nip of a pair of calender rollers, of which one or both are heated. Plain or patterned rollers may be used. (see Point Bonding)

Calendering
A mechanical finishing process used to laminate and to produce special surface features such as high luster, glazing and embossed patterns.

Capacity
In terms of production, it is the maximum production output a machine is designed to deliver.

Card
A machine designed to separate fibers from impurities, align and deliver them to be laid down as a web or to be further separated and fed to an air laid process. The fibers in the web are aligned with each other predominantly in the machine direction. The machine consists of a series of rolls and drums that are covered with many projecting wires or metal teeth.

Card clothing
The wire teeth or serrated flutes that cover the working surfaces of a card.

Carded nonwoven
A nonwoven produced from a carded web that has been bonded by one or more technologies to provide fabric integrity.

Carded web
A web of fibers produced by carding.

Carding
A process for making fibrous webs in which the fibers are aligned either parallel or randomly in the direction that the carding machine produces the web (see Machine direction).

Carpet
All textile floor coverings that are not designated as rugs.

Carpet backing
Support sheet on the back of a carpet through which the tufts are inserted or adhered. Primary backing is the principal material that holds the tufts. Secondary backing is occasionally applied on the underside of some carpeting to lock in the tufts and improve abrasion resistance, dimensional stability and strength.

Carpet underlay
A separate fabric that provides cushioning for the carpet.

Carrier material, bacterial
Material used to prepare the donor. WSP 302.0.R4 (12)

Carrier web
A fabric which supports and facilitates moving a fibrous material through a processing stage.

Cartridge filter
A disposable filter media which is generally long and cylindrical which is placed in a sealed filtration receptacle. The contaminated fluid flows from the outer edge of the filter to the inner hollow core on exiting but leaves its particles in the cartridge media.

Catalyst
A chemical that changes the rate of a chemical reaction, usually to speed it up, and is not consumed.

Cationic
A chemical carrying a positive electrical charge.

Cellulose acetate fibers
See Acetate Fibers.

Cellulosic fibers
Made from plants that produce fibrous products based on polymers of the cellulose molecule. Cotton plants produce separate cellulose fibers. Wood pulp is made by mechanically and chemically separating wood fibers. Rayon is made by dissolving vegetable matter, generally wood pulp, in a solution and extruding the solution through spinnerets into a chemical bath that regenerates the filaments. Some other cellulosic fibers are flax, jute and ramie.

CEN
Acronym for the Comitée Européen de Normalisation or the European Committee for Standardization. The committee is charged with the responsibility to standardize the testing procedures of various European member nations.

Centrifugal Liquid Retention Capacity (CLRC)
The amount of liquid an absorptive hygiene product can retain after being subjected to a known centrifugal force at a specified speed and time.

Centrifugal Spin Weight (CSW)
Also known as spun wet weight, is the recorded weight of an absorptive hygiene product after being subjected to a known centrifugal force.

Champion or advocate
An individual to support creation of a new incoming method. The test standardization committee may select this person, or let the company representative who brought the method to the committee organize the interlaboratory study. It is the responsibility of this person to send out protocols and samples. Follow-up if needed with phone calls and to submit all completed WSP 002.0.R3 (12) testing information to the INDA office for statistical valuation. WSP 002.0.R3 (12)

Char
The flame affected part of a fabric after it has been burned.

Chemical bonding
A common method of web bonding by using chemical agents, which may include adhesive resins and solvents. Most common is resin bonding. Latex resins (adhesive) are applied to the web by a variety of methods: dipping the web into the latex and removing the excess, spraying, foaming or

printing bonding. The resin is usually in a water-based solution, so this bonding process requires heat to remove the water to dry and set the binder into the fabric. This is sometimes referred to as “latex bonding.” WSP 150.1.R4 (12); WSP 150.2.R4 (12)

Chemical finishing
Processes that apply additives to change the aesthetic and functional properties of a material. Examples are the application of antioxidants, flame retardants, wetting agents, and stain and water repellents.

Chemical properties
The response of a fiber to chemical environments such as acids, bases, or solvents.

Chips
Feed stock in the form of pellets or granules. Examples are polymers used in fiber or spunlaid production, wood pulp used in rayon production and wood chips used to make pulp.

Chlorine retention
The tendency of fabrics to retain chlorine after bleaching.

Civil engineering fabrics
See Geotextile.

Clarifier (Flushability)
A process at a wastewater treatment plant for separating suspended solids from the wastewater via settling and consolidation.

Clean room
An enclosed space or room with a ventilating system that cleans the air and reduces the concentration and size of airborne particles to certain levels. WSP 160.1.R4 (12); WSP 160.2.R4 (12)

Clothing
When used to describe a card or garnett machine, the term refers to the sawtooth wire covering that “clothes” the cylinders and combs the fibers.

Cloudy web
An uneven or irregular web that gives a cloud-like appearance.

Clump
A knot of fibers in a web resulting from improper separation of the fibers.

Coagulation
The precipitation of particles from their suspension in a liquid.

Coalescence
In a liquid-liquid dispersion, it is the joining together (or coalescing) of liquid particles to form larger drops.

Coform
The formation of a nonwoven web through the concurrent use of elements from at least two different web formation technologies.

Coating
Application of a liquid material to one or both surfaces of a fabric, which is followed by drying or curing.

Cohesion
The resistance of like materials to be separated from one another. Examples are: The tendency of fibers to adhere to each other during processing, the resistance of a web to being pulled apart, and the resistance of a component of a laminate to being torn apart when the adhesive interface in the laminate is being stressed.

Coir
Fiber derived from the outer husks of the coconut.

Colorfastness
The ability of a textile material to retain its color when exposed to conditions (washing, dry-cleaning, sunlight, etc.) that can remove or destroy color.

Combing
In carding, the part of the process that removes neps and aligns the fibers.

Comfort
The sense of well-being in wearing clothing that comes from characteristics such as hand, breathability, softness, light weight and warmth.

Commissioning
Term refers to the period of time during which a new production line goes through the various stages to bring it into commercial production. Some complicated technologies can take several weeks: checking electronics, hydraulics, metering systems, balancing drive systems, adding fiber or resins, etc.

Comminutor (Flushability)
Also known as a grinder or macerator that is used to reduce the particle size of wastewater solids prior to primary treatment.

Composite material
Combination of two or more distinct materials having a recognizable interface between them.

Complex nonwoven
Term limited to the association of two or more webs or nonwoven fabrics by means of binding, i.e. latex bonding, hydro-entangling, needle punching, thermo bonding or stitch bonding

Composite nonwoven
Term used when the essential part of the composite can be identified as a nonwoven material. If the essential part cannot be identified, the term composite nonwoven is used when the mass of the nonwoven content is greater than the mass of any other component material.

Compression
The act of compressing or the state of being compressed. WSP 120.3.R4 (12); WSP 120.4.R4 (12); WSP 120.5.R4 (12)

Condensation
Liquid or droplets that form when a gas or vapor is cooled below its dew point.

Conditioning
A process of allowing testing materials to reach equilibrium with the moisture and temperature of the surrounding atmosphere. The atmosphere may be a standard such as 65 percent relative humidity and 70°F or 50 percent relative humidity and 52°F, for testing purposes.

Conservative Criteria (Flushability)
Term used in this document to describe a cautious level for passing the Tier 1 tests which take place in the laboratory. These criteria have been set high to take into account the uncertainty associated with extrapolating from laboratory measurement to field suggestions.

Constant-rate-of-extension (CRE) Tensile testing machine
A testing machine in which the rate of increase of specimen length is uniform with time. WSP 110.1.R4 (12); WSP 110.4.R4 (12)

Constant-rate-of-load (CRL) tensile testing machine
A testing machine in which the rate of increase of the load being applied to the specimen is uniform with time after the first 3 seconds. WSP 110.1.R4 (12); WSP 110.4.R4 (12); WSP 110.5.R4 (12)

Constant-rate-of-traverse (CRT) tensile testing machine
A testing machine in which the pulling clamp moves at a uniform rate and the load is applied through the other clamp which moves appreciably to actuate a weighing mechanism, so that the rate of increase of load or elongation is dependent upon the extension characteristics of the specimen. WSP 110.1.R4 (12) ; WSP 110.4.R4 (12)

Contaminant
Any solid, liquid or gas which can adversely affect machinery, a system or person.

Continuous filament
See Filament Fibers.

Contrast ratio, C_o. (Opacity)
100 times the ratio of the diffuse reflectance, Rb, to the diffuse reflectance, Rw. (C_o.89 = 100 Rfb/Rw). These reflectances are absolute; the absolute diffuse reflectance for magnesium oxide being very nearly 0.98. Accordingly, the contrast ratio is 100% for perfectly opaque nonwovens, and is only a few percentage points from a perfectly transparent sheet. WSP 060.1.R3 (12)

Converter
An organization that takes nonwoven fabrics supplied in rolls and provides an intermediate processing step, such as slitting, dyeing, coating, chemical finishes and/or printing. The fabric is then shipped to the finished products manufacturer.

Corona charge
An electrostatic charge applied to some filter media to increase the initial filtration properties of the filter. (see Electret)

Cover
The degree to which a fabric hides an underlying structure.

Covering material
Material used for covering the patient, equipment and certain surfaces, i.e. surgical drapes, to prevent the skin bacteria from the patient and/or bacteria from other non-sterile surfaces from reaching the operation wound (prEN 13795-1). WSP 302.0.R4 (12)

Cover stock
A lightweight nonwoven material used to contain and conceal an underlying core material. Examples are facing materials that cover the absorbent cores of diapers, sanitary napkins and adult incontinence products. The term cover stock now refers generally to facing material (top sheet), barrier leg cuff, back sheet, acquisition/transfer layer and stretchy panels.

Creep
The increase in strain exhibited by a material when held at constant stress.

Crepe
A quality in a fabric imparted by wrinkling or embossing to give crimped surface and greater fabric bulk.

Crimp
The waviness of a fiber. Crimp amplitude is the height of the wave with reference to straight uncrimped fiber. Crimp frequency or level is the number of crimps per inch or centimeter. Crimp energy is the work needed to straighten out a crimped fiber. Crimp percent is the length difference between the crimped and stretched out fiber expressed as a percent.

Crimp retention/stability
The ability of a fiber to maintain its crimp.

Cross direction stiffness
The stiffness of a specimen, clamped with the cross direction of the nonwoven fabric perpendicular to the specimen clamp. WSP 090.2.R4 (12)

Cross laid nonwoven
A cross laid web that has been bonded by one or more techniques to provide fabric integrity.

Cross laid web
A web of fibers formed by cross laying process.

Cross lapping
Process of layering a carded web on a conveyor, moving at right angles so the fibers are oriented in the cross direction increasing the cross directional strength of the fabric and the web weight.

Cross laying
Forming a multi-layered web on a conveyor belt by laying the web in a to and fro pattern at right angles to the direction in which the conveyor belt travels. The orientation of the fibers is dependent on the speed of the web delivery and the speed of the conveyor belt.

Cross-linking
The chemical reactions that create bonds at several points between polymers. These cause the polymers to be less soluble and to undergo changes in elasticity and stiffness.

Cross machine direction (CD)
The width dimension, within the plane of the fabric that is perpendicular to the direction in which the fabric is being produced by the machine. WSP 090.1.R4 (12); WSP 100.2.R3 (12)

Cross-section
The outline profile of a cut end of a fiber when it is cut perpendicular to its long axis. These profiles can be round, oval, irregular or complex regular shapes – depending on the shape of the die used to extrude the synthetic fiber, or for a natural fiber, depending on its growth pattern.

Crystalline
Orderly arrangement of molecules and polymer chains in a fiber or plastic.

CSR
The central supply room of a hospital from which supply items are distributed.

CSR wrap
The covering material wrapped around surgical instrument trays to maintain a bacterial barrier in the hospital's supply room storage area after sterilization.

Curing
A process by which resins, binders or plastics are set into or onto fabrics, usually by heating, to cause them to stay in place. The setting may occur by removing solvent or by cross-linking so as to make them insoluble.

Cut strip test
In nonwovens, a strip test in which the specimen is cut to the specified testing width, i.e. 25 or 50mm wide. WSP 110.4.R4 (12)

Cylinder loading
The situation that occurs when fibers are imbedded so deeply in the wire clothing on a card cylinder that they resist transfer to the doffer cylinder according to the normal fiber path through the card.

Dd

Decay time
The time in seconds for the induced charge to dissipate to 10% of its original level. WSP 040.2.R3 (12)

Decitex (Dtex)
Weight in grams of 10,000 meters of a fiber. It is one-tenth of a tex (see Tex).

Defiberize (defibrate)
A process used to reduce fiber aggregates, such as wood pulp, into individual fibers. This is done by using hammermills or lickerins.

Defoaming agents
(see Antifoaming agents)

Degradation
Deterioration of aesthetic and functional properties of a product – usually after being exposed for some time to heat, cold, light, or use.

Degradation (Flushability)
The breakdown of a product into a simpler molecular structure or form by biological, chemical or physical means.

Degree of polymerization
The average number of molecules (see Monomers) in a polymer.

Dehumidify
To remove water vapor from an airstream or from air in a space.

Delamination
Tendency of a fabric to be pulled apart (layer separation) by normal surface forces or shear tensions.

Delustrant
An additive that is used to dull the luster and to increase the opacity of a fiber or a fabric. The degree of delustering is termed semi-dull, dull and extra dull, depending on the amount of pigment added.

Demand absorbency capacity (DAC)
Maximum absorbed mass of liquid (A_f) divided by the mass of the test piece (m), expressed in g/g. WSP 010.3.R3 (12)

Density, (apparent)
Mass of unit volume of the powder after free fall. Apparent density is expressed in grams per millilitre. WSP 251.0.R1 (12); WSP 270.2.R3 (12)

Denier
The measure of a weight per unit length of a fiber. Denier is numerically equal to the weight in grams of 9,000 meters of the material. Low numbers indicate fine fiber sizes and high numbers indicate coarse fiber sizes. The tex system is used in countries outside the United States. A tex is numerically equal to the weight in grams of one kilometer of fiber. It can be calculated by dividing the denier by nine.

Depth filter
A filter medium which is thick and captures particles within the media.

Diaphragm pressure
Pressure applied to the diaphragm, with no test specimen present, to distend it to the mean bursting distension of the test specimen. WSP 030.1.R3 (12); WSP 030.2.R3 (12)

Diatomaceous earth
A filter media made from diatoms, which are fossils that collected at the bottom of sea beds in prehistoric seas. Also known as “kieselguhr,” the material is characterized by pores and cavities capable of capturing and retaining contaminants.

Digested Sludge (Flushability)
Settled wastewater solids that have been degraded and stabilized under either aerobic or anaerobic conditions. Also known as biosolids.

Diffusion
The movement of molecules or ions through a solution or material in response to differential concentrations or repulsive or attractive forces.

Dimensional stability
The ability of a fabric to maintain or resume its original geometric configuration.

DIN
Deutches Institut fur Normung or The German Institute for Standardization, which establishes standards for classifying and testing filters.

Dipping
Immersion of a textile in a finishing liquid (dip) such as dye or binder softener to improve its adhesion or water repellent properties.

Disintegration (Flushability)
The breakdown of a product into smaller (but not molecular) pieces by physical, chemical or biological means. Disintegration is assessed by the weight loss of a product on various sieve sizes under specific environmental conditions.

Dispersability (Flushability)
The ability of a product to readily break apart due to physical forces.

Dispersion
A distribution of small particles in a medium. It also describes the uniform suspension of fibers in water for wet forming.

Disposables
A general classification of end-markets where the product made from the nonwoven has a relatively short life. Examples of some of the major categories are cover stock for baby diapers and sanitary napkins, wipes, fabric softener, medical apparel and associated items and filters.

Distortion — In nonwoven battings, defects such as holes, lumps, or thin areas caused by movement of fibers. WSP 150.2.R4 (12)

Doff
(a) (verb) The term used for removing a finished fabric from the machine: Doff the roll, or doffing the roll. (b) (noun) In some regions, the term also refers to the roll of finished material removed from the machine.

Doffer
The last cylinder of a card that takes the web of fibers that has been formed and removes it by a combing process (doffer comb) or rolls.

Doffer comb
An oscillating comb that is positioned close to the doffer roll to strip the traveling web away from the card.

Doffer loading
Refers to fibers firmly fixed or plugging the doffer roller's wire preventing the doffer comb from removing the web.

Donor
Material that has been contaminated with a known number of viable cells of a defined strain of Staphylococcus aureus. WSP 302.0.R4 (12)

DOP
Dioctylphthalate (diethyhexyphospate) is a viscous liquid that is heated into an aerosol in the critical particle range to challenge a filter. The aerosol's presence upstream of the filter and downstream are measured to determine the media's efficiency. DOP is used to measure HEPA and ULPA media performance.

Double-stroke
As it pertains to this testing apparatus (flexing and abrasion test). The abrasion cycle with this instrument consists of one forward and one backward motion. WSP 020.2.R3 (12)

Drainline (Flushability)
The pipe system that transports wastewater from the toilet, through the building to the onsite wastewater treatment system or to the municipal sewer collection system.

Drape
The ability of a fabric to fold on itself and to conform to the shape of the article it covers. WSP 090.4.R4 (12)

Draw-through
An air circulating fan located downstream of the heating or cooling coils, humidifiers and filters in an HVAC system.

Drawing
A process of stretching a filament after it has been formed so as to reduce its diameter. The ratio of the final length to the initial length is called the draw ratio. Controlled stretching of the filament by a factor of 4 to 10 causes the molecular chains to become aligned (oriented) along the fiber axis and makes the filament stronger.

Dry spinning
The process in which a liquid polymer solution is passed through spinnerets into a heated air stream that drives off the solvent and coagulates the polymer into fibers. Sometimes referred to as Solvent Spinning.

Dry forming or dry laying
A process for forming a web from dry fibers by using carding equipment. Air laying refers to the formation of random webs with a stream of air.

Dry laid nonwoven
Dry laid web of fibers that has been bonded by one or more bonding techniques to produce a fabric with integrity.

Dry laid web
A web of fibers produced by the dry laying process.

Dry scrubbing
The process of removing heavy concentrations of gaseous contaminants from an airstream by the use of some specially designed adsorbers or chemisorbers.

Drying cylinders
Drying cylinders are used by the resin bonded process. The wetted, loose web is passed over the heated revolving cylinders to drive off the water leaving the cured resin that bonds the web.

Dumbbells
Defects common to wet-formed nonwovens, in which a “long” fiber entangles clumps of “regular” fibers. Typically, clumps are found at each end of the “long” fiber, giving it the appearance of a dumbbell.

Durables
A general classification of end-markets for nonwoven materials. The main characteristic of these markets is that the end products have a long life and are more or less permanent. The larger of these markets includes apparel interlining, automotive, home furnishings and bedding construction materials, carpeting, geotextiles and roofing material markets. See also Long-life nonwovens.

Ee

Efficiency
The ability of a filter device or media to remove particulate of a certain size from a liquid or gaseous fluid by measuring the concentration of the particles upstream and downstream of the device or media.

Ejector Pump (Flushability)
Equipment used to lift wastewater when gravity flow cannot be maintained. In a residential setting these pumps are usually found in basements. Ejector pumps are typically submersible centrifuge type pumps with an open impeller design that can pass solids less than 5 cm in size.

Elasticity
The property inherent within a material to recover to its original shape after the force deforming the material is removed.

Elastomers
Polymers having qualities of stretch and recovery.

Electret
A microfiber filter media in which the fibers have more or less permanent electrostatic charge to attract and retain airborne dust particles. Electret filters can be reusable or disposable.

Electrical conductivity
A measure of the rate that an electrical charge travels from one point to another in an electric field.

Electrical resistivity
The resistance to the movement of an electrical charge.

Electronic air cleaners
These air cleaners electrostatically charge airborne dust particles as they enter the first stage of the device and then captures them as they pass through the second stage of the filter, carrying the opposite electrical charge.

Electrostatic decay
The ability of a material when grounded to dissipate a charge which has been induced on the surface of the material. WSP 040.2.R3 (12)

Electrostatically laid web
A web produced by an electrostatic process.

Electrostatic web forming or laying
Forming a web of fibers, especially microfibers, by means of an electrostatic field from a polymer solution or emulsion, or from a polymer melt.

Elongation
The deformation in the direction of load caused by a tensile force. Elongation is generally expressed as a ratio of the length of the stretched material as a percentage to the length of the unstretched material. Elongation may be determined by the degree of stretch under a specific load or the point where the stretched material breaks. WSP 110.1.R4 (12); WSP 110.4.R4 (12); WSP 110.5.R4 (12)

Elongation at break
The point at which the last component of the stretched material breaks.

Embossing
A process whereby a pattern is pressed into a film or fabric, usually by passing the material between rolls with little clearance, and where one or both rolls has a raised design. At least one of the rolls is usually heated.

Emulsion
A suspension of finely divided liquid droplets within another liquid (see Dispersion).

Entanglement
A method of forming a fabric by wrapping and knotting fibers in a web about each other, by mechanical means, or by the use of jets of pressurized water, so as to bond the fibers. See Hydroentangling.

Exhaust air
Air removed from a space and not reused.

Extension
The change in length of a material due to stretching. WSP 110.1.R4 (12), WSP 110.4.R4 (12)

Extractables
Sum of the soluble acid and salt groups of monomeric, oligomeric and polymeric carboxylates extracted from the superabsorbent polymer. WSP 270.2.R3 (12)

Extrinsic sorptive capacity
The sorptive capacity of a nonwoven fabric to a specified liquid on a per-unit-area basis under specified conditions. While extrinsic sorptive capacity is expressed in terms of volume per unit area, intrinsic capacity has been used to describe capacity in terms of volume per unit mass. By way of example, if a fabric exhibited an **intrinsic** capacity of 5 mL/g, a one-gram mass of that fabric would hold 5 mL whether it was part of a 50 g/m^2 or a 200 g/m^2 fabric. The **extrinsic** sorptive capacity would, however, be four (4) times higher for the 200 g/m^2 fabric than for the lighter weight material. WSP 160.4.R3 (12)

Extrusion
A process by which a heated polymer is forced through an orifice to form a molten stream that is cooled to form a filament or fiber. A solution of the polymer can also be forced through the orifice into a solvent that causes the fiber to solidify

Extrusion coated laminates
Refers to laminates in which a plastic film has been extruded on a nonwoven substrate. WSP 401.0.R2 (12)

Ff

Fabric
A sheet structure made from fibers, filaments or yarns.

Fabric, knitted
A structure produced by interlooping one or more ends of yarn or comparable material. WSP 110.5.R4 (12)

Fabric, nonwoven
A textile structure produced by bonding or interlocking of fibers, or both. Accomplished by mechanical, chemical, or solvent means and combinations thereof. WSP 110.5.R4 (12)

Fabric stiffness
The resistance of a material to bending. WSP 090.2.R4 (12)

Face area
The area of a media used in air or liquid filters.

Facing
An outer covering of a product that is exposed during use or is placed against the body.

Fan
A device using blades for moving or producing artificial currents of air.

Felt (nonwoven definition)
A sheet of matted fibers, most often wool or fur, bonded together by needlepunch and/or chemical processes and the application of moisture, heat and pressure.

Felt (textile definition)
A woven fabric, generally made of wool, heavily shrunk or “fulled” by a combination of moisture, heat, chemicals and pressure so as to make it almost impossible to distinguish the weave.

Fiber
A unit of matter characterized by a high ratio of length-to-width. Material which can be spun into yarn or made into fabric by interlacing (weaving), interlooping (knitting), or interlocking (bonding). Discontinuous fibers are referred to as “staple fibers” with lengths designated in inches or millimeters. Typical textile fibers have length-to-width ratios in the order of 1000 to 1, are longer than one inch, have diameters greater than 10 microns, and mass-per-unit-length (linear density) values in the order of one gram per thousand meters.

Fiber distribution
In a web, the orientation (random or parallel) of fibers and the uniformity of their arrangement.

Fiber diameter(fiber glass –TAPPI)
The measurement (expressed in hundred-thousandths) of the diameter of individual filaments.

Fiber glass chopped strand mats (TAPPI)
A fiberglass reinforcement consisting of short strands of fiber arranged in a random pattern and held together with a binder. Mat is generally used in rolls consisting of ¾ oz/ft^2 material to 2 oz/ft^2 material.

Fiber glass mats (TAPPI)
Randomly oriented strands of glass fibers formed into a felt and held together with a binder, usually of thinned polyester resin in a powder-like form.

Fiber glass mats / Conditioning (TAPPI)
A process of allowing testing materials to reach equilibrium with the moisture and temperature of the surrounding atmosphere. The atmosphere may be a standard such as 50 ± 3% percent relative humidity and 77 ± 2°F (25 ± 1°C) or any other testing conditions may be employed if agreed upon by both buyer and seller.

Fiber variant
A man-made fiber type derived through the use of additives or modification of the polymer chemistry or fiber surface. Fiber variants exhibit or emphasize specific properties and are intended for focused end-uses or specialized applications. The modification may consist of adding end or side groups to the fiber forming polymer, altering spin finish, changing spinneret geometry, or varying any combination of controllable manufacturing parameters.

Fiberfill
Low density fiber construction, used as filling and cushioning, for products like pillows, apparel and quilts made from synthetic fibers. The most common fiber used for fiberfill purposes is virgin polyester. WSP 150.2.R4 (12)

Fibrillate
The break up of a plastic sheet into a fibrous sheet. The term can also mean breaking fibers into smaller fibers, such as the splitting of a bicomponent fiber.

Fibrillated film
A type of fabric made from a process that embosses a film then stretches it in a controlled manner in the machine and cross direction to break open the film into small holes (fibrillate). The fibrillated film has a structure that resembles a fibrous nonwoven fabric. These materials can be used as cover stock, facings for supporting other nonwovens or as supporting scrims.

Fibrous debris
In nonwovens, fibrous material released from a fabric during actions such as wear in surgical operating theaters, hazardous cleaning operations, etc, under specified conditions. WSP 160.4.R3 (12)

Filament fibers
Filaments are extruded fibers produced from a variety of polymers. Filaments are continuous fibers that are produced by forcing a molten polymer through a spinneret. If cut to a shorter length, say 3.8 cm, the term filament fiber changes to “staple” fiber.

Filament yarn
A yarn made of continuous filaments assembled with or without a twist.

Filler
A nonfibrous additive used in a fiber to increase its weight, replace more expensive polymer or change luster and opacity. It is also non-fibrous materials, such as insoluble clay, gypsum, starch or gum added to a fabric to increase its weight or appearance.

Filter fabric
A cloth used to separate particles from their suspension in air or liquids.

Filter media
Material that makes up the filter element. Media can be made of a variety of materials, woven metal, sand, fiber, ceramics, etc.

Finger
Part of an apparatus for testing resistance to wet bacterial penetration, used to bring donor and covering materials into contact with the surface of an agar plate at one spot. WSP 302.0.R4 (12)

Finish
Substance added to fibers and textiles, in a post-treatment, to change their properties. Examples are lubricants and flame retardants.

Finishing
(see After treatment)

Flame resistance
The property of a material to resist ignition, burn slowly or to self-extinguish after the ignition source is removed.

Flame retardant
A chemical used to impart flame resistance. The chemical can be added at the time the fibers are spun or added to the fabric through a finishing process.

Flammability
The characteristics of a material that describe the relative ease for a fabric to ignite and sustain combustion.

Flammability tests
Procedures used to determine the flame resistance and flame retardant properties of materials.

Flashspinning
A modified spunlaid technology in which a polymer/solvent solution is extruded under conditions that rapid solvent evaporation at the spinneret occurs. The individual filaments are disrupted into a highly fibrillar form and are collected on a moving screen to form a web.

Flashspun nonwoven
Webs of fiber produced by the flashspinning method and bonded together by one or more bonding techniques to provide fabric integrity.

Flashspun web
A web of fibers produced by the flashspinning process.

Flex abrasion
Abrasion of a sheet or fabric resulting from unidirectional flexing and frictional passage over a bar or other wear surface. WSP 020.2.R3 (12)

Flexibility — That property of a material which demonstrates the ability of the fabric to be flexed or bowed repeatedly without undergoing a rupture in the material. WSP 020.2.R3 (12)

Flexural rigidity
The resistance of a fiber to bending: fiber stiffness. WSP 090.1.R4 (12); WSP 090.5.R4 (12)

Flocking
A method of applying a velvet surface to a material by dusting, or electrostatically attracting, short fibers onto an adhesive coated surface. The short fibers are made by grinding or cutting.

Flowability
Time for a mass of powder to pass through a specified funnel. The mass of the powder is expressed in grams. WSP 251.0.R1 (12)

Flowrate
Mass of powder flowing through a specified funnel per unit time. Flowrate is expressed in grams per second. WSP 251.0.R1 (12)

Foam bonding
A method for applying a resin to a loose web to bind the fibers. The resin is turned into a foam which then coats the fibers. An advantage of foam bonding is that little to no water is used in the binder thus requiring less heat energy and time to dry and cure the binder.

Foam machine
A machine used to generate foam. Foam is a means of adding a liquid to a web or fabric. Foamed latex binders are added to unbonded webs. Foamed finishes, such as hydrophilic finishes for cover stock, are applied by this method.

Foam spreader
The devise used to spread the foam evenly across the width of the web.

Fog
An aerosol of fine liquid or semi-solid droplets in a gas

Formed fabric
Another term for nonwoven fabric.

FPM
Feet per minute

Fusing
Melting or bonding together of fibers or fabrics.

Fuzz
Untangled fibers that protrude from a fabric's surface or yarn.

Gg

Garnett
The garnett is a fiber processing machine with a series of sawtooth wires that are much coarser than found in a conventional carding system. The garnett process can reduce textile waste, old clothing and assorted natural fibers to a fibrous feed that can be needlepunched.

Gas
A fluid having extreme molecular mobility and no fixed dimensions. It diffuses and expands rapidly to occupy the space in which it is contained. It is the vapor or gaseous state of a substance.

Geogrid
A grid-like material made from various polymers with generally large openings. The material is used to stabilize soil, control erosion and occasionally used as fencing.

Geotextile
A permeable fabric used in civil engineering construction projects such as paving, dams, embankments and drains for the purpose of soil stabilization, sedimentation control, erosion control, support and drainage.

Glass fibers
Formed by extruding and attenuating molten glass. Glass fiber is brittle, which limits its use to a small number of markets. The fiber has the characteristics of withstanding relatively high temperatures of 280-300°C as well as poor heat conductivity and therefore major markets are heat insulation and high temperature filtration. Its characteristics of resistance to mildew, moisture and many oxidizing agents, solvents, alkalis and acids heightens its importance in those end-uses. The fiber also has good electrical resistance properties.

Glass fibers (TAPPI)
Glass which has been extruded into extremely fine filaments. These filaments vary in diameter, and are measured in microns. Glass filaments are treated with special binders and processed similar to textile fibers. These fibers come in many forms such as roving, woven roving, mat and continuous strands.
An individual filament made by mechanically drawing molten glass. A continuous filament is a glass fiber of great or indefinite length—a staple fiber is a glass fiber of relatively short length (generally less than 17 inches).

Grab strength test
A measure of the “effective strength” of a fabric; i.e., the strength of fibers in a specific width together with the additional strength contributed by adjacent fibers. Typically, grab strength is determined on a four-inch wide strip of fabric, with the tensile load applied at the midpoint of the fabric width through one-inch-wide jaw faces that are used to clamp the fabric. WSP 110.1.R4 (12)

Gravure printing or bonding
In the context of nonwoven web bonding, this refers to a method of bonding a web of fibers using the gravure method of printing. The gravure system uses a solid roller that is engraved with numerous small indentations. In the bonding process, the roller is partially immersed into an adhesive resin solution. As the roller turns, the excess solution is removed by a doctor blade, which leaves only the adhesive binder solution in the roller’s indentations. An unbonded web is then squeezed against the gravure roller (generally by a rubber roller) and the resin penetrates the web by osmosis. The web is then dried to remove the water and the binder remains. (see Resin bonding).

Gray fabric
Same as greige.

Greige fabric
Generally refers to woven or knitted fabrics off the loom prior to bleaching, dyeing or finishing treatment. The term is occasionally used to describe nonwovens before a finishing treatment.

Grid
A ridged conductive plate used to detect the saline solution when it penetrates the test specimen. WSP 080.5.R4 (12)

Grinder Pump (Flushability)
Equipment used primarily for transporting wastewater in low pressure sewer systems through smaller diameter pipes to a central collection system. They may be either centrifugal or positive displacement type pumps. These pumps grind the solids into smaller pieces rather than simply passing the solids.

Gsm
Grams per square meter.

Gsy
Grams per square yard.

Hh

Hammermill
A device used to defiberize cellulose pulp, generally available in roll goods form, to individual fibers (fluff pulp) by using high speed, rotating hammers.

Hand
Qualities of a fabric perceived by touch, e.g., softness, firmness, stretch, resilience and drape.

Heat resistance
The ability to resist degradation at high temperatures. The retention of useful properties when measured during heat exposure.

Heat setting
Process by which fibers, yarns or fabrics are heated to a final crimp or molecular configuration so as to minimize changes in shape during use.

Heat stabilized
The ability of a yarn or fabric to resist shrinking or stretching under mechanical or chemical stress. This property is obtained by prior heat-treatment or by use of a chemical additive.

Height at burst
Distance between the upper surface of the test specimen before distension and the top of the test specimen at the bursting pressure. WSP 030.2.R3 (12)

HEPA filter
The acronym for High Efficiency Particulate Air. These filters are designed for filtering gases, normally air, to an efficiency of 99.97% by trapping particles down to 0.3 microns in the DOP test.

Highloft
General term for low density, thick or bulky fabrics, as compared to flat, paper-like fabrics. It is characterized by a high ratio of thickness to weight per unit area. Highloft battings have no more than 10% solids by volume and are greater than 3 mm (0.13 inch) in thickness. WSP 150.1.R4 (12); WSP 120.3.R4 (12)

Holes
Small perforations or openings of varying sizes in a fabric.

Hollow filament fibers
Manmade, continuous filament fibers, with voids created by introduction of air or other gas in the polymer solution or by melt spinning through specially designed spinnerets.

Homogeneity / homogenous sample
For the purpose of this method, all disposable products designed to absorb body fluids, such as baby diapers, feminine hygiene products or adult incontinence management devices. WSP 404.0.R1 (12).

Hot-melt adhesive
A solid material that melts quickly upon heating, then sets to a firm bond upon cooling. Used for almost instantaneous bonding.

Hot-melt laminates
Refers to laminates in which one layer of hot melt adhesive assures the bonding of two juxtaposed layers. WSP 401.0.R2 (12)

Housewrap
A layer of material used on new building construction to prevent air leakage, thereby reducing heating and air conditioning costs and increasing comfort. It is installed in the exterior walls of a new building construction prior to adding the building's final exterior. Housewrap is designed to be semi-permeable and allows water vapors to migrate through it thereby reducing the possibility of

interior wall damage due to moisture build-up.

HVAC
The acronym applies to Heating, Ventilating and Air Conditioning systems that service air in an enclosed space, i.e., buildings, airplanes, cars, etc.

Hybrid
A nonwoven produced by incorporating the advantages of two or more nonwoven manufacturing systems to produce specialized nonwoven structures with properties unattainable by any single nonwoven process.

Hydroentangling, Hydroentangled
(see Spunlace bonding)

Hydrophilic
Having an affinity for being wetted by water or for absorbing water.

Hydrophobic
Lacking the affinity for being wetted by water or for absorbing water.

Hydroscopic, hygroscopic
The ability to absorb moisture from the atmosphere, a property that fibers have in varying degrees.

Hydrostatic pressure
Measures the resistance of nonwoven fabrics to the penetration of water when one surface of the test specimen is subjected to a hydrostatic pressure, increasing at a constant rate, until three points of leakage appear on the other side. The hydrostatic water pressure is measured as the height reached by the water on your testing device as the third leakage point appears.

Ii

Ignition
The beginning of combustion.

Imbibition
Liquid holding capacity of a fabric.

Impingement
The process in which particles are removed from an airstream because of the inertia. As an air containing particle flows toward a filter fiber or other collecting surface, the particle does not follow the air streamlines because of its inertia. Instead it moves in a straight line, colliding with the filter fiber or surface to which it may become attached.

Industrial fabrics
Textiles for non-apparel and non-decorative uses. Examples are wipers, cable wrappings and geotextiles.

Initial modulus
A material's resistance to small deformations, defined as the slope of the stress-strain curve at the origin and sometimes used to indicate fiber stiffness.

Interfacing (Interlining)
A fabric used in garments, to provide weight, thickness (or body) and stability.

Inertia
Any physical body persisting in its present state of rest or moving in a straight line motion unless acted upon by some external force.

ISO
Acronym for the International Standards Organization based in Switzerland.

Isotropic
A fabric having the same physical properties in every direction in the plane of a fabric. It is related to random distribution of fibers in a fabric.

Jj

J-box
A "J" shaped temporary holding or collecting area used in continuous fabric processing. The fabric from one piece of machinery is fed into the top of the J-box. The fabric fan folds and will be extracted from the bottom of the J to go into the next step of the process.

Jaws
The component of the clamp that grips the test material.

Jute
Soft fibers from the inner barks of certain tropical plants.

Kk

Knitted fabric
A fabric made from yarns or filaments that have rows of loops that interlock with the following row.

Knitting
A method of producing a fabric by interlocking a series of loops of yarns or filaments. There are two basic knitting methods:
(a) Warp knitting – A method of knitting in which the yarns or filaments run in the machine direction. This system uses large spools of yarns or filaments (warps). Three different methods of warp knitting are tricot, raschel and milanese.
(b) Weft knitting – A method of knitting in which one yarn or filament is interlooped with the previous course of loops made by the yarn. Circular knitting is a common method of weft knitting.

Ll

Laminate
A layered composite material containing two or more layers bonded together with an adhesive, foam or thermoplastic resin. WSP 401.0.R2 (12)

Lap
A compressed sheet of fibers in a roll form, weighing about 50 pounds. The fibers are not bonded and are used to supply fibers to a card. Also called picker lap.

Lap splitting
A condition caused by a lap which will not unwind in carding in the same thickness as it was wound in picking. This splitting of the sheet of fiber can result in either a thicker or thinner sheet being fed into the card.

Latex
Either a naturally occurring milky appearing fluid from which rubber is made or a dispersion of a synthetic polymer in water. Typically used as binders.

Latex bonding
(see Resin bonding)

Leakage
The moment in time when synthetic urine is observed to flow from the absorbency pad. WSP 354.0.R2 (12)

Lengthwise
The machine direction in which the fabric is produced.

Lickerin
The name for a roller at the beginning of the fiber feed system of a card line. It is a high speed, saw-toothed wire roll that grabs the tufts of fibers fed into the system and deposits the partially opened fibers onto the main card cylinder.

Lickerin loading
A condition that can occur with the lickerin where fiber can become imbedded in the saw-toothed wire reducing the lickerin's ability to grab fiber and transfer it to the main card.

Limiting oxygen index
Measure of flammability that determines the minimum concentration of oxygen in a gas mix that is required to sustain steady burning.

Lint
Particles and short fibers that fall off a fabric product during the stresses of use.

Linters
Short cotton fibers not removed from the cottonseed after the spinnable fibers are removed on first pass through the gin. Linters are cut from the seed. Linters are used to make cellulose-based chemicals and rayon.

Liquid absorbency time
Time required for a sample of absorbent material to become completely wetted by the test liquid i.e. to imbibe a liquid into its interior structure under specified conditions. WSP 010.1.R3 (12); WSP 010.4.R3 (12)

Liquid absorptive capacity
Mass of liquid that is absorbed by unit mass of the test absorbent expressed as a percentage of the mass of the test absorbent, under specified conditions and after a specified time. 010.1.R3 (12); 010.4.R3 (12)

Liquid wicking rate
Measure of the capillarity of the test material, i.e. the rate at which the liquid is transported into the fabric by capillary action. 010.1.R3 (12); WSP 010.4.R3 (12)

Lissajous figure
A geometric figure that starts as a straight line, then becomes a widening ellipse and narrows to again become a straight line. There are 16 movements in one Lissajous figure. WSP 020.5.R3 (12)

Loft
The properties of bulk and resilience of a fabric or batt.

Long staple
A long fiber. Typically used to describe the length of fibers used in the wet forming process by the paper industry.

Long-life nonwoven
Synonymous with durable nonwoven.

Loss on ignition (TAPPI)
Weight loss, usually expressed as percent of total, after burning off an organic sizing from glass fibers, or an organic resin from a glass fiber laminate.

Lubricant
An oil or other substance added to fibers to improve their processability in carding.

Mm

Macerator Toilets (Flushability)
Integrated sewage ejector pumps within the toilet system that break up and pump toilet waste to a gravity flow sewer pipe. These systems may or may not have chopper blades.

Machine direction (MD)
The long direction within the plane of the fabric that is in the direction in which the fabric is being produced by the machine. WSP 090.1.R4 (12); WSP 100.2.R3 (12)

Machine direction stiffness
The stiffness of a specimen, clamped with the machine direction of the nonwoven fabric perpendicular to the specimen clamp. WSP 090.2.R4 (12)

Man-made fibers
Another term for synthetic fibers.

Mannequin
Moulded in appropriate synthetic material, representing the lower part of the body. It represents a female body, but a male adapter is provided. It is designed to deliver saline solution from a reservoir. WSP 354.0.R2 (12)

Married fibers
A term used to describe bundles of unopened fibers of a carded or spunlaid nonwoven. Married fibers are most noticeable in lightweight fabric.

Matrix
In the context of the nonwoven industry, this manufactured fiber is made from two or more dissimilar polymers combined before or during extrusion. These polymers separate into random components during extrusion. The bicomponent fibers could be used in through-air bonded processes.

Maximum absorbed mass (A_f)
The mass of liquid absorbed (in g) at the time T_r, when the absorbed mass variation in the previous 5 s time period is lower than 1% of the absorbed mass corresponding to T_f. WSP 010.3.R3 (12);

Maximum absorption rate (MAR)
Maximum change in liquid absorbed mass per time interval expressed in grams per second^{-1}. The MAR is calculated over 1 second time period from data recorded with sampling intervals of 0.25 s or less. (The maximum absorption rate is observed at the point of inflexion of the curve-absorbed mass of liquid versus time). WSP 010.3.R3 (12)

Mechanical bonding
Bonding a web of fibers by entangling them. This can be achieved by needling, stitching them with fibers or by entangling them by high-pressure water jets.

Mechanical finishing
Changing the appearance or physical characteristics of a fabric by a mechanical process such as calendering, embossing, bulking, compacting and creping.

Media area
The total surface area of media used in the production of a filter. Net effective: The measure of usable media in a filter.

Medium
Medium is synonymous with filter material. “Media” is the plural of “medium.” It is common today to use media as the singular and “medias” as the plural.

Melt blowing
A nonwoven web forming process that extrudes and draws molten polymer resins with heated, high velocity air to form fine filaments. The filaments are cooled and collected as a web onto a moving screen. In some ways the process is similar to the spunbond process, but melt blown fibers are much finer and generally measured in microns. Melt blowing is a spunlaid process. The term is also spelled “meltblowing.”

Melt blown nonwoven
A melt blown web that has been bonded by one or more techniques to provide fabric integrity.

Melt blown web
A web produced by melt blowing.

Melting point
The temperature at which a solid changes to the liquid state.

Melt spinning
The process of passing a liquid (molten) polymer through spinnerets and coagulating the material into fibers in a cooled air stream. See related processes: Melt Blown, Flashspinning and Spunbond.

Membrane filter
A permeable or semi-permeable membrane made of metal, polymer or other materials. These filters are capable of separating micron and sub-micron size particles from liquids and gases.

Membrane Filtration (Flushability)
Membrane technology is a generic term for a number of different separation processes currently being introduced into waste water treatment plants to create process water from wastewater. The membrane acts as a filter that will let water flow through, while it catches suspended solids and other substances. Membrane filtration can be used as an alternative for final clarification, sand filters and active carbon filters, extraction and distillation.

Menstrual tampon/tampon
A device to be inserted into the vagina to absorb menses. WSP 354.0.R2 (12)

Meter (metre)
An SI linear measurement equal to 39.37 inches. Metre is the preferred spelling in many world regions. Multiply the value by 1.196 to convert square meters to square yards.

Metering pump
A component of the spinning process that measures the volume of molten polymer sent to a spinneret.

Methenamine test
A standard flammability test used to measure flame retardancy of traditional textiles and nonwovens. In a controlled environment, the methenamine tablet is ignited on the test sample and the amount of charring and burn is measured.

Microfiber batting
A nonwoven filling material containing fibers, such as polyester or olefin, that have a diameter of less than [10 µm]. WSP 150.2.R4 (12)

Micron
It is a unit of measure and equivalent to one millionth of a meter. In the context of nonwovens, the micron unit of measure is generally used to describe the width of low denier fibers, such as melt blown filaments. The abbreviated form is µm.

Mil
It is a unit of measure equal to one thousandth of an inch. Commonly used to measure the diameter of fibers and the thickness of films.

Mildew resistance
The degree to which fabrics are unaffected by certain fungi that cause odor and discoloration.

Millibar
A unit of atmospheric pressure equal to 1/1000 bar, or 1 mbar is equal to 1.02 cm of water pressure. WSP 080.6.R4 (12)

Mist
An aggregate of fine droplets of a liquid suspended in the air or a cloud of particles forming a haze.

Modulus
The amount of force it takes to stretch a material a unit distance. It is a measure of elasticity. An extensible material or fiber has a low modulus. Stiff materials have a high modulus.

Moisture content
The amount of moisture in a material expressed as a percentage of the material after drying.

Moisture regain (or Regain)
Percentage of moisture in a fiber or fabric after it is equilibrated in a standard humidity and temperature.

Mold
A variety of fungus growths commonly found on the surface of damp decaying organic matter or in warm moist places. It is characterized by a woolly or furry texture.

Molecule
The smallest part of an element or compound that can exist separately without losing its chemical properties.

Molten
A material in the liquid state or melted.

Monofilament
A single filament of fiber.

Monomer
A chemical compound that can be polymerized.

Morphology
Study of the fine, microscopic structure of a fiber or other materials, e.g., its crystalline and amorphous nature.

Nn

Nap
The soft raised fibers of a textile achieved by brushing the fabric.

Natural fibers
Fibers made directly from animals, vegetables or minerals. Examples are silk, wool, cotton, flax, jute, ramie and asbestos.

Necking
The narrowing of a fabric when stretched.

Needle
In the context of the nonwoven industry, the term refers to the barbed needle used by the needlepunched technology. The needles hook the fibers and perform the interlocking function. There are many variations in needle design, barb placement, barb angle, and barb shape depending upon the fiber and desired product outcome.

Needle beam
The component of the needlepunched technology that supports the needle board. The needle beam oscillates generally in an up and down movement penetrating the needle board into the web.

Needle board
In the needlepunched technology, the needle board is the part of the needle loom to which the barbed needles are anchored. The needle board is fastened to the needle beam.

Needlepunched or Needlepunching
Mechanically binding a web to form a fabric by penetrating the web with an array of barbed needles that carry tufts of the web's own fibers in a vertical direction through the web. WSP 150.1.R4 (12); WSP 150.2.R4 (12)

Neps
Small knots of tangled fibers that were not separated before forming the web.

Nip
The line of close contact between two calender rolls between which a fabric or web passes.

Non-bonded batting
A nonwoven filling material that is neither needle-punched, resin bonded, or thermal bonded. (See also needle-punched batting, resin bonded batting, thermal bonded batting). WSP 150.2.R4 (12)

Nonwoven, INDA definition
A fabric made directly from a web of fibers or continuous filament, without the yarn preparation necessary for weaving and knitting. In a nonwoven, the assembly of textile fibers is held together:
(a) by mechanical interlocking in a random web or mat;
(b) by fusing of the fibers, as in the case of thermoplastic fibers; or
(c) by bonding with a cementing medium such as starch, casein, rubber latex, a cellulose derivative or synthetic resin. Initially, the fibers may be oriented in one direction or may be deposited in a random manner. This web or sheet is then bonded together by one of the methods described above. Fiber lengths can range from 0.25 inch to 6 inches for crimped fibers up to continuous filament in spunbonded fabrics. WSP 030.1.R3 (12); WSP 090.1.R4 (12); WSP 110.1.R4 (12)

Nonwoven, ISO 9092 definition (1988)
A manufactured sheet, web or batt of directionally or randomly orientated fibers, bonded by friction, and/or cohesion and/or adhesion, **excluding paper** (see note) and products which are woven, knitted, tufted, stitch-bonded incorporating binding yarns or filaments, or felted by wet-milling, whether or not additionally needled. The fibers may be of natural or man-made origin. They may be staple or continuous filaments or be formed in situ.

Note: To distinguish wetlaid nonwovens from wetlaid papers, a material shall be regarded as a nonwoven if

1. more than 50% by mass of its fibrous content is made up of fibers (excluding chemically digested vegetable fibers) with a length to diameter ratio greater than 300;or, if the conditions in 1) do not apply, then

2. if the following conditions are fulfilled:

more than 30% by mass of its fibrous content is made up of fibers (excluding chemically digested vegetable fibers) with a length to diameter ratio greater than 300 and its density is less than 0.40 g/cm3. WSP 240.2.R3 (12); WSP 241.2.R3 (12)

Nonwoven, ISO 9092 definition (2011)

Nozzle
A term occasionally used in reference to the spinneret of a spunbond production line or fiber spinning system.

Nylon
(see Aramid)

Oo

Oil repellency
The characteristic of a fiber or nonwoven fabric whereby it resists wetting by oily liquids. WSP 080.7.R3 (12)

Olefin fiber
Any synthetic fiber made from long molecular chains of propylene, ethylene or other olefins. These fibers are used widely by the nonwovens industry in disposable and durable end-uses, which include cover stock, automotive, geotextiles, medical apparel, home furnishings and bedding. See Polypropylene fiber.

Oleophilic
A substance that has an affinity to oil (see Sorbent).

Oleophobic
Opposite to the term Oleophilic. The substance has little to no affinity for oil.

On-stream
(see Start-up)

Opener
(see Bale breaker)

Opening
A preliminary operation whereby staple fiber is separated sufficiently from its lap or baled condition so that it can be fed to the web forming part of the process.

Openness
A term describing how tightly or loosely packed a collection of fibers is in any space.

Optical brightener
A colorless compound that contributes whiteness to fabric. It does this by absorbing the ultraviolet component of light and emitting it as visible light.

Organic
Compound molecules that contain one or more carbon atoms.

Orientation
(1). The lining up or parallelism of molecular chains in fibers and films.
(2). The alignment of fibers in a nonwoven material.

Oshibori
A Japanese term referring to the pre-moistened hand towel (disposable or reusable) generally used before dining.

Overlap
Refers to the area where the web from one pass of a crosslapper lays over the edge of the previous lay.

Ozone
Ozone is a gaseous, unstable form of oxygen that is composed of three atoms rather than two. Ozone is a powerful oxidizing agent and is toxic even at low levels. It is a component of smog.

Pp

Padding
Applying a liquid or paste to a textile by dipping it in a bath or by passing it between squeeze rollers that carry the liquid or paste.

Parallel laying
Forming a web in such a way that the fibers or filaments are laid in directions roughly parallel with the machine direction.

Particle
A minute piece, part or portion of matter. It may be solid, semi-solid or liquid. WSP 160.1.R4 (12); WSP 160.2.R4 (12)

Particle count
The quantity of particles in a given volume of fluid.

Pascal
A metric unit of pressure used in measuring an air filter's performance.

Peak force
A term used in tear testing. It is the force required to break the fiber bonds of a nonwoven or other samples of textile materials.

Penetration
The flow of a liquid through pores, pinholes or holes resulting from imperfections or degradations of a fabric.

Penetration (filtration context)
A measure, in percent, of particles of a given size that pass through a filter. If no particles pass through then 100% were trapped. If 97% of particles are trapped, then penetration is 3% (100% - 97% = 3%) and the filter is 97% efficient. Penetration is used to measure the performance of very high efficiency filters.

Percent run-off
The percent of the original mass of liquid which runs from the test specimen. WSP 080.9.R4 (12)

Permanent press
Treatment for garments that permits them to retain their shape, creases or pleats after laundering.

Permeation
The passage of liquids or gases through materials by absorption and diffusion on a molecular level and exiting as a gas.

Petri dish
Receptacle used to prepare agar plates. WSP 302.0.R4 (12)

Physical Disintegration (Flushability)
The breakdown of a product into smaller (but not molecular) pieces by physical forces. Disintegration is assessed by the weight loss of a product on a variety of sieves under specific environmental conditions.

Physical property
The response of a fiber to physical forces.

Picker
A machine that separates staple fiber and forms it into a lap, so it can be fed to a card.

Pigment
A colored or white substance that is insoluble and finely divided. Used to color or to deluster a fiber, fabric or plastic.

Pilling
The tendency of fibers to come loose from a fabric surface and form balled or matted particles of fiber.

Pinsonic thermal joining
A process which uses ultrasonic energy to bond layers of thermoplastic materials.

Plastic
A polymer with its additives. Also, the ability to be deformed and molded.

Plasticizer
Chemical that imparts flexibility, stretch and workability to a fiber or a plastic.

Plates
Pieces of smooth, thin and light material, preferably 225 x 225 x 6 mm (9 x 9 x 1/4 in.) plywood, used to distribute the mass of the weights over the entire area of the highloft battings. WSP 120.4.R4 (12); WSP 120.5.R4 (12)

Pleating
The process of fan-folding materials to increase surface area. Commonly used for filter media to increase efficiency and reduce pressure drop.

Plies
Layers of web, fabric or components of a laminate.

Preliminary Treatment (Flushability)
Is the removal of large solids, grit and in some cases oils and grease from wastewater in a municipal treatment plant so as to improve the efficiency of downstream wastewater treatment processes.

Primary Treatment (Flushability)
Is the removal of settleable solids in a municipal treatment plant to reduce the treatment load on downstream processes.

Point bonding
Using heat and pressure in a discrete pattern to bind thermoplastic fibers to form a nonwoven fabric.

Polyester fiber
A manufactured fiber in which the fiber-forming substance is any long chain of synthetic polymer composed of at least 85% by weight of an ester of dihydric alcohol and terephthalic acid (FTC definition). The physical properties of polyester fiber are excellent strength, high abrasion and resilience with good chemical resistance to acids, solvents and oxidizing agents. Major end-uses for polyester staple fiber are fiberfill, wipes, and durable nonwovens, such as geotextiles, automotive and carpeting. Spunlaid polyester is found in fabric softener substrate, automotive carpeting, modified bitumen roofing and various durable end-markets.

Polymer
A liquid or solid substance made by chemically linking macromolecules together in chains. High polymer denotes substances made from very long chains. Crosslinked polymer describes a substance in which there are molecular links between chains. Polymerization is the process for making these polymers.

Polymerization
The process of changing the molecular arrangement of a compound so as to form new compounds having the same percentage composition as the original, but of greater molecular weight and different physical properties.

Polymer laid nonwoven
(see Spunlaid)

Polyolefin
A fiber made of long-chain polymerized olefin of at least 85% weight, from such monomers as ethylene, propylene or other olefins.

Polypropylene fiber
A manufactured, olefin fiber made from polymers or copolymers of polypropylene. One attractive physical characteristic of polypropylene is its specific gravity of less than one, which results in a larger area volume yield per kilogram or pound of resin or staple fiber compared to competitive fibers. Polypropylene has a relatively low melt temperature which restricts its uses in many nonwoven markets, but it has good strength properties, softness, and chemical resistance to strong acids and alkalis. Major nonwoven markets for staple and spunlaid polypropylene include cover stock, medical apparel and related, geotextiles, carpeting, blankets, automotive and various other durable markets.

Pounding
A process wherein a batt of fibers is repeatedly struck with a hammer-like device to drive wool fibers into the web resulting in entangling the fibers.

ppm
An abbreviation that refers to “parts per million.” It may be expressed by volume as ppm (v) or by mass as ppm (m).

Precipitation
The action of a solid or liquid separating from a solution because of a chemical or physical process or change that has rendered it insoluble.

Precision
Is the measure of agreement among the test results when using homogeneous specimens. Testing precision can relate to two different situations:
(a) Testing within one laboratory with multiple operators, single laboratory sample, and one piece of equipment on one given day.
(b) Testing in multiple laboratories with single laboratory sample, single operator, one piece of equipment on one given day. WSP 002.0.R3 (12)

Pressure
The force or load per unit area. Pressure may be expressed in any appropriate or specified units, such as Pascals (Pa), Newtons per square meter (N/m^2), or pounds-force per square inch (psi). WSP 120.1.R4 (12)

Pressure drop
The pressure drop is the resistance to a fluid passing through a filter media at various flow rates.

Primary backing —The fabric into which a carpet is tufted.

Print bonding
Applying a latex resin binder to a web of fibers in a discrete pattern. See Screen Bonding and Gravure Bonding as the application methods.

Product Flush (Flushability)
Term used in the test methods to describe the number of toilet flushes to be applied to the product in the test.

Protocol
In this method, this term is used for the directions given to the laboratories for conducting the Interlaboratory Study. WSP 002.0.R3 (12)

Pulp
Short cellulose fibers made from wood or cotton.

Purified water
Water that has been through one of three processes; distillation, reverse osmosis, or deionization. WSP 080.3.R4 (12); WSP 080.6.R (12)

Qq

QA
Acronym for Quality Assurance.

Quality control or assurance
The maintenance of product standards or services through testing and standard procedures.

Quenching
Cooling of filaments after extrusion by carefully controlled airflow.

Rr

Random laying
Forming a web in such a way that the fibers or filaments are laid in essentially random directions. This is accomplished by using an air laid or wet laid process.

Random laid nonwoven
A random laid web bonded by one or more bonding techniques to provide fabric integrity.

Random laid web
A web in which the fibers are laid in essentially random directions.

Rate of Absorbency (ROA)
Time required to fully absorb test fluid into the test product. WSP 070.9.R1 (12)

Rated filter capacity
The specific quantity of fluid that a filter manufacturer recommends can be handled by the filter.

Rayon fiber
A manufactured fiber composed of regenerated cellulose, as well as manufactured fibers composed of regenerated cellulose in which the substitutes have replaced not more than 15% of the hydrogen atoms of the hydroxyl group (FTC definition). Rayon is manufactured from the cellulose found in vegetable matter, the major source being wood pulp and cotton linters. The cellulose is dissolved into a viscose solution and then extruded through a wet-spinning system to coagulate the filaments. The principal physical properties of rayon are moderate strength, softness, luster, hydrophilic and ease of dyeing. The major nonwoven market is wipes.

Rb
The diffuse reflectance of the same specimen backed with black and which has not more than 0.005 reflectance. WSP 060.1.R3 (12)

Reconstituted fibers
Fibers made from recovered waste polymer or blends of virgin and recovered waste polymer.

Recovery
The act of recovering or the state of being or having recovered from compressions. WSP 120.2.R4 (12); WSP 120.3.R4 (12) ; WSP 120.4.R4 (12); 120.5.R4 (12)

Reflectance factor
The term is used to describe the ratio, expressed as a percentage, of the radiation reflected by a body to that reflected by a perfect reflecting diffuser under the same conditions. WSP 060.4.R3 (12)

Relaxation
The decay or relaxation of stress exhibited by a material when held at constant strain.

Removal (Flushability)
A consumer product can be separated from wastewater by screening, settling, and/or degradation processes.

Repeatability $_r$
As determined by the test method is the variability found between the test results of randomly selected homogenous specimens, tested at one laboratory, using one technician, one instrument, and one set of environmental conditions which were found on one given day.

Repellency
The ability to resist wetting and staining by fluids and soils.

Reproducibility $_R$
As determined by this test method is the variability found between the test results of randomly selected homogenous specimens, which were tested at different laboratories, using more than one technician at each laboratory, and tested over a two day period using standard laboratory environmental conditions which were found at each laboratory.

Residual monomers *Amount o*
Is the sum of residual monomeric sodium acrylate and acrylic acid. WSP 210.2.R3 (12)

Resilience
The area under the stress-strain curve from the origin to the yield point.

Resiliency
Ability of a fiber or fabric to spring back when crushed or wrinkled.

Resin
Any of a group of solid or semi-solid materials made by chemical synthesis. The materials are often used in plastics or production of synthetic fibers (see Polymer).

Resin binder
Emulsion polymer used for bonding. WSP 150.1.R4 (12)

Resin bonded batting
A nonwoven filling material that is stabilized by spraying it with an acrylic, polyvinyl acetate, or other suitable resin emulsion after which the batting is dried and cured. WSP 150.2.R4 (12)

Resin bonding
A common method of web bonding by using chemical agents, which may include adhesive resins and solvents. Most common is resin bonding. Latex resins (adhesive) are applied to the web by a variety of methods: dipping the web into the latex and removing the excess, spraying, foaming or printing bonding. The resin is usually in a water-based solution, so this bonding process requires heat to remove the water to dry and set the binder into the fabric. This is sometimes referred to as "latex bonding." WSP 150.1.R4 (12); WSP 150.2.R4 (12)

Resistivity
The ratio of the potential gradient paralleling the current passing through the specimen. This is numerically equivalent to the resistance between opposite faces of a unit cube. It is the reciprocal of conductivity. WSP 040.1.R3 (12)

Resistivity surface
The surface resistance multiplied by that ratio of specimen surface dimensions (width of electrodes defining the current path divided by the distance between electrodes) which transforms the measured resistance to that obtained if the electrodes had formed the opposite sides of a square. Surface resistivity is popularly expressed in ohms, or ohms/square (the size of the square is immaterial). Surface resistivity is the reciprocal of surface conductivity. WSP 040.1.R3 (12)

Respirable particle
A particle having a size smaller than 10 µm. WSP 405.0.R1 (12)

Reworked fibers
Fibers that are sourced from several areas and recycled into needlepunched materials often destined for padding or insulation. This material is often referred to as "shoddy."

Rewet
Amount of wetness returned to the surface WSP 070.9.R1 (12)

Roll goods
Fabric rolled up on a core after it has been produced. It is described in terms of fabric weight and the width and length of the material on the roll.

Ruggedness test
Testing the validity of a proposed new test method standard by deliberately changing the testing conditions (i.e. machines, technicians, sample size, etc.). This testing is similar to that of an interlaboratory study but with only one or two laboratories participating. This testing is done to evaluate the effects of variations. However, these variations must be recorded. WSP 002.0.R3 (12)

Run-off
The amount of excess liquid in grams that runs from the test specimen. WSP 080.9.R4 (12)

Rw
The diffuse reflectance of the same specimen backed with a white body having an absolute reflectance of 0.89. WSP 060.1.R3 (12)

Ss

Saline solution
Distilled water containing reagent grade sodium chloride. For this application, it consists of 0.9% saline solution. WSP 080.5.R4 (12)

Salt group
Alkali metal salt of carboxylic acid group, also referred to as neutralized carboxylate. WSP 270.2.R3 (12)

Sample
A portion of nonwoven taken from a production lot, roll, case or cases of product for testing. The sampling unit shall be identifiable and traceable back to its original source. WSP 080.10.R3 (12); WSP 160.1.R4 (12); WSP 160.2.R4 (12)

Saturation bonding
A web bonding technique that saturates a web with an adhesive binder followed by drying and curing.

Screen printing or bonding
In the context of nonwovens, this usually refers to a method of resin bonding a web of fibers. A cylindrical screen containing a latex resin binder is rolled and pressed against a moving web of fibers. As the cylinder rotates against the web, adhesive binder is squeezed into the web. The binder is then dried by heat thereby bonding the web. See Resin Bonding for further information. An advantage of screen bonding (sometimes referred to as latex printing) is that the amount of binder squeezed onto the web can be controlled by the pattern and hole sizes in the screen. Color pigments can be added to the binder and this bonding method is often used to print end products, such as colored wipes.

Screening (Flushability)
The passing of raw wastewater through bar screens, rotating screens or perforated screens to remove larger materials.

Scrim
A textile with an open structure, which may be woven or nonwoven, added to reinforce weaker materials.

Scroop
The term refers to the characteristic crunch when loose, bleached cotton is hand squeezed. The sound is described as the crunch of walking on fresh fallen snow.

Seam strength
The ability of a fabric to hold a seam against tension.

Seaming
Joining the overlap of two pieces of fabric, usually near their edges.

Secondary backing
A layer of material laminated to the underside of a carpet to lock in carpet tufts, improve abrasion resistance, dimensional stability and strength.

Secondary Treatment (Flushability)
The biological treatment process in a municipal treatment plant such as activated sludge, rotating biological contactors and trickling filters that removes dissolved organic matter derived from human waste, food waste, soaps and detergents from wastewater.

Seconds
Imperfect roll goods that have various flaws, such as weight lower or higher than specified, poor bonding, inconsistent web formation, poor tensile strength and many more.

Settling (Flushability)
The separation of solids from liquids using gravity.

Septage (Flushability)
The contents (liquid and solid fractions) pumped from a household building's septic or holding tank. Depending on the location, this raw or untreated sewage is treated at a municipal wastewater treatment plant, treated in a separate treatment facility or land-applied.

Sewer Collection System (Flushability)
System of conduits used to remove and transport human waste and waste waters. They typically begin with connecting pipes from buildings to one or more levels of larger underground horizontal mains, which terminate at wastewater treatment plants. Flow in sewer pipes is generally by gravity, though pumps may be used if necessary.

Short fiber
Staple fiber less that 0.5 inches long. Typically used in wet laid processes, to make fabrics, or as fillers in the absorbent cores of disposable diapers.

Short-life nonwoven
Synonymous with Disposable nonwoven.

Shrinkage
A reduction in length or width due to the effect of heat, moisture or chemical action.

Simulated urine
A testing liquid consisting of a 9 g/l solution of sodium chloride in distilled water with a surface tension of (70 $\pm$ 2) mN/m. WSP 070.3.R3 (12); WSP 080.9.R4 (12)

Sintering
The process of adding a dry adhesive to a web and heating the web to the point that the adhesive melts and flows to bind the web once cooled. The sintering process is commonly done as a finish to apparel interlining. The adhesives are added to the nonwoven surface in a discrete pattern. The sintered interlining will adhere to the apparel fabric when reheated.

Sisal
A tropical plant by the same name with fibrous leaves that are used to make rope and other miscellaneous products.

Smog
A mixture of gases and aerosols generated from a variety of sources, such as automobiles' exhaust, burning coal for electricity generation and discharges from many industrial processes. Smog can contain noxious substances and acids that have a damaging effect to the environment and respiratory organs.

Smoke
An aerosol of particles usually solid formed from combustion of organic materials, such as wood, coal, oil, etc. It usually refers to the soot or carbon particles less than 0.1 mm, which results from incomplete combustion.

Smouldering
A slow, flameless, smoking burning of a fabric.

Solids Retention Time (SRT) (Flushability)
Term used to describe the average time that activated sludge remains in the secondary biological treatment system; this is also known as Sludge Age (SA) or Mean Cell Retention Time (MCRT).

Solution-dyeing
Adding pigments or insoluble dyes into the polymer melt or spinning solution prior to extruding a manmade fiber.

Solution spinning
(see Dry spinning).

Sorbent
A nonwoven fabric used to attract and/or contain fluids. The term is most commonly used to describe products that are used to clean-up environmental oil spills and around machinery in a workplace to capture oil and other fluids. Oleophilic fibers, such as from polypropylene, are widely used in these products.

Sorption
In nonwovens, a process in which liquid molecules are taken up either by absorption or adsorption, or both. WSP 160.4.R3 (12)

Sorptive capacity
In nonwovens, the maximum amount of liquid absorbed and adsorbed under specified conditions. WSP 160.4.R3 (12)

Specific gravity
Ratio of the mass of a material to the mass of an equal volume of water at 4°C.

Specimen
A specific portion of the identified sample upon which a test is performed. Many specimens may be tested from the same sample, using different locations and different directions (MD and CD). WSP 080.10.R3 (12); WSP 160.1.R4 (12); WSP 160.2.R4 (12)

Spin finish
A lubricant applied to fibers to reduce friction and static during processing into yarns and fabrics.

Spinning — A process by which filaments or fabrics, made from filaments, are generated directly by passing a molten polymer through a spinneret.

Spinneret
A disc or plate containing many small holes through which molten polymer is extruded to form filaments. Spinnerets are used in the spunlaid process or production of filaments. Occasionally the spelling is “spinnerette.”

Spray bonding, Spray bonded
A method of binding fibers to form a fabric. The adhesive binder is sprayed onto the web of fibers and subsequently dried and cured. See Resin Bonding.

Spreading
Generally refers to the method of increasing a web’s width, wider than the card’s width, prior to bonding and altering fiber orientation in nonwoven fabric production.

Spunbond, Spunbonded
A spunlaid technology in which the filaments have been extruded, drawn and laid on a moving screen to form a web. The term is often interchanged with “spunlaid,” but the industry had conventionally adopted the spunbond or spunbonded term to denote a specific web forming process. This is to differentiate this web forming process from the other two forms of the spunlaid web forming, which are melt blown and flashspinning.

Spunbond nonwoven, Spunbonded nonwoven
A fabric formed from spunbonded process that has been bonded by one or more methods to provide fabric integrity.

Spunbond/Melt blown composite
A multiple layer fabric that is generally made of various alternating layers of spunbond and melt blown webs: SMS, SMMS, SSMMS, etc.

Spunlace bonding, Spunlaced bonding
The method of bonding a web by interlocking and entangling the fibers about each other with high velocity streams of water (synonymous with Hydroentangling). The web or fabric may have other bonding methods in addition to spunlacing. Spunlacing, not to be confused with spunlaid, is generally produced from a web made up of staple fibers from a dry formed, carded system, but small quantities of spunlace bonding are done on production lines that use a wet laid forming process. A recent technical development is the production of a spunlaced nonwoven from a spunlaid, continuous filament web.

Spunlace nonwoven, Spunlaced nonwoven
A fabric produced by the spunlace technology. Spunlace is synonymous with hydroentangling.

Spunlaid
A method of forming a web in which a polymeric melt or solution is extruded through spinnerets to form filaments which are laid down on a moving screen. Melt spun forming processes include spunbond, flash spinning and melt blown. The most common polymers used are polypropylene, polyester and polyethylene.

Staple fiber
Refers to natural or synthetic cut fibers. The word “staple” is used by the textile industry to differentiate cut fibers from continuous filament fibers, such as that used in the spunlaid process. Synthetic staple fibers used in the needlepunched process are generally about 3.8-4.8 cm in length. The fiber lengths of natural fibers, which include wool, cotton, coir, jute and several others, vary considerably.

Start-up
The time when a new production line is finally put into commercial production after the production line is commissioned. This term is synonymous with “on-stream.”

Static
An accumulation of electrical charge on the surface of fibers or fabrics due to its inadequate dissipation during processing or use.

Statistic
A quantity that is calculated from observations on a sample and that estimates a parameter of a population.

Sterilizing filter
A filter that uses a media of sufficient fineness to remove bacteria. These are usually membrane or depth filters.

Stiffness
The ability of a fabric to resist bending. WSP 090.1.R4 (12)

Stitch bond, Stitch bonded
A technique in which fibers in a web are bonded together by stitches sewn or knitted through the web to form a fabric. The finished fabric usually resembles corduroy.

Stitch bond nonwoven
A nonwoven produced by the stitch bonding process.

Strength, bursting
The force or pressure required to rupture a textile by distending it with a force, applied at right angles to the plane of the fabric, under specified conditions. WSP 110.5.R4 (12)

Stretch nonwoven fabric
This material is capable of at least 20 % stretch in either the MD (machine direction) or CD (cross direction), or both, under loads and conditions encountered in use and of almost complete recovery on removal of the load. WSP 030.1.R3 (12)

Stress-strain curve
Graph showing the amount of stretch or compression obtained as a function of the force applied and the point at which rupture or breakage occurs.

Stretch
The ability of a fabric to grow in length when pulled.

Strip test
In nonwovens, a tensile test in which the full width of the specimen is gripped in the clamps. WSP 110.4.R4 (12)

Substrate
Fabric to which coatings or other fabrics are applied.

Superabsorbent (SAP)
A sorbent material that can absorb many times the amount of liquid ordinarily absorbed by cellulosic materials, such as wood pulp, cotton and rayon.

Surface charge
Electrical charge on a fiber or fabric.

Surface energy
The work necessary to increase the surface area of a liquid – generally expressed in dynes per square centimeter. Dynes are units of work.
Surface filter
A thin filter material that retains contaminants on the surface.

Surface tension
Forces acting between the molecules making up the surface of a liquid, causing the surface to contract to a minimum. Since it is a measure of the attraction of a liquid for itself, it can be related to its ability to mix with other liquids or to wet other surfaces.

Surfactant
A chemical additive that changes the surface attraction between two liquids, or between a liquid and a solid, by changing the surface energy of one or both components.

Swelling
Expansion of a fiber caused by exposure to a solvent or chemical agent.

Syngina
The term is derived from ”synthetic vagina”. WSP 354.0.R4 (12)

Synthetic fiber
A man-made fiber, usually from a molten polymer or from a polymer in solution.

Tt

Tackifier
A viscous substance; usually oil, pressure sensitive resins or solvents, which are applied to the surface or throughout a filter media to increase the retention of dust.

Tear strength
Resistance of a material to being torn.

Tearing force
For nonwovens, the tearing force is recorded as the maximum force required to continue a tear previously started in a fabric. The tearing force may appear as a single peak or a series of peaks

on a force-extension curve, depending on the nature of the material. Typically for nonwoven fabrics, if a small decrease in force occurs at a time when the applied force is increasing, it is not considered as a peak unless the indicated force exceeds the force required to break, individually or collectively, the fibers, fiber bonds, or fiber interlocks. Lower shifts corresponding to fiber movement do not qualify as peaks since the fibers, fiber bonds, or fiber interlocks are not broken. The trapezoid tearing force may be calculated from a single-peak or multiple-peak force-extension curve. WSP 100.2.R3 (12)

Tearing strength
The force required either to start or to continue or propagate a tear in a fabric. WSP 100.2.R3 (12)

Technical textile
A general term used to describe a broad range of textiles that are designed for specific applications. These textiles include nonwovens, wovens, knits and film composites. The types of end-products usually associated with technical textiles are nonwovens and certain woven, knitted and film fabrics used in products, such as protective apparel (hazardous waste, fire, clean room, military, etc.), parachutes, “hi-tech” tenting materials, flags, automotive interior fabrics and housewrap - to name a few.

Tenacity
(a) A measure of the strength of a fiber. The force exerted per unit linear density when tensile stress is applied. Expressed as grams of force per denier or newtons per tex. Newtons are units of force.
(b) The specific stress at the breaking point.

Tensile strength
The strength of a material when subjected to either pulling or to compressive stress. It measures the stress a material can bear without breaking or tearing. High precision electronic test instrument that measures the elongation, tensile strength, tear strength or resistance to compression of materials while pulling or compressing forces are applied. WSP 110.1.R4 (12); WSP 110.4.R4 (12)

Tensile strength (TAPPI)
The ability of a material to resist breaking under tensile stress is one of the most important and widely measured properties of materials used in structural applications. The force per unit area (MPa or psi) required to break a material in such a manner is the **ultimate tensile strength** or

tensile strength at break. The rate at which a sample is pulled apart in the test can range from 0.2 to 20 inches per minute and will influence the results. The analogous test to measure tensile properties in the ISO system is ISO 527. The values reported in the ASTM D638 and ISO 527 tests in general do not vary significantly and either test will provide good results early in the material selection process.

Tertiary Treatment (Flushability)
The process needed in some municipal treatment plants to remove nutrients from wastewater as required by effluent quality standards

Test area
Area of the test specimen within the circular clamping device. WSP 030.2.R3 (12)

Test materials
Are designated as any item that could be tested using this test method and contain properties that could can be measured within the parameters of this test method and with its' equipment. The test materials used for the interlaboratory study should cover the range of materials that this test is designed for, i.e. weight, strength, etc. Each material used in this study when selected should be as homogeneous as possible. WSP 002.0.R3 (12)

Test method
A procedure for the identification, measurement, and evaluation of one or more qualities of a material, product, system or service that produces a test result.

Test specimen, bacterial
A prepared specimen of covering material for which the resistance to bacterial penetration is going to be determined. WSP 302.0.R4 (12)

Tex
A metric measure of the weight per unit of a fiber. It is numerically equal to the weight in grams of one kilometer (1000 meters) of the material. It is also equal to the denier divided by 9 (see Denier).

Texturing
A process for imparting crimp, crepe and bulk to fibers, yarns and fabrics.

TFPIA
Textile Fiber Products Identification Act (approved by the U.S. Congress in 1958 and most recently amended in 1998). This legislation was intended to protect producers and consumers against misbranding and false advertising of the fiber content in textile fiber products. In addition to establishing generic names and definitions for manufactured fibers, the Act also sets forth labeling regulations and tolerances for fiber content.

Thermal bonded/Thermobonded
(1).A web of fibers bonded by a thermal bonding (thermobonding) process.
(2).A technique for bonding a web of fibers in which a heat or ultrasonic treatment, with or without pressure, is used to activate a heat-sensitive material. The material may be in the form of homofil fibres, bicomponent fibers, fusable powders, as part of the web. The bonding may be applied all over (e.g. through or area bonding) or restricted to predetermined, discrete sites (e.g. point bonding).WSP 150.1.R4 (12); WSP 150.2.R4 (12)

Thermal bonded batting
A nonwoven filling material that contains low-melting point fibers or polymers that, when heated, fuse the batting materials together. Thermal bonded batting may also be resin bonded. WSP 150.2.R4 (12)

Thermoplastic
A plastic that melts when heated.

Thermoset
A plastic, once formed, that does not melt when reheated.

Thickness
In nonwovens thickness is the distance between the upper and lower surfaces of the material, measured under a specified pressure. Thickness is usually determined as the distance between

an anvil, or base, and a presser foot used to apply the specified pressure. WSP 120.1.R4 (12); WSP 120.2.R4 (12)

Through-air bonding
A bonding system that that uses high temperature air to fuse the web's fibers. There are two basic systems: blowing hot air through the web in a conveyor oven or passing heated air through the web on a rotating drum. Fabrics made from bi-component fibers or blends of bi-component and regular fiber are often bonded by through-air bonding systems. This method is sometimes referred to as air-through bonding.

Throughput
Amount of output or production per unit time.

Ticking
Strong fabric used as a covering for a mattress or pillow and in upholstery.

Tiered Testing Scheme (Flushability)
A commonly used approach to tests which assess how products behave. The first level tests are designed to be undertaken with minimum time and resources and have high acceptance criteria; the second level tests are generally more representative of a real system and would be undertaken if the results for level one are not definitive. The third tier of testing is typically conducted in full-scale field systems and produces definitive results in the event Tier 1 or Tier 2 test results are inconclusive.

Time to burst
Time taken to distend a test specimen to burst. WSP 030.2.R3 (12)

Titanium dioxide
A natural chemical compound (TiO2) often used to pigment polymers in the spinning process to add whiteness.

Toilet Flush (Flushability)
Term used in the test methods to describe one flushing action.

Tolerance
The permitted variation in the measurement of specified property, such as weight, strength, color, etc., that is being observed in a test method.

Top sheet
The cover stock that is the first layer inside the diaper that touches the body. The material is permeable allowing body fluids to pass through to the diaper's core leaving a dry surface in contact with the wearer's skin.

Torsional rigidity
The resistance of a fiber to twisting, defined as the couple required to twist a fiber of unit length to unit angular deflection or the torque required to cause unit twist.

Toughness
The energy-absorbing capacity of a fiber, defined as the specific work of rupture and obtained by measuring the area under the stress-strain curve.

Tow
A bundle of continuous filaments – the form of most man-made filaments before being cut into staple.

Transition temperature
A temperature at which some radical change, usually a phase change, in the appearance or structure of a substance occurs.

Tricomponent fiber
A fiber that is made from three polymers that are physically or chemically different.

Tufted carpeting
A pile carpeting produced by a tufted process. In the process, fibers are carried by a series of needles and thrust through the carpet backing to be held in place by the backing as the needles are withdrawn. Nonwoven materials are used as primary and secondary carpet backing for some applications, often in automotive and modular carpeting.

Type "A" background count
The particle count taken of the empty test chamber with the Gelbo flex unit turned **off** and the back chamber panel **removed**. WSP 160.1.R4 (12)

Type "B" background count
The particle count taken of the empty test chamber with the Gelbo flex unit turned **on** and the back chamber panel **in place**. WSP 160.1.R4 (12)

Uu

ULPA
The acronym for Ultra Low Penetration Air (filter). Air filters made to ULPA standards have filtration efficiencies of 99.999% on 0.3 micron DOP particles.

Ultrapure water
Water that has been filtered and deionized and is relatively free from particle contamination. WSP 160.2.R4 (12)

Ultrasonic bonding
The use of high frequency sound to generate localized heat through vibration and cause thermoplastic fibers to bond to one another.

Ultraviolet absorbers
Various chemicals or polymers added to the product that absorb the ultraviolet light or otherwise make the material resistant to ultraviolet degradation.

Ultraviolet resistance
The ability to retain strength or other properties upon exposure to ultraviolet light.

Ultraviolet stability
Degree of a material's resistance to degradation by ultraviolet rays.

Ultraviolet degradable
The ability of a substance to be broken down by the action of the ultraviolet part of the light spectrum.

Unbonded
A fiberfill material that has not had any form of bonding treatment.

Underlay
A layer of material, such as foam, felt or rubber padding, placed under carpeting or rugs to provide cushioning and increase service use.

Unidirectional fabric
A fabric having strength mostly in one direction, generally the machine direction.

U.V.
Ultraviolet rays

Unwind
The name often given to the equipment from which a roll of fabric is unwound for further processing or converting. It is also referred to as the unwinder or unwind stand.

Vv

Van der Waals forces
The forces of attraction and repulsion between molecules caused by the electric fields of the electrons (negative) and the nuclei (positive). The forces of molecular attraction explain why particles adhere to a filter's fiber.

Vapors
A substance in the gaseous state which is usually in a liquid or solid state.

Virus
A semi-living, generally inert microscopic particle chiefly protein in composition. They replicate by entering a living cell and direct the cell to reproduce more viruses. The cell is usually destroyed as the new viruses are released to the surrounding environment.

Viscose fiber
(see Rayon fiber)

Volume at burst
Volume of pressurizing fluid pumped at the bursting pressure. WSP 030.2.R3 (12)

Ww

Warp
The yarns that run in the machine direction of a woven fabric.

Warp knitting
(see Knitting)

Wash and wear properties
Ability of a fabric to retain its strength and appearance after repeated washings and dryings.

Wastewater Solids Disposal System (Flushability)
Term to describe the processes (e.g. landfill and incineration) used to handle municipal wastewater treatment output such as screenings and sludge.

Water repellency
The characteristic of a fiber, yarn or fabric to resist wetting. WSP 080.1.R4 (12); WSP 080.2.R3 (12)

Water resistance of nonwoven materials
The characteristics to resist wetting and penetration by water. WSP 080.3.R4 (12); WSP 080.6.R4 (12)

Water vapor permeability coefficient
The product of the permeance and the thickness of the film. The permeability is meaningful only for homogeneous materials, in which case it is a property characteristic of bulk material. The quantity should not be used unless the relationship between thickness and permeance has been verified in tests using several thicknesses of the material. An accepted unit of permeability is the metric perm centimeter, or 1 g per m^2 per day per mm Hg-cm of thickness. The SI unit is the mol/m^2-s-Pa-mm. The test conditions must be stated. WSP 070.4.R3 (12)

Water vapor permeance
The ratio of a barrier's WVTR to the vapor pressure difference between the two surfaces. The accepted unit of permeance is the metric perm, or 1 g.m^2 per day per mm Hg. The SI unit is the mol/m^2-s-Pa. Since the permeance of a specimen is generally a function of relative humidity and temperature, the test conditions are very important and must be stated. WSP 070.4.R3 (12)

Water vapor transmission rate (WVTR)
The time rate of water vapor flow normal to the surfaces, under specific steady-state conditions of temperature and humidity, per unit area. An accepted unit of WVTR is g/m^2 per day. The test conditions of relative humidity and temperature where the driving force is the difference in relative humidity across the specimens must be stated. WSP 070.4.R3 (12); WSP 070.5.R3 (12) part 1; WSP 070.6.R3 (12) part 2

Weak web
A term generally used in the context of web formation in a carding process. It refers to the low cohesion of the fibers to one another and thus the web does not have the strength to transfer from one working component to another in the carding process. This situation can be caused by a number of factors, such as poor fiber finish or humidity problems.

Wear test
A test that evaluates a fabric's properties in actual use through laundering, cleaning and other wearing conditions.

Web
A sheet made by laying down and assembling fibers or by creating holes or cracks in a plastic film.

Web consolidation
(see Bonding)

Weight
The mass of a fabric expressed in grams per square meter or ounces per square yard (Mass per Unit Area) WSP130.1.R4 (12)

Weights
Pieces of metal, for example, of a specific mass to equal 16 pounds used to compress highloft battings. WSP 120.4.R4 (12); WSP 120.5.R4 (12)

Wet laid definition
To distinguish nonwovens from papers, a wet laid material will be defined a nonwoven if:
More than 50%, by mass, of its fibrous content is made up of fibers (excluding chemically digested vegetable fibers) with a length to diameter ratio greater than 300:
or
More than 30%, by mass of its fibrous content is made of fibers in “a” above and meet one or both of the following criteria:
Length to diameter ratio of more than 600.
The density of the fabric is less than 0.4 g/cc.

Wet laying or Wet forming
Wet laid nonwovens are produced in a process similar to paper making. The nonwoven web is produced by filtering an aqueous suspension of fiber onto a screen conveyor belt or perforated drum. Many wet laid nonwovens are made with wood pulp or other natural fibers blended with synthetic fibers or fiberglass.

Wet laid nonwoven
A wet laid web bonded by one or more techniques to provide fabric integrity.

Wet laid web
A web of fibers produced by the wet laying process.

Wet spinning
The process of passing a fiber forming polymer through spinnerets and coagulating the polymer into fibers in a chemical bath.

Wet strength
The resistance of a fabric to being torn when it is wet. Usually compared to its strength when dry.

Wetting agent
Additive adsorbed to material surface that prevents water repellency and helps to spread liquid on the surface.

Wicking
Transport of liquid within an absorbent fabric, vertically into the fabric web and horizontally within the plane of the fabric.

Wood pulp
Cellulosic fibers used to make viscose rayon, paper and the absorbent cores of products such as diapers, sanitary napkins and adult incontinence pads.

Wrinkle
A small crease or fold in a fabric which is generally short in length and usually irregular.

Wrinkle resistance
The ability of a fabric to resist remaining creased, wet or dry, after it has been crushed and compressed.

Xx, Yy, Zz

Yarn
A continuous strand of fibers or filaments that are twisted together, to enable its conversion into a woven, knitted or braided fabric.

Yield
The number of square meters (square yards) produced by a kilogram (pound) of fiber or resin.

Yield point
The point at which a tangent to the stress-strain curve is parallel to a line joining the origin to the breaking point.

Zwitterionic surfactant
A chemical additive bearing both positive and negative charges that change the surface energy between two materials.

Guidance Document: WSP 002.0.R3 (12)

Guidelines for drafting a WSP Standard Test Method

The number in parentheses indicates the year of the last revision

Introduction

This document sets guidelines to assist EDANA and INDA working committees in drafting WSP (World Strategic Partners) standards suitable for use in conformity assessment of nonwoven materials at various stages of the varied production processes.

All WSP test methods will use the same format. The standard test method format template is WSP 002.0.R3 (12) Annex B.

The first page header for the WSP documents will contain:

a) First line, the standard WSP logo
b) Second line, an Arial 16 space
c) Third line capital Arial 16:
   - The document designation (Standard Test/Guidance document)
   - The WSP (World Strategic Partners) indicates a method that has been approved by both INDA and EDANA organizations
   - The four digit number after the WSP 002.0 refers to the procedure number in the WSP manual
   - Capital R and a number which indicates the number of releases this procedure has under gone.
   - number in parentheses indicating the year of the last revision
d) Fourth line the procedure's title in Arial 12
e) Fifth line either an Arial 12 space or a temporary working designation
f) In Arial 8 a statement referring to the last revision

All other page headers contain only the standard WSP logo.

The first page footer for the WSP documents will contain:

a) In the left hand section some of the history about this procedure in Arial 8 i.e.

   Current edition approved 002.0.R3 (12)
   Originally published as WSP 2.0 in 2005
   Last approved as WSP 2.0 in 2008

b) In the center section, the page number in Arial 11 (1 of 18)
c) The right hand section contains **Arial 11 Bold**:
   Reference number
   WSP 002.0.R3 (12) A

   This section is more for convenience; it allows the reader to thumb through the manual to find the methods easier. The last item in this section (WD, BP, A, UM) indicates the present status of this document.

WD = Working draft
BP = Balloting process
A = Approved document
UM = Useful Methods

The heading for each of the clauses in each document shall be numbered with Arabic numerals, beginning with 1 for the Scope heading. The numbering shall be continuous up to any annexes. Numbers given to the clauses of an annex shall be preceded by the letter designating that annex. The numbering shall start over with each additional annex.

A WSP test method typically includes a brief description of a procedure for the determination of certain attributes or variables of a raw material, the construction of two or more materials, or the finished product.

The instructions for performing the WSP test method should include all of the vital details so that this test method can be reproduced in its entirety by any qualified laboratory, and that the results will be statistically the same. The standard method should be supported by experience and adequate data obtained from cooperative testing.

In order to maintain a set of WSP dynamic test methods which have the highest degree of trustworthiness and acceptance worldwide, a periodic review of these methods is required. This review must take place at least every five years to determine whether revisions are desirable due to technological advances in manufacturing or test equipment. If a review does not happen in the desired time frame, the test method will be archived until it is reviewed and updated as needed.

WSP test methods are commonly used in the buying and selling of nonwoven materials and products according to specifications. Therefore, the WSP methods should provide a comprehensive precision statement. A sample statement is included in Annex A of this document.

Some WSP test methods will not have numerical manifestations of precision i.e. pass/fail tests. In those cases, precision shall be addressed and the reasons for not including the data explained.

Subject Headings/Clauses

Following is the sequence for the clauses most generally used but this sequence may not be complete. It may be necessary to include other clauses for specialized subjects. The clauses identified as “mandatory” must be included in all test methods. Other clauses shall be included when the subject matter is applicable to the document.

Each clause shall have a title, placed immediately after its number and on a line separate from the text that follows.

Title with corresponding numerical designation **(mandatory)**
Introduction
Scope **(mandatory)**
Normative References **(mandatory)**
Terms and Definitions **(mandatory - when applicable)**
Symbols and Abbreviated Terms
Principle **(mandatory)**
Materials and Reagents
Safety Hazards **(as notes are mandatory and placed where needed - when applicable)**
Apparatus **(mandatory)**
Preparation of Apparatus
Calibration and Standardization
Conditioning **(mandatory)**
Sampling and Preparation of Test Specimens **(mandatory)**
Procedure **(mandatory)**
Calculation or Interpretation of Results **(One of these two clauses is mandatory)**
Report **(mandatory)**
Annexes **(mandatory)**
Precision **(mandatory)**

If the clause is marked **(mandatory)** but does not apply to the test method it still must be addressed. The clause must be included with a statement - “prior conditioning is not required for this test method.”

1. Scope

Unnumbered paragraphs are used in this clause.

The Scope clause shall appear at the beginning of each document and define without ambiguity the subject of the document. This document will also state in the Scope clause the limits of applicability of the document or particular parts of it. The Scope shall not contain requirements.

It shall be worded as a series of statements of fact. Forms of expression such as “This WSP standard test method [specifies], [establishes], [gives guidelines for] or [defines terms]” shall be used.

Statements of applicability of the document shall be introduced by wording such as “This WSP standard test method is applicable to ……..”
Include in this section the system of units to be used in performing this WSP test method.

NOTE 1 Notes are provided to clarify a situation in the test method. These notes do not give instructions or directions in performing the test method. The notes will be two font sizes smaller than the text of the test method to set them apart from the instructions of the procedure. Notes shall not be considered as requirements of the standard, but if used they should be numbered sequentially throughout the body of the test method and shall be placed near the statement/instructions they clarify. There are three types of notes: (1) The standard note heading will always be in all capital letters followed by the sequential number, i.e. NOTE 1. (2) The safety note heading will also be in all capital letters followed by the sequential number and is always placed within a box and will be placed in the test method to indicate a general concern for safety, i.e.

NOTE 2 SAFETY. (3) The safety warning heading note will be in all bold capital letters followed by the sequential number and is also placed within a box and is used in the test method as a direct warning dealing with a specific task, i.e. NOTE 3 **SAFETY WARNING.**

Annex B of this procedure is the standard template to be used when writing new test methods. All the instructions for completing the method are included in Annex B.

2. Normative Reference

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document applies.

In principle, the referenced documents shall be documents published by EDANA, INDA or ISO. Documents published by other bodies may be referred to in the normative clause, provided these referenced documents are recognized by WSP and are widely accepted and maintain a high level of integrity and are publicly available.

It is preferred that the year date be included when designating normative referenced documents. Undated references may be used only if it is accepted that all future revisions/amendments to the referenced document will be acceptable and will not adversely affect the WSP test method.

2.1 ISO test methods (Example)

a) ISO 5725 -1 Accuracy (trueness and precision) of measurement methods and results – Part 1: General principles and definitions

b) ISO 5725 -2 Accuracy (trueness and precision) of measurement methods and results – Part 2: Basic method for the determination of the repeatability and reproducibility of a standard measurement method

c) ISO 139-2005 Textiles — Standard atmospheres for conditioning and testing

d) ISO 2859-1:1999 Sampling procedures for inspection by attributes

e) ISO 3951-1:2005 Sampling procedures for inspection by variables

2.2 WSP test methods (Example)

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry and EDANA's and INDA's Standard Test Methods.

3. Terms and Definition

The following referenced terms are indispensable for the application of this document:

The terms and definitions clause is an optional element that becomes mandatory when definitions are necessary for the understanding of certain terms used in the document.

To eliminate confusion and misunderstanding on the part of the user of the document, the use of technical terms and words with more than one definition should be included in this clause.

To eliminate multi-definitions for one term, please refer to WSP 001.0.R3 (12) "Standard Terminology Relating to the Nonwoven Industry and EDANA and INDA's Standard Test Methods" to see if that term has been used before. If the term is already in WSP 001.0.R3 (12), include the standard definition in the new test method. If the term is not in WSP 001.0.R3 (12), the word and its definition will be added to WSP 001.0.R3 (12) when the test method is published.

3.1 Sample

Sample is a portion of nonwoven taken from a production lot, roll, case or cases of product, which is taken for testing. The sampling unit shall be identifiable and traceable back to its original source.

3.2 Specimen

A specimen is a specific portion of the identified sample upon which a test is performed. Many specimens may be tested from the same sample, using different locations and different directions (MD machine direction and CD cross direction).

3.3 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

4. Symbols and Abbreviated Terms

The Symbols and Abbreviated Terms clause is an optional element giving a list of the symbols and abbreviated terms necessary for the understanding of the document.

For the sake of convenience and continuity, this element may be combined with the Terms and Definitions clause. If the two elements are combined the title will be "**Terms, Definitions, Symbols and Abbreviated Terms".**

5. Principle

Include in this clause information that explains the relevance and meaning of the test. State the practical uses for the test and how it is typically employed. Avoid repetition of information included in the Scope (clause 1). Include statements to provide the user with comprehensive understanding of the following:

5.1 The significance of the test

How does it relate to the properties of the nonwoven materials being tested and what makes this test unique?

5.2 The appropriateness of the test

How can it be used for the various stages of nonwoven production, specification acceptance, manufacturing control, development and research? Also, what types of nonwoven can or cannot be tested using this test method?

5.3 The fundamental hypothesis intrinsic in the test

Are there any situations while performing this test that may affect the usefulness of the results? Are there any items to watch for while performing this test?

5.4 Any cautions

Are there any cautions that could help the user in the interpretation of the instructions or of the results of this test?

5.5 Comparisons where applicable

Where there are other similar test methods that may help clarify this method, their titles may be included here.

6. Materials and Reagents

This materials and reagents clause is an optional element which may be used to provide a list of the materials needed to perform this test. Also a list of reagents may be included in this clause.

6.1 List the reagents alphabetically

Spell out the full name of the reagent, and immediately after the first mention of the name include within parentheses the exact chemical formula of the reagent, followed by any other descriptive terms. State the desired concentration, if significant, and then follow with instructions for preparation and standardization when required.

6.2 If the reagent is to be used as purchased
Indicate that the reagent is not diluted, dissolved, or purified, then state the chemical formula as given by the manufacturer.

NOTE 2 SAFETY

If a safety note is warranted for the protection of the technician performing this standard, the word Note will be followed by the word Safety and numbered in sequence with other notes, and a box will be placed around the entire body of the note.

NOTE 3 **SAFETY WARNING**

A warning statement identifying a specific hazard and providing information for avoiding or minimizing a particular hazard. This warning note will be placed at the appropriate point in the text. The word NOTE will be followed by the words **SAFETY WARNING** (in bold) and numbered in sequence with the other notes, and a box will be placed around the entire body of the note.

7. Apparatus

In this clause include a description of the essential features of the apparatus and other equipment. To clarify a point or supplement the text, schematic drawings or photographs may be used. Cover under separate subclauses the important features and requirements for the apparatus

The apparatus should be readily available. If not, it should be noted that blueprints or plans can be obtained from either EDANA or INDA associations. Include enough information such as, phone number or e-mail address, so that the association can be contacted.

8. Conditioning

For conditioned testing:
Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139-2005 and then test using the same conditions. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 4 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing nonwovens for a reasonable period of time before the specimens are tested; i.e., 4 hours.

9. Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability,

producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 5 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

9.1 Laboratory samples

From each roll or portion of fabric selected from the lot sample, cut at least one laboratory sample the full width of the fabric and at least 300 mm from each outside edge.

9.2 Test specimens

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material.

10. Procedure

Include in proper sequence detailed directions for performing the test. Make the text of this clause concise, to the point and easily understandable.

10.1 Describe the procedure in successive steps.
text

10.2 Subclause
text

11. Calculation

State the directions for calculating the results of the test including any equations and any required significant figures (the use of significant digits).

Describe the letter symbol immediately under the equation (unless a clause on symbols is included).

If necessary for clarification, a typical calculation should be included in the body of this clause.

Or

11. Interpretation of Results

Use this clause in place of **Calculation** when the results of the tests are expressed in a descriptive form, relative terms or abstract values. When using this clause, list and define the descriptive terms or the values used; i.e., 5 = good, 3 = middle, 1 = bad.

12. Report

In this clause give the detailed information required in reporting the results of the test. There must be sufficient information in this clause to make the results meaningful, useful and reproducible.
Introduce this clause as follows:
In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Number of specimens tested and note CD and MD if significant
g) Software used and version
h) Deviation from the standard test procedure, if any.
i) When calculated, the standard deviation or the coefficient of variation
j) Whether or not samples were conditioned prior to testing and, if so, for how long.
k) Anything unusual noted during the testing.
l) When photos are used as the standard attach copies

13. Precision

The following two methods are reference sources for the precision information:

ISO 5725-1 Accuracy (trueness and precision) of measurement methods and results – Part 1: General principles and definitions

ISO 5725-2 Accuracy (trueness and precision) of measurement methods and results – Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method

a) ISO 5725-2 amplifies the general principles for guidance when designing experiments for the numerical estimation of the precision of measurement methods.
b) ISO 5725-2 also provides a detailed explanation of the basic method to be used in estimating trueness and precision.
c) The statistical model (located in clause 5 of ISO 5725-1) is accepted as a suitable basis for interpretation and analysis of test results.
d) A detailed outline of the requirements for a precision experiment are explained in clause 5 of ISO 5725-2

(The following is just an example.)

13.1 The data

For the repeatability$_{(r)}$ and reproducibility$_{(R)}$ limits of this method are the result of interlaboratory tests carried out in (year) by (whom), and are given in Annex A.

13.2 The absolute difference

Between two single test results obtained under repeatability test conditions in accordance with ISO 5725-2 shall not exceed the repeatability limit r in more than 5% of cases:
Example….$_{r}$ = 0.48 (g/s)

13.3 The absolute difference

Between two single test results obtained under reproducibility test conditions in accordance with ISO 5725-2 shall not exceed the reproducibility limit R in more than 5% of cases:
Example… $_{R}$ = 5.23 (g/s)

13.4 If the repeatability and reproducibility test criteria are not met

The test shall be repeated twice, each in duplicate, after ensuring that the original sample is thoroughly mixed. If these criteria are still not met, report the results as unusual, and then diagnose the source of error, for example by verifying correct operation of the instruments, and testing a portion of a material with a known value.

Example

ANNEX A

(informative)

Statistical results of interlaboratory tests

Figures for the repeatability$_{(r)}$ and reproducibility$_{(R)}$ of this method are the result of collaborative studies carried out in (year) by (whom). The evaluation of the interlaboratory test was carried out in accordance with ISO 5725-2 and results are as follows:

Samples	**A**	**B**	**C**
No. of participating laboratories	10	10	10
No. of non-eliminated laboratories	10	10	9
No. of single values of the non-eliminated laboratories	40	40	40
Mean value (g/s)	10.94	10.62	11.93
Repeatability standard deviation, sr	0.12	0.17	0.15
Repeatability coefficient of variation, CVr (%)	1.07	1.61	1.28
Repeatability limit, r (2.8 x sr)	0.33	0.48	0.43
Reproducibility standard deviation, sR	1.87	1.82	1.73
Reproducibility coefficient of variation, CVR (%)	17.07	17.18	14.46
Reproducibility limit, R (2.8 x sR)	5.23	5.11	4.83

ANNEX B

The Template for drafting a WSP Standard Test Method

(When using this document as a template please remove this line and the two above it and use this as the First page header. The header will include the logo and the following three lines)

STANDARD TEST: WSP XXX.X.RX (XX)

Standard Test Method for ……..

The number in parentheses indicates the year of the last revision

All words in italics must be removed from this template before it is used. They are for guidance only. Arial font will be used for these procedures. Clauses will be bold Arial 12, subclauses bold Arial 11. All test method text will be Arial 11 and all notes will be Arial 9.

1. Scope

A paragraph
No subclause numbering in the scope
The scope shall be concise and to the point so that it can be used as a summary for bibliographic purposes if needed.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative reference

A paragraph
The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document applies.

2.1 ISO test methods

a) ISO 5725-1 Accuracy (trueness and precision) of measurement methods and results – Part 1: General principles and definitions

b) ISO 5725-2 Accuracy (trueness and precision) of measurement methods and results – Part 2: Basic method for the determination of the repeatability and reproducibility of a standard measurement method

c) ISO 139-2005 Textiles — Standard atmospheres for conditioning and testing
d) ISO 2859-1:1999 Sampling procedures for inspection by attributes
e) ISO 3951-1:2005 Sampling procedures for inspection by variables

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry and EDANA's and INDA's Standard Test Methods

3. Terminology

For the purpose of this document, the following terms and definitions apply:

3.1 Sample

Sample is a portion of nonwoven taken from a production lot, roll, case or cases of product, which is taken for testing. The sampling unit shall be identifiable and traceable back to its original source.

3.2 Specimen

A specimen is a specific portion of the identified sample upon which a test is performed. Many specimens may be tested from the same sample, using different locations and different directions (MD and CD).

3.3 *(example)**term***

text of the definition

4. Principle

A paragraph

A subclause shall not be created unless there are more than 1 subclauses at the same level. For example, text in clause 4 shall not be designated as subclause 4.1 unless there is also a 4.2 subclause

NOTE 2 ***SAFETY WARNING***

A warning statement identifying any specific hazard and providing information for avoiding or minimizing a particular hazard. This Warning note will be placed at the appropriate point in the text, if needed.

5. Materials and Reagents

6. Apparatus

A paragraph

6.1 ***subclause***

text

6.2 subclause

text

7. Conditioning

For conditioned testing

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139 and then test using the same conditions. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 3 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing nonwovens for a reasonable period of time before the specimens are tested; i.e., 4 hours.

8. Sampling

A paragraph

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE # An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

8.1 Laboratory samples

From each roll or portion of fabric selected from the lot sample, cut at least one laboratory sample the full width of the fabric and at least 300 mm from each outside edge.

8.2 Test specimens

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material.
(These are some examples)

a) *Direction of test*
b) *Specimen size, labeled to maintain specimen identity.*
c) *Care in handling should be observed so that specimens do not contact any contaminants such as soap, salt, oil etc., which might facilitate or hinder test results.*

9. Procedure

A paragraph

9.1 subclause

text

9.2 subclause

text

10. Calculation

Following the instructions in WSP 002.0.R3 (12), use either the Calculation clause or the Interpretation of Results clause but not both.
A paragraph

Or

10. Interpretation of Results

A paragraph

11. Report

In this clause give the detailed information required in reporting the results of the test. There must be sufficient information in this clause to make the results meaningful, useful and reproducible.

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Number of specimens tested and note CD and MD if significant
g) Software used and version
h) Deviation from the standard test procedure, if any.
i) When calculated, the standard deviation or the coefficient of variation
j) Whether or not samples were conditioned prior to testing and, if so, for how long.
k) Anything unusual noted during the testing.
l) When photos are used as the standard attach copies

12. Precision

(The following is just an example.)

12.1 The data

For the repeatability$_{(r)}$ and reproducibility$_{(R)}$ limit of this method are the result of interlaboratory tests carried out in (year) by (whom), and are given in Annex A.

12.2 The absolute difference

Between two single test results obtained under repeatability test conditions in accordance with ISO 5725-2 shall not exceed the repeatability limit r in more than 5% of cases:
Example….$_r$ = 0.48 (g/s)

12.3 The absolute difference

Between two single test results obtained under reproducibility test conditions in accordance with ISO 5725-2 shall not exceed the reproducibility limit R in more than 5% of cases:
Example… $_R$ = 5.23 (g/s)

12.4 If the repeatability and reproducibility test criteria are not met

The test shall be repeated twice, each in duplicate, after ensuring that the original sample is thoroughly mixed. If these criteria are still not met, report the results as unusual, then diagnose the source of error, for example by verifying correct operation of the instruments, and testing a portion of a material with a known value.

Example - ANNEX A

(informative)

Statistical results of interlaboratory tests

Figures for the repeatability$_{(r)}$ and reproducibility$_{(R)}$ of this method are the result of collaborative studies carried out in (year) by (whom). The evaluation of the interlaboratory test was carried out in accordance with ISO 5725-2 and results are as follows:

Samples	A	B	C
No. of participating laboratories *(the number of laboratories could be as low as 6)*	10	10	10
No. of non-eliminated laboratories	10	10	9
No. of single values of the non-eliminated laboratories	40	40	40
Mean value (g/s)	10.94	10.62	11.93
Repeatability standard deviation, sr	0.12	0.17	0.15
Repeatability coefficient of variation, CVr (%)	1.07	1.61	1.28
Repeatability limit, $_r$ (2.8 x sr)	0.33	0.48	0.43
Reproducibility standard deviation, sR	1.87	1.82	1.73
Reproducibility coefficient of variation, CVR (%)	17.07	17.18	14.46
Reproducibility limit, $_R$ (2.8 x sR)	5.23	5.11	4.83

Guidance Document: WSP 003.0.R3 (12)

Guidelines for Standard Atmospheres for Conditioning and/or Testing

The number in parentheses indicates the year of the last revision

Introduction

This document sets guidelines for EDANA's and INDA's standard atmospheres for conditioning and/or testing Nonwoven materials.

Indeed, most properties of a large part of the nonwovens would probably not be noticeably affected by modifying testing conditions.

If it can be demonstrated and verified through a study that the tested properties were not affected by changing the atmospheric conditions, then ambient conditions can be used. The study must use the same nonwoven material and a variety of atmospheric conditions that would cover any ambient conditions possible.

However, preference is given to 23°C/50% relative humidity because most of the industries to which nonwovens are connected use these conditions (see ISO 139).

1. Scope

The object of this ERT is to define the conditioning atmosphere and the method of conditioning nonwovens before and during testing (See tables 1 and 2).

2. Standard Conditioning and Testing Atmospheric conditions

Table 1 Conditioning and Testing

Designation	Temperature	Relative humidity	Remarks
	ºC	%	
23/50	23	50	Used in nonwoven applications
20/65	20	65	Recommended atmosphere

Table 2 Tolerances

Tolerances	Temperature	Relative humidity
	ºC	%
Ordinary (normal) tolerances (wide tolerances)	± 2	± 5
Reduced tolerances (close tolerances)	± 1	± 2

Reference number
WSP 003.0.R3 (12) A

Current edition approved WSP 003.0.R3 (12)
Originally published as WSP 3.0 in 2005
Last approved as WSP 3.0 in 2008

Guidance Document: WSP 004.0.R2 (12)
List of Useful Addresses

The number in parentheses indicates the year of the last revision

AATCC ♦ AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS
AATCC TECHNICAL CENTER
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ABNT ♦ ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS
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Email: abnt@abnt.org.br
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AENOR ♦ ASOCIACIÓN ESPAÑOLA DE NORMALIZACIÓN Y CERTIFICACIÓN
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AFNOR ♦ ASSOCIATION FRANÇAISE DE NORMALISATION
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Fax: + 33 1 49 17 90 00
Website: www.afnor.fr

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Reference number
WSP 004.0.R2 (12) A

Current edition approved WSP 004.0.R2 (12)
Originally published as WSP 4.0 in 2005
Last approved as WSP 4.0 in 2009

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JISC ♦ JAPANESE INDUSTRIAL STANDARDS COMMITTEE
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NNI ♦ NEDERLANDS NORMALISATIE-INSTITUUT
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Email: info@standard.no
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ON ♦ AUSTRIAN STANDARDS PLUS, INC.
Heinestraße 38
1021 Wien
AUSTRIA
Phone: + 43 1 213 00
Fax: + 43 1 213 00 355
Email: office@as-plus.at
Website: www.as-search.at

SAC ♦ STANDARDIZATION ADMINISTRATION OF CHINA
No. 9 Madian East Road
Haidian District
Beijing, China 100088
Phone: + 86 10 82 26 06 59
Fax: + 86 10 82 26 06 60
Email: sac@sac,gov.cn
Website: www.sac.gov.cn

SCAN ♦ SCANDINAVIAN PULP, PAPER AND BOARD TESTING COMMITTEE
P.O. Box 5406
S-114 86 Stockholm
SWEDEN
Phone: + 46 8 676 70 00
Fax: + 46 8 411 55 18
Email: info@stfi.se

SEE ♦ ILNAS LUXEMBOURG CENTRE
34-40, avenue de la Porte-Neuve
L - 2227 Luxembourg (Lëtzebuerg)
Phone: + 352 46 97 46 1
Fax: + 352 22 25 24
Email: info@ilnas.public.lu
Website: www.ilnas.public.lu

SFS ♦ SUOMEN STANDARDISOIMISLIITTO R.Y.
Malminkatu 34, Fight
00101 Helsinki
FINLAND
Phone: + 358 9 149 93 31
Fax: + 358 9 146 49 25
Email: sfs@sfs.fi
Website: www.sfs.fi

SIS ♦ STANDARDISERINGEN I SVERIGE (Swedish Standards Institute)
Sankt Paulsgatan 6
SE – 118 – 80 Stockholm
SWEDEN
Phone: + 46 8 555 520 00
Fax: + 46 8 555 520 01
Email: info@sis.se
Website: www.sis.se

SII ♦ THE STANDARD INSTITUTION OF ISRAEL
42, Chaim Levanon Street
IL-Tel Aviv 69977
ISRAEL
Phone: + 972 3 646 5154
Fax: + 972-3-641-2762
Email: vered@sii.org.il
Website: www.sii.org.il

SNV ♦ SCHWEIZERISCH NORMEN-VEREINIGUNG (SNV)
Burglistrasse, 29
Winterthur, CH-8400
Switzerland
Phone: + 41 52 224 54 54
Fax: + 42 52 224 54 74
Email: info@snv.ch
Website: www.snv.ch

STRI ♦ ICELAND COUNCIL FOR STANDARDIZATION
IST - Icelandic Standards
Skúlatún 2
IS-105 Reykjavik
Iceland
Tel: +(354) 520 7150
Fax: +(354) 520 7171
e-mail: stadlar@stadlar.is
Website: http://www.stadlar.is

TAPPI ♦ TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY
15 Technology Parkway South
Norcross, GA 30092
U.S.A.
Phone: + 1 770 446 1400
Fax: + 1 770 446 6947
Email: serviceline@tappi.org
Website: www.tappi.org

UNI ♦
ENTE NAZIONALE ITALIANO DI UNIFICAZIONE

Via Sannio 2

20137 MILANO (MI)
ITALY
Phone: + 39 (0) 2 70 02 41
Fax: +39 0270024375
Email: uni@uni.com
Website: www.uni.com

GUIDANCE DOCUMENT: WSP 005.0.R3.(12)

Standard Test Method for Nonwoven Sampling

The number in parentheses indicates the year of the last revision

1. Scope

This test method specifies a general procedure for obtaining a representative sample of a given lot (batch, delivery, etc.) of nonwoven material, for test purposes. The method is suitable for materials in sheet or roll form.

It provides a statistically valid procedure for withdrawing from each lot a certain number of units, taking from each of these units a certain number of sheets, and finally cutting from these sheets a number of pieces from which are taken the actual test specimens necessary for various tests. However, the specimens obtained by this sampling method are random representatives of the material and do not necessarily provide information about systematic variations e.g. across the width or in a certain position along the length of the product. Whenever such information is required, special sampling provisions should be agreed upon between purchaser and vendor.

2. Normative References

The following referenced documents are indispensable for the application of this document:

2.1 ISO test methods

a) ISO 2859-1:1999 Sampling procedures for inspection by attributes
b) ISO 3951-1:2005 Sampling procedures for inspection by variables

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Procedure

Follow the procedure as indicated in ISO 2859-1 (99) and ISO 3951-1 (05).

3.1 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability,

Reference number
WSP 005.0.R3 (12) A

Current edition approved WSP 005.0.R3 (12)
Originally published as WSP 5.0 in 2005
Last approved as WSP 5.0 in 2008

producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 1 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

3.2 Select laboratory sample or sheets

From each roll or portion of material taken from the lot sample, cut at least one laboratory sample the full width of the fabric and 1 m in the machine direction. This is done after removing the first outside wrap or discarding the first 1 m length. For nonwoven fabric components of fabricated systems use the entire system. There are situations that may alter the normal routine:

a) The size and width of the roll or the size and width of the portion of material

b) The unit is a package that can be and may be completely unwrapped
c) With the unit being subdivided
d) With the unit being a reel
e) The unit cannot be or should not be completely unwrapped.

3.3 Select test specimens

a) Specimens shall be kept flat, free from wrinkles or folds and protected from exposure to direct sunlight, liquids, varying humidity conditions and any other harmful influences. The top and bottom layers of the stack should be discarded. Care shall be taken in handling specimens as contact with the hands can appreciably affect the chemical, physical, optical properties or other characteristics of the nonwoven.

b) Attention is also drawn to the sensitivity of certain tests (notably tear) to the quality of the cut edge of the test specimen. The method of test specimen preparation, e.g. die cut template etc. is usually given in the relevant test method or should be agreed upon by the parties. The edge of the sample sheet should not normally form part of actual test specimens.

c) When selecting and cutting specimens please follow the specimen size instructions given in the proper test method. When preparing future test specimens and testing size is unknown cut specimens 300 mm x 450 mm approximately, the greater dimension being in the machine direction and handle these specimens with great care.

4. Report

The test report shall include the following information:

a) Consignment reference
b) Condition in which the lot appears
c) Description of the lot (production date, roll etc)
d) Indication of the sampling method
e) Reference of the lot and of the unit, if necessary
f) Number of units in the lot
g) Number of units selected and if necessary, the number of selected units retained for further tests
h) Number of sheets selected from each unit
i) All the circumstances of such nature as to influence results of future tests
j) Any deviation from the method of sampling specified
k) Name of the person collecting the samples
l) Name of purchaser and vendor
m) Date and place of sampling
n) Identification marks on the samples

Guidance Document: WSP 006.0.R2 (12)
Listing of Equipment Vendors

The number in parentheses indicates the year of the last revision

The listing is made as a service to the nonwoven industry and is not intended to exclude any interested company. The list is available to any vendor who would like their company's name included. Notices of this invitation to be listed were placed in the media which is distributed to the nonwoven industry. If a vendor would like to see their company's name added to the list, the information should be sent to INDA or EDANA. There are no charges associated with this listing. Please contact either INDA or EDANA through their respective websites, www.inda.org or www.edana.org if you would like your company's name added to the list.

EQUIPMENT VENDORS

Company Name And Address

Advanced Testing Instruments
203 Parksouth Drive
Greer, SC 29651 USA

Phone: + 864 989 0566
Fax: + 864 989 0567
Web: www.aticorporation.com
Email: info@aticorporation.com

Exclusive US sales rep for James H. Heal and Textest equipment

Company Name And Address

American Assoc. of Textile Chemists and Colorist
PO Box 12215
Research Triangle Park, NC 27709 USA

Phone: + 919 549 8141
Fax: + 919 549 8933
Web: www.aatcc.org

Spray impact testing equipment; crocking scale

Company Name And Address

Astec Microflow Systems
2180 Andrea Lane #5
Fort Myers, Florida 33912 USA
In Europe:

Phone: + 941 489 3200
Fax: + 941 489 0922
Web: www.astec-microflow.co.uk

Bioquell UK Ltd.
52 Royce Close
West Portway Andover, Hampshire SP10 3TS
England, UK

Phone: + 44(0) 1264 835 835
Fax: + 44(0) 1264 835 836
Web: www.astec-microflow.co.uk

Clean Room Equipment, Ambient Conditioning
- Air Cleaners
- Hoods & Fume Hoods
- Dust-free Hoods
- Fume Hoods

Clean Room Equipment, Furniture
- Biological Safety Cabinets

Clean Room Equipment, Process Stations & Material
- Laminar Flow Workstations

Reference number
WSP 006.0.R2 (12) A

Current edition approved WSP 006.0.R2 (12)
Originally published as WSP 6.0 in 2005
Last approved as WSP 6.0 in 2005

Company Name And Address	Beckman-Coulter Inc. 250 South Kramer Blvd. Brea, CA 92821 – 6232 USA	Phone: +800 526 3821 Fax: + 800 232 3828 Web: www.beckmancoulter.com
		Centrifuges, medical lab equipment
Company Name And Address	Bowe Textile Cleaning USA, Inc. 112 Associate Drive Indian Trail, NC, 28079 USA	Phone: 800 287 0870 Fax: 704 234 2821 Web: www.bowe-tc.com
		Dry Cleaning Machines, Perchloroethylene models
Company Name And Address	BYK Gardner (Altana Chemie 9104 Guilford Road Columbia, MD 21046 USA	Phone: 301 483 6555 Fax: + 800 394 8215 Web: www.byk.com
		Physical Lab Testing Equipment, appearance testing
	In Europe: BYK Gardner GmbH Lausitzer Strasse 8 D-82538 Geretsried, Germany	Phone: + 49 8171 3493 0 Fax: + 49 8171 3493 140
Company Name And Address	CertainTeed Corp. 750 E. Swedesford Road Valley Forge, PA 19482 USA	Phone: + 800 233 8990 Fax: + 610 341 7777 Web: www.certainteed.com
		Thickness Gages
Company Name And Address	Clean Room Products 8605 Wyoming Ave. N Minneapolis, MN USA 55445	Phone: + 800 423 9728 Fax: + 763 425 2004 Web: www.cleanairproducts.com
		Laminar Flow Hoods
Company Name And Address	Clean Rooms International, Inc. 4939 Starr St., SE Grand Rapids, Michigan 49546 USA	Phone: + 877 380 1860 Fax: + 616 452 2372 Email: sales@cleanroomsint.com Web: www/cleanroomsint.com
		Dust-free Hoods, Clean rooms
Company Name And Address	Climet Instrument Co. 1320 W. Colton Ave. Redlands, CA 92374 USA	Phone: + 909 793 2788 Fax: + 909 793 1738 Web: www.climet.com
		Various types of particle counters

Company Name And Address	Electromatic Equipment Co., Inc 600 Oakland Avenue Cedarhurst, NY 11516 USA	Phone: + 516 295 4300 Fax: + 516 295 4399 Web: www.checkline.com

Tachs, Strobes, Tension meters, Force gauges

Company Name And Address	Electro Tech Systems, Inc. 3101 Mount Carmel Avenue Glenside, PA 19038 USA	Phone: + 215 887 2196 Fax: + 215 887 0131 Web: www.electrotechsystems.com

Electro Static Decay Equipment
Humidity Control Systems
Temperature Control Systems

Company Name And Address	Frazier Precision Instruments 925 Sweeney Drive Hagerstown, MD 21740 USA	Phone: + 301 790 2585 Fax: + 301 790 2589 Web: www.frazierinstrument.com

Various Permeability Testers
Various Abrasion Testers

Company Name And Address	Gurley Precision Instruments 514 Fulton Street Troy, NY 12180 USA	Phone: + 800 759 1844 Fax: + 518 274 0336 web: www.gurley.com

Smoothness Testers, Stiffness Testers
Air Permeability Testers

Company Name And Address	HunterLab 11491 Sunset Hills Road Reston, VA 20190-5280 USA (Offices in Hong Kong and Germany; see website)	Phone: + 703 471 6870 Fax: + 703 471 4237 Web: www.hunterlab.com Email: info@hunterlab.com

Color measuring equipment

Company Name And Address	IMass Material Testing Instruments P.O. Box 134 Accord, MA 02018 USA	Phone: + 781 834 3063 Fax: + 781 834 3064 Web: www.imass.com

Slip/peel testers, Friction testers

Company Name And Address	Instron Corporation 825 University Ave. 100 Royal Street Norwood, MA 02062-2643 USA (Office in Canada; see website)	Phone: + 781 828 2500 Fax: 800 877 6674 Web: www.instron.com

Universal material testers (tensile, etc)

Company Name And Address	James H. Heal & Co. Ltd. Richmond Works Halifax, W. Yorkshire HX3 6EP England	Phone: + 44 1422 366355 Fax: + 44 1422 352440 Web: www.james-heal.co.uk

(Agents in the USA and Asia as well as Europe; see website)

Nu-Martindale Abrasion and Pilling Tester
Other physical testing equipment

Company Name And Address	Keithley Instruments, Inc. 28775 Aurora Road Cleveland, Ohio 44139 USA	Phone: + 440 248 0400 Fax: + 440 248 6168 Web: www.keithley.com Email: info@keithley.com

Concentric Ring Meters
High Resistance Meter, Resistivity

Company Name And Address	Laminar Flow, Inc. PO Box 2427 102 Richard Road Ivyland, PA 18974 USA	Phone: + 215 672 0232 Fax: + 215 441 0426 email:info@laminarflowinc.com www.laminarflowinc.com

(Offices in Canada, Central America and Indonesia; see website)

Laminar Flow Systems
Clean Room Furniture

Company Name And Address	Lenzing Instruments Technologiepark 4 A-4851 Gampern, Austria	Phone: +43 7682 93030 - 902 Fax: +43 7682 93030 - 911 Web: www.lenzing-instruments.com Email: team@lenzinginstruments.com

Lister liquid strike through tester
Rewet tester

Company Name And Address	Met One Instruments, Inc. 1600 Washington Blvd. Grants Pass, Oregon 97526 USA	Phone: + 541 471 7111 Fax: + 541 471 7116 Web: www.metone.com

Laser Particle Counter

Company Name And Address	Mezger, Inc 155 Hall St. Spartanburg, SC 29302 – 1523 USA	Phone: + 864 542 8037 Fax: + 864 542 8039 Web: www.mezgerinc.com

US rep for Lenzing Instruments
Martindale

Company Name And Address	MK Systems, Inc. 300 Andover Street Unit #213 Peabody, MA 01960	Phone: + 978 774 1880 Fax: + (240) 595 6196 Web: www.mksystems.com Email: info@mksystems.com
		Gravimetric Absorption Tester Formation Analyzer, Sheet former
Company Name And Address	Mocon, Inc. 7500 Mendelssohn Ave. N Minneapolis, MN 55428 USA	Phone: + 763 493 6370 Fax: + 763 493 6358 Web: www.mocon.com
		Various automated testers for MVTR
Company Name And Address	MTS Systems 14000 Technology Dr. Eden Prairie, MN 55344 USA	Phone: + 800 328 2255 Fax: + 952-937-4515 Web: www.mts.com Email: info@mts.com
(Distributors around the world; see website)		Noise and vibration equipment
Company Name	Paul Gardner Co. 316 N.E. First St. Pompano Beach, FL 33060	Phone: + 954 946 9454 Fax: + 954 946 9309 Web: www.gardco.com Email: gardner@gardco.com
		Abrasion Testers, various lab equipment
Company Name And Address	Porous Materials, Inc. 20 Dutch Mill Rd. Ithaca, NY 14850 USA	Phone: + 607 257 5544 Fax: + 607 257 5639 Web: www.pmiapp.com Email: info@pmiapp.com
(Office in Belgium; see website		Porometers, Permeameters, Porosimeters
Company Name And Address	Qualitest International 9-70 East Beaver Creek Rd. Richmond Hill, Ontario L4B 3B2, Canada Email: sales@qualitest-inc.com	Phone: + 905-944-9825 Fax: + 905 944 0304 Web: www.qualitest-inc.com
(For US offices, see website)		Tensile Testers, Air Permeability Burst, Pilling Elmendorf Tear

Company Name And Address	Rycobel Nijverheidslaan 47 8540 Deerlijk, Belgium	Phone: + 32 66 78 2170 Fax: + 32 66 77 3040 Web: www.rycobel.be Email: info@rycobel.be

Abrasion testers, Color Fastness, Mullen Burst, friction/Peel tester, Handle-o-meter

Company Name And Address	SDL-Atlas 3934 Airway Drive Rock Hill, SC 29732-9200 USA	Phone: + 803 329 2110 Fax: + 803 329 2133 Web: www.sdlatlas.com Email: info@sdlatlas.com

Load Cells, Universal Testers, Friction Testers, Various Testing Lab Equipment

Company Name And Address	Taber Industries 455 Bryant Street PO Box 164 North Tonawanda, NY 14120 USA	Phone: + 716 694 4000 Fax: + 716 694 1450 Web: www.taberindustries.com Email: sales@taberindustrias.com

Abrasion Testers, Stiffness Tester, Thickness Gage, Adhesion Tester

Company Name And Address	Technidyne Corporation 100 Quality Avenue New Albany, IN 47150 USA	Phone: + 812 948 2884 Fax: + 812 945 6847 Web: www.technidyne.com

Technibrite Model TB – 1C
Measure ISO brightness, whiteness, tint, opacity, Color and fluorescence accurately

Company Name And Address	TEXTEST AG Sonnenbergstrasse 72 P.O. Box CH-8603 Schweizenbach Switzerland	Phone: +41 (0) 44 321 21 41 Fax: +41 (0) 44 321 21 43 Web: www.textest.ch Email: info@textest.ch

Air Permeability Testers, Hydrostatic Head

Company Name And Address	Thwing-Albert 14 Collings Ave. West Berlin, NJ 08091 USA (Offices around the world; see website)	Phone: + 856 767 1000 Fax: + 856 767 2615 Web: www.thwingalbert.com Email: info@thwingalbert.com

Handle-O-Meter, Elmendorf Tester and Accessories

Company Name And Address	TMI Testing Machines, Inc. 40 McCullough Drive New Castle, DE 19720 USA	Phone: + 631 439 5400 Fax: + 631 439 5420 Web: www.testingmachines.com Email: info@testingmachines.com

(Offices around the world; see website)

Abrasion, Friction, Permeability and Tensile Testers; Other machines

Company Name And Address	Zwick GmbH August-Nagel-Strasse 11 89079 Ulm, Germany	Phone: + 49 7305 10 0 Fax: + 49 7305 10 200 Web: www.Zwick.de Email: info@zwick.de

(Also has headquarters in the US and Singapore;)

Offer range of testing equipment including tensile, flexure, tear, peel coefficient of friction, puncture, melt flow and hardness testers

GUIDANCE DOCUMENT: WSP 007.0.R2 (12)

For Evaluating Nonwoven Fabrics

The number in parentheses indicates the year of the last revision

1. Scope

This guide covers procedures for testing nonwoven fabrics. The test procedures appear in the following clauses:

Nonwoven Methods	Clause
Abrasion Resistance	18
Absorbency	21
Air Permeability	24
Bacterial Penetration	16
Binder Distribution and Penetration	22
Breaking Force and Elongation (Grab and Strip)	25
Bursting Strength	10
Calibration	9
Conditioning	7
Flexural Rigidity (Stiffness)	12
Mass Per Unit Area	17
Opacity/Brightness	11
Repellency	20
Resistance to Linting	13
Sampling	8
Superabsorbent Materials/powders	23
Thickness	19
Tongue Tear (Single Rip)	15
Trapezoid Tear	14

Table 1

Reference number
WSP 007.0.R2 (12) A

Current edition approved WSP 007.0. R2 (12)
Originally published as WSP 7.0 in 2005
Last approved as WSP 7.0 in 2005

This test method provides the values in both SI units and inch-pound units. Inch-pound units are the customary units used in the United States and these values will be in parentheses in the body of this method. The International System of Units (SI units) are the customary metric units used in most of the rest of the world.
SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

These standards do not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of these standards to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing these tests has been fully trained in all aspects of these procedures.

2. Normative References

The following referenced documents are indispensable for the application of this document:

All of the reference methods used in this document are found in the 2010 version of the Standard Test Methods for the Nonwoven Industry “Worldwide Strategic Partners” (WSP) manual, which is sponsored INDA and EDANA.

2.1 ISO test methods

a) ISO 5725 - 1 Accuracy (trueness and precision) of Measurement Methods and Results – Part 1: General Principles and Definitions

b) ISO 5725 - 2 Accuracy (trueness and precision) of Measurement Methods and Results–Part 2: Basic Method for the Determination of the Repeatability and Reproducibility of a Standard Measurement Method

c) ISO 554: 1976 Standard Conditioning

d) ISO 186: 1985 Nonwoven Sampling

2.3 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA’s and INDA’s Standard Test Methods

b) WSP 003.0.R2 (12) Guidelines for Standard Atmospheres for Conditioning and/or Testing

c) WSP 005.0.R2 (12) Nonwoven Sampling

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Nonwoven fabric

A fabric made directly from a web of fiber, without the yarn preparation necessary for weaving and knitting. In a nonwoven, the assembly of textile fibers is held together: (1). By mechanical interlocking in a random web or mat; (2). By fusing of the fibers, as in the case of thermoplastic fibers; or (3). by bonding with a cementing medium such as starch, casein, rubber latex, a cellulose derivative or synthetic resin. Initially, the fibers may be

oriented in one direction or may be deposited in a random manner. This web or sheet is then bonded together by one of the methods described above. Fiber lengths can range from 0.25 inch to 6 inches for crimped fibers up to continuous filament in spunbonded fabrics.

3.2 Sample

A portion of nonwoven taken from a production lot, roll, case or cases of product which is taken for testing. The sampling unit shall be identifiable and traceable back to its original source.

3.3 Specimen

A specific portion of the identified sample upon which a test is performed. Many specimens may be tested from the same sample, using different locations and different directions

4. Principle

Refer to the desired testing attribute listed in table 1 of this document and that test method will be found in the WSP 2012 manual.

5. Referenced Methods and Locations

Clause	Title of Document
7	WSP 003.0.R3 (12) Pre-conditioning/Testing
8	WSP 005.0.R3 (12) Sampling
9	Calibration when the test instrument requires it
10	WSP 030.1.R3 (12) and 030.2.R3 (12) Test Methods for Bursting Strength of Nonwoven Fabrics:

11	WSP 060.1.R3 (12), 060.2.R3 (12), 060.3.R3 (12), 060.4.R3 (12) Opacity/Brightness
12	WSP 090.1.R4 (12), 090.2.R4 (12), 090.3.R4 (12), 090.4.R4 (12) and 090.5.R4 (12) Test Methods for Flexural Rigidity (Stiffness) of Nonwoven Fabrics
13	WSP 160.1.1 R4 (12),160.2.R4 (12), 160.3.R4 (12), 160.4.R3 (12) Resistance to Linting, Dry and Wet
14	WSP 100.2.R3 (12) Test Method for Tearing Strength of Nonwoven Fabrics by the Trapezoid Procedure
15	WSP 100.3.R3 (12) Test Method for Tearing Strength of Nonwoven Fabrics by the Tongue (Single Rip)
16	WSP 300.0.R4 (12), 301.0.R4 (12), 302.0.R4 (12) Bacterial Filtration Efficiency and Bacterial Penetration
17	WSP 130.1.R4 (12) Test Method for Mass per Unit Area of Nonwoven Fabric
18	WSP 020.1.R3 (12), 020.2.R3 (12), 020.4.R3 (12) and 020.5.R3 (12) Test Methods for Abrasion Resistance of Nonwoven Fabrics
19	WSP 120.1.R4 (12), WSP 120.2.R4 (12) Test Method for Thickness of Nonwoven Fabrics
20	WSP 080.1.R4 (12) through 080.11.R4 (12) Repellency – Spray, Mason jar, Hydrostatic Pressure, Run-off, Wet-back, Oil and Alcohol Resistance
21	WSP 010.1.R3 (12), 010.2.R3 (12) and 010.3.R3 (12) Test Methods for Absorbency of Nonwovens
22	WSP 150.1.R4 (12) Test Method for Binder Distribution and Binder Penetration

23	WSP 200.2.R3 (12) through 270.2.R3 (12) Superabsorbent Materials/Powders
24	WSP 070.1.R3 (12), 070.3.R3 (12), 070.4.R3 (12), 70.5.R3 (12), 70.6.R3 (12), 251.0.R1 (12) Air Permeability, WVTR, Flowrate
25	WSP 110.1.R4 (12), Test Method for Modified Force and Elongation of Nonwoven Fabrics (Grab Test) combined INDA and EDANA methods WSP 110.4.R4 (12) Test Method for Breaking Force and Elongation of Nonwoven Fabrics (Strip Test)

6. Apparatus

Many of the listed test methods require specialized testing equipment. This equipment and a list of equipment vendors is in WSP 006.0.R2 (12).

7. Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in WSP 003.0.R3 (12) Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 2 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

8. Sampling

8.1 Lot sample

Take a lot sample as directed in the applicable material specification. In the absence of such a specification randomly select the roll or pieces that constitute the lot sampling using the following schedule from WSP 005.0.R3 (12).

These units shall be intact and in good condition

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 5	All
6 to 99	5
100 to 400	15
over 400	20

NOTE 3 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

8.2 Laboratory sample

From each roll or portion of material taken from the lot sample, cut at least one laboratory sample the full width of the fabric and 1 m (1 yard) in the machine direction. This is done after removing the first outside wrap or discarding the first 1 m (1 yard) length. For nonwoven fabric components of fabricated systems use the entire system.

8.3 Test specimens

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material.

a) Care in handling should be observed so that specimens do not contact any contaminants such as soap, salt, oil etc.
b) Specimens should be cut _____ mm.
c) Unless otherwise specified, cut ____ specimens, evenly spaced across the available width of each sample.

9. Calibration

Many of the test methods listed require the use of properly calibrated testing equipment. All testing systems should be verified before being used to generate results. Refer to the particular test method or vendor instructions for specific information on the preparation, calibration, and verification of apparatus.

GUIDANCE DOCUMENT: WSP 008.0.R2 (12)

For Evaluating Nonwoven Felts

The number in parentheses indicates the year of the last revision

1. Scope

This guide covers procedures for testing nonwoven felts. Many of the same methods that pertain to nonwoven materials also cover nonwoven felts.

This document will only cover the test methods that are shared by nonwoven materials and nonwoven felts.

The test procedures appear in the following clauses:

Nonwoven Methods	Sections
Air Permeability	16
Breaking Force and Elongation (Grab and Strip)	15
Bursting Strength	10
Calibration	9
Conditioning	7
Flexural Rigidity (Stiffness)	11
Mass Per Unit Area	13
Sampling	8
Thickness	14
Trapezoid Tear	12

Table 1

This test method provides the values in both SI units and inch-pound units. Inch-pound units are the customary units used in the United States and these values will be in parentheses in the body of this method. The International System of Units (SI units) are the customary metric units used in most of the rest of the world.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

Reference number
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Last approved as WSP 008.0 in 2005

NOTE 1 SAFETY

These standards do not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of these standards to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing these tests has been fully trained in all aspects of these procedures.

2. Normative References

The following referenced documents are indispensable for the application of this document:

All of the reference methods used in this document are found in the 2005 version of the Standard Test Methods for the Nonwoven Industry "Worldwide Strategic Partners" (WSP) manual, which is sponsored INDA and EDANA.

2.1 ISO test methods

a) ISO 5725 -1 Accuracy (trueness and precision) of Measurement Methods and Results – Part 1: General Principles and Definitions

b) ISO 5725 - 2 Accuracy (trueness and precision) of Measurement Methods and Results – Part 2: Basic Method for the Determination of the Repeatability and Reproducibility of a Standard Measurement Method

c) ISO 554: 1976 Standard Conditioning

d) ISO 186: 1985 Nonwoven Sampling

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

b) WSP 003.0.R3 (12) Guidelines for Standard Atmospheres for Conditioning and/or Testing

c) WSP 005.0.R3 (12) Nonwoven Sampling

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Nonwoven fabric

A fabric made directly from a web of fiber, without the yarn preparation necessary for weaving and knitting. In a nonwoven, the assembly of textile fibers is held together: (1). By mechanical interlocking in a random web or mat; (2). By fusing of the fibers, as in the case of thermoplastic fibers; or (3). by bonding with a cementing medium such as starch, casein, rubber latex, a cellulose derivative or synthetic resin. Initially, the fibers may be oriented in one direction or may be deposited in a random manner. This web or sheet is then bonded together by one of the methods described above. Fiber lengths can range from 0.25 inch to 6 inches for crimped fibers up to continuous filament in spunbonded fabrics.

3.2 Sample
A portion of nonwoven taken from a production lot, roll, case or cases of product which is taken for testing. The sampling unit shall be identifiable and traceable back to its original source.

3.3 Specimen
A specific portion of the identified sample upon which a test is performed. Many specimens may be tested from the same sample, using different locations and different directions

4. Principle
Refer to the desired testing attribute listed in table 1 of this document and that test method will be found in the WSP 2012 manual.

5. Referenced Methods and Locations

Sections	Title of Document
7	WSP 003.0.R3 (12)Pre-conditioning/Testing
8	WSP 005.0.R3 (12) Sampling
9	Calibration when the test instrument requires it
10	WSP 030.2.R3 (12) Test Method for Bursting Strength of Nonwoven Fabrics
11	WSP 090.1.R4 (12) Test Methods for Flexural Rigidity (Stiffness) of Nonwoven Fabrics
12	WSP 100.2.R3 (12)Test Method for Tearing Strength of Nonwoven Fabrics by the Trapezoid Procedure
13	WSP 130.1.R3 (12) Test Method for Mass per Unit Area of Nonwoven Fabrics
14	WSP 120.1.R4 (12), WSP 120.2.R4 (12) Test Methods for Thickness of Nonwoven Fabrics
15	WSP 110.1.R4 (12), Test Method for Modified Force and Elongation of Nonwoven Fabrics (Grab Test) combined INDA and EDANA methods WSP 110.4.R4 (12) Test Method for Breaking Force and Elongation of Nonwoven Fabrics (Strip Test)
16	WSP 070.1.R3 (12) Air Permeability

6. Apparatus

Many of the listed test methods require specialized testing equipment. This equipment and a list of equipment vendors is in WSP 006.0.R2 (12)

7. Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in WSP 003.0.R3 (12) Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 2 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

8. Sampling

8.1 Lot sample

Take a lot sample as directed in the applicable material specification. In the absence of such a specification randomly select the roll or pieces that constitute the lot sampling using the following schedule from WSP 005.0.R2 (12)

These units shall be intact and in good condition

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 5	All
6 to 99	5
100 to 400	15
over 400	20

NOTE 3 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

8.2 Laboratory sample

From each roll or portion of material taken from the lot sample, cut at least one laboratory sample the full width of the fabric and 1 m (1 yard) in the machine direction. This is done after removing the first outside wrap or discarding the first 1 m (1 yard) length. For nonwoven fabric components of fabricated systems use the entire system.

8.3 Test specimens

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material.
a) Care in handling should be observed so that specimens do not contact any contaminants such as soap, salt, oil etc.

b) Specimens should be cut _____ mm
c) Unless otherwise specified, cut ____ specimens, evenly spaced across the available width of each sample.

9. Calibration

Many of the test methods listed require the use of properly calibrated testing equipment. All testing systems should be verified before being used to generate results. Refer to the particular test method or vendor instructions for specific information on the preparation, calibration, and verification of apparatus.

STANDARD TEST: WSP 010.1.R3 (12)

Three Standard Test Methods for Nonwoven Absorption

The number in parentheses indicates the year of the last revision

1. Scope

This test method covers the evaluation of the behavior of nonwoven fabrics in the presence of liquids. In particular:

a) The liquid absorbency
b) The liquid absorptive capacity.
c) The liquid wicking rate (capillarity)

NOTE 1 It should be noted that these different aspects of absorbency relate to various end uses of the tested products.

NOTE 2 These tests are not applicable to any fabric containing superabsorbent materials.

The SI values are regarded as the official standard system of measurement for this standard test method.

NOTE 3 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document.

2.1 ISO test methods

a) Liquid Absorbency Time
ISO 9073-6: 2000 Textiles – Test methods for nonwovens – Part 6: Absorption 4. Liquid Absorbency Time (EN 29073 part 6)
b) Liquid Absorbency Capacity
ISO 9073-6: 2000 Textiles – Test methods for nonwovens – Part 6: Absorption 5. Liquid Absorptive Capacity (EN 29073 part 6)
c) Liquid Absorbency Capacity
ISO 9073-6: 2000 Textiles – Test methods for nonwovens – Part 6: Absorption 5. Liquid Absorptive Capacity (EN 29073 part 6)
d) ISO 5725 -1 Accuracy (trueness and precision) of measurement methods and results – Part 1: General principles and definitions
e) ISO 5725 -2 Accuracy (trueness and precision) of measurement methods and results – Part 2: Basic method for the determination of the repeatability and reproducibility of a standard measurement method
f) ISO 139: Textiles — Standard atmospheres for conditioning and testing

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g) ISO 3951–5: Samples procedures for inspection by variables — Part 5: Sequential sampling plans indexed by acceptance quality limit (AQL) for inspection by variables (known standard deviation)
h) ISO 565: Test sieves -- Metal wire cloth, perforated metal plate and electroformed sheet - Nominal sizes of openings

2.3 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply

3.1 Liquid absorbency time

Time required for a sample of absorbent material to become completely wetted by the test liquid i.e. to imbibe a liquid into its interior structure under specified conditions.

3.2 Liquid absorptive capacity

Mass of liquid that is absorbed by unit mass of the test absorbent expressed as a percentage of the mass of the test absorbent under specified conditions and after a specified time.

3.3 Liquid wicking rate

Measure of the capillarity of the test material which as the rate at which the liquid is transported into the fabric by capillary action.

4. Principle

In this test method each clause will cover three different procedures dealing with absorbency and each section of the clause will be preceded with the title of that section.

4.1 The liquid absorbency time

The liquid absorbency time test measures the time required for the complete wetting of a specimen strip loosely rolled into a cylindrical wire basket and dropped on to the surface of the liquid from a height of 25mm. In this method the liquid can come into contact with all surfaces of the sample.

4.2 The liquid absorptive capacity

The absorptive capacity method provides a measure of the amount of liquid held within a test specimen after specified times of immersion and drainage. This method measures the liquid stored within the test specimen itself after drainage has occurred vertically. For practical reasons, the drainage time is quite short. This is especially important if very volatile liquids are used, in which case an assessment of evaporation loss may be necessary.

4.3 The liquid wicking rate (capillarity)

The capillarity method measures the rate of vertical capillary rise in a specimen strip suspended in the test liquid.

NOTE 4 This test method basically measures the rate of absorption of the nonwoven and difficulties could be encountered when judging and comparing the results obtained with anisotropic materials.

NOTE 5 The use of colorant is not recommended. If it is used, the colorant should be mentioned in the test report.

5. Apparatus

5.1 The liquid absorbency time

Cylindrical wire basket open at one end with height (80 ± 1) mm, diameter 50 ± 1) mm, constructed of suitable gauge wire to obtain a mass of (3 ± 0.1) g, e.g. 0.5mm diameter stainless steel wire. The mesh should have openings approximately 20 mm square and soldered to create a firm structure. Extra solder or extra lengths partially doubling the rings may be added to adjust the mass. These should be distributed symmetrically in order to maintain the balance of the basket Figure 1.

5.2 The liquid absorptive capacity

5.2.1 Wire gauze test specimen support

Wire gauze test specimen support at least 120 mm x 120 mm with a metal frame. The gauze shall be made from stainless steel test sieve of 2 mm nominal mesh size according to ISO 565. Clips to hold the test specimen on the gauze.

5.2.2 Dish

For containing the wire gauze with the test specimen attached, of sufficient volume to allow a test liquid depth of 20 mm.

5.2.3 Weighing glass

Suitable weighing glass, with cover

5.2.4 Balance

Capable of determining mass to an accuracy of ± 0.01 g

5.2.5 Stopwatch

5.3 The liquid wicking rate (capillarity) — Figure 2

5.3.1 Base plate

Base plate (with leveling screws)

5.3.2 Dish

For the test liquid

5.3.3 Horizontal support

This can be adjusted along a vertical support

5.3.4 Clamps

On the above horizontal support for fastening the samples

5.3.5 Measuring rod

With a millimeter scale, fixed vertically on the horizontal support

5.3.6 Stopwatch

5.3.7 Glass rod

That has a 4 mm to 5 mm diameter and 30 mm in length or standard paper clip (as proposed by INDA).

5.3.8 Test liquid

The test liquid used should be agreed and specified and identified in the test report.

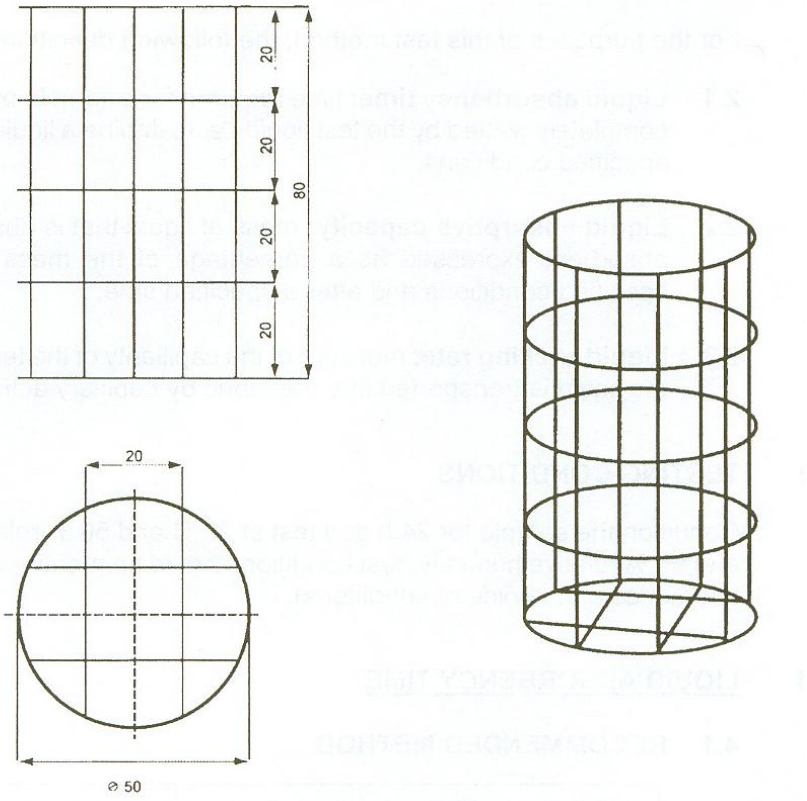

Figure 1
Cylindrical wire basket (dimension in mm)

6. Conditioning

Condition the sample for 24 h and test at 23°C and 50% relative humidity or, if not, at 20°C and 65% relative humidity; test conditions are to be mentioned in the report (see ISO 139 for tolerances and choice of conditions).

7. Procedure

7.1 The liquid absorbency time

Procedure	Worked Example
7.1.1 Cut 5 test specimen measuring (76±1) mm in machine direction and of sufficient length in the cross direction so that they each weigh (5±0.1) g. These strips shall be equally spaced across the fabric sample. When there is a difference in the surface characteristics of the fabric, it may be necessary to duplicate the test procedure so that each side of the fabric faces the internal surface of the basket	76 mm x 165 cm
7.1.2 The liquid shall be left long enough to equilibrate with the conditioned atmosphere.	
7.1.3 Loosely roll a test specimen starting from the short end and place it in the wire basket.	
7.1.4 Drop the basket, on its side, from a height of (25±1) mm from the liquid surface into the container of the specified liquid and start the stopwatch.	
7.1.5 Record the time taken for the basket to completely sink below the surface of the liquid.	6.3 s
7.1.6 Repeat with the other 4 test specimen.	6.0 s 6.7 s 6.4 s 6.2 s
7.1.7 Use fresh conditioned test liquid for each set of 5 test specimen.	
7.1.8 Calculate the average liquid absorbency time, in seconds and the standard deviation.	6.3 x (σ = 0.23 s)

7.2 The liquid absorptive capacity

Procedure	Worked Example
7.2.1 Cut 5 test specimen (100 ± 1) mm x (100 ± 1) mm from the sheet. If the individual test specimen weighs less than 1 g, lay test specimens on top of each other to give to each of the piles a total stacked mass of at least 1 g.	Test specimen: 100 x 100 mm approx. 0.40 g (40g/m^2) (so piles of specimens used)

7.2.2 The liquid shall be left long enough to equilibrate with the conditioned atmosphere.	
7.2.3 Weigh the test specimen (or pile) to an accuracy of 0.01 g, using the balance and the weighing glass with cover.	Pile mass = 1.21 g
7.2.4 Place the test specimen (or pile) on the stainless steel gauze, fastening it (them) at the edges with the clips.	
7.2.5 Place the gauze with the attached test specimen(s) approximately 20 mm below the liquid surface in the dish and start the stopwatch. Introduce the gauze obliquely in order to avoid trapping air bubbles.	
7.2.6 After (60 ± 1) s remove the gauze test specimen support and test specimen (or pile).	
7.2.7 Remove all clips but one at one corner.	
7.2.8 Hang freely vertical to drain for (120 ± 3) s.	
7.2.9 Take the test specimen (or pile) off the gauze without squeezing the liquid from it; place the test specimen in the weighing glass with cover and weight.	Wet pile mass + 7.72 g
7.2.10 Repeat 7.2.3 to 7.2.9 for the other 4 test specimens.	Dry Mass / Wet Mass 1.06 g / 6.98 g 1.22 g / 7.32 g 1.31 g / 8.65 g 1.28 g / 8.32 g
7.2.11 Use fresh conditioned test liquid for each set of 5 test specimens (or piles).	
7.2.12 Calculate: a) The liquid absorptive capacity (LAC) in % of each specimen or each pile from the following: $LAC\% = \frac{M_n - M_k}{M_k} \times 100\%$ M_k: mass in g of the dry test specimen(s) M_n: mass in g of the wet test specimen(s) at the end of the test.	538%; 540%; 500%; 560%; 550%
b) The average liquid absorptive capacity of the 5 test specimens (or piles) and the standard deviation.	538% (σ = 20%)

7.3 The liquid wicking rate (capillarity)

Procedure	Worked Example
7.3.1 Cut at least 5 test specimens (30 ± 1) mm wide x (250 ± 1) mm long in both the machine direction and the cross direction.	MD test specimens 5 CD test specimens Each 30 mm x 250 mm
7.3.2 Punch two holes, (5 ± 1) mm diameter out of one of the short ends of each test specimen at (5 ± 1) mm from short and long sides.	
7.3.3 The liquid shall be left long enough to equilibrate with the conditioned atmosphere.	
7.3.4 Clamp the test specimen vertically to the horizontal support with the punched holes at the bottom.	
7.3.5 Place a glass rod through two slots to keep tension on the test specimen and maintain it vertically.	
7.3.6 Place test specimen neat and parallel to the measuring rod and projecting (15 ± 2) mm below the zero point of the measuring rod.	1 MD test specimen
7.3.7 Lower the horizontal support until the zero point of the measuring rod touches the liquid surface (the lower test specimen edge is then (15 ± 2) mm below the surface.	
7.3.8 At this moment, start stopwatch.	
7.3.9 Record the height of capillary rise of the liquid after 10 s, 30 s, 60 s (and 300 s if required). (If capillary rise is not a uniform straight line, record the highest point)	Time(s) Capillary Rise (mm) 33 48 57
7.3.10 Repeat 7.3.4 to 7.3.9 with the other 9 test specimens.	**Capillary Rise (mm)** **10s 30s 60s** **MD Test Specimens** 30 45 55 29 50 50 32 51 59 37 46 60 **CD Test Specimens** 25 35 42 22 30 45 27 32 43 23 36 40 26 32 47
7.3.11 Use fresh conditioned test liquid for each set of 10 test specimens.	

7.3.12 Calculate the average capillary rise obtained on the 5 test specimens for each specified time and the standard deviation: a) in the machine direction b) in the cross direction 7.3.13 Trace a curve using the data obtained (7.3.12), so that the wicking rate can be calculated at a required time or at a required capillary rise.	Time(s) Capillary Rise (mm) MD 10 32 (σ = 2.8) 30 48 (σ = 2.3) 60 56 (σ = 3.5) CD 10 25 (σ = 1.9) 30 33 (σ = 2.0) 60 43 (σ = 2.4)

8. Report

8.1 The liquid absorbency time

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Number of specimens tested and note CD and/or MD if significant
g) Software used and version
h) Deviation from the standard test procedure, if any
i) Average liquid absorbency time and its standard deviation
j) Whether or not samples were conditioned prior to testing and, if so, for how long
k) Anything unusual noted during the testing
l) Identification of the liquid and include the surface tension and measurement method used

8.2 The liquid absorptive capacity

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Number of specimens tested and note CD and/or MD if significant
g) Software used and version
h) Deviation from the standard test procedure, if any
i) Average liquid absorptive capacity and its standard deviation
j) Whether or not samples were conditioned prior to testing and, if so, for how long
k) Anything unusual noted during the testing
l) Identification of the liquid and include the surface tension and measurement method used

8.3 The liquid wicking rate (capillarity*)*

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Number of specimens tested and note CD and/or MD if significant
g) Software used and version
h) Deviation from the standard test procedure, if any
i) Average liquid wicking rate and its standard deviation
j) Whether or not samples were conditioned prior to testing and, if so, for how long
k) Anything unusual noted during the testing
l) Identification of the liquid

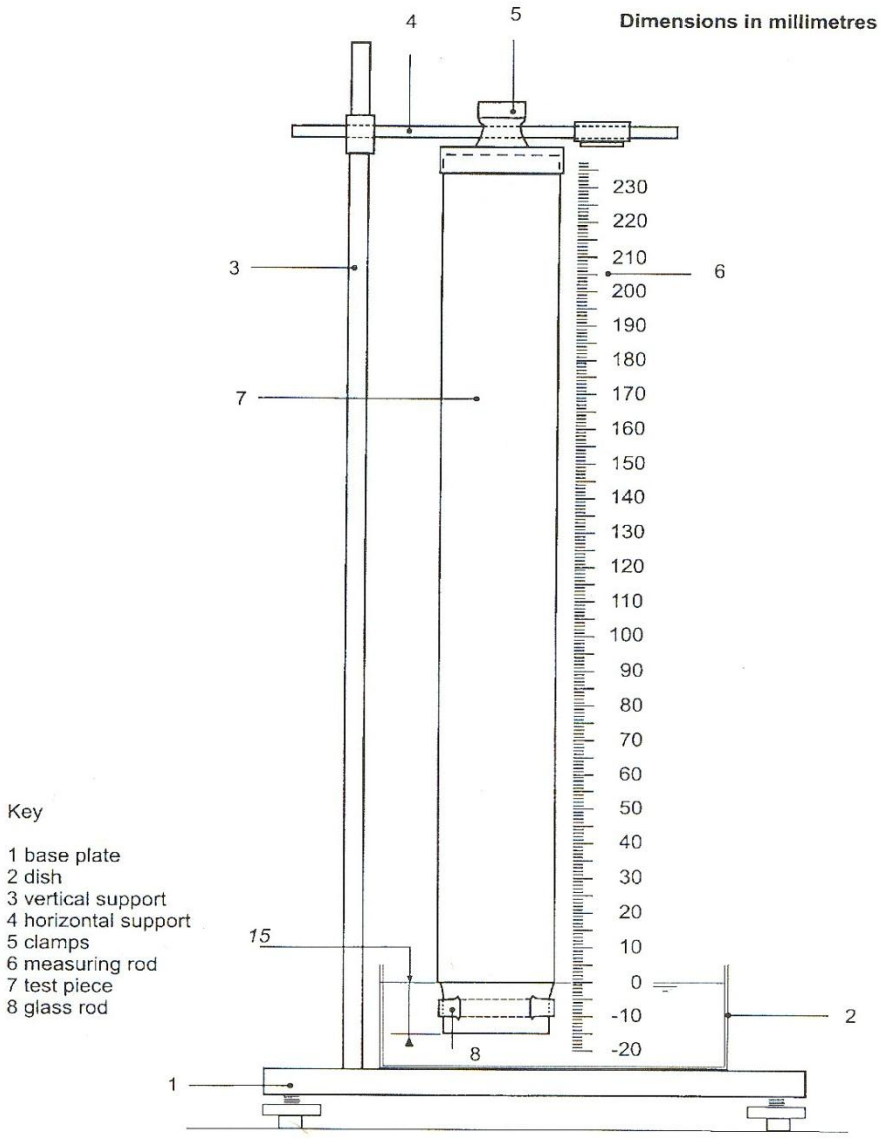

Figure 2 – Test apparatus for wicking rate measurement

STANDARD TEST: WSP 010.2.R3 (12)

Standard Test Method for Measuring the Rate of Sorption of Wiping Materials

The number in parentheses indicates the year of the last revision

1. Scope

This test method gives a technique for quantifying the rate of sorption of wiping materials. Briefly stated, a stack of wiping materials of known mass and dimensions is placed on the surface of a thermostatically controlled tank of water. The time required for the stack to wet out is recorded. From these measurements and from the mass of the wetted stack of wipers, a rate of sorption through the plane of the wiper can be calculated.

When the rate is calculated as a flux on a per-unit-area basis, it is termed the extrinsic rate of sorption, R_e [mL/m^2/s]. The rate calculated on a per unit – mass basis is termed the intrinsic rate of sorption, R_i [mL/g/s]. If basis weight is given in units of grams per square meter, then the two rates of sorption are related via the equation:

$R_e = R_i$ x basis weight (1)

The test rests on three hypotheses: that the rate of sorption is independent of the area of the specimens, that the rate of sorption is independent of the number of plies used to do the test, and that the sorptive capacity of the wiper is independent of the number of plies used to do the test. These hypotheses have been shown to be valid within the limits described in this procedure.

In addition to the measurement of rate of sorption, the method also permits the simultaneous determination of basis weight and sorptive capacity.

The SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

Reference number
WSP 010.2.R3 (12) A

Current edition approved WSP 010.2.R3 (12)
Originally published as WSP 10.2 in 2005
Last approved as WSP 10.2 in 2008

2. Normative References

The following referenced documents are indispensable for the application of this document:

C. F. Mattina and J. M Oathout, “A New Method for Determining the Rate of Sorption of Wiping Materials,” CleanRooms, 8(4), 18-24 (1994), and International Nonwovens Journal, 7(1) 48 (1995).

J.M. Oathout and C.F. Mattina, “A Comparison of Selected Industrial and Household Wiping Materials for Rate of Sorption, Sorptive Capacity and Strength,” International Nonwovens Journal, 7 (1) 58 (1995).

2.1 ISO test methods

a) ISO 5725-1 Accuracy (trueness and precision) of measurement methods and results – Part 1: General principles and definitions

b) ISO 5725-2 Accuracy (trueness and precision) of measurement methods and results – Part 2: Basic method for the determination of the repeatability and reproducibility of a standard measurement method

c) ISO 139 : Textiles — Standard atmospheres for conditioning and testing

d) ISO 3951-1:2005 Sampling procedures for inspection by variables

2.2 WSP test methods

a) WSP 001.0.0 R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA’s and INDA’s Standard Test Methods

3. Apparatus

3.1 A mechanical balance

With a sensitivity of 10 mg, such as an Ohaus Cent-o-gram Model, is adequate.

3.2 A hand-held digital electronic stopwatch

Capable of reading to 0.01 s, such a Fisher Model 14-648-10, is acceptable.

3.3 For a thermostat

A utility water bath such as Cole-Parmer Model G-12500-30 may be used. Alternatively, any container of convenient size and shape (e.g., a rubber tray with dimensions 0.4 m x 0.3 m x 0.2 m) filled with water and fitted with temperature controller (e.g., Cole-Parmer Model G-1266-30 is adequate. The thermostat should be controllable to 25 ± 1° C and deep enough so that the topmost ply of a stack of fully wetted wipers is not higher than the surface of the water.

4. Preparation of Specimens

4.1 The specimens to be tested

Should be square or rectangular and have areas which lie between 25000 mm^2 (approximately equal to a square 150 mm on a side) and 60000 mm^2 (approximately equal

to a square 250 mm on a side). For areas smaller than 25000 mm^2, edge-effects come into play, and a unique rate of sorption cannot be obtained using this method. For areas larger than 60000 mm^2, handling the stacks of wipers becomes operationally difficult. In such instances, it is best to cut the wipers to a smaller size. The aspect ratio of the wipers should not be greater than, at most, 2:1.

4.2 If the stack of wipers to be tested

Originates with materials which were previously folded, uniform placement of the stack onto the surface of the water may be especially difficult to achieve. If a choice exists between placing a stack of wipers slightly concave up or slightly concave down, the former configuration is preferred since it reduces the likelihood of the formation of an air pocket.

4.3 Occasionally, a stack of unfolded wipers

Will not lie as flat as desirable for uniform placement upon the surface of the water. In such instances, modest compression of the stack or bending the previously folded creases backwards will correct the problem.

4.4 In rare instances

A wiper will be encountered that is sufficiently two-sided such that its measured rate of sorption depends on which side of the stack faces the pool of water during the performance of the test. In such cases, the rate should be determined separately from both sides and the two values averaged. In order to guard against this rare occurrence, it is suggested that during successive determinations of rate of sorption with any given wiper the stack be placed on the surface of the water, sometimes with one side facing upwards, sometimes with the other side facing upwards.

5. Procedure

5.1 Begin with a stack of 10 wipers [n=10]

The mass of the stack, $\mathbf{m_d}$ [g], is determined on the balance to three significant figures; the length 1[m], and width w[m], of the stack are measured and recorded to the nearest millimeter. The stack is placed gently upon the surface of the water in the tray in one continuous smooth motion. The timer is started simultaneously with the placement of the stack on the water and stopped at the last disappearance of dryness from the topmost ply of the stack; the time, $\mathbf{t_n}$[s] is recorded. The stack of wipers is then lifted out of the water, held vertically by adjacent corners at a slight angle to the horizontal, and allowed to drain for 60 seconds. The mass of the wetted stack of wipers, $\mathbf{m_w}$[g], is then determined on the balance.

5.2 Repeat the experiment once or twice again

At the same value of n, then again at one or two different values of n, perhaps 5 or 15 wipers, in order to establish that there is no ply-dependence of the measured rate. While that phenomenon is known to occur only with slower sorbing wipers, i.e. when $\mathbf{R_e}$ is less than approximately 200 $mL/m^2/s$, demonstrating that $\mathbf{R_e}$ does not vary systematically with **n** is a worthwhile exercise. In those relatively rare instances when ply-dependence is found to exist, extrapolation to n = 1 ply provides a unique value for the rate of sorption.

6. Calculations

From these measurements, basis weight, extrinsic and intrinsic sorptive capacity are calculated as follows:

$bw = m_d/[n \times 1 \times w]$ (2)
$A_e = [(m_w - m_d)/0.997]\ [n \times l \times w]$ (3)
$A_i = A_e/bw$ (4)
$R_e\ [(m_w – m_d/0.997]/[l \times w]\ /t_n$ (5)
$R_i = R_e/bw$ (6)

where:

n is the number of wipers
bw is the basis weight [g/m^2]
A_e is the extrinsic sorptive capacity [mL/m_2]
A_i is the intrinsic sorptive capacity [mL/g]
R_e is the extrinsic rate of sorption [$mL/ m^2/s$]
R_i is the intrinsic rate of sorption [mL/g/s]
And 0.997 g/mL is the density of water at 25°C.

NOTE 2 The water in the thermostat should be changed frequently if it is known or suspected that surface-active agents are present in the wipers being tested, having been added during their manufacture to render them hydrophilic. Otherwise, the surfactants will be extracted from the wipers and may alter the surface tension, viscosity, etc. of the thermostatically controlled water, thereby influencing the measurement of the rates of sorption of subsequently tested samples.

NOTE 3 A helpful addition to the test is a timer which can be operated by a foot switch so that both hands may be used to place the stack of wipers onto the surface of the water.

7. Precision

The precision of the test has been established by selecting a single wiper, which was believed to be of extremely uniform manufacture. Ten stacks of these wipers were prepared and they were tested using the protocols described above with the results shown in Table 1. Applying standard statistical methods to these data gives the following averages and standard deviations:

The dispersion of the data indicates that the single standard deviation for this method of determining rate of sorption is approximately 9%.

Precision results of the test wipers

N	Dimensions [mm x mm]	Basis weight [g/m^2]	A_e [mL/m^2]	A_i [mL/g]	R_e [mL/m^2/s]	R_i [mL/g/s]
20	229 x229	65.3	272	4.16	2800	42.9
20	229 x229	65.3	272	4.17	2890	44.2
20	229 x229	66.1	275	4.16	2370	35.9
20	229 x229	68.5	284	4.15	2400	35.0
20	229 x229	68.1	284	4.17	2460	36.1
20	229 x229	67.6	283	4.18	2750	40.6
20	229 x229	64.7	268	4.14	2780	42.9
20	229 x229	65.8	274	4.16	2510	38.2
20	229 x229	66.2	276	4.17	2320	35.0
20	229 x229	67.6	280	4.14	2420	35.9

Table A 1.

STANDARD TEST: WSP 010.3.R3 (12)

Standard Test Method for Nonwovens Demand Absorbency

The number in parentheses indicates the year of the last revision

1. Scope

This test method describes the evaluation of the absorbency of fabrics when one side is in contact with a liquid and the fabric is under mechanical pressure.

This test is designed to allow comparison of absorbent materials such as nonwovens and is not intended to simulate in-use conditions of finished products. Demand absorbency is also called demand wetability.

The SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative references

The following referenced documents are indispensable for the application of this document.

2.1 ISO test methods

a) ISO 9073-12:2001 Test Methods for Nonwovens Part 12: Demand Absorbency [EN 29073 part 12 (UAP1)]

b) ISO 139 : Textiles — Standard atmospheres for conditioning and testing

c) ISO5725–2: Accuracy (trueness and precision) of measurement methods and results — Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

This method is derived from the work of Burgeni and Kapur (Textile Research Journal, Vol 37, pp 356-366, May 1967). It is a modification of the Italian test method UNI 4818, Part 25 and

Reference number
WSP 010.3.R3 (12) A

Current edition approved WSP 010.3.R3 (12)
Originally published as WSP 10.3 in 2005
Last approved as WSP 10.3 in 2008

Swedish test method Svensk Standard SIS 251228. The Tappi test method T561 om-96 is similar.

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Maximum absorbed mass (A_f)

The mass of liquid absorbed (in g) at the time Tf, when the absorbed mass variation in the previous 5 s time period is lower than 1% of the absorbed mass corresponding to T_f.

3.2 Demand absorbency capacity (DAC)

Maximum absorbed mass of liquid (A_f) divided by the mass of the test specimen (m), expressed in g/g.

3.3 Maximum absorption rate (MAR)

Maximum change in liquid absorbed mass per time interval expressed in gs^{-1}. The MAR is calculated over 1 s time period from data recorded with sampling intervals of 0.25 s or less. (The maximum absorption rate is observed at the point of inflexion of the curve-absorbed mass of liquid versus time).

4. Principle

The method measures the demand absorbency of a nonwoven under a constant mechanical pressure. The test specimen is placed on a specified porous plate, which is connected by a siphon to a liquid reservoir. The level in the reservoir is set below the upper surface of the porous plate see figure 2. The demand absorbency is measured in terms of the change in mass of the reservoir with time see figure 1.

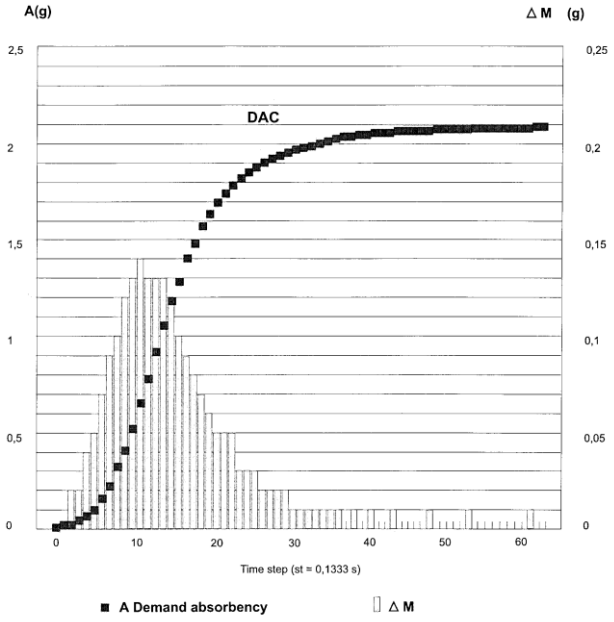

Figure 1

5. Apparatus

5.1 Plain porous glass plate

Diameter (60 ± 1) mm set into the top of a funnel, which has a minimum outlet diameter of (7.0 ± 0.2) mm. The plate (4 ± 1) mm thick has a porosity rating of 2 (40 to 90 µm) and a flow rate of 2.5 to 3.5 g/s under the conditions specified in the calibration procedure.

5.2 Glass reservoir

Cylindrical at least 80 mm in diameter.

5.3 Siphon assembly

Consisting of a glass U - tube and a flexible silicone rubber tube, both with an internal diameter of (8.0 ± 0.2) mm.

5.4 Electronic balance

To weigh the reservoir and its content, capable of determining the mass to an accuracy of 0.01g.

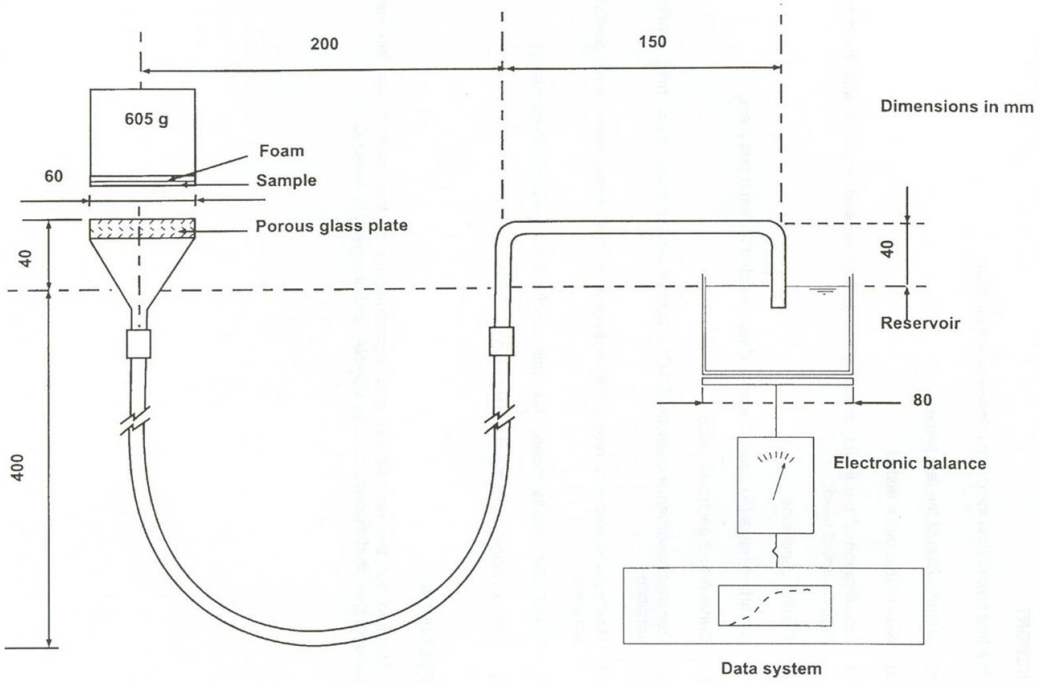

Figure 2
Demand Absorbency Apparatus

5.5 Data acquisition system

This allows the change of mass of the reservoir to be recorded against time (e.g. microprocessing device, data analysis and printing device). If this is a digital system it should be able to take readings at least four times per second.

NOTE 2 The sampling time interval is defined by $\Delta t \leq 0.25$ s. Generally the 5 s are a multiple of Δt and ΔT = 5 s, but if it is not the case, the maximum difference between ΔT and 5 s could be $\pm$ 1% ΔT. In this case the resulting error on T_f and more conclusively on A_f , is completely negligible.

NOTE 3 High absorbent rate materials may need readings taken eight times per second.

5.6 Hydrophobic polyether-polyurethane foam specimen

Should be (55 ± 1) mm in diameter and (2.0 ± 0.5) mm thick, with 20 regular open cells per cm and a density of (28 ± 3) kg/m³.

5.7 Cylindrical weight

Should be (60 ± 1) mm in diameter and the total mass of the weight and the foam specimen is (605 ± 5) g, which corresponds to an imposed pressure on the test specimen of (2.50 ± 0.05) kPa.

5.8 Test liquid

Demineralized water is normally used (according to ISO 3696), but other appropriate liquids can be used. The liquid used should be specified and identified in the test report. Use at temperature (20 ± 2) °C.

5.9 Cleaning product

As an example sulphochromic acid (e.g. 1/3 $K_2Cr_2O_7$ 50g/L and 2/3 H_2SO_4, 95%) or equivalent.

6. Assembly of Apparatus

The layout of the apparatus is shown in figure 2. The components are assembled according to the dimensions given.

a) The hydrophobic foam is attached to the bottom of the weight with hydrophobic double-sided tapes so that the foam can be changed from time to time.
b) In order that the apparatus is filled with liquid without any entrained air bubbles, ensure all the tubes are filled and then connect them to the funnel containing the porous medium under water as shown in figure 3.
c) Using a spirit level, align the top surface of the porous medium and the horizontal part of the top external surface of the glass U-tube ensuring both are (40.0 ± 0.5) mm above the liquid level in the reservoir.
d) Set up the data acquisition system and check it for effectiveness.

NOTE 4 The flow resistance of the apparatus itself will affect the results and this is governed by the dimensions and shapes of the tubes, the water level and the porosity of the porous medium. Consequently it is essential to adhere to the specifications of the apparatus and the defined procedure if good reproducibility is to be obtained.

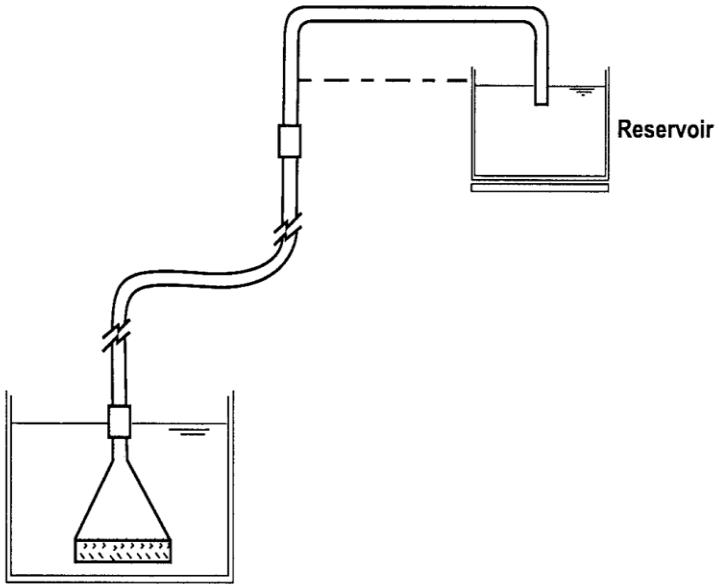

Figure 3
Showing water levels

7. Sampling

7.1 Mark the nonwoven samples

So that the face that is to be in contact with the porous plate is readily identifiable.

7.2 Cut out 5

Test specimens from each sample (55 ± 1) mm in diameter.

8. Conditioning

For Conditioned Testing:

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 5 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested.

9. Preparation and Calibration of Test Apparatus

Calibration of the porous medium

Determination of flow through the porous medium using the data acquisition system

a) The apparatus is the same as for the test method, see clause 5
b) The test liquid is demineralized water

c) Assemble the equipment as demonstrated in clause 6 and Figure 4
d) Form a cup from the porous medium by wrapping adhesive tape around it. It need not be perfectly watertight and a small leakage will have no effect on the results

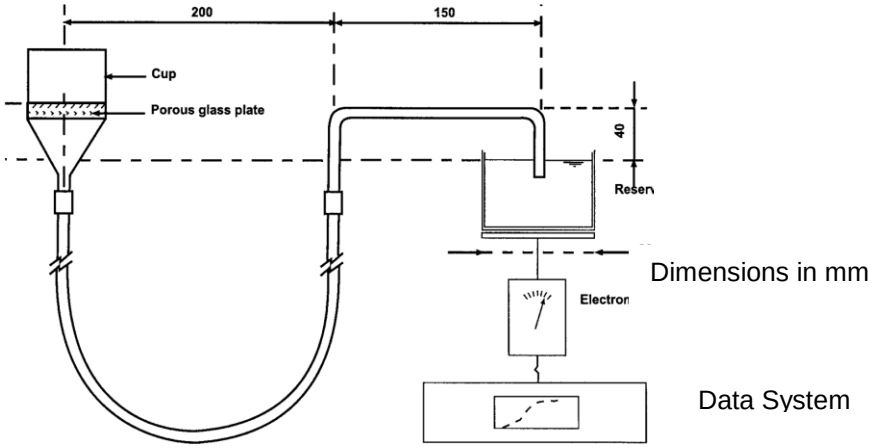

Figure 4
Equipment assembled

e) Start the data acquisition system
f) Pour 11 ml of demineralized water into the cup
g) Record the increasing mass of the reservoir and water in it with time. Ensure that the mass increases a minimum of 10g
h) Once the flow into the reservoir has stopped, stop the data acquisition system and draw a mass versus time curve, see Figure 5

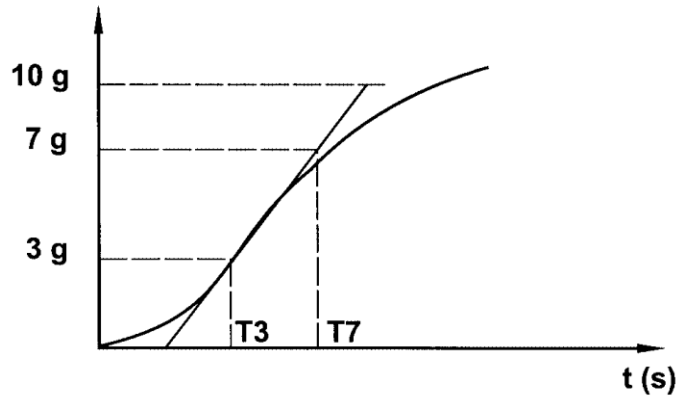

Figure 5
Calibration of the porous medium

i) Determine the discharge times t_3 and t_7 corresponding to 3g and 7g of water mass increase:

j) Calculate the flow rate (FR):

$$FR(g/s) = \frac{4}{t_7 - t_3}$$

10. Procedure

Procedure	Worked Example
10.1 Weigh the test specimen and record the mass (m) in g.	M= 0.317 g
10.2 If necessary, dry the foam attached to the weight with a hair drier.	
10.3 Attach the test specimen to the foam face of the weight with hydrophobic double-sided tape using 3 specimens of 1 cm^2.	
10.4 Ensure that the height of the porous plate and the horizontal part of the top external surface of the u-tube are (40.0 + 0.5) mm above the liquid surface.	Mass of reservoir at start of test (Mo) = 243.27 g
10.5 Weigh the reservoir of liquid and record the mass Mo in g. If the balance has a tare facility, it can be convenient to set this at this time in which case Mo=0.	
10.6 Start the data acquisition system.	
10.7 Place the weight with the foam and test specimen attached onto the porous medium. As far as possible, ensure that the face of the test specimen is parallel to the face of the porous medium and also that the test specimen is concentric to the medium at the time the test specimen and porous medium come into contact.	
10.8 Record the decreasing mass of the reservoir and liquid with the data acquisition system (Mt).	Estimated maximum absorbed mass (Ae) = 2g 1% Ae = 0.02 g
10.9 Run the test and record the mass until the mass variation within 5 s is lower than 1% of the estimated maximum absorbed liquid (Ae). Stop the data acquisition system.	Mass variation within 5 s < 0.02 g
10.10 Remove the weight from the porous medium and remove the test specimen from it.	
10.11 Repeat steps 10.1 to 10.10 with the other four test specimens.	
10.12 Use fresh conditioned test liquid for each set of five test specimens.	
10.13 After each set of five tests, clean the porous medium with sulphochromic acid or equivalent cleaning product and then rinse with distilled water.	

11. Calculation

NOTE 6 The sampling time interval is defined by $\Delta t \leq 0.25$ s. Generally the 5 s are a multiple of Δt and ΔT = 5 s, but if it is not the case, the maximum difference between ΔT and 5 s could be $\pm$ 1% ΔT, in this case the resulting error on T_f and more conclusively on A_f is completely negligible.

NOTE 7 Independently of the method of calculation, the final time Tf usually presents a large coefficient of variation (contrary to the maximum absorbed mass $A_{f)}$. For this reason, Tf is mentioned in the test report only if requested.

Expression of the Results	Worked Example
11.1 Several characteristics can be determined for each test specimen on the basis of absorbed mass (A) against time (t).	
11.1.1 Calculate and draw the curve of A against t (see figure 1 for an example) with $A_t = M_0 - M_t$.	
11.2 Maximum absorbed mass (A_f).	
11.2.1 Calculate for each test specimen:	
11.2.2 The maximum absorbed mass (A_f) is recorded at the time Tf at which the mass variation within the previous 5 s time period is lower than 1% of the maximum absorbed mass.	M_r = 241.56g M_o = 243.27g A_r = 1.71g
11.2.3 In practice the calculation is made on a time period ΔT close to 5 s and equal to a full number N of time steps Δt, i.e.:	
$\Delta T = N\Delta t \geq 5$ s	ΔT = 38 x 0.133 s = 5.054 s > 5 s
with $(N-1)\Delta t < 5$ s	37 x 0.133 s = 4.921 s 4.921 s < 5 s
and $A_f - A_{(T_f - \Delta T)} < \frac{1}{100} A_f$	$A_f - A_{(T_f - \Delta T)} = 0 < \frac{1}{100} A_f$
11.3 Demand absorbency capacity (DAC).	DAC=1,1/0,317= 5.39 g/g
11.3.1 Calculate for each test specimen $DAC = A_f / m$	
11.4 Maximum absorption rate (MAR).	
11.4.1 In general: $AR_x = [(M_x - M_{x-1})/(t_x - t_{x-1})]$ where AR_x is the absorption rate corresponding to the time interval t_{x-1} to t_x. If $\Delta M_x = \lvert M_x - M_{x-1} \rvert$ and $\Delta t_x = (t_x - t_{x-1})$, Then with a constant sampling interval Δt $ARx = \Delta Mx / \Delta t$	
11.4.2 It is thus necessary to calculate the mass change ΔM for each sampling interval, and to identify the maximum change. The mass changes for other sampling intervals are then ranked in order of decreasing magnitude until the sum of the sampling intervals is greater than 1 s.	
11.4.3 The MAR for the 1 s period is based on the individual, highest, ranked changes whose total sampling intervals are equal to or less than 1 s. In this case the highest ranked mass changes are completed with the due proportion of the next ranked change. That proportion is related to the time required to be added to the already summed sampling intervals in order to total 1 s.	
11.4.4 The calculations are best laid out as a table,	

see data table in Annex A 11.4.5 For each sampling interval after absorption has started calculate the mass absorbed, ΔM until the recorded mass stabilizes. Rank the n highest values of ΔM in descending order such that n Δt > 1 s and (n-1) Δt < 1 s, let these be ΔM_{max}, ΔM_{max-1}, ΔMmax-2,....ΔM_n.	n =8 nΔt = 8 x 0.1333 = 1.06 s > 1s (n-1)Δt = 7 x 0.133 = 0.93 < 1s
If (n-1) Δt < 1 s : calculate a factor k = [(1 - (n - 1)Δt)] / Δt	k= (1 - 7 x 0.133) / 0.133 = 0.52
then: MAR = ΔM_{max} + ΔM_{max-1} + ΔM_{max-2} ...+ ΔM_{n-1} + k [ΔM_{n-1} - k(ΔM_{n-1} - ΔM_n)]	MAR = [0.19+0.19+0.17+0.16 +0.16 +0.15 + 0.15 + 0.52(0.15-0,01)] g / s MAR= 1.25 g / s
If (n-1) Δt = 1 s, k=0	
NOTE 8 For material having an exceptionally high absorbent rate the following rule is applicable: If 60% of the DAC is reached in less than 1 second, the maximum time step for measurement will be reduced from 0.25 s to 0.125 s and the time for calculating the MAR will be reduced from 1 sec to 0.5 sec.	
NOTE 9 If the sampling interval Δt_x is not constant the calculation is obviously more complex and needs to be based on AR, rather than ΔM. The n highest value of AR_x are easily ranked in descending order in a table mentioning in parallel the corresponding Δt_x, i.e.:	
From AR_m AR_{m-1} to AR_n, and to which correspond Δtm Δt_{m-1} to Δt_n, such that $\sum_{x=m}^{x=n} \Delta t_x > 1s$	
and $\sum_{x=m}^{x=n-1} \Delta t_x \leq 1s$	
calculate the factor $k' = \left[1 - \sum_{x=m}^{x=n-1} \Delta t_x\right] / \Delta t_n$	
and MAR = k'[AR_{n-1} – k'(AR_{n-1} – AR_n)] Δt_n $+ \sum_{x=m}^{x=n-1} AR_x \Delta t_x$	

12. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Number of specimens tested and note CD and/or MD if significant
g) Software used and version
h) Deviation from the standard test procedure, if any
i) Identification of the liquid and include the surface tension and measurement method used
j) Whether or not samples were conditioned prior to testing and, if so, for how long
k) Anything unusual noted during the testing
l) Absorbed mass (A) against time (t) data recorded for each specimen
m) Curve A/t for each specimen
n) Demand absorbency capacity (DAC) individual results, mean, max, coefficient of variation
o) Maximum absorbency rate (MAR) individual results, mean, max, coefficient of variation
p) If individual results, mean, max, min, coefficient of variation (if requested)

13. Precision

The data for the repeatability$_{(r)}$ and reproducibility$_{(R)}$ of this method are the result of collaborative studies carried out by EDANA using ISO 5725-2 and the results are given in Annex B

ANNEX A

(informative)

MAR Calculation Explanation

A constant sampling time interval of 0.133 s is used in this example

Time (s)	M (g)	ΔM (g)	Rank
0.133	243.270 M_o	0.000	
0.266	243.260	0.010	
0.400	243.220	0.040	
0.766	242.920	0.130 = ΔM_n	(8)
0.800	242.770	0.150 = ΔM_{n-1}	(7)
0.933	242.600	0.170	(3)
1.066	242.440	0.160	(4)
1.200	242.250	0.190 = ΔM_{max}	(1)
1.333	242.060	0.190 = ΔM_{max-1}	(2)
1.466	241.900	0.160	(5)
1.500	241.750	0.150	(6)
2.266	241.590	0.040	
2.400	241.560	0.030	
2.533 $T_f - \Delta T$	241.560 M_f	0.000	
2.666	241.560	0.000	
7.600 (T_f)	241.560 M_f	0.000	

Number of time steps

n = 8, indeed per clause (10.4.5) $n \Delta t = 8 \times 0.133 \text{ s} = 1.06 \text{ s} > 1 \text{ s}$

$(n - 1) \Delta t = 7 \times 0.133 \text{ s} = 0.93 \text{ s} \leq 1 \text{ s}$

Factor k

$k = [1 - (n-1) \Delta t] / \Delta t$

$k = (1 - 7 \times 0.133) / 0.133 = 0.52$

$MAR = \Delta M_{max} + \Delta M_{max-1} + \Delta M_{max-2} \ldots + \Delta M_{n-1}$

$+ k [\Delta M_{n-1} - k(\Delta M_{n-1} - \Delta M_n)]$

MAR = [0.19 + 0.19 + 0.17 + 0.16 + 0.16 + 0.15 + 0.15 + 0.52 (0.15 – 0.01)]

MAR = 1.25 g / s

ANNEX B

(informative)

Precision

The figures for repeatability(r) and reproducibility(R) of this method are the result of collaborative studies carried out by EDANA with the following data. The evaluation of this interlaboratory test was carried out in accordance with ISO 5725 -2.

Sample Identification	**A**	**B**	**C**	**D**
DAC				
nº laboratories	5	5	5	5
Average (g/g)	4.50	4.34	7.62	5.61
s_r	0.301	0.121	0.289	0.116
s_R	0.393	0.321	0.767	0.499
CV_r	6.74%	2.80%	3.78%	2.04%
CV_R	8.80%	7.46%	10.01%	8.81%
r (2.8 s_r)	0.842	0.338	0.810	0.324
R (2.8 s_R)	1.100	0.899	2.147	1.398
MAR				
nº laboratories	4	4	4	4
Average (gs^{-1})	0.70	0.51	0.44	0.37
s_r	0.035	0.043	0.085	0.024
s_R	0.062	0.065	0.135	0.031
CV_r	5.0%	8.4%	19.4%	6.6%
CV_R	8.8%	12.8%	30.6%	8.5%
r (2.8 s_r)	0.098	0.12	0.238	0.067
R (2.8 s_R)	0.174	0.182	0.378	0.087

s_r	standard deviation of repeatability
CV_r	coefficient of repeatability (%)
r	repeatability limit (2.8 x s_r)
s_R	standard deviation of reproducibility
CV_R	coefficient of reproducibility (%)
R	reproducibility limit (2.8 x s_R)

STANDARD TEST: WSP 010.4.R3 (12)

Test Method for the Evaluation of Oil and Fatty Liquids Absorption

The number in parentheses indicates the year of the last revision

1. Scope

This test method has been developed by EDANA and covers the evaluation of nonwoven fabrics designed to absorb oil and other fatty liquids. Such products are commonly known as sorbent products. This method is directly derived from WSP 010.2.R3 and covers two parameters, which should be tested sequentially.

a) The liquid absorbency time.
b) The liquid absorption capacity

NOTE 1 These tests are applicable to any fabric designed to absorb oil, in particular those made out of meltblown polypropylene.

The SI values are regarded as the official standard system of measurement for this standard test method.

NOTE 2 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are useful but not indispensable for the application of this document.

2.2 ISO test methods

a) Liquid Absorbency Time

ISO 9073-6: 2000 Textiles – Test methods for nonwovens – Part 6: Absorption 4. Liquid Absorbency Time (EN 29073 part 6)

b) Liquid Absorbency Capacity

ISO 9073-6:2000 Textiles – Test methods for nonwovens – Part 6: Absorption 5. Liquid Absorptive Capacity (EN 29073 part 6)

c) Liquid Absorbency Capacity

ISO 9073-6:2000 Textiles – Test methods for nonwovens – Part 6: Absorption 5. Liquid Absorptive Capacity (EN 29073 part 6)

d) ISO 2859-1:1999 Sampling procedures for inspection by attributes
e) ISO 3951-1:2005 Sampling procedures for inspection by variables

Reference number
WSP 010.4.R3 (12) A

Current edition approved WSP 010.4.R3 (12)
Originally published as WSP 10.4 in 2005
Last approved as WSP 10.4 in 2008

2.3 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry.

b) WSP 010.2.R3 (12) Standard Test Method for Measuring the Rate of Sorption of Wiping Materials

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply

3.1 Liquid absorbency time

Time required for a sample of absorbent material to become completely wet by the test liquid i.e. to imbibe a liquid into its inner structure under specified conditions.

3.2 Liquid absorptive capacity

Mass of liquid that is absorbed by unit mass of the test product expressed as a percentage of the mass of the test product under specified conditions and after a specified time.

4. Principle

The test consists in imbibing a specimen with a specified liquid up to saturation, measuring the time taken to saturate the specimen, and measuring the amount of liquid retained by the specimen after a time during which excess liquid is allowed to flow freely out of the specimen.

5. Equipment and Reagents

5.1 Test Liquid.

Motor oil SAE 10 W 40, or hydraulic oil Grade ISO 32. (e.g. Mobil DTE24)

Note 2: these types of oil are not equivalent and are used to simulate different conditions of use. Type of oil used during the test should be specified in the report.

5.2 Recipent

For containing the test specimen, of sufficient volume to allow a test liquid depth of 15 cm.

5. 3 Weighing glass

Suitable weighing glass

5. 4 Balance

Capable of determining mass to an accuracy of ± 0.01 g

5.5 Stopwatch

5.6 Horizontal support

That can be adjusted along a vertical support

5.7 Suspension device

Designed to suspend square samples vertically by a corner, assuring the sample stays in a planar shape, preventing it to roll up on itself. See figure 1.

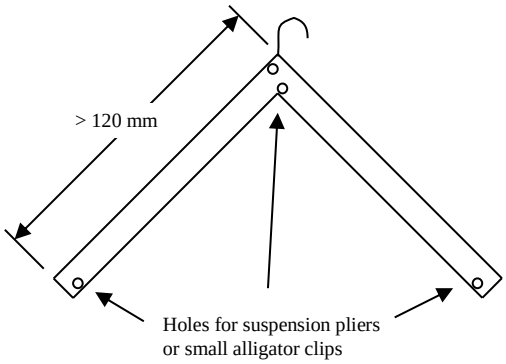

Figure 1

6. Test conditions

This test method is describing a quality control test and do not require sample conditioning. Testing has to occur during or immediately after production (i.e. within one hour maximum).
Test liquid should be at 23°C ± 2°C.

7. Sampling

7.1 Lot Size

Samples should be cut with a hand cutter around a template, 100 mm x 100 mm.
A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

7.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (*Sampling procedures for inspection by attributes)* or ISO 3951-1:2005 (*Sampling procedures for inspection by variables)* can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

8. Procedure

8.1 Cut specimens with a hand cutter and template and weigh them with an accuracy of ± 0.01 g. These samples shall be equally spaced across the fabric sample.

8.2 The liquid shall be at 23°C ± 2°C.

8.3 Carefully position the sample horizontally a few millimeters above the liquid surface, and drop it. Start the stopwatch at the same time.

8.4 Record the time taken for the specimen to completely saturate.

8.5 Once saturated, immerse the sample and submerse it vertically below the surface of the liquid for 120 s

8.6 Carefully remove the sample from the liquid using laboratory pliers, securing the sample by a corner.

8.7 Hang the sample vertically from a horizontal stand by a corner, using a device such as in Fig.1. Allow the liquid to flow freely during 30 s.

8.8 Weigh the test specimen to an accuracy of 0.01 g, using the balance and the weighing glass with cover.

8.9 Calculate:

a) The liquid absorptive capacity (LAC) in % of each specimen from the following:

$$LAC\% = \frac{M_n - M_k}{M_k} \times 100\%$$

M_k: mass in g of the dry test specimen(s)

M_n: mass in g of the wet test specimen(s) at the end of the test.

9. Report

9.1 Liquid absorbency time

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Number of specimens tested.
g) Software used and version
h) Deviation from the standard test procedure, if any
i) Average liquid absorbency time and its standard deviation
j) Anything unusual noted during the testing
k) Identification of the liquid

9.2 The liquid absorptive capacity

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Laboratory testing conditions
d) Number of specimens tested and note CD and/or MD if significant
e) Deviation from the standard test procedure, if any
f) Average liquid absorptive capacity and its standard deviation
g) Whether or not samples were conditioned prior to testing and, if so, for how long
h) Anything unusual noted during the testing

STANDARD TEST: WSP 020.1.R3 (12)

Standard Test Method for the Abrasion Resistance of Nonwoven Fabrics — Inflated Diaphragm Apparatus

The number in parentheses indicates the year of the last revision

1. Scope

This test method covers the determination of the resistance to abrasion of a nonwoven, both wet and dry specimens, using the inflated diaphragm tester.

The measurement of the resistance to abrasion of nonwovens is a very complex issue. The resistance to abrasion is affected by many factors such as the physical properties of the fibers, the denier of the fibers, the method of bonding of the fabric, the overall structure of the fabric, and whether or not any amount of added chemical finish was applied to the material.

The resistance of nonwoven material to abrasion as measured on any testing machine in the laboratory is generally only one of several factors contributing to performance or durability as encountered in the actual use of the material. Laboratory tests should not be relied upon where differences in laboratory test findings are small.

The SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately

Note 1 Safety

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative reference

The following referenced documents are indispensable for the application of this document.

2.1 ISO test methods

a) ISO 139 : Textiles — Standard atmospheres for conditioning and testing
b) ISO 3951-1:2005 Sampling procedures for inspection by variables
c) ISO 2859-1:1999 Sampling procedures for inspection by attributes

Reference number
WSP 020.1.R3 (12) A

Current edition approved WSP 020.1.R3 (12)
Originally published as WSP 20.1 in 2005
Last approved as WSP 20.1 in 2008

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply

3.1 Abrasion

The wearing or grinding away of any part of the fabric by mechanical action.

3.2 Other definitions

For other nonwoven terms used in these test methods, refer to WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

4. Principle

A specimen is abraded by rubbing either unidirectional or multidirectional against an abradant having specified surface characteristics. A specimen is held in a fixed position and supported by an inflated rubber diaphragm which is held under constant pressure. The resistance to abrasion is determined using either the number of cycles to wear a hole in the specimen or visual assessment of the specimen surface after a specified number of cycles.

The resistance to abrasion is also greatly affected by the conditions of the tests.

The abradant must be discarded at frequent intervals or checked periodically against a standard. The measurement of the relative amount of abrasion may also be affected by the method of evaluation and may be influenced by the judgment of the operator.

There is a definite need for measuring the relative resistance to abrasion. There is a need for good standardized test methods that could clarify some of the variability and lessen the confusion around abrasion testing.

There is difficulty in obtaining good agreement of results on the same type of testing instrument, within and between laboratories.

5. Apparatus

Inflated diaphragm abrasion tester as seen in figure 1 which has the following essential parts:

5.1 Surface abrasion head

The specimen is mounted in a circular clamp over a rubber diaphragm by means of a clamping ring and a tightening collar. The circular opening of the clamping ring is 94.0 ± 1.3 mm in diameter and that of the collar 95.3 mm or more. The height from the surface of

the clamped-in specimen to the upper edge of the tightening collar shall not exceed 9.5 mm. The clamping area of the body of the clamp and the ring should have gripping surfaces to prevent slipping of the specimen and leakage of air pressure during the test. Means should be provided for supplying air pressure to the body of the clamp so that the pressure under the diaphragm can be controlled between 0 and 41 kPa with an accuracy of ±5 % of range.

5.2 Diaphragm

The rubber diaphragm should be 1.40 ± 0.25 mm in thickness. A metallic contact pin 3.2 mm in diameter is sealed into the center of the diaphragm flush with the diaphragm surface. Provision should be made for a flexible electrical connection from this contact pin to the ground of the machine. The strain distribution on the diaphragm must be uniform so that when inflated without the specimen, it assumes the shape of a section of a sphere. Pressure can be controlled from 0 to 41 kPa.

5.3 Driving mechanism

The design of the driving mechanism is such that the circular clamp makes a reciprocal motion of 115 ± 15 double strokes per minute of 25 mm stroke length. Provision shall be made for rotation of the clamp in addition to the reciprocating motion so that one revolution can be completed in 100 ± 10 double strokes.

5.4 Balance head and abradant plate

The abradant is mounted upon a plate, which is rigidly supported by a double-lever assembly to provide for free movement in a direction perpendicular to the plane of the reciprocating specimen clamp. The abradant plate assembly should be well balanced to maintain a vertical pressure equivalent to a mass of 0 to 2.2 kg by means of dead weights. Provision should be made to mount different abradants such as abrasive paper, fabrics, etc., on this plate, and to stretch them into an even position. An electrically insulated contact pin, adjustable to the thickness of the abradant is mounted into this plate on the length axis at one of the turning points of the center of the clamp.

5.5 Some testers

Can also be equipped with a continuous changing abradant head which is optional.

5.6 Machine stopping mechanism

Contact between the adjustable pin on the lower side of the abradant plate and the contact pin inserted into the center of the diaphragm closes a low-voltage circuit and stops the machine.

5.7 Indicators

Means should be provided for indicating the diaphragm pressure, and the number of abrasion cycles (1 cycle = 1 double stroke).

Figure 1
One Type of Inflated Diaphragm Abrasion Tester

6. Conditioning

For conditioned testing:
Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in **ISO 139**. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 2 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing nonwovens for a reasonable period of time before the specimens are tested, i.e. 4 hours.

7. Sampling

7.1 Lot Size
A lot should be established based on a logical break in the process or as prescribed by a regulation or traceability requirements.

7.2 Sampling
If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (*Sampling procedures for inspection by attributes)* or ISO 3951-1:2005 (*Sampling procedures for inspection by variables)* can be used. In and of themselves, these are not valid sampling plans by default. An agreement

between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 to1200	35

8. Preparation, Calibration, and Verification of Apparatus

Prepare the machine according to the manufacturer's instructions and using the conditions given in clause 6 of this procedure.

Verification of the Total Operating System of the Apparatus:

8.1 Verify the total operating system

By testing specimens of a standard material for abrasion values and comparing that data

with historical data from that same standard material. This verification of the system is recommended on a daily basis before use, but at a minimum should be done on a weekly basis. In addition, the total operating system should be verified whenever there are changes in the abradant material.

8.2 Test the standard material specimens
Test as directed in clause 9.

8.3 Compare the data with previous data.
If the average is outside the tolerances established, recheck the total system to locate the cause for the deviation

9. Procedure

9.1 Place the specimen
Over the rubber diaphragm in a smooth condition and clamp the specimen in place without distorting the fabric.

9.2 Place some standard abradant
On the abradant plate under sufficient tension to be held smooth and in such a position that the contact pin, reaching through a hole in the abradant, is even with the surface of the abradant. The abradant information should be included in the final report, i.e. type of abradant used in the study.

9.3 Set the air pressure
Under the diaphragm and force on the abradant plate. The air pressure should be 28 kPa and the load on the abradant should be 454 g. Be sure that the air pressure control and the contact between inflated specimen and loaded abradant are in equilibrium before abrasion is started. To ensure consistent inflation of the diaphragm, inflate to a higher air pressure (25 %) and then reduce to testing pressure.

9.4 Establish the direction of abrasion:

9.4.1 Standard multidirectional
Engage the rotation mechanism of the specimen clamp.

9.4.2 Unidirectional
When this is used, disengage the rotation mechanism of the specimen clamp and bring the specimen into the desired direction by turning and setting the clamp after the diaphragm has been inflated. Include this information in the final report.

9.5 Note pilling or matting of fibers
If pilling or matting is interfering with proper contact between the specimen and the abradant, stop the machine and remove any interfering material.

9.6 Note wear pattern

If anything causes the specimen to have an uncharacteristic wear pattern, discard this specimen, recalibrate and verify the test instrument and test an additional specimen.

9.7 For wet specimens

If abrasion of wet specimens is desired, cover the dry clamped-in specimen with 10 ml of distilled water at a temperature of 23 ± 1°C.

10. Interpretation of Results

The end point is determined by one of the following:

10.1 Option A, Running to Failure

Abrade the specimen until all fibers in the center of the abrasion area are worn off so that the contact pin in the abradant plate comes in contact with the pin in the diaphragm, actuating an electrical relay and stopping the machine.

10.2 Option B, Using a Visual Rating

Abrade the specimen a specified number of cycles and then evaluate visually for the effect of the abrasion on the fabric structure as indicated in table 1:

Visual Abrasion Rating

Grading Description	Changes to the Specimen
No. 5	No fabric structure change
No.4	Slight change in surface condition but with little or no abrasion wear to fabric surface
No.3	Moderate change in fabric with visual fraying
No.2	Substantial change in fabric and with some wearing away of the fabric.
No.1	Severe change in fabric with a hole worn through the fabric

Table 1

NOTE 3 Unless the continuous changing abradant head is used, it is recommended that the abradant paper be changed at some regular frequency, such as every 100 to 300 cycles. This frequency is dependent upon the type of sample being tested.

11. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Type of abradant used
c) Frequency with which the abradant paper was changed
d) Air pressure under the diaphragm and load on the abradant plate
e) Type of abrasion
f) Number of cycles to reach the end point as determined by electrical contact
g) Complete identification of all materials tested and method of sampling
h) Name and address of testing institution

i) Make and model of testing equipment
j) Laboratory testing conditions
k) Number of specimens tested and note CD and/or MD if significant
l) Software used and version
m) Deviation from the standard test procedure, if any
n) When calculated, the standard deviation or the coefficient of variation
o) Whether or not samples were conditioned prior to testing and, if so, for how long
p) Anything unusual noted during the testing

12. Precision

The precision is yet TBD

STANDARD TEST: WSP 020.2.R3 (12)

Standard Test Method for the Abrasion Resistance of Nonwoven Fabrics — Flexing and Abrasion Method

The number in parentheses indicates the year of the last revision

1. Scope

This test method covers the determination of the abrasion resistance of Nonwoven fabrics using the flexing and abrasion tester.

This test method applies to most Nonwoven fabrics providing they do not stretch excessively.

The SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative references

The following referenced documents are indispensable for the application of this document.

2.1 ISO test methods

a) ISO 139 : Textiles — Standard atmospheres for conditioning and testing
b) ISO 3951-1:2005 Sampling procedures for inspection by variables
c) ISO 2859-1:1999 Sampling procedures for inspection by attributes

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

Reference number
WSP 020.2.R3 (12) A

Current edition approved WSP 020.2.R3 (12)
Originally published as 20.2 in 2005
Last approved as WSP 20.2 in 2008

3.1 Abrasion
The wearing or grinding away of any part of the fabric by mechanical action

3.2 Abrasion cycle
When abrasion testing, one or more movements of the abradant across a fabric surface can be one abrasion cycle. The abrasion cycle is dependent on the programmed motions of the abrasion machine. It may consist of one back-and-forth unidirectional movement, as in the rotary platform test method, or a combination of both directions in the inflated diaphragm test method. In the oscillatory cylinder abrasion method, an abrasion cycle consists of one circular movement of the specimen.

3.3 Double-stroke
As it pertains to this test, the abrasion cycle with this instrument consists of one forward and one backward motion, or a double-stroke.

3.4 Flexibility
That property of a material which demonstrates the ability of the fabric to be flexed or bowed repeatedly without undergoing a rupture in the material.

3.5 Flex abrasion
Abrasion of a sheet or fabric resulting from unidirectional flexing and frictional passage over a bar or other wear surface.

3.6 For other definitions of Nonwoven terms used in these test methods
Refer to WSP 001.0.R3 (12) (Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods)

4. Principle

Abrasion resistance is measured by subjecting the specimen to unidirectional reciprocal folding and rubbing over a specific bar under specified conditions of pressure, tension, and abrasive action. Resistance to abrasion is evaluated by either determining the percent loss in breaking force of an abraded specimen compared to an unabraded specimen or the cycles to rupture, or both.

This test method gives poor correlation between-laboratories and within laboratories.

If there are areas of realistic differences between test results for two laboratories, comparative tests should be performed to determine if there is a statistical bias between them, using a standard statistical evaluation.

The measurement of the resistance to abrasion of Nonwoven fabrics is very complex. This resistance to abrasion is affected by many factors. To alleviate some of the confusion, these factors should be spelled out clearly in the final report;

a) Type and size sample.
b) Type and model of equipment.
c) Additives to the fabric, if any.
d) Differences in performing the test, such as abradant used, tension applied, and pressure applied, etc.
e) Whether or not technician is properly trained and certified.

This test method is useful when pretreatment is used on the material. This testing is then preformed to evaluate the change in strength or barrier properties.

Attach requester's protocol or other instructions. This is for historical information as to how the test was actually requested and performed.

5. Apparatus

5.1 Flex abrasion testing machine (See figure1)
Must consist of the following:

5.1.1 Balanced head and flex block assembly
This is comprised of two parallel, smooth plates

5.1.1.1 The balanced head
Is rigidly supported by a double-lever assembly to provide free movement in a direction perpendicular to the plate of the flex block. This head must remain stationary during the test and must be balanced to maintain a uniform vertical pressure from the dead weights.

5.1.1.2 The flex block
Is capable of reciprocating at 115 ± 10 double stokes per minute of 25 ± 2 mm stroke length.

5.1.1.3 Clamps
Are secured to the front of each plate of the head and flex-block assemblies to permit mounting of the specimen. The clamps have surfaces that prevent slippage of the specimen and permit the specimen (after it has been folded over the abradant bar) to be centrally positioned and aligned with its long direction parallel to the reciprocating flex bar.

5.1.2 Flexing bar yoke
Is sufficiently rigid to prevent distortion during the specimen loading and capable of applying tension to the rigidly secured flexing bar with the force acting parallel to the surface of the head and block assembly plates and perpendicular to the fold of the specimen such that an evenly distributed tension is provided across the fold of the specimen.

5.1.2.1 A positioning device
Is provided to position the flexing bar and yoke assembly while loading the specimen such that the edge of the flexing bar is parallel to the fold of the specimen during the test. The position device is capable of moving into contact with the yoke prior to loading the

specimen and moving away from contact with the yoke just prior to starting the test machine.

5.1.3 Thumb screw
That allows moving the clamp to provide slack take-up of the specimen.

5.1.4 Machine stopping mechanism
A micro switch, or equivalent, to stop the machine is actuated by the release of the tension release on the specimen when it ruptures.

5.1.5 Cycle counter
This has a stop mechanism to record the number of cycles (double strokes) and stops the machine at fabric failure.

5.1.6 Automatic shutoff
Is part of the cycle counter or in-line timer, or equivalent, with set and stop mechanism capable of stopping the machine at a predetermined number of cycles.

5.1.7 Calibrated tension weights
Which have the individual masses of 250, 500, and 1000 g that can provide up to a total of 2500 g that fits on a weight rack that is attached by cables to the yoke to adjust tension to the specimen. Individual weight tolerances are ± 1%.

5.1.8 Calibrated head weights
Which have the individual masses of 250, 500, and 1000 g that can provide up to a total of 2500 g that fits on the balanced head, to apply pressure to the specimen. Individual weight tolerances are ±1%.

5.2 Working flex bar
Is used for testing, 1.6 ± 0.4 by 11.2 ± 1.6 mm in cross section, made with tool steel tipped with an edge of cemented carbide. The top, bottom, and edge of the bar that is in contact with the specimen is finished by grinding and polishing, leveling off the microscopic projection without breaking the edges of the bar. The bar is capable of firmly attaching to the yoke.

5.3 Standardized master flex bar
Is used to standardize the working flex bar. It includes a storage container to prevent bar damage, available from the manufacturer.

5.4 Standardization nonwoven fabric
Is used for verifying the working flex bar

5.5 Calibration ribbon
A fused acetate ribbon, 25 mm wide is available from the manufacturer.

5.6 Tensile testing machine
A CRE, CRL, or CRT type machine conforming to known standards, with working range, capacity, and elongation indicator and designed for operation at a speed of 300 ± 10 mm/min.

5.7 Nylon brush
Medium bristle or equivalent.

5.8 Solvent
To be used as a degreasing agent, for cleaning flexing bar.

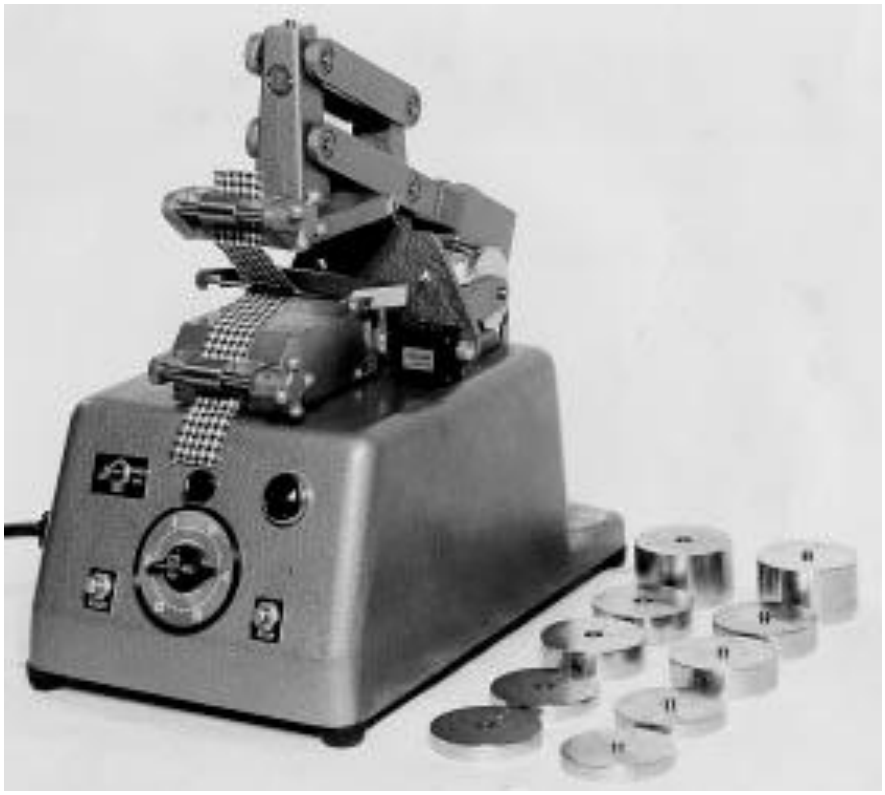

Figure 1
Flex abrasion testing machine

6. Sampling

6.1 Lot Size
A lot should be established based on a logical break in the process or as prescribed by a regulation or traceability requirements.

6.2 Sampling
If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (*Sampling procedures for inspection by attributes)* or ISO 3951-1:2005 (*Sampling procedures for inspection by variables)* can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 to1200	35

NOTE 2 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

7. Conditioning

Bring samples to moisture equilibrium in a standard atmosphere for testing nonwovens as directed in ISO 139 (see clause 2). Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 3 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

8. Preparation and Calibration of Test Apparatus

Prepare the machine according to the manufacturer's instructions and using the conditions given in clause 7 of this procedure.

8.1 Verification of the total operating system of the apparatus

Verify the total operating system by testing specimens of a standard material for abrasion values and comparing that data with historical data from that same standard material. This verification of the system is recommended on a daily basis or before use, but at a minimum should be done on a weekly basis. In addition, the total operating system should be verified whenever there are changes in the abradant material. If a tensile machine is going to be used in the testing of the samples it must also be calibrated/verified before being used.

8.1.1 Test samples of the standard material specimens

As directed in clause 9

8.1.2 Compare this data with previous data

If the average is outside the tolerances established, recheck the total system to locate the cause for the deviation.

NOTE 4 A low level of head pressure is required to prevent rippling of the fabric during testing. The rippling is caused by a high degree of friction between fabric and the bar when abnormally high head pressures are applied and results in insufficient relative motion between the bar and the fabric specimen under test.

8.2 Flex cables, pulleys, and weight rack

Inspect flex cables periodically for wear. Replace when they become frayed.

8.2.1 Keep pulley bearings clean to maintain free movement

If movement becomes restricted, mark the location of the pulleys and bearings so they can be reinstalled in the same position, then remove the bearings from the unit and flush with degreasing solvent, followed by soaking in No. 10 machine oil prior to installation.

8.2.2 Inspect the weight rack periodically

To make sure the rods are straight. If rods become bent, bend them back to their original straightness. Replace rods if they cannot be straightened.

8.3 Flex block

8.3.1 Inspect the flex block periodically

Check for smoothness and parallelism to the upper head. If the test block becomes scratched or uneven, return it to the factory to be reground or replaced. As needed, adjust flex cables when wear is observed on the sides of the flex block due to contact with the positioning yoke.

8.3.2 If the flex block wobbles from side to side

Adjust or replace the gib. Refer to the manufacturer's instruction manual to make this adjustment.

8.3.3 Place a few drops of sewing machine oil

Into the two holes on the left side of the reciprocating table on a monthly basis, particularly when subjected to heavy use

8.4 Upper head assembly

8.4.1 Periodically examine the bottom surface of the upper head for smoothness.

If the bottom surface of the upper head becomes scratched or uneven, replace or return it to the factory to be reground.

8.4.2 Periodically check the upper head assembly for balance and alignment.

With no weights on the head it should maintain balance and the upper head should be parallel with the flex block. If balance and alignment are not evident, remove bearings, clean with degreasing solvent, soak in No. 10 oil and replace in their original position. Periodically examine the alignment of the upper head by lowering the head, without the flex bar in position, until it makes contact with the flex block. The edges of the head and the flex block should be parallel within 0.08 mm of any corner.

8.5 Yoke

Periodically examine the yoke for wear, particularly in the grooves that hold the flex bar. Replace the yoke if worn as indicated by a loose fit of the flex bar.

8.6 Weight rack

8.6.1 If the weight rack makes contact

With the end-point-switch when a specimen is properly loaded, loosen the locknuts on the weight rack. Then tighten the cable adjusting nuts approximately one turn each. Tighten the nuts equally. Start the instrument again to verify sufficient clearance. If necessary, continue to adjust cable nuts until clearance during operation is obtained.

8.6.2 If the weight rack makes contact

With the pulleys when a specimen is properly loaded, loosen the lock nuts on the weight rack, and then loosen the cable adjusting nuts approximately one turn each. Tighten the nuts equally. Start the instrument again to verify sufficient clearance. If necessary, continue to adjust cable nuts until clearance during operation is obtained.

8.6.3 If the position of the flex bar and yoke assembly shifts laterally to the left

Before 25 cycles have been completed on two consecutive specimens, loosen the locknuts holding the flex cable to the weight rack and tighten the right side cable adjusting nut until proper tracking is observed. Tighten the nuts equally. Start the instrument again to verify proper tracking. If necessary, continue to adjust right-side cable nuts until proper tracking during operation is obtained.

8.6.4 If the position of the flex bar and yoke assembly shifts laterally to the right
Before 25 cycles have been completed on two consecutive specimens, adjust the left-side cable adjusting nut in a like manner as described in clause 8.6.3

9. Procedure

9.1 For nonwoven materials
Cut MD and CD specimens from different positions across the width and length of the nonwoven sample. Consider the long direction as the test direction.

9.2 Test the test specimens
In the standard atmosphere for testing nonwovens in accordance with clause 7.

9.3 Alternately press the start and stop buttons in rapid succession
This will jog the flex block to the rear starting position.

9.4 Clean the flexing bar in degreasing solvent after each test
Wipe the plate surfaces with solvent-saturated tissue after each test.

9.5 Place the working flex bar into the yoke
Always ensuring it is properly seated with the carbide edge facing the rear of the machine and the bar number face up.

9.6 Loosen the yoke positioner set screw
Using the yoke positioner, move the flex bar forward, such that the carbide edge is approximately 3 mm to the rear of the scribed centerline mark on the left side of the upped head. Tighten the yoke positioner set screw to hold the yoke in this position.

9.7 Mount one end of the specimen
Centrally and squarely in the upper balance head plate clamp such that the face of the fabric will be in contact with the bar. Secure by rotating the locking knob clockwise.

Ensure that the specimen is clamped between the clamp bar with the rubber gasket and the faceplate of the upper head. Do not clamp the specimen between the cam and the clamp bar, otherwise the specimen may move in the clamp causing erroneous results.

9.8 Thread the specimen around and under the carborundum edge of the flex bar
Then place squarely and centrally in the clamp of the lower platform plate, making sure the specimen is between the clamp bar with the rubber gasket and the faceplate of the flex block. Do not tighten the clamp. Ensure that any pills or other fiber debris that may interfere with the contact between the flex bar and test specimen are removed.

9.9 Press the head release button
Slowly lower the balanced head. Do not allow the head to drop with any force on to the flex bar or flex block.

9.10 Apply the required tension head weights to provide
A 4:1 tension to head weight ratio. For many nonwovens, 1.8 kg of tension weights to 454 g of head weights has been found satisfactory. For some fabrics, other weight-tension combinations may be used to shorten or lengthen the number of test cycles, but, in any event, the 4:1 ratio must be maintained.

9.11 Grasp the specimen at the front of the lower back clamp
Maintaining equal tension across the short direction and draw the specimen taut until the edge of the bar is aligned with the scribe line (centerline) on the upper balanced head, ensuring that the top section of the specimen lays directly over the bottom section of the specimen, then rotate the lower clamp knob counterclockwise to secure the specimen.

9.12 Release the yoke positioner locking screw
This allows the yoke positioner to position its self.

9.13 Set the cycle counter to zero and start the test machine
If breaking force after a predetermined number of cycles is to be determined, manually stop or set the automatic cycle stop to stop at the specified number of cycles. In the absence of a specified number of cycles, run the test to 2000 cycles.

9.14 Monitor the test throughout its duration and when required make the following adjustments:

a) After the first 25 cycles, check the bar for lateral shifting. If lateral shifting occurs, stop the test and adjust yoke cables in accordance with 8.3. Discard the specimen and repeat the test on an additional specimen.
b) Carefully clip and remove pills of matted fiber debris interfering with proper contact between the specimen and flexing bar if they cause a marked vibration of the pressure plate, then repeat 9.14.a.
c) If the specimen slips in the clamps, if the tension and pressure on the folded specimen do not remain constant during the test, or an irregular wear pattern is obtained, stop the test, discard the specimen, and repeat the test on an additional specimen.

9.15 After the machine has stopped
At the predetermined number of cycles or at fabric failure, lift the balanced head and secure it in the top position, then remove the test specimen.

9.16 Continue as directed in clause 10
Until the desired number of MD and CD specimens have been tested. Unless noted in the specification, test a minimum of ten specimens in each direction (MD and CD)

9.17 If breaking force is specified in the specification
It should be done after the specimens have been abraded to the agreed upon number of cycles. Remove from the abrading machine and determine the breaking force of all 10 MD and CD specimens using WSP 110.4.R3 (12) (Strip tensile), and follow WSP 110.4.R3 reporting process.

10. Calculation

10.1 If required by the specification
Average the number of cycles to rupture the abraded specimens. Record all ten MD and CD separately and also include the average for each.

10.2 As stated in clause 9.17 use WSP 110.4.R3 to perform the strip tensile test
Follow the procedure for reporting the results.

10.3 If clause 10.2 is needed
Then it is important that the average breaking strength of ten unabraded strip specimens be tested in both MD and CD directions.

10.4 When required
Calculate the percentage of loss breaking strength to the nearest 1 % as the abrasion resistance for both directions. (MD and CD)

When data are automatically computer processed, calculations are generally contained in the associated software.

11. Report
In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Abrasion resistance, number of cycles to rupture CD and MD
d) Abrasion resistance, percent loss in breaking strength CD and MD
e) Breaking strength of unabraded test specimens, CD and MD.
f) Tension and pressure
g) Make and model of testing equipment
h) Laboratory testing conditions
i) Number of specimens tested and note CD and/or MD if significant
j) For computer processed data, identify the software used and version
k) Name and address of testing institution
l) Deviation from the standard test procedure, if any
m) When calculated, the standard deviation or the coefficient of variation
n) Whether or not samples were conditioned prior to testing and, if so, for how long
o) Anything unusual noted during the testing
p) When photos are used as the standard, attach copies

12. Precision

12.1 Precision — TBD

STANDARD TEST: WSP 020.4.R3 (12)

Standard Test Method for Abrasion Resistance of Nonwoven Materials (Rotary Platform, Double-Head Method)

The number in parentheses indicates the year of the last revision

1. Scope

This method covers the determination of the abrasion resistance of nonwoven fabrics using the rotary platform, double-head tester (RPDH).

The SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document:

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2.1 ISO test methods

a) ISO 139 : Textiles — Standard atmospheres for conditioning and testing
b) ISO 3951-1:2005 Sampling procedures for inspection by variables
c) ISO 2859-1:1999 Sampling procedures for inspection by attributes

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Abrasion

The wearing away of any part of a material by rubbing against another surface.

Reference number
WSP 020.4.R3 (12) A

Current edition approved WSP 020.4.R3 (12)
Originally published as WSP 20.4 in 2005
Last approved as WSP 20.4 in 2008

3.2 Abrasion cycle

When abrasion testing, one or more movements of the abradant across a fabric surface can be one abrasion cycle. The abrasion cycle is dependent on the programmed motions of the abrasion machine. It may consist of one back-and-forth unidirectional movement, as in rotary platform test method, or a combination of both directions in the inflated diaphragm test method and in the oscillatory cylinder abrasion method. An abrasion cycle consists of one circular movement of the specimen.

4. Principle

A specimen is abraded using rotary rubbing action under controlled conditions of pressure and abrasive action. The test specimen, mounted on a platform, turns on a horizontal axis, against the sliding rotation of one or two abrading wheels. One abrading wheel rubs the specimen outward toward the periphery and the other, inward toward the center. The resulting abrasion marks form a pattern of crossed arcs over an area of approximately 30 cm^2. Resistance to abrasion is evaluated by various means which will be described later.

The measurement of the resistance to abrasion by a nonwoven is very complex. The resistance to abrasion is affected by many factors, such as the properties of the fibers used, the bonding mechanics of the material, which process was used to produce the material.

The resistance to abrasion is also greatly affected by the conditions of the tests, such as the nature of abradant used, the pressure between the specimen and abradant, and the physical specimen, i.e. wet or dry.

Abrasion tests are all subject to variation due to changes in the abradant during specific tests. All abradant wheels must be properly cleaned and reconditioned at standard intervals and discarded when these wheels no longer meet the standard.

The resistance of the nonwoven materials to abrasion can be measured and reported, when using the following: standard number of cycles, a standardized abradant wheel and using a standard weight.

This abrasion process can also be greatly affected by laboratory conditions, so the laboratory conditions must also be reported with the test results.

Before any predictions of a nonwoven’s usefulness can be drawn from this abrasion test, actual end-use trials should be conducted and compared to the abrasion test.

Out of control manufacturing processes occurring within and between lots of the same fabric can be measured satisfactorily with this RPDH tester.

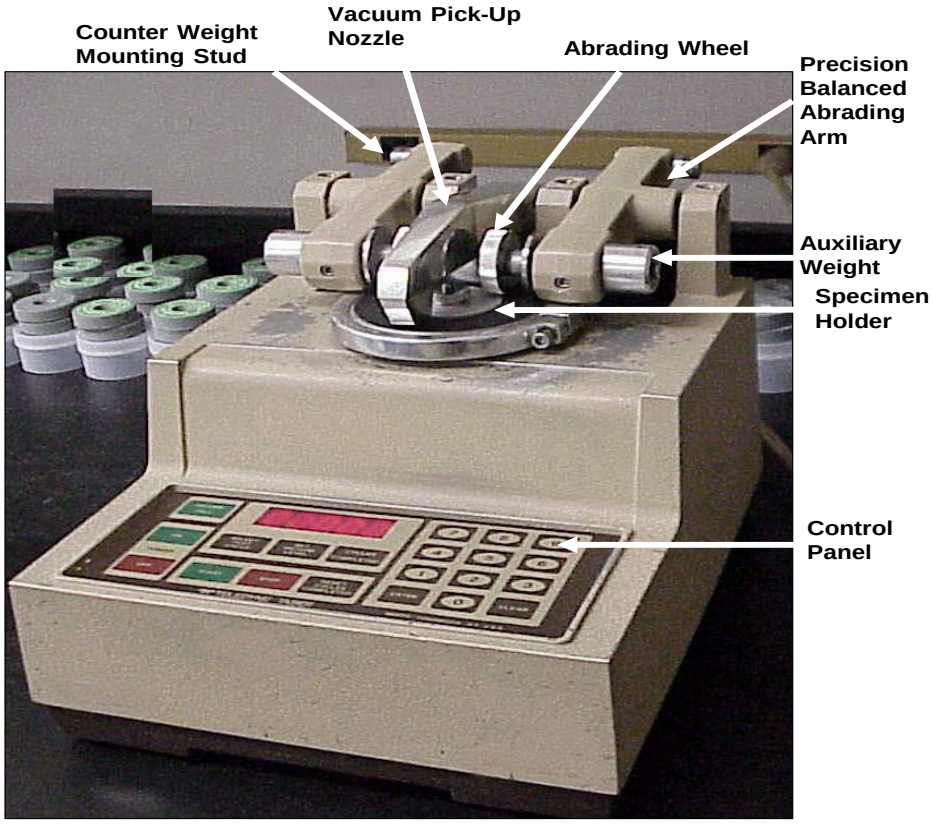

Figure 1

5. Apparatus

5.1 Rotary platform, double-head (RPDH) abrader (See Figure 1)
Comprised of a housing of compact design, a removable flat-circular specimen holder, a pair of pivoted arms to which the abrasive wheels are attached, a motor for rotating the platform and specimen, a fan for cooling the motor, a vacuum nozzle and vacuum cleaner for removal of lint from specimen, and a counter for indicating the revolutions of the specimen holder.

5.2 Abrasive wheels
Which are attached to the free end of the pivoted arms rotate and when resting on the specimen the motion of the abrasive wheels will be in opposite directions. This action is provided by the rotation of the specimen.

5.2.1 Rubber-based wheels
One of the options for rubber-based wheels is CS-0: resilient, rubber with no abrasive, 12.7 mm thick and 50.8 mm in diameter, surface rubber hardness, 50-55A Durometer which can be purchased from the machine manufacturer.

5.2.2 Vitrified-based wheels
One of the options for these wheels is H-18: Non-resilient, vitrified, calibrade, medium grain/medium bond. These wheels can also be purchased from the machine

manufacturer. These wheels are the hard abrasive type. They may be cut with a diamond point to resurface the wheels. The position of these wheels is critical and it is recommended that they always be used as sets.

5.3 Diamond wheel refacer (See Figure 2)
This resurfacer should be used at standard intervals to maintain the uniform surface.

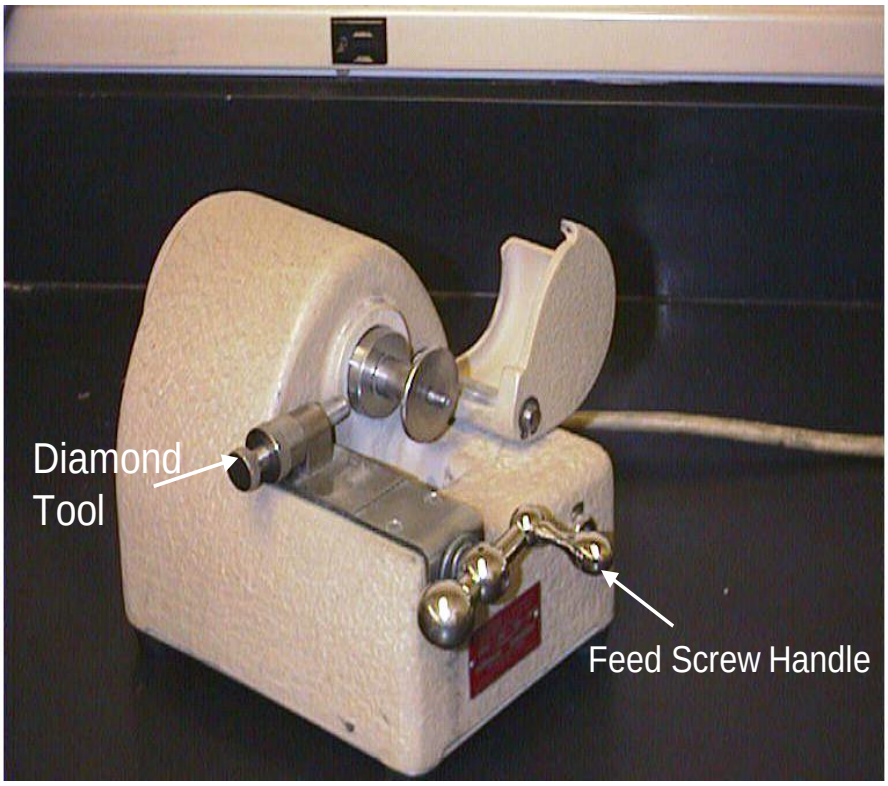

Figure 2

5.4 The specimen holder
Is supported by an adapter that is motor-driven and provides motion for the circular travel of the specimen holder. The type of specimen holder must be specified because there are different kinds of holders. The type needed for this use is the **tensioning type.** The textile specimen holder can be ordered from Taber Industries; model number E 140-15.

There are two clamping rings used to secure the specimen to the specimen holder, one for use with lighter weight nonwovens, and a larger one for use with heavier-weight nonwovens.

5.5 Weights and counterweights
The RPDH abrader is provided with a load adjustment for varying the load of the abrader wheels on the specimen. The pivoted abrader arms without auxiliary weights or counter weights apply a load against the specimen of 250 g per wheel. The manufacturer also provides additional weights that can be used to increase the load to 500 or 1000 g, and a

counterweight attachment that can be used to reduce the load on the specimen to 125 g per wheel.

5.6 Auxiliary equipment

A stiff brush is provided for the removal of loose particles from the surface of the wheels. (Compressed air is recommended for cleaning vitrified-based wheels.)

6. Sampling

6.1 Lot Size

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

6.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (*Sampling procedures for inspection by attributes)* or ISO 3951-1:2005 (*Sampling procedures for inspection by variables)* can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 2 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

NOTE 3 Results obtained on small hand samples can only be considered as representative of that sample and cannot be assumed to be representative of the material portion from which the small hand sample was taken.

7. Conditioning

7.1 For conditioned testing:

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 4 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested.

7.2 For wet testing:

Specimens to be tested in the wet condition shall be immersed in water at room temperature until thoroughly wetted. To thoroughly wet a specimen, it may be necessary to add not more than 0.05 % of a nonionic wetting agent to the water. A test of any wet specimen shall be completed within two minutes after its removal and blotting from the water.

8. Preparation, Calibration, and Verification of Apparatus

8.1 Wheel position

The mounted position of rubber-based wheels, with respect to the center of the specimen holder, is critical. The lateral distance from the left-hand wheel mounting flange to the center of the specimen holder should be 25.8 mm, and from the same point to the right-hand wheel mounting flange, the distance should be 27.4 mm. Since the position of vitrified-based abrasive wheels with respect to the center of the specimen holder is not critical, it is recommended for convention that they should be equally spaced on both sides, 26.6 mm from the wheel mounting flange to the center of the specimen holder.

8.2 Wheel bearings

The abrader wheel bearings, that is the two pairs of bearings installed in the free end of the pivoting arms to support the abrader wheels, should not stick when caused to spin rapidly by a quick driving motion of the forefinger. The degree of freedom of rotation of these bearings, however, is not critical.

8.3 Platform position

The vertical distance from the center of the pivot point of the abrader arms to the top of the specimen holder should be approximately 25 mm. This measurement is specified to prevent the possibility of errors incurred by installing a thrust bearing or the like to support the specimen platform. Adaptations should be made to maintain that the platform will remain at the above specified level. The specimen platform should rotate in the plane of its surface. If it fails to do so and exhibits a tendency to wobble, the holder and adapter should be replaced or a thrust bearing installed to support the specimen holder.

8.4 Platform speed

The platform should rotate at approximately 70 ± 3 rpm.

8.5 Load adjustment, counterweight

A counterweight attachment is provided with the RPDH abrader to reduce the load of the abrader wheels on the specimen. The use of this counterweight is not recommended, because studies have indicated variability in results due to the unequal counter-weighing of the individual arms.

8.6 Selection of wheels for test

a) Since variations exist in abrasive quality between and within rubber-based wheels of the same grade, a method should be followed in the selection of wheels for a particular test that will reduce this variation. Test all rubber-based wheels individually on a selected reference fabric known to have a minimum of variation in its abrasion resistance. Group the wheels in sets of three pairs such that the average abrasiveness of the three falls within a specified tolerance. Then use the wheels in sets as established.

b) In the use of vitrified-based calibrade wheels, both wheels of the pair to be used should be similar in abrasion characteristics. Check this on a selected reference fabric. Once a satisfactory pair is obtained, it may be used for an indefinite period without changing its abrasive quality provided neither wheel becomes clogged with finishing material, which is not easily removed.

9. Procedure

Test the conditioned specimens in the standard atmosphere as directed in ISO 139.

9.1 Mounting of specimen

Place the test specimen face up, unless otherwise specified, over the rubber mat on the specimen holder. Lightly secure the clamp plate and knurled nut in place to hold the center of the specimen. Place the ring clamp over the specimen and holder with the screw of the clamp at one end of the warp, partly tighten it, and push half way down. Draw fabric taut over the specimen holder by pulling on corners and edges of fabric, then tighten the clamp ring further, and push the ring all the way down over the edge of the holder, thus putting tension on the fabric as it is secured on holder. Then finish tightening the clamp plate and nut, and finally, retighten the clamp ring. Avoid buckling the fabric when tightening. Trim off excess fabric if it impedes the operation of the machine.

9.2 Number of revolutions

The number of revolutions of the table to which the specimen is to be subjected will depend on the type of material being tested, the type of abrader wheels used, and the type of test employed. The number of cycles should be predetermined by mutual agreement.

9.3 Cleaning of specimen

Clean the head abrader of abrasive particles on a scheduled basis. A vacuum cleaner or a brush may be used for this purpose. Do not remove the specimen from the specimen holder until the entire test is completed. Wipe the rubber mat clean after each test. If the tester is equipped with a suction nozzle, position the nozzle 0.8 mm to 1.6 mm above the specimen surface. The vacuum force should be adjusted to lift the abraded particles, but not the specimens.

9.4 Resurfacing and cleaning of wheels,

The use of one or two wheels must be specified. Due to uneven wear and clogging of the surface crevices with fiber particles, sizing, finishing materials, and the like, the abrading wheels should be resurfaced or cleaned at established intervals during tests, the frequency depending on the type of material being tested and the type of wheels used. Rubber-based wheels wear unevenly during use and clog up as the abrading progresses, thus requiring resurfacing and cleaning at appropriate intervals. Resurfacing disks (carborundum-coated paper) of various degrees of coarseness are available for this purpose. These are mounted on the resurfacing platform which replaces the specimen holder on the center shaft. A stiff brush may be used for removing loose particles from the surface of the wheels.

9.5 Vitrified-based wheels

May become accidentally chipped or marred or crevices of the surface may become clogged. When surface crevices become clogged, clean particles using an air hose during the test. If cleaning is difficult or surfaces are marred or chipped, resurface using the wheel resurfacing unit (figure 2). Resurface at specified intervals, depending upon the nature of the wheel surface clogging. If clogging is rapid and severe, consider using a different type of abrasive wheel.

10. Interpretation of Results

This method does not recommend any specific interpretation of results. After the specimens have been abraded to the set number of cycles or other specified end-point they may be evaluated as agreed upon between purchaser and seller. Two of the ways the material may be evaluated are:

a) By comparing the end results to a set of standard photos i.e. photo #5 the best and photo #1 the worst.
b) The end point on the abrasion could be to a standard size hole (13 mm).

11. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Number of specimens tested and which side of the material was tested
g) Software used and version
h) Deviation from the standard test procedure, if any
i) When calculated, the standard deviation or the coefficient of variation
j) Whether or not samples were conditioned prior to testing or were they tested wet
k) Anything unusual noted during the testing
l) When photos are used as the standard, attach copies
m) Type of wheel or wheels, how many wheels used and load adjustment or counterweight, if used
n) Average number of cycles to reach endpoint

12. Precision

Precision — The precision for this method is yet to be determined.

STANDARD TEST: WSP 020.5.R3 (12)

Standard Test Method for the Abrasion Resistance of Nonwoven Fabrics using a Nonwoven Modified Martindale Abrasion Test Method

The number in parentheses indicates the year of the last revision

1 Scope

This test method covers the determination of the abrasion resistance of Nonwoven fabrics using the Martindale abrasion tester. Nonwovens of all types may be tested by this method.

The SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document:

2.1 ISO test methods

a) ISO 139 : Textiles—Standard atmospheres for conditioning and testing
b) ISO 3951-1:2005 Sampling procedures for inspection by variables
c) ISO 12947-1 Martindale abrasion testing apparatus
d) ISO 2859-1:1999 Sampling procedures for inspection by attributes

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Abrasion

The wearing or grinding away of any part of the nonwoven fabric by mechanical action.

Reference number
WSP 020.5.R3 (12) A

Current edition approved 020.5.R3 (12)
Originally published as WSP 020.5.R3 in 2008
Last approved as WSP 020.5.R3 in 2005

3.2 Abrasion cycle (Martindale)
The completion of all the abrasion movements tracing a Lissajous figure comprising 16 rubs (which is 16 revolutions of the two outer drives and 15 revolutions of the inner drive). This is one cycle of the Martindale abrasion testing equipment.

3.3 Abrasion rubs (Martindale)
One revolution of the two outer drives of the Martindale abrasion equipment.

3.4 Lissajous figure
A geometric figure that starts as a straight line then becomes a widening ellipse and narrows again to become a straight line. There are 16 movements in one Lissajous figure.

3.5 For other definitions
Of nonwoven terms used in this test method, refer to WSP 001.0.R3 (12) (Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods)

4. Principle

Abrasion resistance is measured by subjecting the specimen to a rubbing motion in the form of a specific geometric figure (Lissajous), that is, a straight line, which becomes a gradually widening ellipse, until it forms another straight line in the opposite direction and traces the same figure again under known conditions of pressure and abrasive action. Resistance to abrasion is evaluated by various means which are described later in clause 10.

The nonwoven Martindale procedure differs from the textile Martindale procedure in three major ways:

a) The specimen holder assembly (as stated in clause 5.4 of ISO 12947-1:98 E) is not used to hold the specimen but in this method it is used to hold the abradant material.
b) The abrading table and assembly (as stated in clause 5.2.3 of ISO 12947-1:98 E) is not used as the abrading table in this method but is used to hold the test specimen in place for testing.
c) The nonwoven specimens are subjected to the abrasive wear of the abradant for a given number of rubs, predetermined by the customer and the supplier. After the abrasion is completed the specimens are rated according to the agreed upon pictorial standard.

This test, with all its variability, is still the best abrasion test to simulate the end use of the elbow area of a surgical gown in actual use.

The resistance to abrasion can also be affected greatly by the variety of conditions found at testing:

a) Placement and type of the rubber abradants used.
b) Cleaning the abradant at frequent intervals.
c) Calibration of the Lissajous figure pattern is very important.
d) Careful placement of the specimen properly on the holder.

e) Careful placement of the proper weight on the abrasion head, creating the desired pressure between the specimen and abradant.
f) Carefully check that the proper pictorial standard was used by all laboratories.

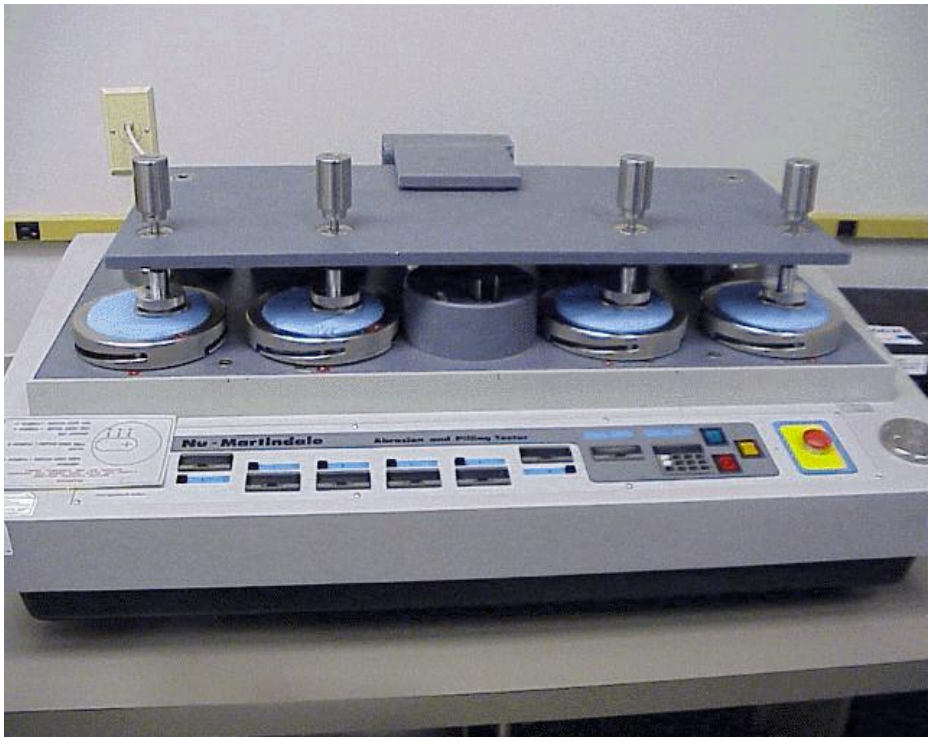

Figure 1 Martindale Abrasion Tester

5. Apparatus

Martindale abrasion tester (See Figures 1 and 2.

5.1 Standard felt

This felt is used under the specimen while it is being tested (as a support to soften the hard metal surface). This felt should have mass per area of 750 ± 50 g/m^2 and 2.5 ± 0.5 mm thick.

5.2 Standard rubber abradant

This is a silicone rubber which is reinforced internally with fiberglass and has a rubber surface hardness of 81A Durometer. The Shore A should be 81 ± 9. The thickness of the rubber should be 1.27 ± 0.2 mm.

5.3 Punches or press cutters

Should be 38 mm for cutting the abradant and 140 mm in diameter for cutting the specimens and felt.

5.4 Loading weights (2 sets)

These weights come in two sizes:

a) The large weights weigh 795 ± 7 g and apply 12kPa of pressure to the spindle of the abradant holder.
b) The small weights weigh 595 ± 7 g and apply 9kPa of pressure to the spindle of the abradant holder.

5.5 A set of pictorial grading standards

That is agreeable to both the customer and the supplier, i.e. grading (1) = the worst and (5) = the best.

6. Sampling

6.1 Lot Size

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

6.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (*Sampling procedures for inspection by attributes)* or ISO 3951-1:2005 (*Sampling procedures for inspection by variables)* can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 to1200	35

NOTE 2 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

NOTE 3 Results obtained on small hand samples can only be considered as representative of that sample and cannot be assumed to be representative of the material portion from which the small hand sample was taken.

1	Motor
2	Top Plate
3	Shaft
4	Body
5	Insert
6	Head
7	Holes for Straight Line Motion Driving Pins
8	Rear Bearing Cup
9	Quick Release Nuts
10	Retaining Nuts
11	Abrading Table
12	Weights
13	Indicator Lamp
14	Totalisor F114/6
15	Start
16	Stop
17	Presettable Counter FE 114/5
18	Block Spanner
19	Driving Pins for Straight Line Motion
20	Gear Boxes
21	Driving Pins for Lissajous Motion
22	Front Bearing Cups

The key for figure 2

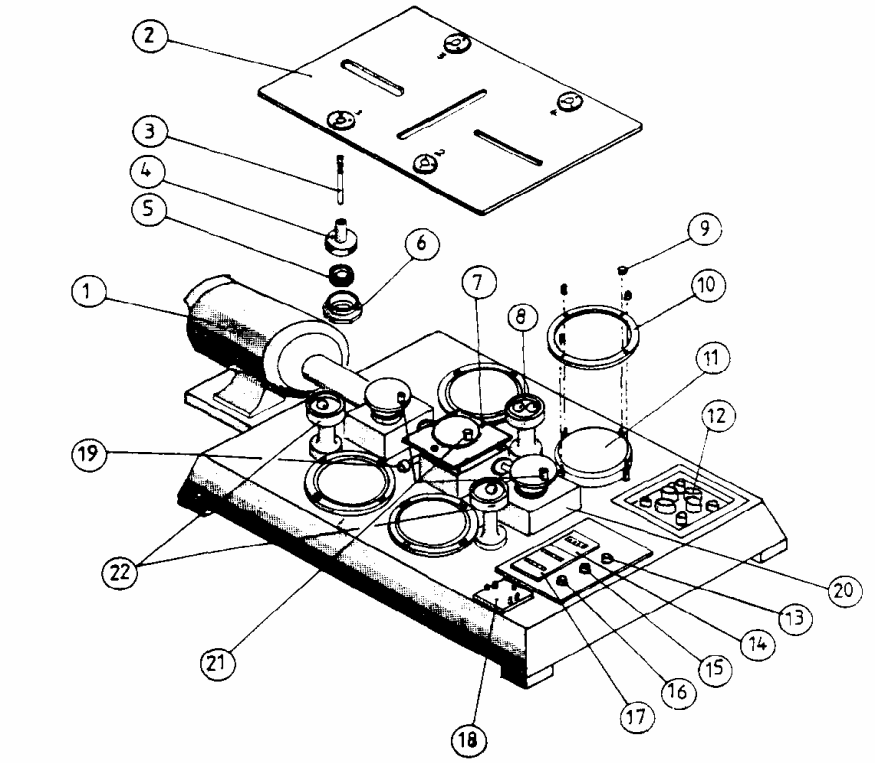

Figure 2 Schematic of the Martindale
This schematic is for an older style Martindale

7. Conditioning

7.1 For conditioned testing:

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 4 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested.

8 Preparation and Calibration of Test Apparatus

The preparation of this apparatus shall be carried out in accordance with the instructions listed in the equipment manual from Martindale.

The apparatus should also be calibrated in accordance with ISO 12947-1.

9. Procedure

9.1 On each testing table

Place a piece of felt, approximately 140 mm, followed by a piece of the test specimen sample of the same size. Place the mounting weight (which is supplied with the machine) on the table to flatten the test specimen and felt pieces. Secure the test specimen and the felt to the table with the clamping ring in place then remove the weight and inspect for tucks or ridges. If necessary, repeat the mounting process.

9.2 Assemble the abradant holder

By placing the abradant (rubber) face down into the abradant holder, which is located on the front right corner of the machine. The rubber abradant should be cut to 38 mm and then assembled in the holder according to the manufacturer's instructions.

9.3 Place the assembled abradant holder

On the machine above the table and add the required weight to give the desired pressure for each specimen. Either use the set of 9 ± 0.2 kPa weights or 12 ± 0.3 kPa weights, whichever the customer and suppler agreed upon.

9.4 Using the manufacturer's directions

Set the counter system to record the desired movements and start the abrasion machine. The machine should stop at the number of cycles preset on the machine.

9.5 Remove the abradant assembly

Carefully so as not to bend the spindles. You can easily determine whether or not the spindles are bent by rolling them slowly across a flat surface. If the spindles are bent, they are useless, may have affected your results and should be replaced.

10. Evaluation

While the specimens are still in place on the machine carefully inspect them using a good light source.

This initial inspection is done before the specimens are removed from their stands and graded using the pictorial standards.

11. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Number of specimens tested and note CD and/or MD if significant
g) Software used and version
h) Deviation from the standard test procedure, if any
i) When calculated, the standard deviation or the coefficient of variation

j) Whether or not samples were conditioned prior to testing and, if so, for how long
k) Anything unusual noted during the testing
l) When photos are used as the standard, attach copies
m) Type of abradant used and the specifications for this abradant
n) Amount of pressure applied (9 or 12 kPa)
o) Number of cycles the specimens were subjected to

12. Precision

The precision is yet TBD

ANNEX A

A1. Possible Causes of Low Precision When Martindale Testing

A1.1 Following are some of the causes for low precision

When evaluating test result between and/or within laboratories

A1.1.1 Using bent shafts

A1.1.2 Using worn bearings that are no longer calibrated

A1.1.3 Using different software to calculate the test results

A1.1.4 Using the wrong set of weights

A1.1.5 If the abradent is worn and the fiberglass is starting to show through on the pad, all pads must be changed.

A1.1.6 Failure to clean the abradent surface after each specimen

STANDARD TEST: WSP 030.1.R3 (12)

Standard Test Method for Hydraulic Bursting Strength of Nonwoven Materials – Motor Driven Diaphragm Bursting Strength Tester Method

The number in parentheses indicates the year of the last revision

1. Scope

This test method describes the measurement of the resistance of nonwoven materials to bursting using the hydraulic diaphragm bursting tester. This test method is generally applicable to most nonwoven processes and products.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document:

2.1 ISO test methods

a) ISO 139: Textiles — Standard atmospheres for conditioning and testing
b) ISO 3951-1:2005 Sampling procedures for inspection by variables
c) ISO 2859-1:1999 Sampling procedures for inspection by attributes
d) ISO 10012 Measurement management systems—Requirements for measurement processes and measuring equipment

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

Reference number
WSP 030.1.R3 (12) A

Current edition approved WSP 030.1.R3 (12)
Originally published as WSP 30.1 in 2005
Last approved as WSP 30.1 in 2008

3.1 Bursting pressure
(Pressure at burst) Maximum pressure applied to a test specimen clamped over an underlying diaphragm until the test specimen ruptures.

3.2 Bursting strength
(Strength at burst) Pressure obtained by subtracting the diaphragm pressure from the mean bursting pressure.

3.3 Diaphragm pressure
Pressure applied to the diaphragm, with no test specimen present, to distend it to the mean bursting distension of the test specimen.

4. Principle

This method for the determination of diaphragm bursting strength of nonwoven fabrics is being used by the nonwoven industry for the evaluation of a wide variety of end uses.

The nonwoven material is clamped over an expandable diaphragm. The diaphragm is stretched by hydraulic pressure to the point of specimen rupture. The difference between the total pressure required to burst the specimen and the pressure required to just inflate the diaphragm is reported as the bursting strength.

5. Apparatus

5.1 Hydraulic Diaphragm Bursting Tester
The testing machine shall meet the requirements of 5.1.a – 5.1.e

a) Clamps
These clamps for securing the test specimen between two annular, plane, parallel, and preferably stainless steel surfaces, shall not have any slippage during the test. The upper and lower clamping surfaces shall have a circular opening at least 75 mm in diameter and coaxial apertures of 31 ± 0.75 mm in diameter: The surfaces of the clamps between which the specimen is placed shall have concentric grooves spaced no less than 0.8 mm apart and shall be of a depth not less than 0.015 mm. from the edge of the aperture. The surfaces of the clamps shall be metallic and any edge which might cause a cutting action shall be rounded to a radius of not more than 0.4 mm. The lower clamp shall be integral with the chamber in which a screw shall operate to force a liquid pressure medium at a uniform rate of 95 ± 5 mL/min against the rubber diaphragm.

NOTE 2 The clamping mechanism and clamping surfaces are subject to considerable wear and distortion, and they should be examined periodically and repaired or replaced when necessary.

b) Diaphragm
48 mm diaphragm of molded synthetic rubber, 1.80 ± 0.05 mm in thickness with reinforced center, clamped between the lower clamping plate and the rest of the apparatus so that before the diaphragm is stretched by pressure underneath it the center of its upper surface is below the plane of the clamping surface. The

pressure required to raise the free surface of the diaphragm plane shall be 30 ± 5 kPa (4.3 ± 0.8 psi). This pressure shall be calibrated at least once a month. To test, a bridge gage may be used, the test being carried out with the clamping ring removed.

NOTE 3 The diaphragm should be inspected frequently for permanent distortion and renewed as necessary.

c) Pressure gage
Is a maximum reading pressure gage of the Bourdon type with the appropriate capacity, graduated in SI or inch/pounds units and accurate throughout the entire range of its scale to within a value of 1 % of its maximum capacity. The capacity of the gage shall be such that the individual readings will be not less than 25 % or more than 75 % of the total capacity of the gage.

d) Hydraulic pressure system
Is a means of applying controlled increasing hydrostatic pressure to the underside of the diaphragm until the specimen ruptures. The fluid is displaced by a piston in the pressure chamber of the apparatus. The recommended chamber fluid is USP chemically pure 96 % glycerin. The hydraulic system, including the gages shall be mounted so as to be free of externally induced vibrations. At the time of rupturing the specimen, there must be a mechanism for stopping any further application of the loading pressure and for holding, unchanged the pressure in the chamber until the results have been recorded.

e) Aluminum foil for the calibration of apparatus
Standardized sheets of aluminum can be purchased from the manufacturer which have a known bursting strength and can be used for calibrating the overall performance of this apparatus.

6. Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 4 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

7. Sampling

7.1 Lot Size

A lot should be established based on a logical break in the process or as prescribed by a regulation or traceability requirements.

7.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (*Sampling procedures for inspection by attributes)* or ISO 3951-1:2005 (*Sampling procedures for inspection by variables)* can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 to1200	35

NOTE 5 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

8. Calibration

8.1 Verification of testing apparatus

All calibrations done on the equipment for this procedure should meet ISO 10012 – 5. Check the operation of the testing machine at least once each month by bursting five specimens of standard aluminum sheet. The average of the indicated bursting resistance for the five standard specimens of aluminum sheets should be between ± 5 % of that marked on the package of the standardized aluminum sheets.

8.2 Calibration of testing gage

Calibrate the gage while still inclined at the same angle at which it is used. This can be accomplished by a dead-weight tester (piston type), or a column of mercury. This calibration is done with the gage in its normal position in the tester.

NOTE 6 Possible causes of low readings a) Gage error b) Gage expansivity too high c) Excessive gage pointer friction d) Air in hydraulic system e) Diaphragm collapsed too far at zero	Possible causes of high readings are a) Gage error b) Loose gage pointer c) Gage pointer bent by stop-pin d) Insufficient clamping force e) Non-uniform clamping f) Stiff or inelastic diaphragm g) Diaphragm above clamping plate at zero

9. Procedure

9.1 Insert the specimen under the tripod

After the specimen is pulled taut across the plate, it is then clamped in place by bringing the clamping lever as far to the right as possible

9.2 Inflate the diaphragm

By moving the operating handle to the left

9.3 While the diaphragm is inflating

Grab the latch that is located below, or to the right, of the operating handle. At the instant the specimen ruptures swing the latch as far as it will go to bring the operating handle to an idling (neutral) position. Record the total pressure required to rupture the specimen

9.4 Immediately after rupture

In rapid succession, release the clamping lever over the specimen. Immediately relieve the strain on the diaphragm by dropping the latch back to its normal position, throw the operating handle to the right, and record the pressure required to inflate the diaphragm (tare pressure)

NOTE 7 If the pressure stops increasing, as indicated by the dial, and the specimen has not broken, push the operating lever to remove the pressure. Record that the stretch of the fabric exceeds the dimensional

10. Calculation

Calculate the bursting pressure of each specimen by subtracting the tare pressure required to inflate the diaphragm from the total pressure required to rupture the specimen

11. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model (type of bursting tester) used
e) The bursting strength of each individual specimen and their average in kPa,
f) Laboratory testing conditions
g) Number of specimens tested and note if specimens were wet or dry
h) For computer processed data, identify the software used and the version
i) Deviation from the standard test procedure, if any
j) When calculated, the standard deviation or the coefficient of variation
k) Whether or not samples were conditioned prior to testing and, if so, for how long
l) Anything unusual noted during the testing

12. Precision

The precision for this method is yet to be determined.

STANDARD TEST: WSP 030.2.R3 (12)

Standard Test Method for Nonwovens Burst

The number in parentheses indicates the year of the last revision

1. Scope

This test method covers the determination of bursting strength and bursting distension of nonwovens fabrics.

From the available data there appears to be no significant difference in the burst strength results achieved using hydraulic or pneumatic burst testers for pressures up to 800 kPa. This pressure range covers the majority of performance levels expected of general apparel. For specialty fabrics requiring high bursting pressures, the hydraulic apparatus is more suitable.

The SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document:

2.2 ISO test methods

a)EN ISO 13938-1: 1999 Textiles–Bursting Properties of Fabrics- Part 1: Hydraulic Method for Determination of Bursting Strength and Bursting Distension (revision of ISO 2960:1974)

b) ISO 139: Textiles—Standard atmospheres for conditioning and testing
c) ISO 2859-1:1999 Sampling procedures for inspection by attributes
d) ISO 3951-1:2005 Sampling procedures for inspection by variables

2.3 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

Reference number
WSP 030.2.R3 (12) A

Current edition approved WSP 030.2.R3 (12)
Originally published as WSP 30.2 in 2005
Last approved as WSP 30.2 in 2008

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Bursting distension
(Distension at burst) expansion of a test specimen at the bursting pressure. It is expressed either as height at burst or as volume at burst.

3.2 Bursting pressure
(Pressure at burst) Maximum pressure applied to a test specimen clamped over an underlying diaphragm until the test specimen ruptures.

3.3 Bursting strength
(Strength at burst) Pressure obtained by subtracting the diaphragm pressure from the mean bursting pressure.

3.4 Diaphragm pressure
Pressure applied to the diaphragm, with no test specimen present, to distend it to the mean bursting distension of the test specimen.

3.5 Height at burst
Distance between the upper surface of the test specimen before distension and the top of the test specimen at the bursting pressure.

3.6 Test area
Area of the test specimen within the circular clamping device.

3.7 Time to burst
Time taken to distend a test specimen to burst.

3.8 Volume at burst
Volume of pressurizing fluid pumped at the bursting pressure.

4. Principle

A test specimen is clamped over an expansive diaphragm by means of a circular clamping ring. Increasing fluid pressure is applied to the underside of the diaphragm causing distension of the diaphragm and the fabric. The volume of fluid is increased at a constant rate per unit time until the test specimen bursts. The bursting strength and bursting distension are determined.

5. Apparatus

The bursting tester shall comply with the following requirements:

5.1 The apparatus shall be capable
Of producing various constant rates of increase in volume per unit time between 100 cm^3/min and 500 cm^3/min to within ± 10% of the indicated value. If the apparatus is not equipped to adjust fluid volume, a testing time to burst of (20 ± 5) s may be applied. This shall be indicated in the test report.

5.2 Bursting pressure
Shall be indicated with an accuracy of ± 2% of full-scale range above the first 20% of range.

5.3 Height at burst
Up to 70 mm shall be indicated with an accuracy of ± 1 mm. Zero position of the measuring gauge shall be adjustable according to the thickness of the specimen.

5.4 Means for indication of the volume at burst
(If available) must to within ± 2% of the indicated value.

5.5 The test area
Of 50 cm^2 (79.8 mm diameter) shall be used.

NOTE 2 Other test areas of 100 cm^2 (112.8 mm diameter) or 10 cm^2 (35.7 mm diameter) or 7.3 cm^2 (30.5 mm diameter) may be used if the preferred test area is not applicable in the existing testing equipment, or due to high or low expansion of the fabric or other fabric requirements, or by mutual agreement.

NOTE 3 Results with different sample sizes are not comparable to each other.

5.6 The clamping device shall provide
Clamping of the test specimen securely without distortion or damage and prevent slippage during the test. The clamping ring shall allow undisturbed vaulting of highly expansive fabrics (e.g. fabric test specimens whose height at burst is greater than half of the test specimen diameter).

NOTE 4 All test specimen clamping ring inner diameters shall be accurate to ± 0.2 mm. To avoid test specimen damage a small curvature at the inner edge of the clamping ring facing the test specimen is recommended.

5.7 A safety cover shall enclose the clamping device
During the test when the expansion of the test specimen takes place. It shall allow clear observation of the expansion of the test specimen during the test.

5.8 The diaphragm shall meet the following requirements:
a) Thickness up to 2 mm
b) Highly expansive
c) If the diaphragm is to be used several times, it shall be elastic within the range of height at burst observed during the test.
d) Resistant against pressurizing fluids used

6. Sampling

6.1 Cut suitable size samples

Single ply with diameter at least 13 mm greater than the ring clamp of the test apparatus. (11 cm x 11 cm for 50 cm^2 test)

6.2 Lot size

A lot should be established based on a logical break in the process or as prescribed by a regulation or traceability requirements.

6.3 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (*Sampling procedures for inspection by attributes)* or ISO 3951-1:2005 (*Sampling procedures for inspection by variables)* can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 to1200	35

NOTE 5 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

7. Conditioning

For conditioned testing

7.1 Dry testing

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

7.2 Wet testing

Immerse the test specimen for a period of 1 h in grade 3 water in accordance with EN ISO 3696 at a temperature of (20 ± 2) °C. An aqueous solution containing not more than 1g of a nonionic wetting agent per liter may be used instead of water. Immediately after removal of a test specimen from the liquid, briefly place it on blotting paper to remove excess water and perform the test same as the dry following clause 8.

NOTE 6 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested.

NOTE 7 For fabrics with low extensibility (known from previous experience or preliminary testing) e.g. for fabrics for technical application, a test area of 100 cm^2 is recommended. In cases where these conditions

cannot be met or are not appropriate, alternative test areas according to NOTE 2 may be used if mutually agreed.

NOTE 8 Comparison of results requires the test to be performed with the same test areas and rates of increase in volume.

8. Procedure

Procedure	Worked example
8.1 Weigh and calculate mass per unit area (g) in g/m^2.	W=0.303 g
8.2 Set a test area Of 50 cm^2 in accordance with 7.5.	$g = \frac{0.303 \times 104}{11 \times 11}$ g/m^2 = 25.04 g/m^2
8.3 Set a constant rate of increase For volumes of between 100 cm^3/min and 500 cm^3/min depending on test area and fabric requirements. Or adjust a time to distend a test specimen to burst of (20 + 5)s using preliminary trials, if a constant rate of increase in volume is not applicable.	
8.4 Place the test specimen Over the diaphragm so that it lies in a flat tensionless condition, avoiding distortion in its own plane. Clamp it securely in the circular holder, avoiding jaw damage, to prevent slippage during the test. Place the distension recording device into the measuring position and adjust it to the zero position. Fasten the safety cover in position according to machine requirements. Apply pressure to the test specimen until the fabric bursts.	
8.5 Immediately after burst Reverse the apparatus to starting position. Note bursting pressure (P) and height at burst (H) and/or bursting volume. If the test specimen bursts close to the edge of the clamping device, report this fact. Reject jaw breaks occurring within 2 mm of the clamping line.	P = 436 kPa H = 23.9mm
8.6 Repeat for the remaining 4 samples.	P (kPa) / H (mm) 438 / 23.7 440 / 24.3 427 / 24.1 439 / 23.9
8.7 Diaphragm correction With the same test area and rate of increase in volume as that employed in the above tests, distend the diaphragm without the presence of a test specimen by an amount equal to the mean height at burst or the mean volume at burst of the test specimen. Note the pressure at this distension of the diaphragm as the “diaphragm pressure” (P^2).	P^2=15.3 kPa

9. Calculation

Calculation	Expression of results
9.1 Calculate the arithmetic mean Of the bursting pressure values (P_1) in kPa. Round the result to three significant figures.	P_1=436 kPa
9.2 Calculate the arithmetic mean Of the height at burst values (H) in mm. Round the result to two significant figures.	H = 24.0 mm
9.3 Subtract From P_1 the diaphragm pressure (P_2) in kPa as determined according to 8.7, to obtain the bursting strength ($P= P_1 - P_2$). Round this result to three significant figures.	P=421 kPA
9.4 If required Calculate the burst factor with g = mass per unit area in g/m^2. $X = \frac{P}{g}$ **If required** Calculate the arithmetic mean of the volume at burst values in cm^3. Round the result to three significant figures.	$x = \frac{421}{25.04} = 16.08$

10. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Number of specimens tested and note if specimens were wet or dry
g) Software used and version
h) Deviation from the standard test procedure, if any
i) When calculated, the standard deviation or the coefficient of variation
j) Whether or not samples were conditioned prior to testing and, if so, for how long
k) Anything unusual noted during the testing
l) When photos are used as the standard, attach copies
m) Average measured bursting pressure
n) Mean height at burst and the thickness of the diaphragm used
o) Diaphragm pressure corresponding to mean height at burst
p) Mean bursting strength in kPa

NOTE 9 Pneumatic Bursting Tester. (ISO 13938 – 2: Pneumatic Method) The procedure described for the hydraulic method is applicable to the pneumatic except the specifications relating to the rate of volume increase per unit time.

STANDARD TEST: WSP 040.1.R3 (12)

Standard Test Method for Surface Resistivity of Nonwoven Fabrics

The number in parentheses indicates the year of the last revision

1. Scope

This method determines the surface electrical resistivity of fabrics, webs, films, or other sheet-like materials. The electrical resistivity influences the accumulation of electrostatic charge on the surface of the material and its subsequent dissipation.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document:

2.1 ISO test methods

a) ISO 139 : Textiles—Standard atmospheres for conditioning and testing
b) ISO 2859-1:1999 Sampling procedures for inspection by attributes
c) ISO 3951-1:2005 Sampling procedures for inspection by variables

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

2.3 Other test methods

NFPA 99 (92) See 12 - 4.1.3.8 (f) (3)[1]
Federal Test Method No. 191 A-Method 5930
Electrical Resistivity of Fabrics[2] D 257 DC Resistance or Conductance of Insulating Materials

1 National Fire Protection Association, 1 Batterymarch Park, PO Box 9101, Quincy, MA 02269
2 General Services Administration, Building 197, Washington Navy Yard, Washington, DC 20407

Reference number
WSP 040.1.R3 (12) A

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3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Resistivity
Is the ratio of the potential gradient paralleling the current passing through the specimen. This is numerically equivalent to the resistance between opposite faces of a unit cube. It is the reciprocal of conductivity.

3.2 Surface resistivity
Is the surface resistance multiplied by that ratio of specimen surface dimensions (width of electrodes defining the current path divided by the distance between electrodes) which transforms the measured resistance to that obtained if the electrodes had formed the opposite sides of a square. Surface resistivity is popularly expressed in ohms, or ohms/square (the size of the square is immaterial). Surface resistivity is the reciprocal of surface conductivity.

4. Principle

Specimens, equilibrated to specific temperature and humidity conditions, are tested for electrical resistance using an electrical resistance meter.

Fabrics, films or nonwovens that are used in areas where flammable, combustible, or explosive atmospheres may be encountered, should not accumulate static charges which may discharge with sufficient energy to cause ignition. Additionally, fabrics, films, or nonwovens that are handled in rapidly moving or automatic converting equipment should not accumulate excessive static charges. Surface electrical resistivity measurements quantify the ease by which electrical charges may be dissipated from the fabrics.

5. Apparatus

5.1 Electrical resistance meter

5.2 Conditioning and test chamber

5.3 Standard resistors
1×10^{11} ohm, 1×10^{10}.ohm, 1×10^{9} ohm

5.4 Radioactive bar

5.5 Two rectangular flat metal surfaces
Of suitable size to serve as electrodes - see ASTM D 257
Alternatively, two concentric ring electrodes of spacing suitable to the materials being measured and the purpose of the results may be used.

5.6 Gloves
Latex or cotton knit gloves to prevent contamination of fabric surfaces.

NOTE 2 **SAFETY WARNING**

The safety recommendations provided by the radioactive bar manufacturer should be followed. The radioactive bar emits alpha radiation which is externally harmless to the human body. The radioactive isotope polonium 210 is toxic and precaution should be exercised to prevent ingestion or inhalation of the solid material. Do not take the radio active bar apart or touch the radioactive strip. If the strip is touched or handled, wash hands thoroughly at once. Return the device to the manufacturer when it loses its effectiveness as a static eliminator or for disposal if use is to be discontinued. ***Do not discard as scrap.***

6. Preparation of Apparatus

6.1 The test unit should be installed

In a standard conditioned environment identical to the environment used to condition the specimens (see clause 8).

6.2 Calibrate the electrical resistance meter

According to the systems manufacturer's recommendations. This calibration should be done periodically in compliance with a total quality system.

6.3 Electrodes should be kept clean

And not touched with ungloved hands.

7. Conditioning

Conditioning of samples is critical for the accurate execution of this test.

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

a) In fabrics where the end use requires antistatic treatments or the electrostatic propensity is critical, measurements at 20%R.H. may be required within an appropriate test chamber.
b) For Federal Test Method #5930 40% R.H. and 24°C are specified.
c) For NFPA-99 50% R.H. and 21° ± 2°C are specified.
d) For nonwoven measurements, standard conditions can be found in ISO 139 or WSP 3.0 (05).
e) Wherever possible methodology for exposing specimens to conditioning atmospheres should follow ISO 139

NOTE 3 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

8. Sampling

8.1 Lot Size

A lot should be established based on a logical break in the process or as prescribed by a regulation or traceability requirements.

8.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (*Sampling procedures for inspection by attributes)* or ISO 3951-1:2005 (*Sampling procedures for inspection by variables)* can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 to1200	35

NOTE 4 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

8.3 Test specimens

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material:

a) For testing with concentric ring electrodes, samples should be die or scissor cut to a size at least as large as the diameter of the outer ring.
b) For parallel electrodes one set of machine direction (MD) and one set of cross direction (CD) specimens the size of the electrode used should be obtained.
c) In all cases, the exact sample size depends on the construction of the particular equipment being used.

9. Procedure

9.1 Optionally remove static charges

Using a radioactive bar.

9.2 Place the test specimen in firm contact with the electrodes

The contact should be such that when additional pressure is applied between the specimen and the electrodes the test results are not effected.

9.3 For parallel plate electrodes test both MD and CD

Report only the lower reading by direction.

9.4 For concentric ring electrodes

The charge follows the path of least resistance automatically.

9.5 Measure the electrical resistance of the specimen

According to the operating instructions and procedures for the particular resistance meter being used. Allow the current to pass through the specimen for a minimum period of one minute until a constant reading is obtained. The criterion for constant electrical resistivity is a charge in the value of Log R of less than 0.1 units per minute. The time to reach a constant reading may vary with the applied voltage and with the resistance of the test sample. High voltages for prolonged periods of time may damage the fabric. If a constant reading is not reached at one minute, then report the reading at one minute.

9.6 For reference purposes

80 – 100 volts at 2.5 cm. electrode separation for one minute should be used for the parallel plate configuration, and a similar voltage gradient for the concentric ring case (see clause 7 e)

9.7 Avoid the use of any electrically conductive liquids

On either the fabric test specimens or the apparatus.

10. Calculation

10.1 Compute the resistivity in ohms

Per square for each test specimen as follows:

For the parallel electrode case:

$$\text{Resistivity} = \frac{\text{Measured resistance (ohms) x Width of Specimen}}{\text{Distance between electrodes}}$$

For the concentric ring cases:

$$\text{Resistivity} = \frac{2.73 \times \text{measured resistance (ohms)}}{\text{Log}\ \frac{\text{outer electrode radius}}{\text{Inner electrode radius}}}$$

NOTE 5 On occasion, the needle may move toward or beyond 0 when the range switch setting is decreased. If this happens, reverse the polarity; i.e., set the **METER** switch on the VOM to the "-" position and proceed to read the meter; the needle should now move in the opposite direction.

NOTE 6 If it was necessary to reverse polarity and set the **METER** switch to "-", report the results in parenthesis and with a "-" sign as in the following example:

Resistivity = -(2.69 x 1010) ohms

11. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Report the logarithm of the average of the three calculated resistivities in ohms per square of fabric
g) Number of specimens tested and note CD and/or MD if significant
h) For computer processed data, identify the software used and the version
i) Deviation from the standard test procedure, if any
j) When calculated, the standard deviation or the coefficient of variation
k) Whether or not samples were conditioned prior to testing and, if so, for how long
l) Anything unusual noted during the testing
m) When photos are used as the standard, attach copies

NOTE 7 In the measurement of surface resistivity, the same numerical result is obtained regardless of the size of the square.

12. Precision

The precision for this method is yet to be determined.

ANNEX A

Notes on testing equipment

A 1. Resistance meters used in conjunction with the electrode systems should be capable of measuring values from 10^8 to 10^{15} ohms.

A 2. Suitable concentric ring meters are available from:

Keithley Instruments, Inc.
28775 Aurora Road
Cleveland, Ohio 44139

Hewlett-Packard Company
5301 Stevens Creek Blvd
Bldg. 51 L-SC Santa Clara, CA 95052-8059
1-800-452-4844 Model 43339B
High Resistance Meter Model 16008B Resistivity Cell

A 3. High Resistance meters 10^8 – 10^{13} are available from:

Custom Scientific Instruments, Inc.
13 Wing Drive
Cedar Knolls, NJ 07927

Glen Rad
300 G Baker Avenue
Concord, MA 01442

A 4. Radioactive bar for removal of charges:
Staticmaster Ionizing Unit Model 2 U 500
Nuclear Products Company
2519 North Merced Avenue
So. El Monte, CA 91734

STANDARD TEST: WSP 040.2.R3 (12)

Standard Test Method for Electrostatic Decay of Nonwoven Fabrics

The number in parentheses indicates the year of the last revision

1. Scope

This method determines the electrostatic properties of a material in film or sheet form by measuring the time required to dissipate a charge from the surface of the material.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document:

2.1 ISO test methods

a) ISO 139:Textiles—Standard atmospheres for conditioning and testing
b) ISO 3951-1:2005 Sampling procedures for inspection by variables
c) ISO 2859-1:1999 Sampling procedures for inspection by attributes

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

2.3 Other standard test method

NFPA-99-92 Sec. 12-4.1.3.8(f) (3)[1]
Federal Test Method STD No. 101C, Method 4046, Electrostatic Properties of Materials[2]

1 National Fire Protection Association, 1 Batterymarch Park, PO Box 9101, Quincy, MA 02269
2 General Services Administration, Building 197, Washington Navy Yard, Washington, DC

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3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Electrostatic decay
The ability of a material when grounded to dissipate a charge which has been induced on the surface of the material.

3.2 Decay time
The time in seconds for the induced charge to dissipate to 10% of its original level.

4. Principle

A flat sheet material is tested to determine its ability to dissipate an electrostatic charge by mounting samples of the material, subsequently charging the material to 5000V and then timing the charge dissipation.

Fabrics, films, nonwovens, or other materials which may be used in situations where electrostatic charge is objectionable may be tested using this method. These situations may be safety related such as use around flammable materials or practical such as handling the fabric or film on automated equipment.

5. Apparatus

5.1 Static decay meter
The static decay meter shall be capable of imparting a high voltage charge of at least 5000 volts positive and negative, and have a voltmeter and time capable of measuring the charge and timing its decay to a present limit. The meter should be equipped with a set of electrodes capable of supporting samples 89 x 140 mm and making good electrical contact.

5.2 Gloves
Latex or cotton knit gloves which will prevent contamination of fabric surfaces.

6. Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 2 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

7. Sampling

7.1 Lot Size

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

7.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (*Sampling procedures for inspection by attributes)* or ISO 3951-1:2005 (*Sampling procedures for inspection by variables)* can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 to1200	35

NOTE 3 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

7.3 Test specimens

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material.

a) Care in handling should be observed so that specimens do not contact any contaminants such as soap, salt, oil etc.
b) Specimens should be cut 89 x 140 mm

8. Preparation of Apparatus

8.1 The test unit should be installed in a conditioned environment

Identical to the environment used to condition the specimens

8.2 The apparatus should be turned on

And "warmed-up" for at least 30 minutes prior to calibration or testing

8.3 Calibrate the instrument using manufacturer's instructions for the unit

This calibration should be done daily or alternately, prior to each round of testing. Calibration results should be recorded as part of a total quality system

8.4 Be sure the instrument is clean

And that the cut-off switch for the timer is set properly

8.5 Be sure the electrodes are kept clean

And that that are rust free

9. Procedure

NOTE 4 Some circumstances may result in a specimen having a residual charge when it is initially tested and may not necessarily be indicative of a failed specimen. When allowed to equilibrate to the testing environment and retested, the specimen may no longer retain a residual charge

9.1 Remove the magnets from the Faraday cage

a) Moisten a paper towel
b) Clean the magnets and the specimen clamping surfaces with 70% alcohol
c) Mount the specimen in the Faraday cage

9.2 Selecting the proper settings

a) Select the CUTOFF level by depressing the appropriate button
b) Check zero on the SAMPLE CHARGE meter and adjust to zero if necessary
c) With the HIGH VOLTAGE OFF, depress the OPERATE CHG button and record the reading of the SAMPLE CHARGE meter as the residual charge
d) Depress the HIGH VOLTAGE + button

e) Rotate the HIGH VOLTAGE ADJUST control knob clockwise to set the CHARGING VOLTAGE meter to +5 D.C. Kilovolts
f) Depress the OPERATE ZERO/STBY button and check zero on the SAMPLE CHARGE meter. Adjust to zero if necessary
g) Depress the OPERATE CHG button
h) When the needle on the SAMPLE CHARGE meter stops moving, record the charge to the nearest 250 volts, then depress the OPERATE TEST button
i) Record the decay time from the display
j) Depress the HIGH VOLTAGE OFF button
k) Depress the HIGH VOLTAGE – button
l) Repeat 9.2 g) to 9.2 j) once more
m) Repeat 9.1 c) to 9.2 l) for each specimen

10. Calculation

Calculate the average for each direction/face

11. Report

In addition to the precise test results, the report shall include the following information:
a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Number of specimens tested and note CD and/or MD if significant
g) For computer processed data, identify the software used and the version
h) Deviation from the standard test procedure, if any
i) Both the average and individual maximum for each direction/face
j) Whether or not samples were conditioned prior to testing and, if so, for how long
k) Anything unusual noted during the testing
l) If the material is not chargeable, report not chargeable with this method
m) If decay time exceeds one minute report as (> 1 min).

12. Precision

The precision for this method is yet to be determined.

STANDARD TEST: WSP 060.1.R3 (12)

Standard Test Method for Optical Properties (Opacity) of Nonwoven Fabrics

The number in parentheses indicates the year of the last revision

1. Scope

This test covers the evaluation of the optical properties of nonwovens by testing for opacity. This test measures the opacity of a specimen using a photometric system as specified in TAPPI T452.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document:

2.1 ISO test methods

a) ISO 139 : Textiles — Standard atmospheres for conditioning and testing
b) ISO 3951-1:2005 Sampling procedures for inspection by variables
c) ISO 2859-1:1999 Sampling procedures for inspection by attributes

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Contrast ratio, C_o.89 (Opacity)

100 times the ratio of the diffuse reflectance, Rb, to the diffuse reflectance, Rw. (Co.89 = 100 Rb/Rw). These reflectances are absolute; the absolute diffuse reflectance for

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magnesium oxide being very nearly 0.98. Accordingly, the contrast ratio is 100% for perfectly opaque nonwovens, and is only a few percentage points from a perfectly transparent sheet.

3.2 Rb
The diffuse reflectance of a specimen backed with black and which has not more than 0.005 reflectance.

3.3 Rw
The diffuse reflectance of the same specimen backed with a white body having an absolute reflectance of 0.89.

4. Principle

The essential principle of this method for determining the opacity of nonwovens when combined with a white backing is higher than that of nonwovens when combined with a black backing. In the former case, light transmitted through the imperfectly opaque sheet is largely reflected by the white backing, and a portion of the light thus reflected is transmitted through the nonwoven a second time.

The opacity of a nonwoven is influenced by the opacity of the fibers, the number of fibers in a given area, coating used and the like.

The determination of opacity is of vital importance to both the manufacturer and the consumer. In meeting an opacity specification, the manufacturer may be able to predict whether or not it is possible to adjust the opacity of a given nonwoven by changing certain parameters.

Opacity may be used by the consumer to evaluate appearance (eg., apparel, draperies). When comparisons are made between fabrics under identical conditions, small differences can be detected visually. Actual differences in appearance can be represented by very small measured differences.

5. Apparatus

5.1 Opacity Meter
Is equipped with an accurate linear or a corrected photometric system. The reflectances involved in the determination of contrast ratio should be normal illumination and diffuse viewing or the equivalent converse, i.e., diffuse illumination and normal viewing.

a) Standard black backing – consisting of a cavity lined with black velvet or other material which will cause the reflectance of the cavity to be 0.005 or less.
b) Standard white backing – having an effective absolute reflectance equal to 0.89 when illuminated under the conditions of actual testing with a sheet of nonwoven in place.
c) Incandescent light source – with the color temperature adjusted to yield an overall instrument response equivalent to the Commission International de l' Eclairage (CIE) function EaY which has an effective wavelength of 572 mm. In a single

photocell instrument, stability requires that the voltage must not change by more than approximately 0.1%.

d) Photoelectric cell – corrected with optical fibers in combination with optic and lamp to produce an overall response of CIE EaY, which closely approximates the response of the human eye.
e) Specimen holder – so constructed that the specimen may be viewed or illuminated through a round window at least 14.3 mm (.6 in.) in diameter and to hold the specimen flat to with 0.15 mm (10 mils).

NOTE 2 this apparatus is available from: Technidyne Corporation 1862 Production Drive Louisville, KY 40299

6. Sampling

6.1 Lot Size

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

6.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
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151 to 280	32
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501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
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26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 to1200	35

NOTE 3 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

6.3 Test specimens

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material.

a) Do not touch the test areas with the fingers and keep these areas perfectly clean and free from folds and wrinkles.
b) Cut at least five specimens of sufficient size to fit the specimen holder and completely cover the standard backings.

7. Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 4 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

8. Calibration and Standardization

Check the calibration utilizing evaluated opal glass or master standards at frequent intervals and readjust as necessary in accordance with the manufacturers instructions. (TAPPI T425 om-91 appendix A may be referenced.)

9. Procedure

9.1 Adjust the effective reflectance of the white backing

So that the instrument gives a correct reading of opacity with standards evaluated for opacity

9.2 The 0 of the instrument should be checked and adjusted if necessary
Then with the apparatus turned on and the specimen aperture covered with the black body, the scale reading should not exceed 0.5 divisions with 100 divisions equal to full scale.

9.3 With the specimen backed by the standard white backing
Set the instrument to read 100.0

9.4 Replace the white backing with the black body
Then read the meter to obtain the contrast ratio. Record the individual results to three significant figures.

10. Calculation of Results

Compute the contrast ratio range, R (largest minus smallest value), and if five specimens were tested for a sample, multiply by 0.51 to obtain the 95% confidence limits of the mean.

11. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Report the mean value of contrast ratio for each test sample to the nearest 0.1% together with the 95% confidence limits. (Co.89 + 0.51 R [*or other appropriate factor for R*]).
f) Laboratory testing conditions
g) Number of specimens tested and note CD and/or MD if significant
h) For computer processed data, identify the software used and the version
i) Deviation from the standard test procedure, if any
j) When calculated, the standard deviation or the coefficient of variation
k) Whether or not samples were conditioned prior to testing and, if so, for how long
l) Anything unusual noted during the testing

12. Precision

Precision – The precision of this method has not been determined.

STANDARD TEST: WSP 060.2.R3 (12)

Standard Test Method for Optical Properties Brightness of Nonwoven Fabrics

The number in parentheses indicates the year of the last revision

1. Scope

This test covers the evaluation of the optical properties of nonwovens by testing for brightness. This test measures the reflecting power of an infinitely thick stack of materials under spectral and geometric conditions as specified in TAPPI Method T452.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document:

2.1 ISO test methods

a) ISO 139 : Textiles — Standard atmospheres for conditioning and testing
b) ISO 3951-1:2005 Sampling procedures for inspection by variables
c) ISO 2859-1:1999 Sampling procedures for inspection by attributes

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

2.3 TAPPI test methods

T452 om-92 Brightness of Paper and Paperboard

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

Brightness
As applied to white and near white nonwovens, has come to be associated with the numerical value of their reflectance to light in the blue and violet portions of the spectrum.

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This special use of the term was derived from long use of the word as a descriptive of the "whiteness" of nonwovens. Additionally, the results from a brightness measurement on each of two "white" nonwovens will usually correlate well with the subjective estimates of the relative whiteness of the two samples.

4. Principle

This use of the term "brightness" is applicable to all naturally colored nonwovens. A measurement of brightness, per se, is not of great significance when the nonwovens contain added coloring matter (such as yellow or green dye-stuff) which appreciably absorbs light in that part of the spectrum extending from about 400 to 500 nanometers. Such a measurement may have significance if it is one of several reflectives measured at various effective wavelengths for the purpose of establishing spectral reflectivity.

5. Apparatus

5.1 Brightness instrument

Is a reflection meter of such design and in such adjustment that its calibration is correct to within tolerances specified in the section on calibration.

Apparatus is available from: Technidyne Corporation 100 Quality Ave., New Albany, IN 47150

5.2 Ultimate standard of reflectance

Magnesium oxide (Mg0), prepared and deposited on a block of magnesium carbonate.

5.3 Calibration standards

These calibration standards are comprised of at least five master standards and two working standards.

6. Sampling

6.1 Lot Size

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

6.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (*Sampling procedures for inspection by attributes)* or ISO 3951-1:2005 (*Sampling procedures for inspection by variables)* can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small

samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 to 1200	35

NOTE 2 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

NOTE 3 More specimen sheets may be required for thin samples to prevent show-through of the backing weight. If show-through occurs, increase the number of sheets for the stack until the measured brightness is not changed by adding to its thickness.

7. Calibration and Standardization

7.1 Check the instrument readings

When in use, check the instrument readings against the values of the master standards daily. If the instrument is found to be out of tolerance (greater than 0.3 point), adjust the instrument (frequently it is the focus of the lamp image) so that the readings agree with the assigned values. (TAPPI T452 om-92 Appendix B "Calibration Service" may be referenced).

7.2 Your laboratory test instrument should

Your laboratory test instrument should be calibrated with a known master instrument of the same type and design. Check with the equipment supplier.

8. Conditioning

For conditioned testing:

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 4 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

9. Procedure

9.1 Care in handling specimens

Without touching the test areas of the specimen, remove the protective cover sheet, placing it on the back of the stack. Place the stack over the specimen aperture of the instrument with the machine direction of the nonwoven parallel to the place determined by the axes of the incident and reflected light.

NOTE 5 If it is considered desirable to orient the test specimen in some other direction or to average the readings in both principle directions, clearly state this in the report.

9.2 Placing the flat based weight

Place a 1 kg weight having a flat base upon the stack. Measure and record the brightness reading to 0.1 unit.

9.3 Repeat testing this stack six times

Move the top sheet to the back of the stack and take another reading. Repeat this procedure until six different sheets have been tested.

10. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Average percentage brightness of the sample based on magnesium oxide = to one decimal place, also include the minimum and maximum readings
d) Name and address of testing institution
e) Make and model of testing equipment
f) Laboratory testing conditions

g) Number of specimens tested and note CD and/or MD if significant
h) For computer processed data, identify the software used and the version
i) Deviation from the standard test procedure, if any
j) When calculated, the standard deviation or the coefficient of variation
k) Whether or not samples were conditioned prior to testing and, if so, for how long
l) Anything unusual noted during the testing

11. Precision

11.1 Precision

The precision for this method is yet to be determined.

STANDARD TEST: WSP 060.3.R3 (12)

Standard Test Method for Nonwoven Brightness

The number in parentheses indicates the year of the last revision

1. Scope

This test method determines the factor of diffuse reflectance of nonwovens in the blue region of the visible spectrum (degree of brightness). The reflectance factor is the ratio, expressed as a percentage, of the radiation reflected by a body relative to the radiation reflected under the same conditions by the perfect diffuser. In any case it is necessary to ensure that the stack of sample sheets employed is sufficiently thick as to be completely opaque. The degree of brightness is the factor of diffuse reflectance in the blue region of the visible spectrum when determined by a reflectometer equipped with a filter having a wavelength of 457 nm.

The SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document:

2.1 ISO test methods

a) ISO 2469: 1977
b) ISO 139 : Textiles — Standard atmospheres for conditioning and testing
c) ISO 3951-1:2005 Sampling procedures for inspection by variables
d) ISO 2859-1:1999 Sampling procedures for inspection by attributes

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

Reference number
WSP 060.3.R3 (12) A

Current edition approved WSP 060.3.R3 (12)
Originally published as WSP 60.3 in 2005
Last approved as WSP 60.3 in 2008

3. Principle

It is vital to take the following precautions in order to carry out correct measurements

a) Samples are to be stored away from light prior to the tests
b) The stack of specimens should be sufficiently thick to ensure that the background material does not affect the reflectance factor
c) Reference to be made to the perfect diffuser
d) Apparatus is equipped with a lamp, follow the equipment manufacturer on when to change the lamp

4. Apparatus

4.1 A reflectometer

Whose geometric features comply with ISO standard 2469.

4.2 A proper filter

Which provides an effective wavelength of 457 nm.

4.3 A standard sample

Of known brightness, determined by comparison with the perfect diffuser.

5. Sampling

5.1 Lot Size

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

5.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (*Sampling procedures for inspection by attributes)* or ISO 3951-1:2005 (*Sampling procedures for inspection by variables)* can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 to 1200	35

NOTE 2 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

6. Conditioning

For conditioned testing:

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 3 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

7. Procedure

7.1	Prepare a sufficient number of specimens so that the opacity of the stack of sheets may be regarded as complete. (To meet this requirement, there must be no change in the measurement results, if the number of specimens is doubled).	
7.2	If possible, identify the right side and the reverse side of the specimen.	
7.3	Protect the pile of specimens with additional sheets above and below.	
7.4	Prepare the apparatus. a) Make sure that the apparatus is in perfect working condition. b) Make sure that the apparatus is fitted with appropriate filters for measuring brightness (wavelength 457 nm). c) Allow the apparatus to warm up for at least 15 min. in order to stabilize the lamp temperature. d) Make sure that the standard sample is not damaged.	
7.5	Place the standard sample on the apparatus.	
7.6	Adjust the apparatus so that it indicates the value R of the standard's diffuse reflectance factor (this value has been measured by comparison with the perfect diffuser).	R=89.5
7.7	Take the stack of specimen sheets to be tested, remove the protective sheet, and substitute to the standard the stack of specimens as prepared. Read off the value R_∞ of the diffuse reflectance factor of the first layer	R_∞ = 83
7.8	Make sure that, if the number of specimens had been doubled, the value read off for R_∞ would be the same.	83
7.9	Take away the first specimen, place it on the back of the pile and then measure R_∞ on the second sample.	83.5 – 82.5
7.10	Repeat the operation until at least ten values have been obtained.	83 – 83.5 – 82

7.11	Return the standard sample to the apparatus and make sure that no deviation has occurred. In the event of a deviation repeat the measurements.	82.5 – 83 83
7.12	Place the specimens on the apparatus again and repeat the measurements on their other face.	81 – 81.5 – 82 – 81.5 80.5 – 81 – 81
7.13	Return the standard sample to the apparatus again and make sure that no deviation has occurred.	81.5 – 82 – 81.5
7.14	Calculations and results. a) Calculate the mean of the diffuse reflectance factors for the right side. b) Calculate the mean of the diffuse reflectance factors for the reverse side. c) Calculate the mean of the right side and the reverse side factors.	$\frac{82.9}{10} = 82.9$ $\frac{81.35}{10} = 81.4$ 82.2

8. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment and its correct reflectance to the reference standard.
e) Laboratory testing conditions
f) Number of specimens tested and note CD and/or MD if significant
g) For computer processed data, identify the software used and the version
h) Deviation from the standard test procedure, if any
i) When calculated, the standard deviation or the coefficient of variation
j) Whether or not samples were conditioned prior to testing and, if so, for how long
k) Anything unusual noted during the testing
l) Average brightness coefficient and standard deviation for face A and face B.
m) Overall average brightness.

9. Precision

9.1 Precision

The precision for this method is yet to be determined.

STANDARD TEST: WSP 060.4.R3 (12)

Standard Test Method for Nonwoven Opacity

The number in parentheses indicates the year of the last revision

1. Scope

This test method measures the opacity of a nonwoven on a nonwoven backing by diffuse reflectance.

The opacity (nonwoven backing) is the ratio, expressed as a percentage, of the luminous reflectance factor of a single sheet of ordinary nonwoven material placed on a black background (R_o), relative to the luminous reflectance factor of the same sample placed on a sufficient number of superimposed nonwoven sheets so that the result is not altered if the number of sheets is increased (intrinsic reflectance factor R_∞).

SI values are regarded as the official standard system of measurement for this standard test method.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document:

2.1 ISO test methods

a) ISO 139: Textiles — Standard atmospheres for conditioning and testing
b) ISO 3951-1:2005 Sampling procedures for inspection by variables
c) ISO 2859-1:1999 Sampling procedures for inspection by attributes
d) ISO 2469: 1977

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

The term "reflectance factor" is used to describe the ratio, expressed as a percentage, of the radiation reflected by a body to that reflected by a perfect reflecting diffuser under the same conditions.

Reference number
WSP 060.4.R3 (12) A

Current edition approved WSP 060.4.R3 (12)
Originally published as WSP 60.4 in 2005
Last approved as WSP 60.4 in 2008

4. Principle

Remarks
It is vital to take the following precautions in order to carry out correct measurements:

a) Samples to be stored away from the light prior to testing, in order to ensure that they do not undergo change
b) The intrinsic reflectance factor (R∞) to be determined with a sufficient number of samples
c) Reference to be made to the perfect diffuser
d) Apparatus is equipped with a lamp, follow the equipment manufacturer on when to change the lamp

5. Apparatus

5.1 A reflectometer
Whose geometric features comply with ISO standard 2469

5.2 Filter providing a general response
Equivalent to the tristimulus value "Y" of the CIE colorimetric reference system of 1931
Evaluated for the sample under test with the CIE luminator C (filter FMY/C)

5.3 Black cavity in the form of a hollow cylinder lined with black velvet
Having a luminous reflectance factor of less than 0.5 %

5.4 Using a standard sample
Which has a known diffuse reflectance factor previously determined by comparison with the perfect diffuser

6. Sampling

6.1 Lot Size
A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

6.2 Sampling
If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (*Sampling procedures for inspection by attributes)* or ISO 3951-1:2005 (*Sampling procedures for inspection by variables)* can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can

therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.
In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 to1200	35

NOTE 2 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

7. Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 3 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

8. Procedure

Procedure		Worked Example
8.1	Prepare a sufficient number of samples so that the opacity of the stack of sample sheets may be regarded as complete. (To meet this requirement, there must be no change in the measurement result, if the number of sheets is doubled).	
8.2	If possible, identify the right side and the reverse side of the fabric.	
8.3	Protect the pile of samples with additional sheets above and below.	
8.4	Prepare the apparatus. a) Make sure that the apparatus is in perfect working order. b) Make sure that the apparatus is fitted with appropriate filters for measuring opacity (filter FMY/C). c) Allow the apparatus to warm up for at least 15 min. in order to stabilize the lamp temperature. d) Make sure that the standard sample is not damaged.	
8.5	Place the standard sample on the apparatus.	
8.6	Adjust the apparatus so that it indicates the value R of the standard sample's diffuse reflectance factor. This value has been measured by comparison with the perfect diffuser.	R = 89.5
8.7	Take the stack of sample sheets to be tested, remove the protective sheet and substitute to the standard the stack of samples as prepared. Read off the value R_∞ of the diffuse reflectance factor of the first layer.	Right side measurements R_∞ / R_0 / $\frac{Ro}{R\infty}$ 87.5 / 66.5 / 76 87.5 / 67.5 / 77.1 87.5 / 63.5 / 72.6 87.5 / 66.5 / 76 87.5 / 65 / 74.3 87.5 / 63.5 / 72.6 87 / 65 / 74.7 87 / 64.5 / 74.1 87.5 / 63.5 / 72.6 87.5 / 64.5 / 73.7
8.8	Make sure that, if the number of samples in the pile had been doubled, the value read off for R_∞ would be the same.	
8.9	Take away the stack of sample sheets except the sample for which the value R_∞ has been read off. Place the black cavity at the back of this sample. Read off the reflectance factor on the black background R_0.	

8.10 Carry out the measurement of R_∞ then that of R_o on the second sample and so on until at least ten measurements have been made.

8.11 Replace the samples by the standard sample and make sure that no deviation has occurred on the apparatus.

8.12 Return the stack of sample sheets to the apparatus and determine R_∞ and R_o on the reverse side of the samples.

Reverse side measurements

R_∞	R_o	$\frac{Ro}{R\infty}$
87	67	77
87.5	64	73.1
87.5	66.5	76
87.5	65	74.3
87.5	63.5	72.6
87.5	64.5	73.7
88	64.5	73.3
87.5	64	73.1
87	63.5	73
87.5	63	74.3

8.13 Substitute the standard sample for the samples and make sure that no deviation has occurred on the apparatus.

8.14 Calculations and results:

a) Calculate the ratio $\frac{Ro}{R\infty}$ for each of the ten measurements on the right side and ascertain the average.

Average for right side: 74.37

b) Calculate the ratio $\frac{Ro}{R\infty}$ or each of the ten measurements on the reverse side and ascertain the average.

Average for reverse side: 74.04

c) Calculate the average of the right and reverse side factors.

74.21

9. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment

e) Filter (being appropriate to measure opacity)
f) Average opacity coefficient and its standard deviation for face A and face B
g) Overall average opacity coefficient
h) Laboratory testing conditions
i) Number of specimens tested
j) For computer processed data, identify the software used and the version
k) Deviation from the standard test procedure, if any
l) Whether or not samples were conditioned prior to testing and, if so, for how long
m) Anything unusual noted during the testing

10. Precision

10.1 Precision

The precision for this method is yet to be determined.

STANDARD TEST: WSP 070.1.R3 (12)

Standard Test Method for Air Permeability of Nonwoven Materials
This Method also Includes EDANA's ERT 140.2 – 99

The number in parentheses indicates the year of the last revision

1. Scope

This test method covers the measurement of the air permeability of nonwoven materials.

This test method applies to most fabrics including woven fabrics, nonwoven fabrics, air bag fabrics, blankets, napped fabrics, knitted fabrics, layered fabrics, and pile fabrics. The fabrics may be untreated, heavily sized, coated, resin-treated, or otherwise treated.

SI values are regarded as the official standard system of measurement for this standard test method.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document:

2.1 ISO test methods

a) ISO 5725-1 Accuracy (trueness and precision) of Measurement Methods and Results – Part 1: General Principles and Definitions

b) ISO 5725-2 Accuracy (trueness and precision) of Measurement Methods and Results – Part 2: Basic Method for the Determination of the Repeatability and Reproducibility of a Standard Measurement Method

c) ISO 139:Textiles — Standard atmospheres for conditioning and testing

d) ISO 2859-1:1999 Sampling procedures for inspection by attributes

e) ISO 3951-1:2005 Sampling procedures for inspection by variables

f) ISO 9237:1995 Determination of the Permeability of Fabrics to Air

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

Reference number
WSP 070.1.R3 (12) A

Current edition approved WSP 070.1.R3 (12)
Originally published as WSP 70.1 in 2005
Last approved as WSP 70.1 in 2008

Air permeability
Air permeability is the velocity of an air flow passing perpendicularly through a test specimen under specified conditions of test area, pressure drop (ΔP) and time.

4. Principle

The rate of flow of air passing perpendicularly through a given area of fabric is measured at a given pressure difference across the fabric test area over a given time period.

Air permeability is an important factor in the performance of nonwoven products, i.e. air and gas filters made from different processes, several different types of protective clothing and vacuum cleaner bags. In protective clothing, for example, comfort as it relates to breathability is directly related to air permeability.

5. Apparatus

5.1 Air permeability testing apparatus

5.1.1 Test head

Circular specimen holder, with an orifice allowing the test to be carried out on a area of 20 cm², 38cm^2 or 50 cm². The tolerance on the test heads or test areas shall not exceed more than ± 0.5%

NOTE 2 Other test areas may be used on this machine and can be purchased from the equipment manufacturer, sizes such as 5 cm^2, 25 cm^2 and 100 cm^2. The 100 cm^2 head is for measuring extremely dense specimens.

5.1.2 Clamping system to secure test specimens

Secure the specimen by means of the clamping system provided without distortion of the specimen

NOTE 3 If air leakage accrues around the gasket, check the condition of the gasket and the seal.If the leak still persists call the equipment manufacturer.

5.1.3 Powerful vacuum pump

Used for drawing a steady flow of air perpendicularly through the test area and for adjusting the airflow rate to provide the pressure differentials of between the two surfaces of the fabric being tested. The most common pressure differentials used are 100 to 200 Pa (0.4 to 0.8 inches of water). Use the desired pressure differential that meets your testing criteria. The pressure differential used shall be recorded in the final testing report.

5.1.4 Pressure gage or manometer

Connected to the test head to indicate a pressure drop across the test specimen area, with an accuracy of ± 2%.

5.1.5 Flowmeter, volumeter, counter or measure aperture

Indicating the rate of air flow through the test area with an accuracy of ± 2%.

5.1.6 Calibration Plate
With a known air permeability at the prescribed test pressure differential to verify the apparatus.

5.1.7 Means of calculating
And displaying the required results.

5.2 Some means of cutting the specimens
If your machine cannot accommodate large sheet samples (cutting dies or templates).

6. Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 4 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

7. Sampling

7.1 Lot Size
A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

7.2 Sampling
If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (*Sampling procedures for inspection by attributes)* or ISO 3951-1:2005 (*Sampling procedures for inspection by variables)* can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE.5 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

8. Preparation of Test Apparatus and Calibration

8.1 Set-up procedures for testing equipment

These machines could come from different manufacturers and may vary greatly. Prepare and verify calibration of the air permeability tester as directed in the manufacturer's instructions.

8.2 When using microprocessor automatic data gathering systems

Set the appropriate parameters as specified in the manufacturer's instructions.

8.3 Level the test instrument

8.4 Verify the calibration

For the range and required water pressure differential that will be used

NOTE.6 When measuring some bulky materials the lateral air-flow through the clamping area may represent a significant amount of the total air-flow and may distort the test results. When testing very bulky materials the specimen should be measured twice in the same spot. The first test is done in the normal manner. However,

before performing the second test cover the material with the rubber plate which is supplied with the instrument. The true air permeability of the test specimen is calculated from the difference of these two test results.

9. Procedure

9.1 Place each test specimen

Onto the test head of the test instrument, and perform the test as specified in the manufacturer's operating instructions.

NOTE 7 Place coated test specimens with the coated side down (towards low pressure side) to minimize edge leakage.

9.2 Perform tests at the water pressure differential

Specified by a material specification or contract order. In the absence of either, use the water pressure differential required by your organization, i.e. from 100 to 200 Pa (0.4 to 0.8 in. of water).

9.3 Read and record

There are numerous equations that can be used to record this data, use the proper equation for your organization. The following are some of the equations used:

a) $cm^3/s/cm^2$
b) $l/s/cm^2$
c) mm/s
d) m/s
e) $l/dm^2/min$
f) $m^3/s/m^2$
g) dm^3
h) cfm
i) $cm^3/s/cm^2$
j) $m^3/h/m^2$
k) $ft^{3/}min/ft^2$

The individual test results shall be reported using one of the equations listed either in SI units or in inch-pound units and shall be rounded to three significant digits.

NOTE 8 Never record the finished results as; " ___Frazier units". Legally that term is too ambiguous.

9.4 Remove the tested specimen

And continue as directed in 9.1 – 9.4 until all specimens have been tested for each laboratory sampling unit.

9.5 When a 95 % confidence level for results

Has been agreed upon in a material specification or contract order, fewer test specimens may be sufficient.

NOTE 9 For fabrics so open or so dense that the recommended pressure differential (200 Pa) cannot be obtained on the apparatus, another pressure differential may be used. This must be specifically stated in the report.

NOTE 10 Which side of the fabric was tested, or whether the fabric has been tested on both sides, must be mentioned.

NOTE 11 If minimum condition set for ΔP cannot be obtained, then various plies (layers) of the product should be tested. The number of plies tested should be mentioned.

10. Calculation

10.1 Air permeability, individual specimens

Calculate the air permeability of individual specimens using values read directly from the test instrument in SI units as $cm^3/s/cm^2$ or in inch-pound units as $ft^3/min/ft^2$ or use any other unit that is appropriate for your test results and round-off the results to three significant digits. When calculating air permeability results, follow the manufacturer's instructions as applicable.

NOTE 12 Remember there are some types of air permeability test equipment that require using a correction factor to attain the final results, if the testing was done at or above 600 m (2000 ft) above sea level.

10.2 Air permeability average

Calculate the average air permeability for each laboratory sampling (5 to 10 specimens) unit and for the lot.

11. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Number of specimens tested and note CD and/or MD if significant
g) For computer processed data, identify the software used and the version
h) Deviation from the standard test procedure, if any
i) When calculated, the standard deviation or the coefficient of variation
j) Whether or not samples were conditioned prior to testing and, if so, for how long
k) Anything unusual noted during the testing
l) Where ever options were given, the option used shall be reported
    - The size of the test head used
    - The air pressure differential used
    - The number of specimens for each sample
    - The reporting units, i.e. $m^3/s/m^2$

12. Precision

The precision for this method is yet to be determined.

STANDARD TEST: WSP 070.3.R3 (12)

Standard Test Method for Nonwoven Coverstock Liquid Strike-Through Time Using Simulated Urine

The number in parentheses indicates the year of the last revision

1. Scope

This test method measures the strike-through time, i.e. the time taken for a known volume of liquid (simulated urine) applied to the surface of a test portion of nonwoven coverstock, which is in contact with an underlying standard absorbent pad, to pass through the nonwoven. This test method is only designed to compare strike-through time of nonwoven coverstock. It is not intended to simulate in-use conditions for finished products.

SI values are regarded as the official standard system of measurement for this standard test method.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Referenced Documents

The following referenced documents are indispensable for the application of this document.

2.1 ISO test methods

ISO 9073-8: 1995 Textiles – Test method for nonwovens – Part 8: Determination of liquid strike-through time (simulated urine)
(EN 29073 part 8)

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

Simulated urine

Consisting of a 9 g/l solution of sodium chloride in distilled water with a surface tension of (70 ± 2) mN/m.

Reference number
WSP 070.3.R3 (12) A

Current edition approved WSP 70.3.R3 (12)
Originally published as WSP 70.3 in 2005
Last approved as WSP 70.3 in 2008

4. Principle

A specified quantity of simulated urine is discharged at a prescribed rate under specified conditions onto a test specimen of nonwoven, which is superimposed on a reference absorbent pad. The time taken for the entire liquid dose to penetrate the nonwoven is measured electronically.

5. Reagents and Materials

Use only reagents of recognized analytical grade, unless otherwise specified.

5.1 Standard Absorbent Pad (Blotter Paper)

Reference absorbent pad, consisting of five layers of reference blotter paper (100 mm x 100 mm) with the test side uppermost and having a mean strike-through time, in 10 determinations without using any coverstock nonwoven material, of 3 seconds or less.

a) Must have an absorbent rate of (3 ± 0.5) s or less (ISO 9073-6)
b) The Liquid Absorption Capacity, of the paper, as determined by standard WSP 10.1, must at least 480 %.
c) The mass per unit area of paper must be (90 ± 4) g/m² and the air flow resistance, as determined by ISO 5636, must be (1.9 ± 0.3) kPa.

NOTE 2 This pre-cut blotter paper can be purchased in the U.S. from:
W. Fritz Mezger, Inc
155 Hall St.
Spartanburg, SC 29302

NOTE 3 Also this information concerning suitable blotter paper may be obtained from following nonwovens industry associations: EDANA, Avenue Herrmann Debroux, 46 B-1160 Brussels, Belgium Phone +32 2 734 93 10 Fax +32 2 733 35 18 info@edana.org
INDA, 1100 Crescent Green Suite 115, Cary NC 27518 Phone +1 919 233 1210, Fax +1 919 233 1282

5.2 Simulated urine

Consisting of a 9 g/l solution of sodium chloride in distilled water with a surface tension of (70 ± 2) mN/m. This surface tension should be checked before each series of tests, as surface can alter tension during storage.

NOTE 4 The surface tension of adult human urine is published as 69 to 70 mN/m. There is a suggestion that some babies' urine could have a lower surface tension (e.g. 45 mN/m). The surface tension of the simulated urine can be adjusted by the addition of a surfactant. In this case it should be reported as a deviation from standard procedure and the surface tension should be stated in the test report.

6 Apparatus

6.1 Burette

This has a 50 ml capacity and is attached to a supporting stand.

6.2 Funnel

Fitted with a magnetic valve, giving a rate of discharge of 25 ml in (3.5 ± 0.25) s.

6.3 Ring stand
To support the funnel

6.4 Strike-through plate (see figures 1 and 2)
Constructed of 25 mm thick transparent acrylic sheet, of total mass (500 ± 5) g, fitted with corrosion-resistant electrodes consisting of 1.6 mm diameter platinum or stainless steel wire set in grooves of cross-section 4.0 mm x 7.0 mm cut in the base of the plate and fixed with quick-setting epoxy resin. The electrodes shall be positioned as shown in figures 1 and 2.

6.5 Baseplate
Made of transparent acrylic sheet, approximately 125 mm x 125 mm square and 5 mm thick.

6.6 Electronic timer
Which can be read to the nearest 0.01 s.

NOTE 5 The sensitivity of the timing mechanism is such that different apparatus could give results slightly lower or higher than the specification for the standard absorbent pad alone.

NOTE 6 Users of the method are therefore advised to validate their equipment against results provided by the producer of the blotter paper.

NOTE 7 This complete machine can be purchased from:
W. Fritz Mezger, Inc
155 Hall St.
Spartanburg, SC 29302

7. Sampling

7.1 Lot Size
A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

7.2 Sampling
If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (*Sampling procedures for inspection by attributes)* or ISO 3951-1:2005 (*Sampling procedures for inspection by variables)* can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 8 Results obtained on small hand samples can only be considered as representative of that sample and cannot be assumed to be representative of the material portion from which the small hand sample was taken.

8. Conditioning

For Conditioned Testing

Bring test samples and blotter paper both to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 9 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested.

9. Procedure

9.1 Set up the ring stand
By positioning the burette with the tip inside the funnel.

9.2 Cut the required number of specimens of Nonwoven
125 mm x 125 mm, test specimens being selected in accordance with ERT 130 if applicable.

9.3 Place one nonwoven test specimen
On top of one set of 5 reference blotter papers on the base plate. Place the nonwoven on the blotter paper in such a way that the side of the nonwoven, which is intended to be in contact with the user's skin, is uppermost. Ensure that the electrodes in the strike-through plate are clean. Place the strike-through plate on top of the nonwoven with the center of the plate over the center of the test specimen. Center the burette and the funnel over the plate.

9.4 Adjust the height of the funnel
So that the funnel is (5 ± 0.5) mm above the top of the cavity in the plate (i.e. 30 mm above the test specimen).

9.5 Ensure the electrodes are connected to the timer
Activate the timer and set the clock to zero.

9.6 Fill the burette with simulated urine
Keep the discharge valve of the funnel closed and run 5.0 ml of liquid from the burette into the funnel.

9.7 Open the magnetic discharge valve
Of the funnel to discharge 5.0 ml of liquid. The initial flow of liquid will complete the electrical circuit and start the timer. It will stop when the liquid has penetrated into the nonwoven and fallen below the level of the electrodes in the strike-through plate.

9.8 Record the time
Indicated on the electronic timer.

10. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Number of specimens tested and note CD and/or MD if significant
g) For computer processed data, identify the software used and version.
h) Deviation from the standard test procedure, if any

i) When calculated, the standard deviation or the coefficient of variation
j) Whether or not samples were conditioned prior to testing and, if so, for how long
k) Anything unusual noted during the testing
l) When photos are used as the standard, attach copies
m) Individual strike-through times, in seconds
n) Average strike-through times, in seconds

11. Precision

Precision

The precision for this method is yet to be determined.

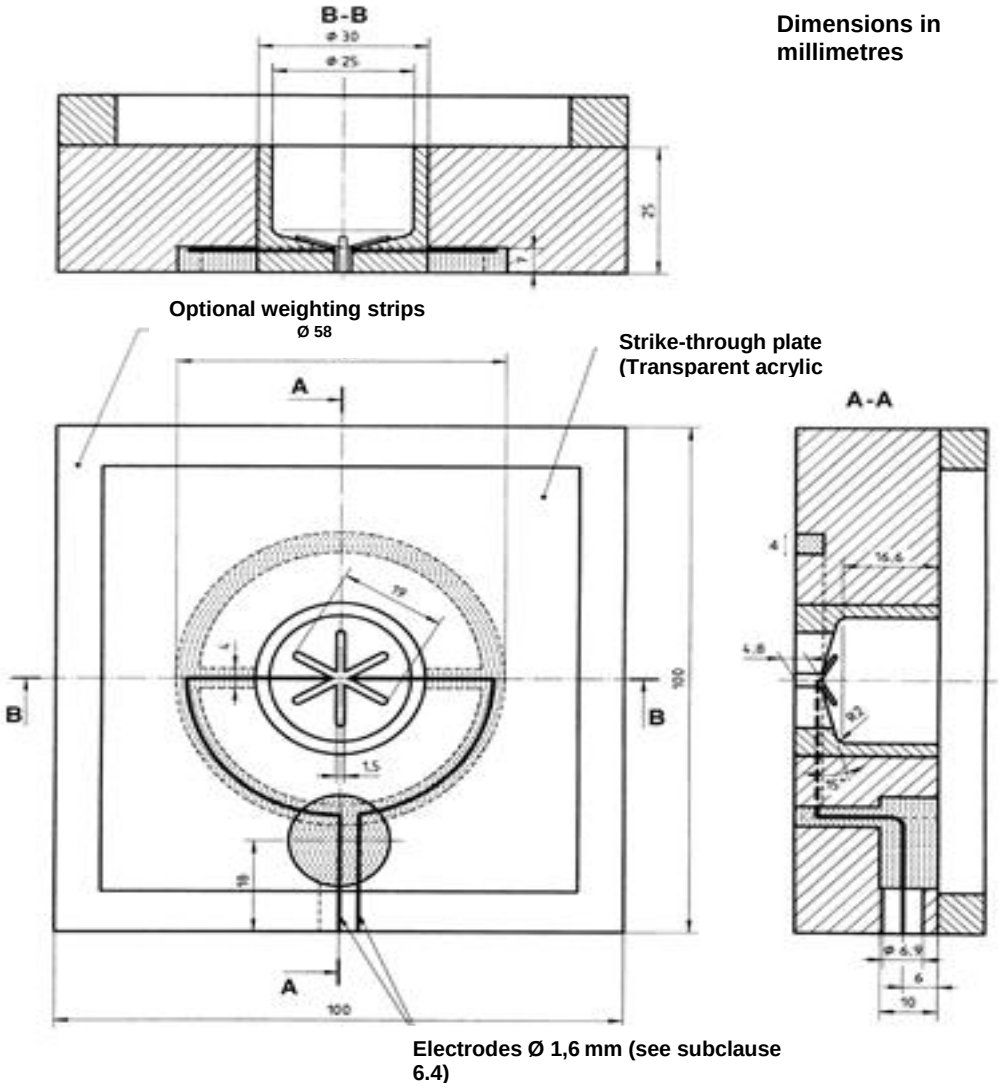


Figure 1
Strike-through plate

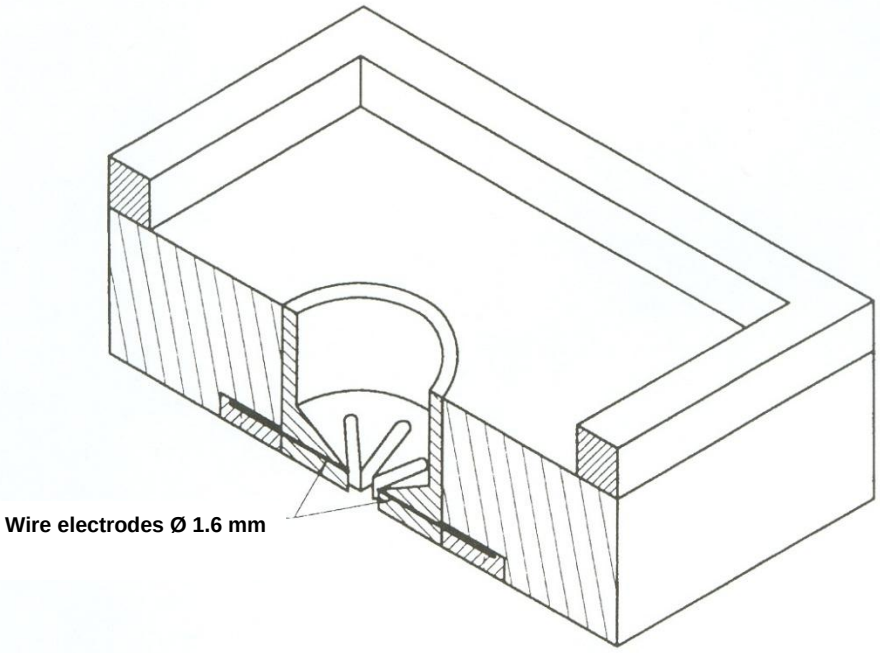


Figure 2 – Section across strike-through plate on centreline of 25 mm diameter cavity

STANDARD TEST: WSP 070.4.R3 (12)

Standard Test Method for Water Vapor Transmission Rates of 500 to 100,000 gm/m^2/day

The number in parentheses indicates the year of the last revision

1. Scope

This test method covers a procedure for determining the rate of water vapor transmission through flexible barrier materials. The method is applicable to sheets and films up to 3 mm (0.1in.) in thickness, consisting of single fabrics and plastic film, including coated materials. It provides for the determination of (1) water vapor transmission rate (WVTR), (2) the permeance of the film or fabric to water vapor, and (3) for homogeneous materials, water vapor permeability coefficient.

NOTE 1 Values for water permeance and water vapor permeability must be used with caution. The inverse relationship of WVTR to permeability must be used with caution. The inverse relationship of WVTR to thickness and the direct relationship of WVTR to the partial pressure differential of water vapor may not always apply.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 2 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document:

2.1 ISO test methods

a) ISO 5725-1 Accuracy (trueness and precision) of Measurement Methods and Results – Part 1: General Principles and Definitions

b) ISO 5725 -2 Accuracy (trueness and precision) of Measurement Methods and Results – Part 2: Basic Method for the Determination of the Repeatability and Reproducibility of a Standard Measurement Method

c) ISO 139 Standard Conditioning

d) ISO 2859-1:1999 Sampling procedures for inspection by attributes

e) ISO 3951-1:2005 Sampling procedures for inspection by variables

Reference number
WSP 070.4.R3 (12) A

Current edition approved WSP 070.4.R3 (12)
Originally published as WSP 70.4 in 2005
Last approved as WSP 70.4 in 2008

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Water vapor permeability coefficient

The product of the permeance and the thickness of the film. The permeability is meaningful only for homogeneous materials, in which case it is a property characteristic of bulk material. The quantity should not be used unless the relationship between thickness and permanence has been verified in tests using several thicknesses of the material. An accepted unit of permeability is the metric perm centimeter, or 1 g per m^2 per day per mm Hg-cm of thickness. The SI unit is the mol/m^2-s-Pa-mm. The test conditions must be stated.

3.2 Water vapor permeance

The ratio of a barrier's WVTR to the vapor pressure difference between the two surfaces. The accepted unit of permeance is the metric perm, or 1 g/m^2 per day per mm Hg. The SI unit is the mol/m^2-s-Pa. Since the permeance of a specimen is generally a function or relative humidity and temperature, the test conditions are very important and must be stated.

3.3 Water vapor transmission rate (WVTR)

The time rate of water vapor flow normal to the surfaces, under specific steady-state conditions of temperature and humidity, per unit area. An accepted unit of WVTR is g/m^2/day. The test conditions of relative humidity and temperature where the driving force is the difference in relative humidity across the specimens must be stated.

4. Principle

A dry chamber is separated from a wet chamber of known temperature and humidity by a permanent guard film and the barrier material to be tested. The purpose of the guard film is to define a definite air gap and to quiet or still the air in the air gap while the air gap is characterized. The dry chamber, guard film and the wet chamber make up a diffusion cell in which the test film is sealed. A first test is made of the water vapor transmission rate of the guard film and air gap between an evaporator assembly that generates 100% relative humidity. Water vapor diffuses through the air gap and the guard film and then mixes with a dry gas flow that sweeps the guard film. The mixture is carried to a water vapor sensor. The sensor produces an electrical signal, the amplitude of which is proportional to water vapor concentration. The electrical signal is routed to a computer for processing. The computer calculates the transmission rate of the air gap and guard film and stores the value for further use. The transmission rate of the guard film and air gap is stored in the computer as CalC. The barrier is then sealed in the test cell. Again, water vapor diffuses through the air gap and the guard film and the test barrier and then mixes with a dry gas flow that sweeps the test barrier. Also again, this mixture is carried to the vapor sensor.

The computer then calculates the transmission rate at which moisture is transmitted through the material being tested according to equation.

TR -1 Testbarrier = TR-1 Testbarrier, Guardfilm, Airgap – TR-1 Guardfilm, Airgap

The purpose of this test method is to obtain reliable values for the WVTR of barrier materials. WVTR is an important property of materials and can be directly related to product performance and product stability. Data from this test method is suitable as a referee method of testing, provided that the interested parties have agreed on sampling procedures, standardization, procedures, test conditions, and acceptance criteria.

5. Material and Reagents

5.1 Desiccant
For drying air stream

5.2 High purity level chromatograph grade distilled water (HPLC)
For producing 100% relative humidity.

5.3 Sample holder
A cardboard or metal holder to make loading of the specimens easier.

6. Apparatus

This method utilizes water vapor transmission apparatus comprised of the following:

6.1 Test cells
The apparatus has six test cells within two assemblies. Figure 1 shows a typical cell cross section. The six cells are formed by metal halves which, when closed upon the test specimens, will accurately define a circular area for each. A typical acceptable diffusion cell area is 10 cm^2. The volume enclosed by each cell half, when clamped is not critical. It is desirable that the air gap between the water evaporator assembly and the guard film should be as small as practical, but not so small that an unsupported film which happens to sag or buckle will contact the evaporator assembly. The barrier under test should be in intimate contact with the guard film. A depth of approximately 3.2mm has been found to be satisfactory for the carrier gas side of 10cm^2 cells.

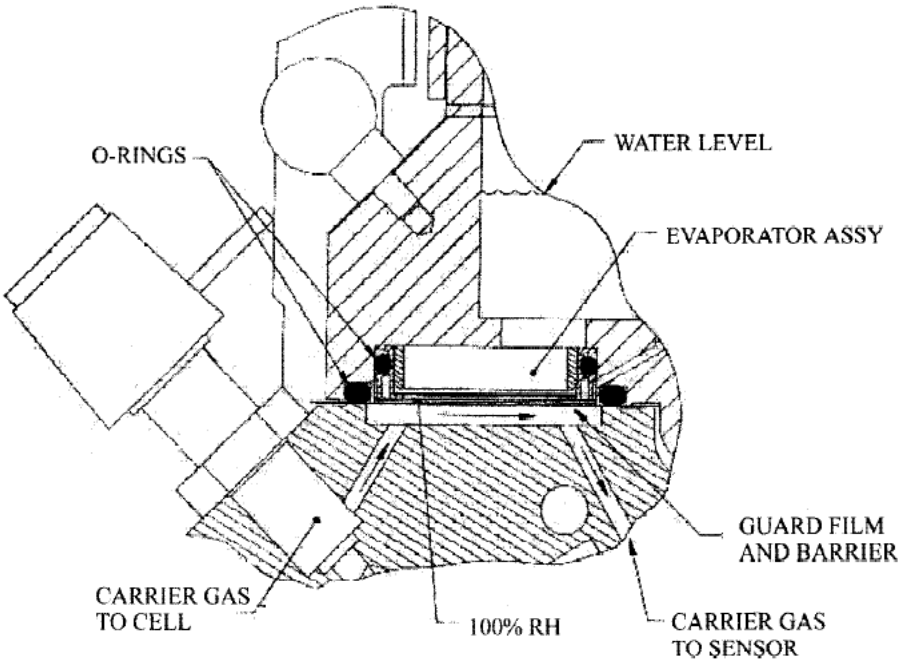


Figure 1

6.1.1 Test cell o-ring

An appropriately sized groove machined into the humid chamber side of the test cell retains a neoprene O-ring. The test area is considered to be the area established by the inside contact diameter of the compressed O-ring when the test cell is clamped shut against the test specimen.

6.1.2 Test cell sealing surface

Is a flat rim around the dry side of the diffusion cell. This is a critical sealing surface against which the test specimen is pressed; it shall be smooth and without radial scratches.

6.1.3 Test cell air passages

Two holes in the dry half of the diffusion cell that pass carrier gas and water vapor to either exhaust ports or the sensor assembly. One cell at a time can be connected to the sensor assembly by solenoid valves.

6.1.4 Test cell guard film

A flat film covers the humid side of each cell. The film is a barrier that stills the air in the gap between the water evaporator and the mounting plane of the specimen. The guard film is a very high transmitter of water vapor. Its transmission rate as well as that of the air gap is accounted for in the apparatus measurements.

6.1.5 Water vapor sensor

A water vapor detector capable of sensing 0 to 100% relative humidity with sufficient accuracy so the apparatus can determine transmission rates down to 500 g/m^2 per day.

6.1.6 Past sensor dryer
A no maintenance dryer that removes water vapor from the measurement gas stream after it passes through the water vapor sensor.

6.1.7 Mass flowmeter
A means of regulating the flow of dry air within an operating range of 0 to 200 cc/min is required.

6.1.8 Flow - metering valves
Fine metering valves capable of controlling the dry air flow rate to each test.

6.2 Computer system
A computer provides the main control, calculating, and data storage device for the system.

6.3 Temperature control
It is desirable to thermostatically control the temperature of the test apparatus. A Thermo-Electric Device (TED) attached to the apparatus in such a manner as to ensure good thermal contact. A thermistor sensor and an appropriate control circuit will serve to regulate the temperature from 20 to 50°C to within 0.1°C.

6.4 Barometric pressure sensor
A sensor measures the ambient barometric pressure so that variations are automatically corrected in the calculations.

7. Conditioning (special)

For this test method the specimen conditioning will take place inside the testing chamber prior to testing the specimen. The following two points were copied from clause 9 of this test method.

7.1 (9.5 conditioning the sample)
During the setting of test parameters it is necessary to select to condition or not condition. Experience has shown that most materials will condition in 10 to 20 minutes. Operators often choose not to condition but go directly to “TEST” and run extra cycle through cells.

7.2 (9.6 establish equilibrium rate)
After the system has cycled through the cells a few times, the measurements indicate that an equilibrium transmission rate has been reached. The system can be made to stop further testing of each cell by a setup in the computer. When successive values for any cell are within 1% testing will cease; this is known as convergence mode. In most cases, two to ten test cycles per cell are sufficient. Better barriers may require more cycles to come to equilibrium.

8. Sampling

8.1 Lot Size

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

8.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (*Sampling procedures for inspection by attributes)* or ISO 3951-1:2005 (*Sampling procedures for inspection by variables)* can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 3 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

8.3 Pre-test sample consideration

Mount the test samples to the sample/specimen holder made to fit the apparatus. In general, these materials are high transmitters and the specimens do not require a significant conditioning period; they reach equilibrium, in just a few examination periods. (Experience has shown that individual examination periods range from 2 to 10 minutes). The time required for pre-test sample conditioning varies as a function of many factors such as barrier composition, thickness, test temperature, etc. Note also that the permeation system will require some time to stabilize with materials having low transmission rates after it has been used to test materials with high transmission rates. For this reason it is desirable when testing a number of different samples, sequentially, that materials having similar permeability characteristics should be tested together, or alternatively, the examination time should be extended to ensure that the apparatus reaches an equilibrium value consistent with the conditioning state of the specimens. If unfamiliar with the material being tested, the operator should investigate the effect of examination time.

9. Procedure

9.1 Preparation of apparatus (see figure 1)

a) If preceding tests have exposed the apparatus to high moisture levels, out gas the system to desorb residual moisture. Purge the system with dry air for a period of 3 to 4 hours.
b) Calibrating the system: Determining the transmission rate of the air gap and the guard film "CalC".
c) Fill the reservoir with HPLC water.
d) Place a blank specimen holder in the system and tighten the clamp.
e) Adjust the gas flow to each cell for uniform RH reading for all cells.
f) Set all cells to "CalC".
g) The computer will automatically determine a "CalC" value for each cell.

9.2 Number of specimens tested

Test enough specimens to obtain the desired result, but never less than three per sample.

9.3 Preparation of test samples

a) Cut the test specimens to shape using a template or die cutter.
b) Measure specimen thickness at four equally spaced points within the test area and at the center in accordance with guidelines described in WSP 120.1
c) Mount the specimens to the holder noting the material identity in each location. Do not write on testing area of the material.
d) Because of the type of material that is used for the guard film grease should not be used on either the lower cell sealing surface or the upper cell O-ring.

e) Align the holder over the pins in the bottom portion of the cells of the apparatus, place the upper portion of the cells on the base of the apparatus, and then tighten the clamp.

9.4 Put the specimen in TEST MODE

The specimens are placed into test via the computer keyboard. Enter the global test parameters and individual cell parameters. Place each cell into "TEST MODE".

9.5 Conditioning the sample

During the setting of test parameters it is necessary to select to condition or not condition. Experience has shown that most materials will condition in 10 to 20 minutes. Operators often choose to not condition but go directly to "TEST" and run extra cycle through cells.

9.6 Establish equilibrium rate

After the system has cycled through the cells a few times, the measurements indicate that an equilibrium transmission rate has been reached. The system can be made to stop further testing of each cell by a setup in the computer. When successive values for any cell are within 1% testing will cease; this is known as convergence mode. In most cases, two to ten test cycles per cell are sufficient. Better barriers may require more cycles to come to equilibrium.

NOTE 4 When testing materials for which the operator has no previous history, additional time must be allowed to assure that true equilibrium has been reached and it is best to not use the convergence mode.

9.7 System report

The system will indicate DONE when all cells have reached equilibrium (when in convergence mode) and it stops testing. A printed record of the test should be obtained before continuing to test additional barriers.

9.8 Standby and shutoff procedures:

a) At the conclusion of a test, but in anticipation of further testing, place the instrument in standby.
b) When the system is not to be used for an extended period, dry the system then the electrical power may be turned off.

10. Calculation

10.1 WVTR - The calculation of water vapor transmission rate uses the formula

$WVTR=FP_{sat}(T)RH/(AP_{sat}(T)(1-RH))$
Where:
F = the flow of in cc/min
$P_{sat}(T)$ = the density of water in saturated air at temperature, T. (Section 10)
RH = the relative humidity at specified locations in the cell.
A = the cross section area of the cell, and,
$P_{sat}(T)$ = the saturation vapor pressure of water vapor at temperature, T.

10.2 Permeance - calculate sample permeance (if required) using the following relationship

$$\text{WVTR Metric Perms} = \frac{WVTR}{Pw} = \text{g/m}^2 \text{ per day mm Hg}$$

where:
WVTR = Specimen water vapor transmission rate, g/m^2 day, and
P_w = Water vapor partial pressure gradient across the test specimen, mmHg.

10.3 Permeability coefficient

Calculate the water vapor permeability coefficient (if required) using the following relationship:

Permeability = metric perms x T

where:

T = the average thickness of the specimen, cm

Note that permeability calculations are meaningful only in cases where materials have been determined to be homogeneous.

11. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Cell identification
f) Barrier material thickness
g) Total time
h) Examination time
i) Test temperature
j) Barometric pressure
k) Carrier gas flow rate
l) Air gap and guard film transmission rate (CalC)
m) Measured barrier transmission rate
n) Start time and elapsed time of testing
o) Remarks
p) The average permeance of all specimens of at type tested in each cell

q) The values of Cal C (the transmission rate of the air gap and guard film). WVTR and elapsed time from start of test. These entries should be rounded off to three significant figures or less, as may be consistent with the operator's estimate of precision and bias.
r) The means used to obtain the calibration factor
s) The effective area exposed to permeation
t) The time to reach steady-state after introduction of the diffusion cell into the test chamber
u) A description of the conditioning procedure.

12. Precision

12.1 Six specimens were mounted on a cardboard sample holder

And these were tested on six instruments. Each sample, A through F, was tested on each instrument for a 6 x 6 array. The six instruments were owned by different organizations but were at one location at the time of testing.

12.2 In all cases

Values for samples A through F were calculated by the algorithms in the apparatus computer. The measured data was then entered into INDA's software (ISO 5725 -2) and the between instrument results were calculated as between laboratory data. The measurement precision is as follows:

Sample Tested	Average WVTR g/m^2day	5_R	SR	r	R
A	20086	38.2	693.1	108.8	1940.7
B	20012	85.5	700.2	239.5	1960.4
C	20895	74.7	720	209.2	2106.1
D	20148	74.3	870.9	208.2	2438.6
E	20512	63.8	966.8	178.6	2707.2
F	20219	41.5	689.3	116.2	1929.9

NOTE 5 The precision and bias of results obtained with reduced-area masked samples have not been established.

WVTR Precision with 95% Probablility Level
Expressed as Standard Error and Critical Difference

	Spec in Avg	Within Within	Laboratory Instrument	Within Between	Laboratory Instrument
Material	N	SE	CD	SE	CD
A	1	38.2	107	693.1	1941
	3	22.1	52	400.2	1120
	6	15.6	44	283.0	792
B	1	85.5	239	700.2	1961
	3	49.4	138	404.3	1132
	6				
C	1	74.4	208	720.0	2016
	3	43.0	120	415.7	1164
	6	30.4	85	293.9	823
D	1	74.3	208	870.9	2439
	3	42.9	120	502.8	1408
	6	30.3	85	355.5	996
E	1	53.8	179	966.8	2707
	3	36.8	103	558.2	1563
	6	26.0	73	394.7	1105
F	1	41.5	115	689.3	1930
	3	24.0	67	398.0	1114
	6	16.9	47	281.4	788

WVTR Components of Variance – All Samples (as Standard Deviation)

Source	Symbol	(Average)
Instrument	VI	773.4
Error	V	63.0

WVTR Precision with 95% Probability Level
Expressed as Standard Errorr and Critical Difference

	Spec in Avg	Within Within	Laboratory Instrument	Within Within	Laboratory Instrument
Material	N	SE	CD	SE	CD
	1	63.0	176	773.4	2165
	3	36.3	102	446.5	1250
	6	25.7	72	315.7	884

Note: 6 Often other units than Transmission Rate are useful for characterizing and selecting this class of materials for various applications. The two most common units are Permeance and Permeability Coefficient. Values for water vapor permeance and water vapor permeability must be used with caution. The inverse relationship of WVTR to thickness and the direct relationship of WVTR to the partial pressure differential of water vapor may not always apply. To calculate sample permeance, if required, use the following relationship

$$\text{Metric perms} = \frac{\text{WVTR}}{P_w} = \text{g/m}^2 \text{ per day per mm Hg.}$$

Where:

WVTR = Specimen water vapor transmission rate, g/m^2 day, and P_w= Water Vapor partial pressure gradient across the specimen, mm Hg. To calculate the water vapor permeability coefficient, if required, use the following relationship:

$$\text{Permeability} = \text{metric perms} \times t,$$

Where:

t = the average thickness of the specimen, cm. Note that permeability calculations are meaningful only in cases where materials have been determined to be homogeneous.

STANDARD TEST: WSP 070.5.R3 (12) part 1

Standard Test Method for Water Vapor Transmission Rate by the Principle of Measurement of Relative Humidity in a Dry Cell

The number in parentheses indicates the year of the last revision

1. Scope

This test method covers a procedure for determining the rate of water vapor transmission ranging between 500 to 100.000 g/m²/day through nonwoven and plastic barriers materials. The method is applicable to films, barriers consisting of single or multilayer synthetic or natural polymers, nonwoven fabric, and nonwoven fabrics coated with films up to 3 mm in thickness.

This test method provides for the determination of water vapor transmission rate (WVTR), It relates specifically to the use of an apparatus sold by Mocon, Inc. under the name Permaltran W model 100K.

The values stated in metric units are to be regarded as the standard. The acceptable units for water vapor transmission rate are usually g/m²/day.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document:

2.1 ISO test methods

a) ISO 5725-1 Accuracy (trueness and precision) of Measurement Methods and Results – Part 1: General Principles and Definitions

b) ISO 5725-2 Accuracy (trueness and precision) of Measurement Methods and Results – Part 2: Basic Method for the Determination of the Repeatability and Reproducibility of a Standard Measurement Method

c) ISO 139: Standard Conditioning

d) ISO 2859-1:1999 Sampling procedures for inspection by attributes

e) ISO 3951-1:2005 Sampling procedures for inspection by variables

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

Reference number
WSP 070.5.R3 (12) part 1 A

Current edition approved WSP 070.5.R3 (12)
Originally published as WSP 70.5 in 2005
Last approved as WSP 70.5 in 2008

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

Water vapor transmission rate (WVTR)
The steady-state time rate of water vapor flow through unit area of a specimen, normal to the surfaces under specific conditions of temperature and humidity at each surface.

A common practice accepted unit of water vapor transmission rate is metric g/m²/day. The test conditions of relative humidity and temperature where the driving force is the difference in relative humidity across the specimen must be stated.

4. Principle

The purpose of this test method is to obtain values for the water vapor transmission rate of barrier materials. Water vapor transmission rate is an important property of materials and can be related to shelf life; product stability, breathability, and wearing comfort. Data from this test method is suitable as a referee method of testing, provided that the purchaser and seller have agreed on sampling procedures, test conditions, and acceptance criteria

A dry chamber, guard film, and a wet chamber make up a diffusion cell in which the test film is scaled. A first test is made of the water vapor transmission rate of the guard film and air gap between an evaporator assembly that generates 100% relative humidity. A sensor produces an electrical signal, the amplitude of which is proportional to water vapor concentration. The electrical signal is routed to a computer for processing. The computer calculates the transmission rate of the air gap and guard film and stores the value for further use. The barrier is then sealed in the test cell and the apparatus started in the test mode.

As before, the electrical signal representing the water vapor is sent to the computer which then calculates the transmission rate of the combination of the air gap, the guard film, and the test barrier. The computer then uses this information to calculate the water vapor transmission rate of the material being tested. The computer determines when the measured results indicate that the specimens have reached equilibrium values and the testing is considered finished.

5. Material and Reagents

5.1 Desiccant
For drying air stream.

5.2 High purity level chromatograph grade distilled water (HPLC)
For producing 100% relative humidity.

5.3 Sample holder
All test specimens must be mounted on the metal film holder provided with the Permaltran-W model 100 K, following the instructions in the instrument operating manual.

6. Apparatus

This method utilizes water vapor transmission apparatus comprised of the following:

6.1 Test cells
The apparatus has six test cells within two assemblies. Figure 1 shows a typical cell cross section. The six cells are formed by metal halves which, when closed upon the test specimens, will accurately define a circular area for each. A typical acceptable diffusion cell area is 10 cm^2. The volume enclosed by each cell half, when clamped is not critical. It is desirable that the air gap between the water evaporator assembly and the guard film should be as small as practical, but not so small that an unsupported film which happens to sag or buckle will contact the evaporator assembly. The barrier under test should be in intimate contact with the guard film. A depth of approximately 3.2mm has been found to be satisfactory for the carrier gas side of 10cm^2 cells.

6.1.1 Test cell O-ring
An appropriately sized groove machined into the humid chamber side of the test cell retains a neoprene O-ring. The test area is considered to be the area established by the inside contact diameter of the compressed O-ring when the test cell is clamped shut against the test specimen.

6.1.2 Test cell sealing surface
Is a flat rim around the dry side of the diffusion cell. This is a critical sealing surface against which the test specimen is pressed; it shall be smooth and without radial scratches.

6.1.3 Test cell air passages
Two holes in the dry half of the diffusion cell that pass carrier gas and water vapor to either exhaust ports or the sensor assembly. One cell at a time can be connected to the sensor assembly by solenoid valves.

6.1.4 Test cell guard film
A flat film covers the humid side of each cell. The film is a barrier that stills the air in the gap between the water evaporator and the mounting plane of the specimen. The guard film is a very high transmitter of water vapor. Its transmission rate as well as that of the air gap is accounted for in the apparatus measurements.

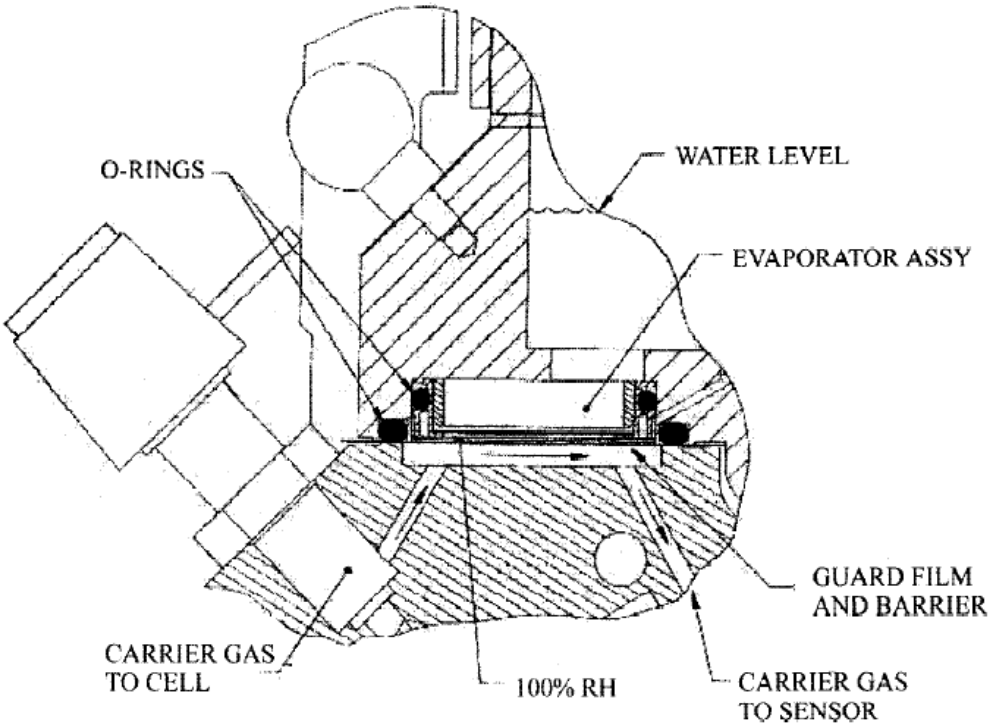


Figure 1

6.1.5 Water vapor sensor
A water vapor detector capable of sensing 0 to 100% relative humidity with sufficient accuracy so the apparatus can determine transmission rates down to 500 g/m^2/day.

6.1.6 Past sensor dryer
A no-maintenance dryer that removes water vapor from the measurement gas stream after it passes through the water vapor sensor.

6.1.7 Mass flow-meter
A means of regulating the flow of dry air within an operating range of 0 to 200 cc/min is required.

6.1.8 Flow- metering valves
Fine metering valves capable of controlling the dry air flow rate to each test.

6.2 Computer system
A computer provides the main control, calculating, and data storage device for the system.

6.3 Temperature control
It is desirable to thermostatically control the temperature of the test apparatus. A thermo-electric device (TED) attached to the apparatus in such a manner as to ensure good thermal contact. A thermistor sensor and an appropriate control circuit will serve to regulate the temperature from 20 to 50°C to within 0.1°C.

6.4 Barometric pressure sensor

A sensor measures the ambient barometric pressure so that variations are automatically corrected in the calculations.

7. Conditioning

7.1 No preconditioning is required for this procedure

7.2 Any conditioning of the specimens

To the water vapor driving force (differential relative humidity) and temperature is carried out during the test within the test apparatus. In general, these materials are high transmitters and the specimens do not require a significant conditioning period; they reach equilibrium in just a few examination periods. (Experience has shown that individual test periods range from 2 to 10 minutes). The time required for sample conditioning varies as a function of many factors such as barrier composition, thickness, test temperature, etc.

8. Sampling

8.1 Lot Size

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

8.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

9. Preparation of Test Apparatus and Calibration Pre-Test Sample Considerations

9.1 Preparation of apparatus (figure1)

Carrier gas can be sourced from the Mocon dryer unit (see instrument manual) or from a regulated supply of class 3.5 nitrogen of > 99.95 % purity. Instrument inlet pressure must be within (103.4 ± 10) Kilo Pascal.

9.1.1 If preceding tests

Have exposed the apparatus to high moisture levels, outgas the system to desorb residual moisture. Purge the system with dry air for a period of 3 to 4 hours.

9.2 Calibrating the system

Determine the transmission rate of the system including the air gap and the guard film. (CalC) is an acronym for the transmission rate of the apparatus hardware, air gap, and guard film without any test specimens present.

9.2.1 Fill the reservoir with HPLC water.

9.2.2 Place a blank specimen holder in the system and tighten the clamp.

9.2.3 Adjust the gas flow to each cell for uniform RH reading for all cells.

9.2.4 Set all cells to (CalC)

9.2.5 The computer will automatically

Determine the empty cell transmission rate (CalC) value for each cell.

Insert the Mocon reference film, and measure the water vapor transmission rate for each cell, as defined in clauses 10 and 11. Verify that the reported WVTR data for each cell are within ± 10 % of each cell's stated value.

If this condition is not met, perform a new (CalC) determination, as specified in clause 9, and repeat the measurement of the reference film. If this still fails to meet the test condition, contact the instrument service representative for instructions.
Repeat this step weekly.

10. Procedure

Handle the test specimen carefully to avoid altering the state of the material.

10.1 Mount each test specimen

On the metal film holder supplied with the instrument. Each specimen should cover all of the 6 test positions corresponding to the 6 measurement cells. For each specimen, 6 measurements will be performed.

If testing a laminated material mount the better barrier portion towards the carrier gas side of the test cell and the poorer barrier towards the guard film.

10.2 Because of the type of material that is used for the guard film

Grease should not be used on either the lower cell sealing surface or the upper cell O-ring.

10.3 Align the border over the pins in the bottom portion of the cells of the apparatus

Place the upper portion of the cells on the base of the apparatus, and then tighten the clamp.

10.4 Put the specimens into the test mode

Via the computer keyboard. Enter the global test parameters and individual cell parameters. Place each cell into "TEST MODE".

10.5 Conditioning the specimen

During the setting of test parameters in the apparatus it is necessary to select to condition or not condition. Experience has shown that most materials will condition in 10 to 20 minutes. Operators often choose not to condition but go directly to test and run an extra cycle through the cells.

10.6 Establish equilibrium rate

After the system has cycled through the cells a few times, the measurements indicate that an equilibrium transmission rate has been reached. This can be determined by manual

examination of data or the system can be made to stop further testing of each cell by a setup in the computer. When successive values for any cell are within 1 %, testing will cease; this is known as convergence mode. In most cases, two to ten test cycles per cell are sufficient. Low permeability barriers may require more cycles to come to equilibrium.

NOTE 2 When testing materials for which the operator has no previous history, additional time must be allowed to assure that true equilibrium has been reached and it is best to not use the convergence mode.

NOTE 3 Also the permeation system will require some time to stabilize with materials having low transmission rates after it has been used to test materials with high transmission rates. For this reason it is desirable when testing a number of different samples, sequentially, that materials having similar permeability characteristics should be tested together, or alternatively, the testing time should be extended to insure that the apparatus reaches an equilibrium value consistent with the conditioning state of the specimens. If unfamiliar with the material being tested, investigate the effect of examination time. The preceding precaution is usually not necessary when going from low to higher transmitting specimens.

10.7 System report

The system, will indicate DONE when all cells have reached equilibrium (when in convergence mode) and the instrument stops testing. A printed record of the test should be obtained before continuing to test additional barriers.

10.8 Standby and shutoff procedures

At a conclusion of a test, but in anticipation of further testing, place the instrument in standby.

When the system is not to be used for an extended period, dry the system and turn off the electrical power.

11. Calculations

11.1 The test apparatus automatically

Carries out the calculations given in sections 11.1.1 and 11.1.2.

11.1.1 The calculation of water vapor transmission rate values uses the formula

$$WTVR = FP_{sat}(T)RH/(AP_{sat}(T)(1-RH)) \text{ gm/m}^2 \text{ day}$$

where :

F = the flow of carrier gas in cc/min
$P_{sat}(T)$ = the density of water in saturated air at temperature T, in °K
RH = the relative humidity at specified locations in the cell
A = the cross section area of the cell, in cm^2,
$P_{sat}(T)$ = the saturation vapor pressure of water, in mmHg at temperature T.

11.1.2 The reported transmission rate

Is the result of the two measurements described in clause 4 and is calculated according to equation:

$$({}^{TR}\text{TEST BARRIER})^{-1} =$$

$$({}^{TR}\text{TEST BARRIER.GUARD FILM.AIRGAP})^{-1} - ({}^{TR}\text{GUARD FILM.AIRGAP})^{-1}$$

where :

^{TR}TEST BARRIER = the transmission rate of the test barrier, in gm/m²/day

^{TR}TEST BARRIER.GUARD FILM.AIRGAP = the transmission rate, in gm/m²/day, of the test barrier, the guard film and the air gap of the apparatus, and,

^{TR}GUARD FILM.AIRGAP = the transmission rate, in gm/m²/day of the guard film and the air gap of the apparatus. This is also called (CalC).

12. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Cell identification
f) Barrier material thickness
g) Total time
h) Examination time
i) Test temperature
j) Barometric pressure
k) Carrier gas flow rate
l) Air gap and guard film transmission rate (CalC)
m) Measured barrier transmission rate
n) Start time and elapsed time of testing
o) Remarks
p) The average permeance of all specimens of at type tested in each cell
q) The values of (CalC) (the transmission rate of the air gap and guard film). WVTR and elapsed time from start of test. These entries should be rounded off to three significant figures or less, as may be consistent with the operator's estimate of precision and bias.
r) The means used to obtain the calibration factor
s) The effective area exposed to permeation
t) The time to reach steady-state after introduction of the diffusion cell into the test chamber
u) A description of the conditioning procedure.
v) The serial number and expiration date of the reference film.

13. Precision

13.1 Important remarks

The apparatus can be used in one of two modes.

For the purpose of EDANA ring test, the six independent test cells obtain data at 6 different positions on one test specimen. The individual values for each of the 6 positions must be reported.

In the other mode of use, which is not relevant for the present EDANA ring test, six totally independent results can be obtained from specimens cut from various locations of the same larger sample, or from other samples, and each specimen is treated as an independent result.

13.2 Summary

Inter-laboratory test data have shown that the variance in determining water vapor transmission rate (WVTR) for the various types of materials covered by this standard is dependent upon the type of material under evaluation. In the light of this no general statement can be made concerning least critical differences relative to comparisons between the WVTR of the different types of materials.

13.3 Inter-laboratory test program

An inter-laboratory study of the WVTR was conducted in 2000 and the data analyzed using the adjunct to E 691. Seven laboratories participated in determining the WVTR for three different materials, obtaining three test results for each material. Each test result was the average of six determinations made during one cycle of the test apparatus. Certain laboratories conducted the complete procedure on more than one apparatus. However in order to avoid bias within the analysis, the result of only one randomly selected apparatus was utilized from those laboratories.

The materials evaluated in the inter-laboratory test program were defined as:

A. Spunbonded / meltblown/ nonwoven (SMS)
B. Blue-colored spunbonded nonwoven (Blue)
C. Laminate of a film and a nonwoven (Laminate)

14.4 Precision

The precision information in Table 1 is given in the units of measurement ($g/m^2/day$) and is for the comparison of two test results, each of which is the average of six determinations obtained in one cycle of the test apparatus.

15. Report

Wait until the equilibrium is reached. When equilibrium has been reached, the measurements are stabilized and mean values can be calculated on the next *-marked results. Calculation should be made of the results of at least three *-marked values.
Report the calculated mean of all samples measured, the number of samples measured, and the standard deviation among all samples measured.

ANNEX A
(Informative)

Statistical Results of interlaboratory tests

Figures for the repeatability and reproducibility of this method are the result of collaborative studies carried out by EDANA in 2003. The evaluation of the interlaboratory test was carried out in accordance with ISO 5725-2 and results are as follows:

Sample	All Data	Sample A	Sample B
No. of participating laboratories	7	7	7
No. of non-eliminated laboratories	6	6	6
No. of single values of the non-eliminated laboratories:	114	60	60
Average:	4520	4524	4516
Repeatability standard deviation, sr:	484	353	333
Repeatability coefficient of variation, CVr:	10.408	7.8028	7.3738
Repeatability limit, r (2.8 x sr):	1355.2	988.4	932.4
Reproducibility standard deviation, sR:	128	138	120
Reproducibility coefficient of variation, CVR:	2.8319	3.0504	2.6572
Reproducibility limit, R (2.8 x sR):	358.4	386.4	336

STANDARD TEST: WSP 070.6.R3 (12) part 2

Standard Test Method for Measuring the Moisture Vapor Transmission Rate by the Principle of Measuring the Time to Increase Humidity

The number in parentheses indicates the year of the last revision

1. Scope

This test method covers a procedure for determining the rate of water vapour transmission ranging from 0.03 to 10.000 g/m2/day through nonwovens, plastic films and combinations thereof (composite materials).

This method refers specifically to the use of an apparatus developed by Lyssy Instruments, now manufactured and sold by PBI-Dansensor, Ringsted, Denmark. The manufacturer refers to said apparatus by the denomination “Water Vapor Permeability Tester L80 – 5000”

Said apparatus measures, in static conditions (no transport of the humid air, as opposed to the procedure described in part one of this method), the time needed to increase the humidity on one side of the sample from a defined ‘dry’ start value to a final value, after allowing saturated air to come through the material to be evaluated. The measured time value is converted into a permeability value by a microprocessor.

The Lyssy apparatus has been evaluated by an EDANA Task Force which came to the conclusion that the apparatus is reliable and satisfies the needs of EDANA member companies. It has also been found that the method is reproducible and repeatable. Statistical evidence is given in Annex A.

SI values are regarded as the official standard system of measurement for this standard test method.

SAFETY NOTE 1

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative reference

The following referenced documents are indispensable for the application of this document:

Reference number
WSP 070.6.R3 (12) part 2 A

Current edition approved WSP 070.6.R3 (12)
Originally published as WSP 70.6 in 2005
Last approved as WSP 70.6 in 2008

2.1 ISO

a) ISO 5725-1 Accuracy (trueness and precision) of Measurement Methods and Results – Part 1: General Principles and Definitions

b) ISO 5725-2 Accuracy (trueness and precision) of Measurement Methods and Results – Part 2: Basic Method for the Determination of the Repeatability and Reproducibility of a Standard Measurement Method

c) ISO 139: Standard Conditioning

d) ISO 2859-1:1999 Sampling procedures for inspection by attributes

e) ISO 3951-1:2005 Sampling procedures for inspection by variables

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry and EDANA's and INDA's Standard Test Methods

b) WSP 070.5.R3 (127) part 1: Standard Test Method for measuring the moisture vapor transmission rates through nonwovens and plastic barriers.

3. Terminology

For the purpose of this document, the following terms and definitions apply:

Water vapor transmission rate
Is defined as the steady state time of water vapor flow expressed in grams per square meter and per day (g/m²/day) through a unit area of a specimen, normal to the surface at a given temperature.

4. Principle

A sample is fixed between two hermetically sealed cups. The lower cup is filled with water, so that the air gap between the water surface and the sample is saturated with water vapor.

The upper cup contains an air humidity sensor. The air contained in the cup is dried via a purge flow of dry air to a known value, generally 9.9% RH.

The system monitors the time it takes for the air in the upper cup to get from the initial relative humidity value to 10.1% RH. This measurement is made repeatedly until consistency among consecutive results is obtained.

The system translates the time measured into vapor transmission rate, in $g/m^2/day$.

5. Apparatus

Water Vapor Permeability Tester Lyssy L80-5000.
Specifically designed sample supports in sufficient number. These supports can be obtained from the apparatus manufacturer.
Manufacturer: PBA Dansensor, Ringsted, Denmark.

6. Conditioning

Not applicable for this procedure

7. Sampling

7.1 Lot Size

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

7.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (*Sampling procedures for inspection by attributes)* or ISO 3951-1:2005 (*Sampling procedures for inspection by variables)* can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

8. Procedure

8.1 Adjusting the airflow

a) The airflow to the instrument is controlled by a splitting device and a needle valve in the drying cartridge. Turning the screws clockwise is decreasing, turning counter-clockwise is increasing the airflow.
b) Open first the needle valve, in the bottom plate of the drying cartridge 1 to 2 turns and adjust the splitter for a drying speed of 1 to 2 scale divisions per second.
c) Check the lowest value in the UNDER DRY cycle.

8.2 Calibration

a) Open the measuring chamber by turning the hand-wheel counter-clockwise for at least three turns.
b) Insert the test standard on top of presently installed sample (aluminum protection foil) and remove the lower sample afterwards.
c) Close the measuring chamber by turning the hand-wheel clockwise and tighten smoothly.
d) Press STOP
e) The calibration can be started by pressing TEST STD
f) When parameter 17 is OFF, the calibration will be repeated until the STOP key is depressed. When parameter 21 is ON, the software continues to measure the test standard as a sample, after reaching the equilibrium, until the series is ended by depressing STOP.

NOTE 2 The apparatus needs to be calibrated before initiating sample evaluation. The frequency of calibration should be defined by each laboratory, in accordance with an accepted calibration plan.

NOTE 3 Refer to Lyssy L80-5000 operator's manual for comprehensive information on the calibration procedure.

8.3 Evaluation of samples

a) Make sure the lower cell water temperature thermostat is set to 37°C, and that the apparatus has been switched on long enough to guarantee a stable temperature of 37± 1°C.

b) Open the measuring chamber by turning the handwheel counter-clockwise for at least three turns.
c) Insert the test sample on top of presently installed sample and remove the lower sample afterwards.
d) When measuring a plastic film laminated to a nonwoven, make sure the nonwoven (fibrous side) is on the top. Use all precautions not to damage the new sample during its insertion.
e) Close the measuring chamber by turning the handwheel clockwise and tighten smoothly.
f) End any preceding entries with ENTER, or measurement with STOP.
g) Check whether actual parameters are suitable for the new sample by pressing MEMO and going thru all the stored parameters with the ► key.
h) By pressing SPLE-NAME, enter the new sample name. Confirm the entry with ENTER.
i) Press SAMPLE. The measurement will now be started.
j) Wait until the equilibrium (around 8-10 values measured) is reached and press STOP.

9. Calculation

The apparatus proceeds automatically with all required calculations

10. Evaluation of the results

The apparatus automatically prints a report of the measured permeability at each measurement cycle, until the system reaches the equilibrium. Calculate the moisture vapor transmission rate of any measured sample as being the mean of the latest 4 results printed on the print-out.

Report the calculated mean of all samples measured, the number of samples measured, and the standard deviation among all samples measured.

ANNEX A

(informative)

Statistical results of interlaboratory tests

Figures for the repeatability and reproducibility of this method are the result of collaborative studies carried out by EDANA in 2003. The evaluation of the interlaboratory test was carried out in accordance with ISO 5725-2 and results are as follows:

SAMPLE	All data	Sample A	Sample B
No. of participating laboratories	7	7	7
No. of non-eliminated laboratories	6	6	6
No. of single values of the non-eliminated laboratories:	114	60	60
Average:	4520	4524	4516
Repeatability standard deviation, sr:	484	353	333
Repeatability coefficient of variation, CVr:	10.408	7.8028	7.3738
Repeatability limit, r (2,8 x sr):	1355.2	988.4	932.4
Reproducibility standard deviation, sR:	128	138	120
Reproducibility coefficient of variation, CVR:	2.8319	3.0504	2.6572
Reproducibility limit, R (2,8 xsR):	358.4	386.4	336

STANDARD TEST: WSP 070.7.R4 (12)

Standard Test Method for Nonwovens — Repeated Liquid Strike -Through Time (Simulated Urine)

The number in parentheses indicates the year of the last revision

This test method measures the strike-through time (STT) for each of three subsequent doses of liquid (simulated urine) applied to the surface of a test piece of nonwoven coverstock. The STT is defined as the time taken for a known volume of liquid to pass through the nonwoven that is in contact with an underlying dry standard absorbent pad.

This test method is intended for Quality Control and is designed for comparison of STT for different nonwoven coverstocks It does not simulate in-use conditions for finished products.

SI values are regarded as the official standard system of measurement for this standard test method.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.1 ISO test methods

a) ISO 5725-1 Accuracy (trueness and precision) of Measurement Methods and Results – Part 1: General Principles and Definitions

b) ISO 5725-2 Accuracy (trueness and precision) of Measurement Methods and Results – Part 2: Basic Method for the Determination of the Repeatability and Reproducibility of a Standard Measurement Method

c) ISO 139: Textiles — Standard atmospheres for conditioning and testing

d) ISO 2859 -1:1999 Sampling procedures for inspection by attributes

e) ISO 3951-1:2005 Sampling procedures for inspection by variables

f) ISO 9073–8 Textiles – Test Method for Nonwovens: Determination of Liquid Strike-Through Time (Simulated Urine)

g) ISO 9073–13: 2001 Repeated liquid strike-through time

Reference number
WSP 070.7.R4 (12) A

Current edition approved WSP 070.7.R4 (12)
Originally published as ERT 153 in 2002
Last approved as WSP 70.7 in 2009

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

Simulated urine
Consisting of a 9 g/l solution of sodium chloride in distilled water with a surface tension of (70 ± 2) mN/m.

4. Principle

Three subsequent doses of simulated urine are discharged at a prescribed rate, and under specified conditions, onto a test piece of nonwoven which is placed on a reference absorbent pad. The time taken for each of the liquid doses to penetrate the nonwoven is measured electronically, using conductometric detection. The absorbent pad remains unchanged and wet between the doses.

5. Material and Reagents

5.1 Absorbent pad

Consisting of ten plies of filter (blotter) paper (100 mm x 100 mm) with the test side upwards, as specified by the supplier. The mean STT, in 10 replicate determinations without the nonwoven, must be 1.7 ± 0.3 s.

The liquid absorption capacity, of the (blotter) paper, as determined by standard ERT 10, must have a minimum capacity of 480 %

NOTE 2 Information concerning suitable filter paper may be obtained from the following nonwovens industry associations: EDANA, Avenue Herrmann Debroux, 46 B-1160 Brussels, Belgium Phone +32 2 734 93 10 Fax +32 2 733 35 18
INDA, 1100 Crescent Green Suite 115, Cary NC 27518; Phone +1 919 233 1210, Fax +1 919 233 1282

5.2 Simulated urine

Consisting of a solution of 9.0 g/l of analytical grade sodium chloride in deionized water, with a surface tension of 70 ± 2 mN/m at 23 ± 2 ºC.

This surface tension should be checked before each series of tests, as surface tension may change during storage.

6. Apparatus

6.1 Burette

50 ml capacity with supporting stand, or a 5 ml pipette.

6.2 Strike-through tester

This instrument is designed such that it releases a standard aliquot of saline solution into a cavity. Through a (star-shaped) opening in the bottom of the well that rests on the test piece, liquid drains through the test piece into an absorbent pad. The presence and disappearance of the test liquid in the well is detected conductometrically. The time required for the liquid to drain from the well is determined by an electronic timer that is connected to the conductometer.

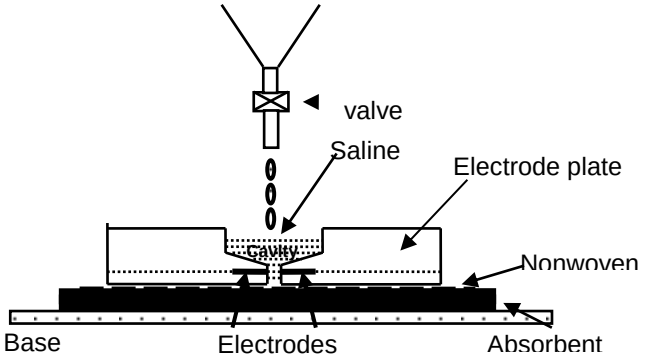


Figure 1

The instrument consists of the following parts:

a) Funnel, fitted with a magnetic exit valve, capable of discharging 25 ml of saline solution in 3.5 ± 0.25 s.

b) Support for the funnel so the funnel position can be adjusted vertically. The distance between the funnel exit and the base plate must be adjustable from 4.5 cm to at least 15 cm.

c) Electronic conductivity detector capable of detecting saline solution with 0.05 s response time. The detector should be connected with the electrodes in the strike-through plate 6.2.f. The principle of electrical wiring should be as indicated below:

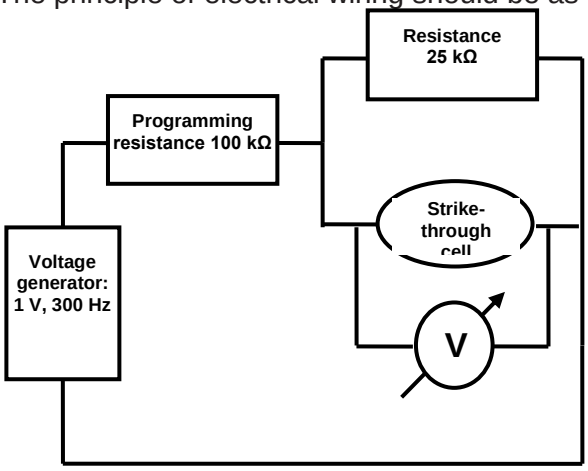


Figure 2

d) Typically, a threshold value is defined for V. Below the threshold value the cell condition is “conducting” which corresponds with presence of liquid. Above the threshold, the cell condition is “non-conducting”, i.e. absence of liquid. A threshold value of 0.150 V has proven to be successful.

e) Equivalents are allowed. To be successful, the applied voltage must alternating with a frequency of about 300 Hz, the cell current must be about 10 µA and the voltage drop across the strike-through cell must be steep enough when going from a “conducting” to a “non-conducting” condition, such that the disappearance from fluid from the cell can be detected with an accuracy of 0.05 s.
f) Electrode plate (see figures B 1 and B 2) constructed of 25 mm thick transparent acrylic sheet of total mass (500 ± 5) g, fitted with corrosion-resistant electrodes consisting of 1.6 mm diameter platinum or stainless steel wire.
g) The electrodes shall be positioned as shown in figures B 1 and B 2.
h) The plate surface, electrode surface and the star-shaped cavity must be clean and free from deposits and particulate matter. Clean regularly, e.g. with a mildly abrasive car polish and a dry cloth, and/or hot water.
i) The voltage drop across the electrodes must be 0.2 ± 0.01 V when the electrode compartment is empty and < 0.140 V when the compartment is filled with 0.9 % saline solution.
j) Baseplate made of transparent acrylic sheet, approximately 125 x 125 mm square and 5 mm thick.
k) Electronic timer for measuring the STT, accurate to 0.01 sec. The timer is connected with the conductivity detector (6.2.c) such that as conductive liquid closes/opens the contact between the electrodes, the timer starts/stops.

6.3 Calibration orifice (figure 3)

The orifice gives a specified time for the passage of 10 ml of saline solution. The exact time must be provided with the orifice with an accuracy of 0.01 s, and can be anywhere between about 2 ± 0.2 seconds. This is for verification of the correct operation of the test equipment.

The orifice must fit leak-tight, (e.g. with an “O-ring) onto the electrode plate.

NOTE 3 A suitable instrument, is provided under the name “Lister AC”, by Lenzing Technik GmbH & Co KG, Austria. This company can also provide the calibration orifice.

6.4 Stopwatch

Capable of measuring 60 min with the accuracy of 1 s.

Chapter 1

7. Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139.

NOTE 4 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

8. Sampling

8.1 Lot Size

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

8.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (*Sampling procedures for inspection by attributes)* or ISO 3951-1:2005 (*Sampling procedures for inspection by variables)* can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 5 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

9. Instrument Calibration Verification

9.1 This check has to be carried-out regularly

For verifying correct operation of the instrument. The actual checking frequency can be derived from a control chart, as it depends on the type of products tested, and the likeliness of contamination of the electrode plate. In addition, it is done 1) for new electrode plates, 2) when the instrument has not been used for a couple of days, and 3) after cleaning of the electrode plate.

The check intends to provide the operator an independent verification of instrument accuracy in case of unexpected or suspicious test results.

a) Place the electrode plate on top of the calibration orifice as indicated in figure B 4. Then place the assembly on a suitable receiver, e.g. a Petri dish, such that liquid can run freely from the bottom of the orifice.
b) Make sure that the electronic timer and conductivity detector are switched on, and the electrode plate is connected to the detector.
c) Position the funnel such that the exit tube is 4.5 cm above the top of the orifice plate and over the middle of the electrode cavity.
d) Pipette 10 ml of simulated urine into the funnel, with the discharge valve closed.
e) Release the liquid by opening the valve. The test liquid runs into the electrode cavity and further through the orifice. The timer starts electronically as soon as the simulated urine closes the contact between the electrodes.
   After all of the test liquid has passed through the orifice, the timer stops.
f) Repeat steps 9.1.c. through 9.1.e two more times for conditioning the equipment.
g) Repeat steps 9.1.c through 9.1.e ten times. Each time, record the time required for the 10 ml aliquot to run through the orifice, as given by the electronic timer, to an accuracy of 0.05 s.
h) Calculate the average time and the relative standard deviation.
i) Verify whether the average result fits with the reference value that is provided with the orifice.
   If the average result is within ± 7 % of the specified value, the instrument is working correctly.
j) After the test series, rinse the orifice with warm water (max. 60 °C).

10. Procedure

10.1 Position the funnel

So the dispensing tip is 45 ± 1 mm above the top of the instrument baseplate.

10.2 Cut a nonwoven test piece

125 x 125 mm,

10.3 Prepare 1 set of 10 plies of filter (blotter) paper

Stacking the paper plies on top of each other, test side upwards.

10.4 Place the nonwoven test piece
On top of the set of 10 plies of filter (blotter) papers that are placed on the baseplate of the instrument. Position the nonwoven such that the direction of liquid flow during the test corresponds with the intended use of the nonwoven, e.g. for personal hygiene products the side of the nonwoven that is intended to be in contact with the user's skin must be facing upwards.

10.5 Place the strike-through plate
On top of the nonwoven with the center of the plate approximately over the center of the test piece. Center the funnel over the cavity in the plate.

10.6 Check whether the timer display shows zero.
If not, re-set.

10.7 Dispense with the pipette or burette
5.0 ml of simulated urine into the funnel, while keeping the discharge valve of the funnel closed.

10.8 Open the magnetic discharge valve
Of the funnel to discharge the 5.0 ml of liquid. The initial flow of liquid will close the electrical circuit and start the electronic timer.

a) The timer will stop when the liquid has penetrated through the nonwoven and dropped below the level of the electrodes in cavity of the strike-through plate.
b) As the timer stops, start the stopwatch.

10.9 Record the time indicated
By the electronic timer (STT-1), to an accuracy of 0.01 s.

10.10 Wait for a time period of 60 s (stopwatch)
In this period, dispense a fresh aliquot of 5.0 ml of test liquid into the funnel.

10.11 As the stopwatch reads 60 s
Repeat steps 10.8 thru 10.10 for measuring the STT of the second dose (STT-2).

10.12 As the stopwatch reads 60 s
Repeat steps 10.8 thru 10.9 for measuring the STT of the third dose (STT-3).

10.13 Clean and dry
The bottom of the electrode plate with a dry tissue or cloth before testing the next piece of nonwoven.

10.14 Repeat
The test procedure for the required number of test pieces.

10.15 Rinse the electrode plate
With deionized water, and dry with a dry tissue or cloth.

NOTE 6 Occasionally, the conductivity detector may not detect an endpoint, or the STT comes out exceedingly long (> 5 x the intra-lab standard deviations away from the average), and well after the visually detected endpoint. In that case, discard the result.
Upon recurrence, clean the electrode as indicated under 6.2.f.

11. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Number of specimens tested and note CD and/or MD if significant
g) For computer processed data, identify the software used and the version
h) Deviation from the standard test procedure, if any
i) When calculated, the standard deviation or the coefficient of variation
j) Whether or not samples were conditioned prior to testing and, if so, for how long
k) Anything unusual noted during the testing
l) When photos are used as the standard, attach copies
m) Surface tension of simulated urine, if different from the value specified in 5.2
n) Individual STT for each of the doses (STT1, STT-2 and STT-3), to an accuracy of 0.01 second.
o) Calculate the average and standard deviation for all of the STT-1, STT-2 and STT-3, for replicate test pieces from the same material portion/lot, if required.

12. Precision

The data for the repeatability and reproducibility of this test method were established by inter-laboratory tests carried out in 2003 by EDANA and are given in Annex A. The evaluation of the laboratory tests was carried out according to ISO 5725-2.

ANNEX A

(Informative)

PRECISION

Figures for the repeatability and reproducibility of this method are the results of collaborative studies carried out in 2003 by EDANA, with the following data:

Series 1
In this study 6 participating laboratories tested the calibration of their instrument, with the following variables:

1) Orifice. The instrument manufacturer provided 2 replicate orifices for the test.
2) The own cell (electrode plate) used in each laboratory.
3) A reference cell was circulated between labs.
4) Simulated urine (No surfactant) as test fluid.
5) Simulated urine with 0.08 % of amphoteric surfactant, as the test fluid, for testing robustness.

Series 2
In this study 6 participating laboratories tested the performance of their instruments, using 10 plies from the same lot of absorbent paper as the test substrate, i.e. without nonwoven. The variables were:

1) Test cell (electrode plate), each laboratory used its own cell.
2) A common reference cell was circulated between labs.
3) Simulated urine (No surfactant) as test fluid.
4) Simulated urine, with 0.08 % of amphoteric surfactant, as the test fluid, for testing robustness

Series 3
In this study 6 participating laboratories tested the performance of their instruments, using 10 plies from the same lot of absorbent paper, with two types of nonwoven. Only simulated urine was used as test fluid, for assessing the influence of the finish from the nonwoven.

1) Test cell (electrode plate), each its own cell.
2) A common reference cell was circulated between labs.
3) Simulated urine (No surfactant) as test fluid.

Summary: Lister AC Ringtest 2[0]

Test series 1

	Ref-Cell				Own-Cell			
	Orifice 1		Orifice 2		Orifice 1		Orifice 2	
	No Surf.	Surfactant	No Surf.	Surfactant	No Surf.	Surfactant	No Surf.	Surfactant
N:o of participating laboratories	6	6	6	6	6	6	6	6
N:o of non-eliminated laboratories	6	6	6	6	6	6	6	6
N:o of single values of the non-eliminated laboratories	60	60	59	60	60	60	60	60
Average (sec)	1,99	1,93	2,09	1,95	2,05	1,90	2,11	2,08
Standard deviation of repeatability, s_r	0,087	0,156	0,096	0,110	0,121	0,122	0,093	0,091
Coefficient of repeatability, CV_r	4,4 %	8,1 %	4,6 %	5,6 %	5,9 %	6,4 %	4,4 %	4,4 %
Repeatability limit, r (2,8 x s_r)	0,243	0,437	0,268	0,309	0,338	0,341	0,260	0,254
Standard deviation of reproducibility, s_R	0,211	0,188	0,121	0,215	0,193	0,183	0,182	0,204
Coefficient of reproducibility, CV_R	10,6 %	9,7 %	5,8 %	11,0 %	9,4 %	9,6 %	8,6 %	9,8 %
Reproducibility limit, R (2,8 x s_R)	0,592	0,525	0,339	0,601	0,539	0,512	0,509	0,572

Test series 2

	STT-1				STT-2				STT-3			
	Ref-Cell		Own-Cell		Ref-Cell		Own-Cell		Ref-Cell		Own-Cell	
	Paper 10 sheets		Paper 10 sheets		Paper 10 sheets		Paper 10 sheets		Paper 10 sheets		Paper 10 sheets	
	absent	absent	absent	absent	absent	absent	absent	absent	absent	absent	absent	absent
	No Surf.	Surfactant	No Surf.	Surfactant	No Surf.	Surfactant	No Surf.	Surfactant	No Surf.	Surfactant	No Surf.	Surfactant
N:o of participating laboratories	6	6	6	6	6	6	6	6	6	6	6	6
N:o of non-eliminated laboratories	6	6	6	6	6	6	6	6	6	6	6	6
N:o of single values of the non-eliminated laboratories	60	60	60	60	60	60	60	60	60	60	60	59
Average (sec)	1,44	2,52	2,70	4,11	10,46	13,07	1,41	2,34	2,55	4,02	10,06	12,46
Standard deviation of repeatability, s_r	0,082	0,155	0,163	0,368	0,553	0,573	0,124	0,139	0,153	0,413	0,709	0,753
Coefficient of repeatability, CV_r	5,7 %	6,2 %	6,0 %	9,0 %	5,3 %	4,4 %	8,8 %	5,9 %	6,0 %	10,3 %	7,1 %	6,0 %
Repeatability limit, r (2,8 x s_r)	0,231	0,434	0,457	1,030	1,549	1,603	0,347	0,389	0,428	1,156	1,985	2,110
Standard deviation of reproducibility, s_R	0,103	0,175	0,198	0,408	0,737	0,717	0,159	0,242	0,257	0,603	1,149	1,526
Coefficient of reproducibility, CV_R	7,2 %	6,9 %	7,3 %	9,9 %	7,0 %	5,5 %	11,3 %	10,3 %	10,1 %	15,0 %	11,4 %	12,2 %
Reproducibility limit, R (2,8 x s_R)	0,288	0,489	0,553	1,144	2,063	2,008	0,445	0,678	0,721	1,690	3,217	4,273

Test series 3

	STT-1				STT-2				STT-3			
	Ref-Cell		Own-Cell		Ref-Cell		Own-Cell		Ref-Cell		Own-Cell	
	Paper 10 sheets		Paper 10 sheets		Paper 10 sheets		Paper 10 sheets		Paper 10 sheets		Paper 10 sheets	
	No Surf.	No Surf.	No Surf.	No Surf.	No Surf.	No Surf.	No Surf.	No Surf.	No Surf.	No Surf.	No Surf.	No Surf.
	Carded	Spunbond	Carded	Spunbond	Carded	Spunbond	Carded	Spunbond	Carded	Spunbond	Carded	Spunbond
N:o of participating laboratories	6	6	6	6	6	6	6	6	6	6	6	6
N:o of non-eliminated laboratories	6	6	6	6	6	6	6	6	6	6	6	6
N:o of single values of the non-eliminated laboratories	60	60	60	60	60	60	60	60	60	55	60	57
Average (sec)	1,08	2,01	2,29	1,23	2,39	3,40	1,06	1,96	2,20	1,25	2,34	3,56
Standard deviation of repeatability, s_r	0,092	0,123	0,283	0,093	0,140	0,959	0,082	0,099	0,119	0,082	0,114	1,023
Coefficient of repeatability, CV_r	8,5 %	6,1 %	12,3 %	7,6 %	5,9 %	28,2 %	7,7 %	5,1 %	5,4 %	6,6 %	4,9 %	28,7 %
Repeatability limit, r (2,8 x s_r)	0,257	0,344	0,791	0,261	0,393	2,686	0,230	0,278	0,332	0,230	0,319	2,865
Standard deviation of reproducibility, s_R	0,102	0,177	0,364	0,103	0,159	1,168	0,143	0,215	0,243	0,142	0,280	1,195
Coefficient of reproducibility, CV_R	9,4 %	8,8 %	15,9 %	8,4 %	6,6 %	34,3 %	13,4 %	10,9 %	11,0 %	11,4 %	12,0 %	33,5 %
Reproducibility limit, R (2,8 x s_R)	0,285	0,495	1,018	0,288	0,444	3,269	0,399	0,601	0,681	0,398	0,785	3,345

ANNEX B

(Informative)

Figure B 1 — B 4

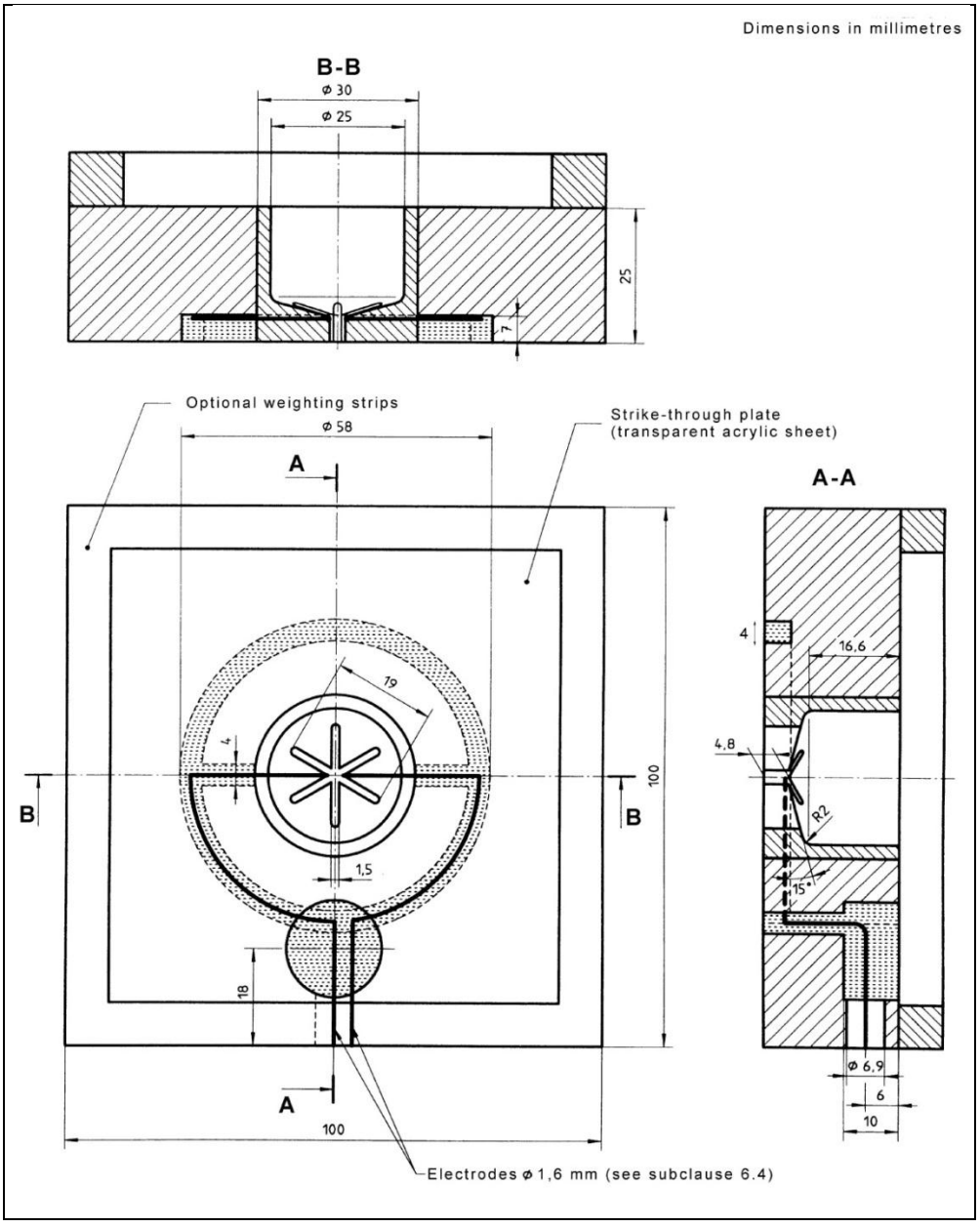


Figure B 1- Strike-through plate

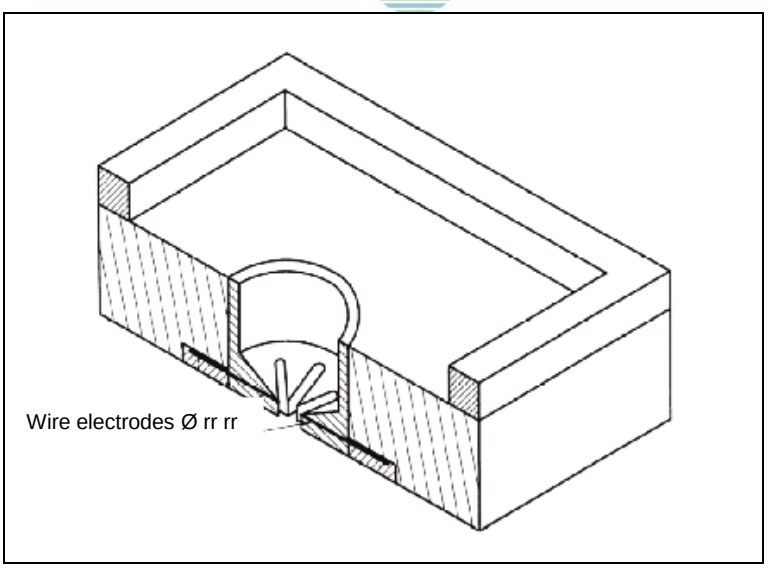


Figure B 2
Section across strike-through plate on centerline of 25 mm cavity

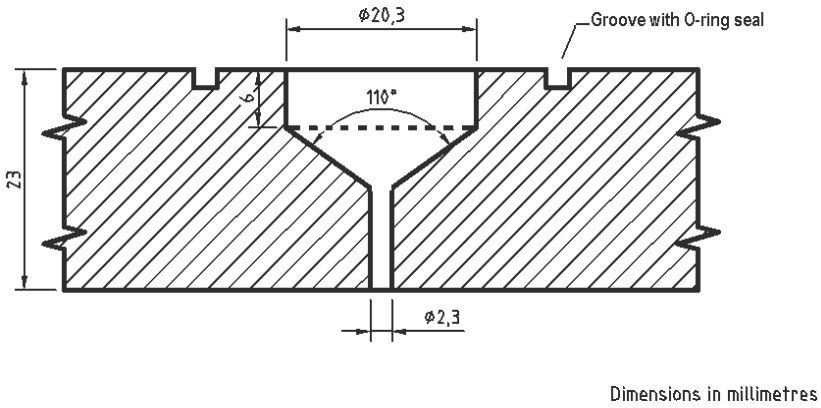


Figure B 3
Calibration orifice

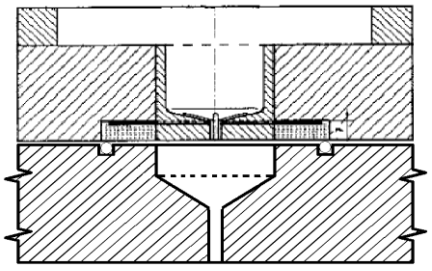


Figure B 4 Assembly of electrode plate and calibration orifice

STANDARD TEST: WSP 070.8.R4 (12)

Standard Test Method for Wetback After Repeated Strike-Through Time

The number in parentheses indicates the year of the last revision

1. Scope

The purpose of the test is to examine the ability of diaper coverstock to resist the transport back onto the skin of a liquid which has already penetrated the coverstock.

This test corresponds with Repeated Liquid Strike-Through Time - WSP 070.7.R4 (12). This test method is intended for Quality Control and is designed for comparison of wetback for different nonwoven coverstocks and treatments. It does not simulate in use conditions for finished products.

SI values are regarded as the official standard system of measurement for this standard test method.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.1 ISO test methods

a) ISO 5725-1 Accuracy (trueness and precision) of Measurement Methods and Results – Part 1: General Principles and Definitions

b) ISO 5725–2: Accuracy (trueness and precision) of measurement methods and results — Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement

c) ISO 139: Textiles — Standard atmospheres for conditioning and testing

d) ISO 2859-1:1999 Sampling procedures for inspection by attributes

e) ISO 3951-1:2005 Sampling procedures for inspection by variables

f) ISO 9073-8 Textiles – Test method for nonwovens – Determination of liquid strike-through time (simulated urine).

NOTE 2 ISO 9073-8 measures the STT for a single dose contrary to WSP 070.7.R4 which measures the STT for repeated doses.

g) EN ISO 9237 Paper and Board - Determination of air permeance (medium range).

Reference number
WSP 070.8.R4 (12) A

Current edition approved WSP 070.8.R4 (12)
Originally published as WSP 70.8 in 2002
Last approved as WSP 70.8 in 2009

h) ISO 9073-14 Textiles – Test method for nonwovens – Part 14: Wetback after repeated strike-through time

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Principle

A piece of coverstock is placed over a standard absorbent medium (10 plies of filter paper) which is then loaded three times according to the Repeated STT method WSP 70.7 with a specific quantity of simulated urine. After the third dose a Simulated Baby Weight (SBW) is placed onto the coverstock and absorbent medium to ensure even spreading of the liquid.

A pre-weighed pick-up paper is then placed on the coverstock and the weight (SBW) again put on top.

The mass of liquid absorbed by the pickup paper is defined as wetback.

4. Material and Reagents

4.1 Absorbent pad

Consisting of ten plies of filter (blotter) paper size 100 mm x 100 mm with the test side upwards, as specified by the supplier. The mean strike-through time, in 10 replicate determinations without the nonwoven, must be 1.7 ± 0.3 s.

The liquid absorption capacity, of the filter (blotter) paper, as determined by standard WSP 010.1.R3, must have a minimum capacity of 480 %

4.2 Simulated urine

Consisting of a 9 g/l solution of sodium chloride in deionised water with a surface tension of 70 ± 2 mN/m at 23 ± 2^{o}C

NOTE 3 This surface tension should be checked before each series of tests, as surface tension may change during storage.

4.3 Pick-up (blotter) paper

125 mm x 125 mm square.

Paper characteristics:

The mass per unit area of paper must be 90 ± 4 g/m² and the air flow resistance, as determined by ISO 5636, must be 1.9 ± 0.3 kPa.

NOTE 4 Information concerning suitable filter paper may be obtained from the following nonwovens industry associations: EDANA, Avenue Herrmann Debroux, 46 B-1160 Brussels, Belgium Phone +32 2 734 93 10 Fax +32 2 733 35 18 info@edana.org
INDA, 1100 Crescent Green Suite 115, Cary NC 27518 Phone +1 919 233 1210, Fax +1 919 233 1282

5 Apparatus

5.1 A burette with a 50 ml capacity
With a supporting stand, or 5 ml pipette.

5.2 Funnel, fitted with a magnetic valve
Giving a rate of discharge of 25 ml in 3.5 ± 0.25 s.

5.3 Ring stand to support the funnel.

5.4 Strike-through plate (see figures 1 and 2)
Constructed of 25 mm thick transparent acrylic sheet, of total mass 500 ± 5 g, fitted with corrosion-resistant electrodes consisting of 1.6 mm diameter platinum or stainless steel wire set in grooves of cross-section 4.0 mm x 7.0 mm cut in the base of the plate and fixed with quick-setting epoxy resin.

a) The electrodes shall be positioned as shown in figures 1 and 2.
b) The plate surface, electrode surface and the star-shaped orifice must be clean and free from deposit or particulate matter. Clean regularly, e.g. with mildly abrasive car polish and dry cloth, and/or hot water.
c) Base plate, of transparent acrylic sheet, approximately 125 mm x 125 mm square and 5 mm thick.

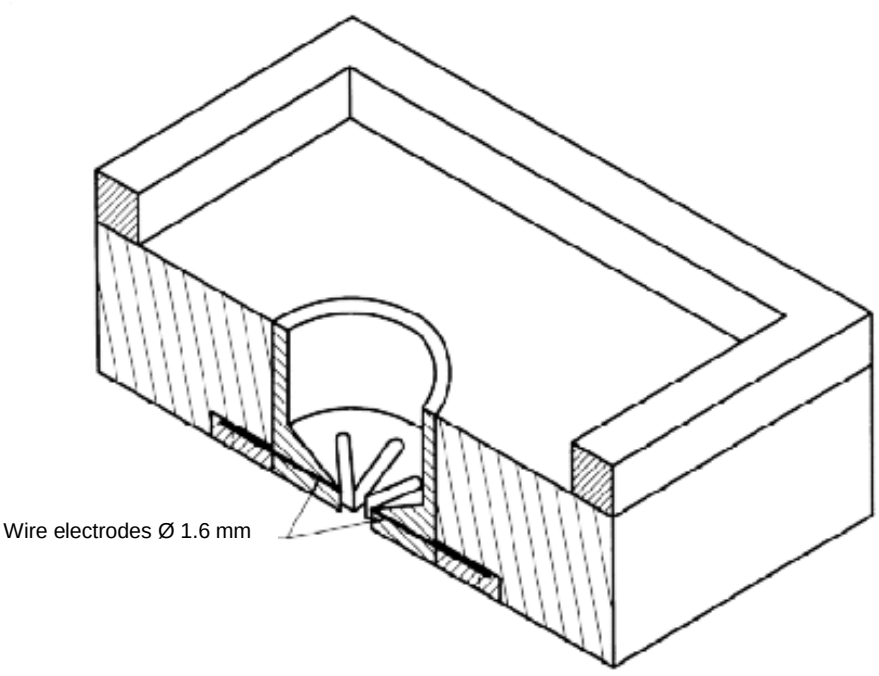


Figure 1
Section across strike-through plate on center line of 25mm dia. cavity

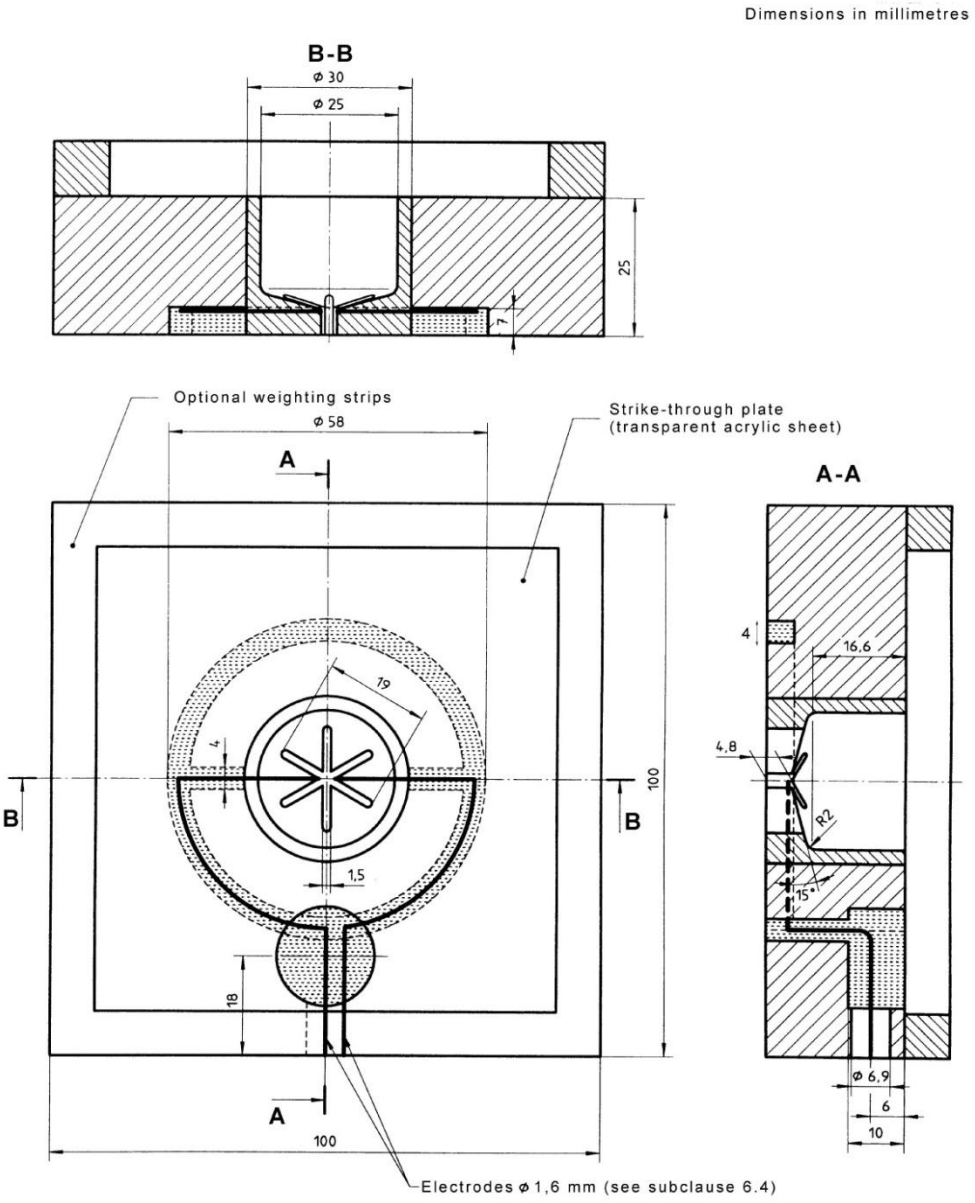


Figure 2
Liquid Strike-through Plate

5.5 Electronic timer

Measuring to the nearest 0.01 s

5.6 Simulated Baby Weight (SBW)

Consisting of:

a) A weight, stainless steel base 10 cm x 10 cm including a handle, of total mass 4000 ± 20 g.
b) A polyurethane foam rubber, 10 cm x 10 cm x 2 cm height, as described in 10.5.
c) A polyethylene film 25µm thick.

Wrap the P.E. film around the foam, securing the film in place with tape then taping the film and foam to the weight (see figure 3 below).

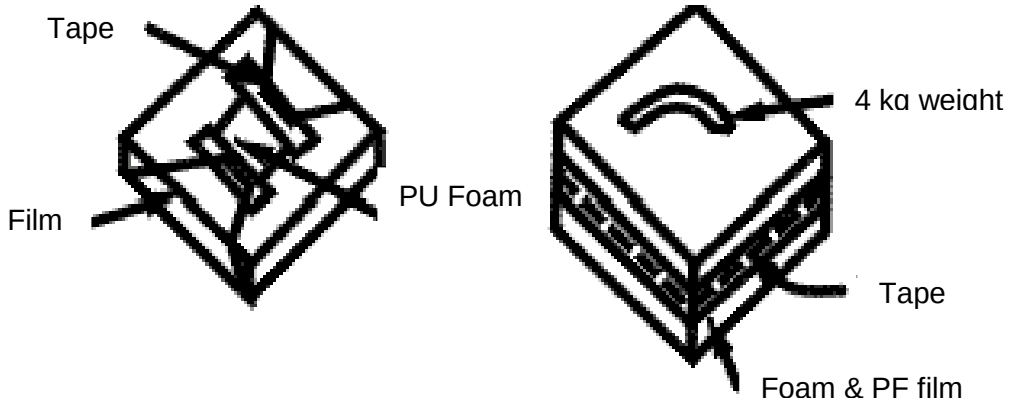


Figure 3

6. Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 5 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

7. Sampling

7.1 Lot Size

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

7.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables (“s” method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 6 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer’s risk, consumer’s risk, acceptable quality level, and limiting quality level.

8. Procedure

This test is conducted in conjunction with the repeated strike-through test WSP 070.7.R3 (12) as follows:

8.1 Set up the ring stand holding the funnel

Make sure that the timer and conductivity detector are switched on, and electrodes are connected.

8.2 Cut the nonwoven test pieces

125 mm x 125 mm, selected in accordance with ISO 139, if applicable.

8.3 Prepare 1 set of 10 plies of filter paper

Stacking the paper plies on top of each other, placing the test side upwards.

8.4 Weigh the set of 10 plies of filter paper

Place them with the test side upwards on the strike-through baseplate. The mass (W) of the filter paper will be used as a parameter to determine the total quantity of liquid (Q) required for the wetback test.

a) The quantity of liquid (Q) will be calculated by multiplying W by the loading factor (LF) of the filter paper (see remarks clause).
b) The recommended loading factor is 3.30.

8.5 Place the nonwoven test piece on top of the set of 10 plies of filter paper
Position the nonwoven such that the direction of liquid flow during the test corresponds with the intended use of the nonwoven.

NOTE 7 When testing personal hygiene products the side of the nonwoven that is intended to be in contact with the user's skin must be facing upwards.

8.6 Place the strike-through plate on top of the nonwoven
With the center of the plate approximately over the center of the test piece. Center the funnel over the orifice in the plate. If using a Lister instrument this corresponds with the position defined by the designated positioning template.

8.7 Adjust the height of the funnel
So that the dispensing tip is 45 ± 1 mm above the top of the instrument baseplate. For Lister equipment this corresponds to the minimum position of the head, as defined by the vertical positioning ring.

8.8 Check whether the timer display shows zero
If not, reset.

8.9 Dispense with the pipette or burette
5.0 ml of test liquid into the funnel, while keeping the discharge valve of the funnel closed.

8.10 Open the magnetic discharge valve of the funnel
To discharge the 5.0 ml of liquid. The initial flow of liquid will complete the circuit and start the electronic timer.

The timer will stop when the liquid has penetrated into the nonwoven and dropped below the level of the electrodes in the strike-through plate. At that time, start the stopwatch.

8.11 Record the time
Indicated by the electronic timer (STT-1).

8.12 Use the stopwatch to record a time interval of 60 s
During this period, dispense a fresh aliquot of 5.0 ml of test liquid into the funnel.

8.13 As the stopwatch reads 60 s
Repeat steps 9.9 – 9.11 for measuring the STT of the second dose (STT-2).

8.14 As the stopwatch reads 60 s
Repeat steps 8.9 – 8.11 for measuring the STT of the third dose (STT-3).

8.15 Add additional quantity of test liquid
(AQ) in order to reach the specified quantity (Q).

$$AQ\ (ml) = Q\ (ml) – 15\ ml$$

8.16 Remove the baseplate with the sample and filter (blotter)paper
From the strike-through apparatus.

8.17 Gently place the 4 kg weight assembly (SBW)
Onto the sample.

8.18 The weight (SBW) remains in place for 3 minutes
To ensure even diffusion of the liquid.

8.19 Remove the weight (SBW)
Without disturbing the nonwoven test piece.

8.20 Weigh two layers of pick-up paper
To an accuracy of 0.001 g, record the mass (P_1) and place them on the test piece.

8.21 Remove residual liquid by wiping the contact surface of the weight (SBW)
With a dry tissue before gently replacing it over the pick up paper. A loading speed should be applied in such a way that the last 5 cm displacement takes 5 ± 1 s.

8.22 The weight (SBW) remains in place for 2 minutes ± 2 s
During which time wetback has occurred.

8.23 Remove the weight (SBW)
Reweigh the pick-up (blotter) paper (P_2), to an accuracy of 0.001 g.

8.24 Calculate
The wetback value (WB) = P_2 - P_1 (expressed in g).

8.25 Repeat for the required number of test pieces
A minimum of 3 tests on test pieces from each sample is recommended.

NOTE 8 If STT-3 is higher than 20 s, indicating non-durable treatment of the nonwoven, repeat the test with one dose only. After STT-1 add additional quantity of test liquid [AQ (ml) = Q (ml) – 5 ml] and measure the wetback according to 8.15 -8.23.

9. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Surface tension of simulated urine, if different from the value specified

g) Individual strike-through times, in s to an accuracy of 0.1 s.
h) Individual wetback (expressed in g) to an accuracy of 0.01 g.
i) Number of specimens tested and note CD and/or MD if significant
j) For computer processed data, identify the software used and the version
k) Deviation from the standard test procedure, if any
l) When calculated, the standard deviation or the coefficient of variation
m) Whether or not samples were conditioned prior to testing and, if so, for how long
n) Anything unusual noted during the testing

10. Remarks

10.1 The loading factor (LF)

Is dependent on the liquid absorbency capacity (LAC) and will change as the LAC changes.

a) A loading factor of 3.30 was found to be appropriate when using paper (blotter) filters of a LAC of least 480 %.

b) A knowledge of the wetback vs. loading factor curve for a coverstock is useful sometimes, as close to the break point, wetback dispersion increases dramatically.

c) The use of control nonwoven samples is strongly recommended to monitor the correct functioning of the test. Good wetback samples, one with wetback 0.12 g or less and the other around 0.20 g, are sufficient to monitor the test.

10.2 If the LAC of the filter (blotter) paper

Used differs from the 480 % minimum or if a refined procedure is needed for research or for ranking purpose, different loading factors can be used. Modified LAC and LF should be mentioned in the report.

NOTE 9 If the LAC differs from the specifications, the filter paper supplier will indicate the recommended LF corresponding to this different LAC. It is recommended that the same filter paper batches are used for wetback comparison purpose.

10.3 The application of the weight (SBW) in 8.17 and 8.23 is a critical step

The training of the operator can be provided by practising the placement of the weight on a balance without overcharging the balance by more than a few grams (5g).

Alternately an automatic system with a pneumatic piston can be used to apply the weight assembly consistently.

10.4 Maintenance

The repeatability of this test depends on the maintenance of the strike-through plate in order to avoid the formation of sodium chloride crystals, the creation of a water film or any other contamination on the walls that could modify the strike-through time measurement, see the maintenance instructions from the plate manufacturer.

10.5 The polyurethane foam specifications shall be:

a) Density: 25-75 kg/m³ (ASTM D 3574-86, test A)
b) Hardness: 150-250 N for 40% compression and 5 cm sample (ASTM D 3574-86, test B)

11. Precision

See Annex A

ANNEX A
(Informative)

Precision

Figures for the repeatability and reproducibility of this method are the results of collaborative studies carried out in 2000 by EDANA, with the following data:

	SAMPLE A	SAMPLE B	SAMPLE C
No. of participating laboratories	6	6	6
No. of non-eliminated laboratories	6	6	6
No. of single values of the non-eliminated laboratories	60	60	60
Wetback measuring after	STT-1	STT-3	STT-3
Average (g)	0.13	0.13	0.17
Standard deviation of repeatability, s_r	0.01	0.03	0.05
Coefficient of repeatability, CV_r	9.8%	23.2%	28.5%
Repeatability limit, r (2.8 x s_r)	0.04	0.09	0.14
Standard deviation of reproducibility, s_R	0.02	0.04	0.06
Coefficient of reproducibility, CV_R	17.5%	30.2%	34.3%
Reproducibility limit, R (2.8 x s_R)	0.06	0.11	0.17

Sample A: non-durable hydrophilic carded nonwoven
Sample B: durable hydrophilic carded nonwoven
Sample C: durable hydrophilic spunlaid nonwoven

STANDARD TEST: WSP 070.9.R1 (12)

Standard Test Method for Nonwoven Adult Incontinent products: Rate of Acquisition and Re-Wet Test
This method is used as a in-process verification

The number in parentheses indicates the year of the last revision

1. Scope

To measure the ability of incontinence products to accept and retain 0.9% saline solution under simulated in-use conditions of load and pressure.

To determine amount of time required for an absorbent article to absorb a fixed quantity of 0.9% saline solution.

SI values are regarded as the official standard system of measurement for this standard test method.

NOTE: 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Referenced Documents

The following referenced documents are used in the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document applies.

2.1 ISO test methods

a) 9073-8: 1995 Textiles – Test method for nonwovens – Part 8: Determination of liquid strike-through time (simulated urine)
b) (EN 29073 part 8)
c) ISO 2859-1:1999 (Sampling procedures for inspection by attributes)
d) ISO 3951-1:2005 (Sampling procedures for inspection by variables)
e) ISO 139-2005 Textiles — Standard atmospheres for conditioning and testing

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods
b) WSP 070.3.R3 (12) Standard Test Method for Nonwoven Coverstock Liquid Strike-Through Time Using Simulated Urine

Reference number
WSP 070.9.R1 (12) A

Current edition approved WSP 070.9.R1(12)
Newly published method as WSP 070.9.R1 in 2012

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Simulated urine
Consisting of a 9 g/l solution of sodium chloride in distilled water with a surface tension of (70 ± 2) mN/m.

3.2 Sample
Sample is a portion of an absorbent product taken from a production lot, roll, case or cases of product, which is taken for testing. The sampling unit shall be identifiable and traceable back to its original source.

3.3 Rate of Absorbency (ROA)
Time required to fully absorb test fluid into the test product.
A specified quantity of simulated urine is discharged at a prescribed rate under specified conditions onto a test specimen of an absorbent article with a nonwoven cover The time taken for the entire liquid dose to penetrate the nonwoven is measured.

3.4 Rewet
Amount of wetness returned to the surface of an incontinent product onto an absorbent filter paper.

4. Principle

A specified quantity of simulated urine is discharged at a prescribed rate onto a test specimen with a nonwoven cover. The time taken for the entire liquid dose to penetrate the nonwoven is measured **(ROA)**

A pre-weighed filter paper is then placed on the specimen and a known weight is applied carefully on top of the filter paper and specimen

The mass of liquid absorbed by the filter paper is defined as (**rewet)**

5. Reagents and Materials

Use only reagents of recognized analytical grade, unless otherwise specified

Simulated urine
A testing liquid consisting of a 9 g/l solution of sodium chloride in distilled water with a surface tension of (70 ± 2) mN/m

6. Apparatus

6.1 250-ml separatory funnel,
Discharging 7 ml/sec or a metering pump calibrated to deliver desired fluid amount at a constant rate of 7 ml/sec

6.2 NIST Traceable Timer

6.3 Dosing tube (Figure 1), with weight (Figure 2)

(weight 2.2 lbs, 4” x 4” x 0.5”: tube height 9”, diameter 1”)

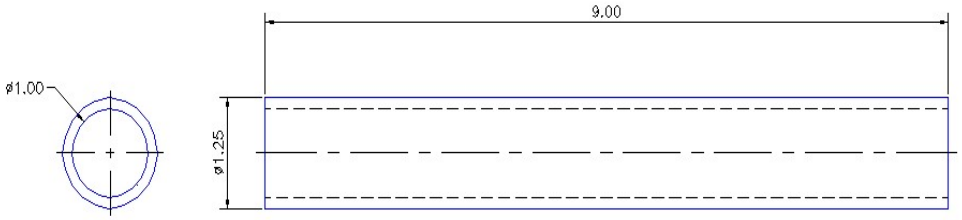


Figure 1

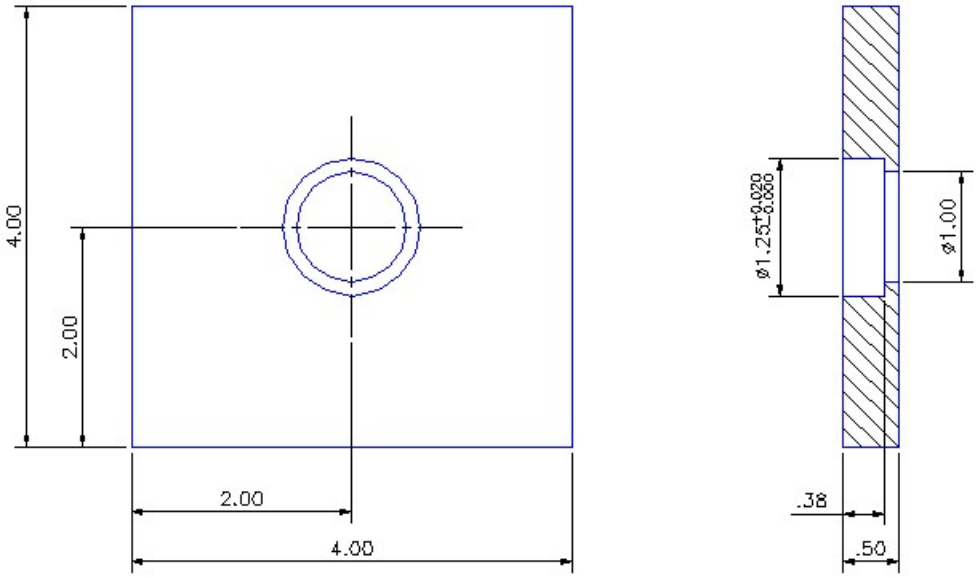


Figure 2

NOTE: 2 For more apparatus information and equipment drawings contact: INDA.

6.4 Filter Paper,

AFI Grade 950, 9.0 cm diameter or equivalent filter paper.

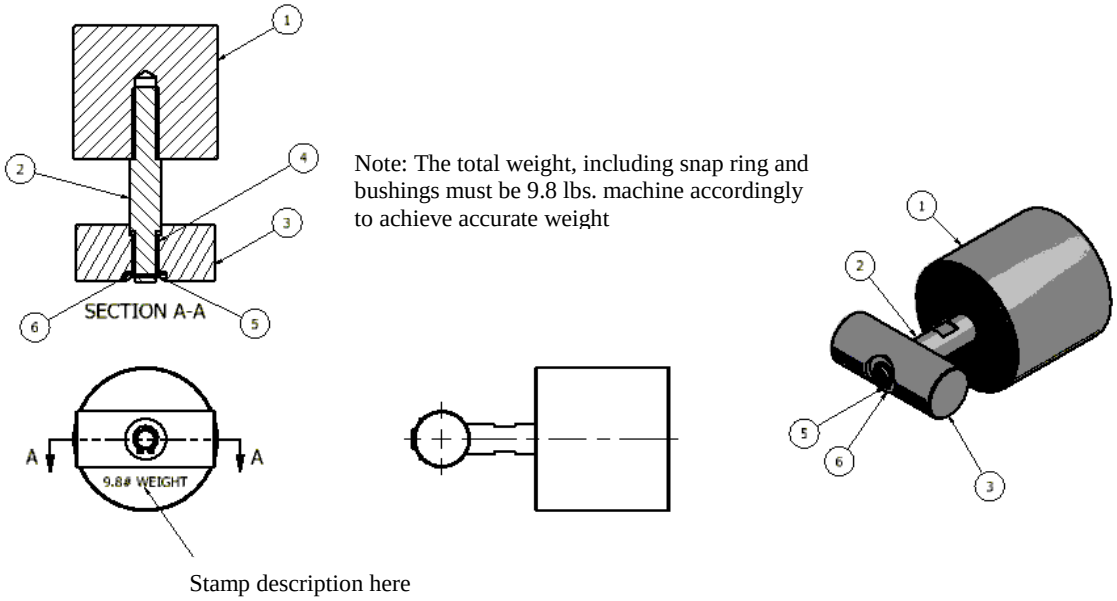
6.5 100-ml volume graduated cylinder

6.6 Analytical Balance,

Which is able to weigh to nearest 0.01 grams.

6.7 Stainless steel cylindrical

With a weight 9.8 lbs.: 9.0 cm, or 1.0 psi see figure 3



Note: The total weight, including snap ring and bushings must be 9.8 lbs. machine accordingly to achieve accurate weight

Figure 3

7. Calibration and Variation

All testing equipment used with this method must be calibrated according the equipment manufacturer.
This equipment must also have in place a variation system to monitor that the calibration is still in effect, i.e. daily, weekly or monthly.

8. Conditioning

Conditioning the test specimens for this in-process test is not required.

If the specimens are tested under standard laboratory conditions ISO 139: 2005 to qualify the in-process testing, then the sampling instructions in clauses (9.2 and 9.3) must be followed.

9. Sampling

9.1 Test specimens

Care in handling should be observed so that specimens do not contact any contaminants such as soap, salt, oil etc., which might facilitate or hinder liquid penetration.

a) Select 5 products for testing
b) Record the production code or date for each sample
c) Prepare product so it lies flat:
   - Trim waist elastic and leg gathers, if present
   - Fold under the front and back wing flaps

NOTE: 3 Results obtained on small samples can only be considered as representative of that sample and cannot be assumed to be representative of the material portion from which the small sample was taken.

9.2 Lot Size

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

9.3 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE:4 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

10. Procedure

10.1 Measure out a volume of test solution

Which is described in 10.1.1 for the product being tested (e.g., 100 ml or 200 ml. depending on the product) with a graduated cylinder and transfer the solution to the separatory funnel.

10.1.1 Fluid dosage:

Varies by Product Type and, in some cases, by size

a)	Briefs: medium - bariatric	Single dose of 200 ml. 100ml for youth and small
b)	Undergarments and pant liners:	Single dose of 100 ml.
c)	Pads:	Single dose of 30 ml (category 1 only) and 75ml (for category 2 pads)
d)	Underpads:	Not applicable
e)	Protective Underwear:	Single dose of 100 ml.

10.1.2 Prepare product so it lies flat

a)	Briefs:	Trim waist elastic and leg gathers, if present; fold under the front and back wing flaps
b)	Undergarments:	Unfold; trim waist elastic and leg gathers, if present
c)	Protective Underwear:	Tear at the side seams; trim waist elastic and leg gathers, if present

NOTE 5: Make sure the timer is ready, as timing for the rewet test will be initiated.

10.2 Center the dosing tube over the target zone

Which is at the notch in the center of the crotch area.

10.3 Deliver the test solution

Into the dosing tube by fully opening the stopcock on the funnel or starting the metering pump. The end of the funnel should be lever with the end of the dosing tube.

10.4 Start the timer

When fluid flow starts from the funnel or pump

10.5 Stop the timer

When all of the solution has passed into the product *(all the wet sheen has disappeared)* - record the time in seconds as the **Rate of Acquisition (ROA)**.

NOTE:6 If the fluid leaks around the flat base of the test ring, it is an indication that the absorbent core is not uniform. Highlight this in the test results.

10.6 Restart the timer

Wait ten (10) minutes and weigh a stack of dry filter paper and record as weight W1

NOTE:7 - The stack should have a dry weight of about 10.0 grams

10.7 After the 10-minute waiting period

Place the stack of filter paper in the center of the wetted target area.

10.8 Place a 1.0-psi cylindrical weight on the top of the dry filter paper
Make sure the stack is level, not tipping to one side or the other. Start the timer.

NOTE: 8 The weight should be gently lowered onto the filter paper stack.

10.9 After one minute
Remove the weight and the wetted out papers.

10.10 Reweigh the filter paper stack
Record as weight W2

NOTE:9: If the entire stack of filter paper is wetted, the test is invalid and must be re-evaluated with a new sample using a heavier (5.0-g additional) stack of dry filter paper.

10.11 Repeat the above steps for all 5 product samples
Recording each result separately

11. Calculations:

REWET (g) = W2 (Wet filter paper weight) - W1 (Dry filter paper weight)
Report the average of the 5 products tested

12. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Laboratory testing conditions if required
e) Number of specimens tested
f) Deviation from the standard test procedure, if any
g) When calculated, the standard deviation or the coefficient of variation
h) Whether or not samples were conditioned prior to testing
i) Anything unusual noted during the testing

13. Precision

The precision for this method is yet to be determined.

Standard Test: WSP 070.10.R1 (12)

Standard Test Method for Nonwoven Adult Incontinent Products: Centrifugal Liquid Retention Capacity Test (Dry Weight vs. Wet Spun Weight)

The number in parentheses indicates the year of the last revision

1. Scope

To measure the liquid retention capacity of incontinence products after subjecting it to centrifugal forces.

This test method follows a liquid absorption capacity test.

SI values are regarded as the official standard system of measurement for this standard test method.

NOTE: 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative Reference

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document applies.

2.1 ISO test methods

a) ISO 11948-1:1996(E) Liquid Absorption Capacity Test
b) ISO 3696:1987 Water for Analytical use – Specification and Test
c) ISO 6353-2:1983 Reagents for Chemical Analysis – Part 2; Specifications

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry and EDANA's and INDA's Standard Test Methods.

3. Terms and Definition

The following referenced terms are indispensable for the application of this document:

3.1 Centrifugal Liquid Retention Capacity (CLRC) is the amount of liquid an absorptive hygiene product can retain after being subjected to a known centrifugal force at a specified speed and time.

Reference number
WSP 070.10.R1 (12) WD

Current edition approved WSP 070.10.R1 (12)
Originally published as WSP 070.10.R1 in 2012
Last approved as WSP 070.10.R1 in 2012

3.2 Centrifugal Spin Weight (CSW) also known as spun wet weight, is the recorded weight of an absorptive hygiene product after being subjected to a known centrifugal force.

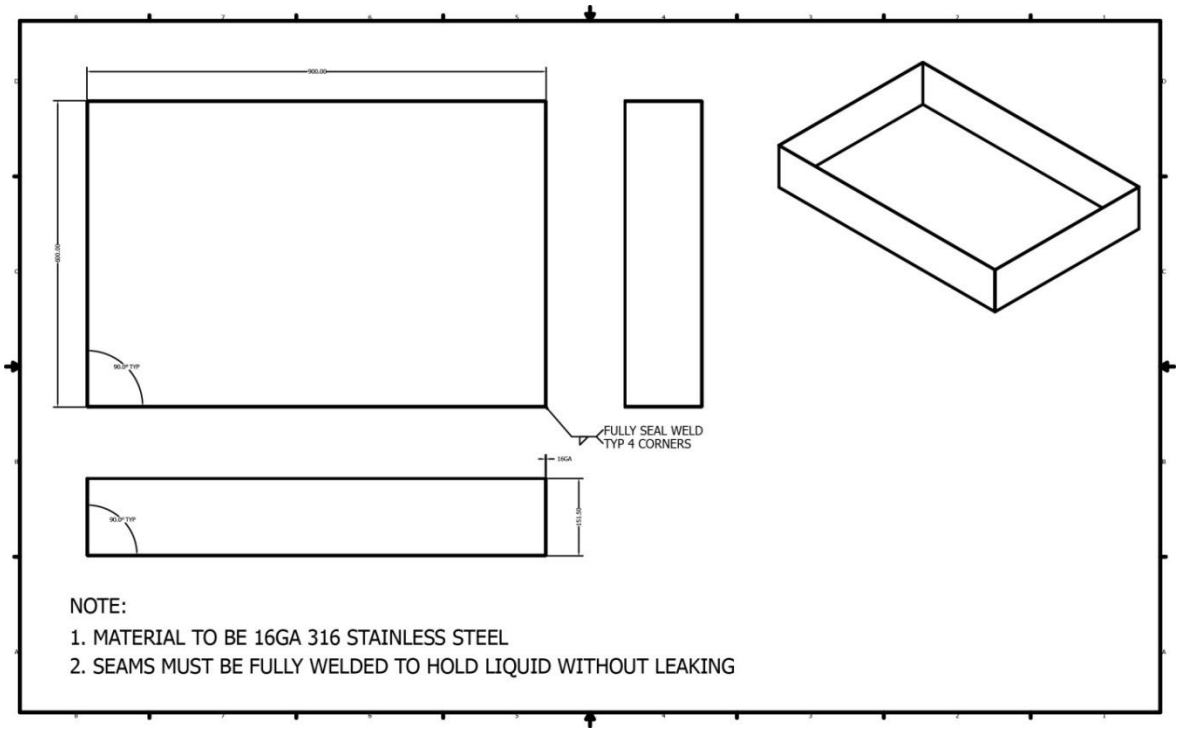
4. Principle

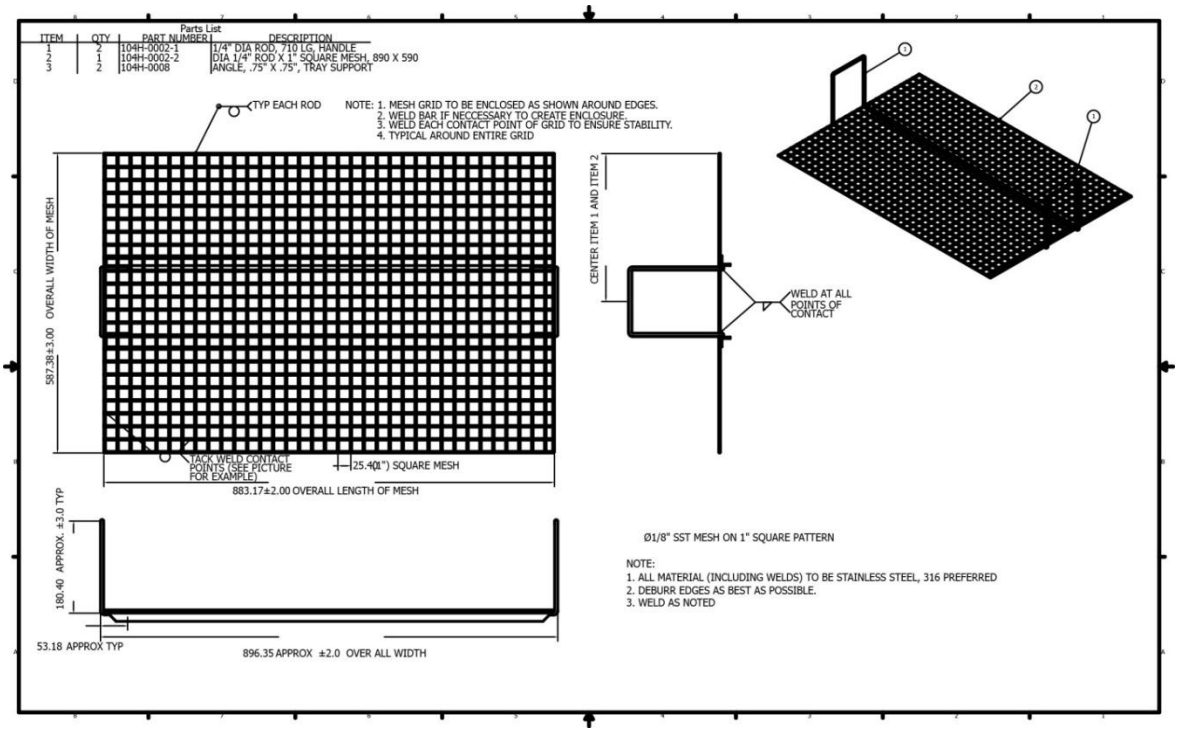
The test specimen is intended to absorb and retain liquid. This test will discover the amount of liquid the test specimen can retain after being subjected to a centrifugal force spin cycle.

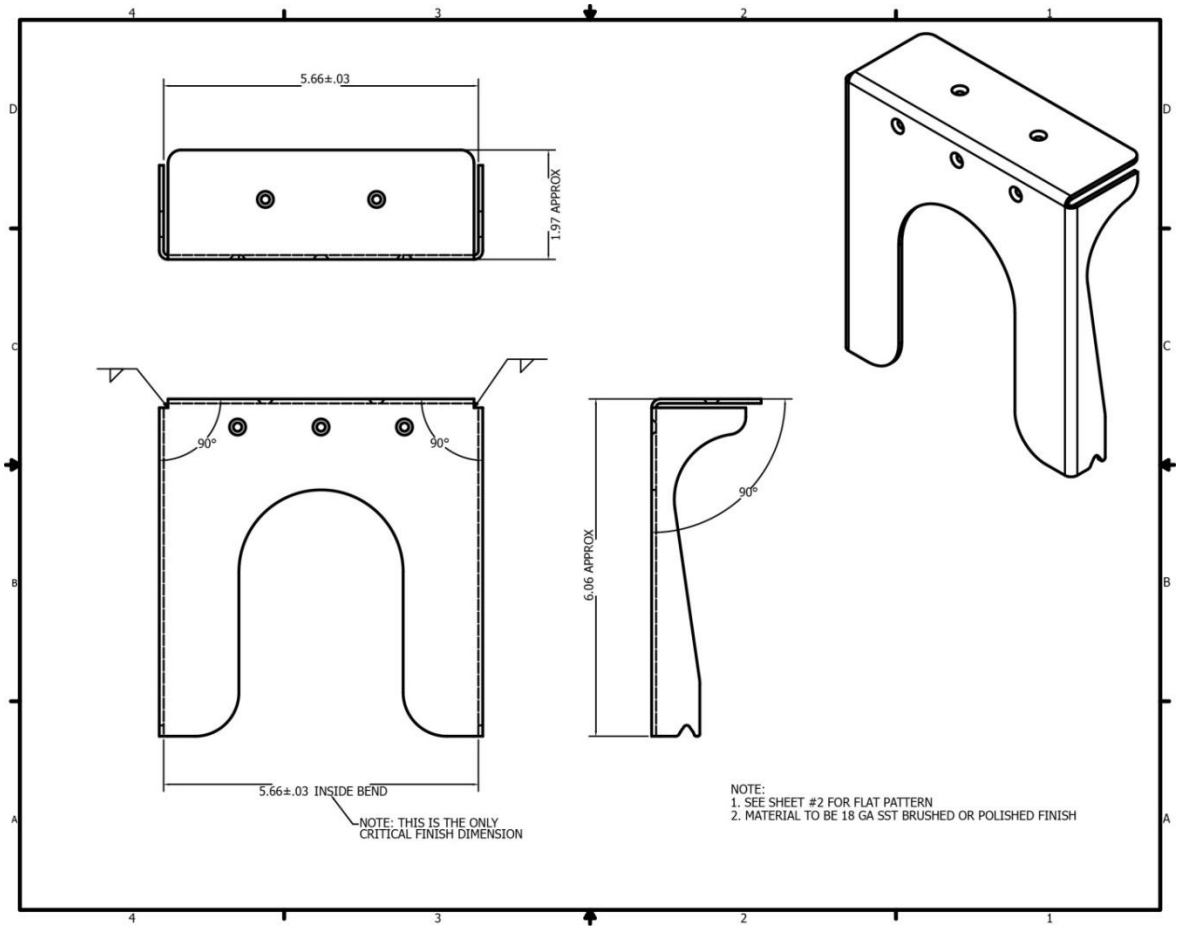
5. Apparatus

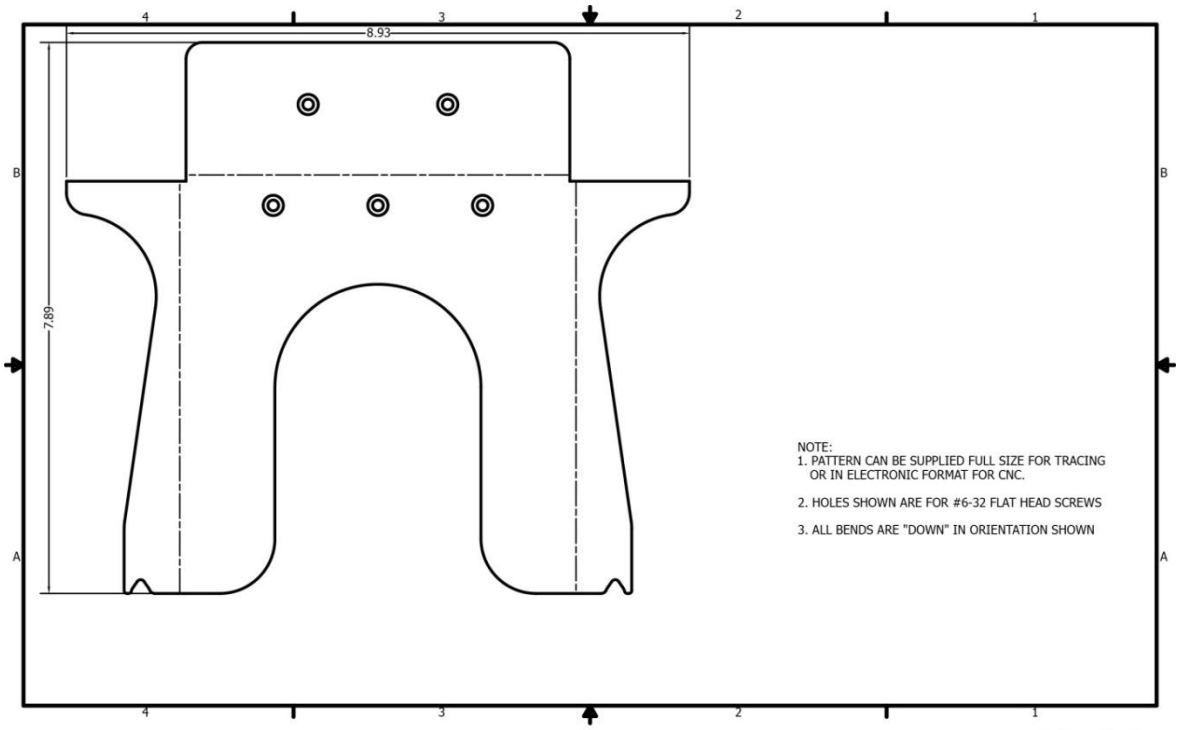
5.1 Fisher & Paykel Ecosmart Model WA37T26G washing machine or equivalent (available at Lowe's Home Improvement). Machine to be capable of a 7 minute 15 second spin cycle at 750 RPM.

5.2 Weighing Tray (See Figures below) large enough to hold test sample(s)

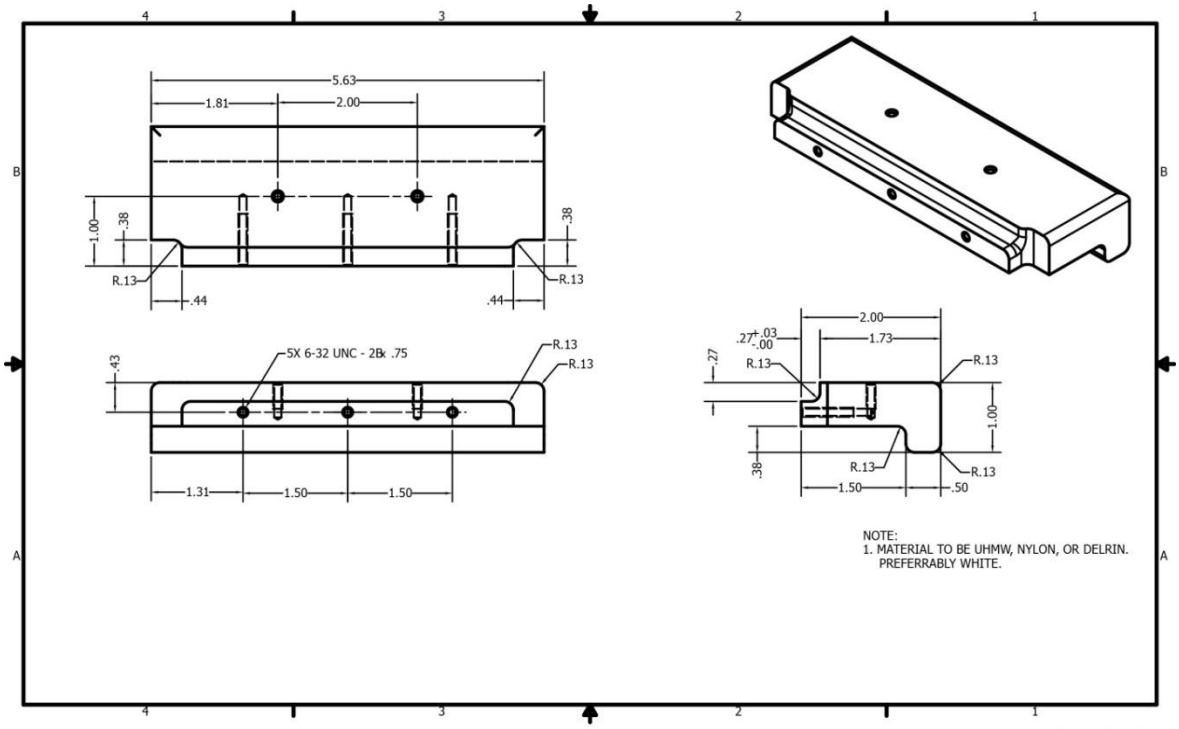



Parts List
ITEM | QTY | PART NUMBER | DESCRIPTION
1 | 2 | 104H-0002-1 | 1/4" DIA ROD, 710 LG, HANDLE
2 | 1 | 104H-0002-2 | DIA 1/4" ROD X 1" SQUARE MESH, 890 X 590
3 | 2 | 104H-0008 | ANGLE, .75" X .75", TRAY SUPPORT
TYP EACH ROD
NOTE: 1. MESH GRID TO BE ENCLOSED AS SHOWN AROUND EDGES.
2. WELD BAR IF NECCESSARY TO CREATE ENCLOSURE.
3. WELD EACH CONTACT POINT OF GRID TO ENSURE STABILITY.
4. TYPICAL AROUND ENTIRE GRID
587.38±3.00 OVERALL WIDTH OF MESH
TACK WELD CONTACT POINTS (SEE PICTURE FOR EXAMPLE)
25.40(1") SQUARE MESH
883.17±2.00 OVERALL LENGTH OF MESH
CENTER ITEM 1 AND ITEM 2
WELD AT ALL POINTS OF CONTACT
180.40 APPROX. ±3.0 TYP
53.18 APPROX TYP
896.35 APPROX ±2.0 OVER ALL WIDTH
Ø1/8" SST MESH ON 1" SQUARE PATTERN
NOTE:
1. ALL MATERIAL (INCLUDING WELDS) TO BE STAINLESS STEEL, 316 PREFERRED
2. DEBURR EDGES AS BEST AS POSSIBLE.
3. WELD AS NOTED


5.66±.03
1.97 APPROX
90°
90°
6.06 APPROX
90°
5.66±.03 INSIDE BEND
NOTE: THIS IS THE ONLY CRITICAL FINISH DIMENSION
NOTE:
1. SEE SHEET #2 FOR FLAT PATTERN
2. MATERIAL TO BE 18 GA SST BRUSHED OR POLISHED FINISH



NOTE* - 104H-0005
USED TO BE



NOTE* - 104H-0006
USED TO BE

5.3 Analytical Lab Balance which is capable of weighing to the nearest 1.0 grams

6. Calibration and Variation

All testing equipment used with this method must be calibrated according the equipment manufacturer.

This equipment must also have in place a variation system to monitor that the calibration is still in effect, i.e. daily, weekly or monthly.

7. Conditioning

The test samples should be first tested to ISO 11948-1:1996 (E) Test method to measure the absorptive capacity. Using the recorded weights for each sample as the spin weigh for this method the sample should be tested under this method without delay to ensure the volume of simulated urine contained in the sample has not changed.

8. Sample

A test sample for this method is one complete article that has not been cut, damaged or modified from its intended use condition by the end customer

9. Procedure

9.1 Record upon completion of test method ISO 11948-1:1996(E) Liquid Absorption Capacity Test record the final wet weight. This weight will be used as the Centrifugal Spin Weight (CSW) for this method.

9.2 Place the urine saturated sample from the ISO 11948-1:1996 E test in the washing machine with the absorbent core facing the vertical side of the washing tub.

NOTE: 2

This test procedure allows for multiple samples to be tested at the same time. Be sure none of the samples are overlapping, If testing multiple samples it is advised to mark each with indelible ink for identification.

9.3 Power on the washing machine.

9.4 Set the machine to the Spin Cycle by using the arrow button on the Wash Progress display.

9.5 Select the Medium speed on the spin cycle display.

9.6 Push the start button to start the machine spin cycle.

NOTE: 3

The spin cycle speed is 670 RPM and the complete cycle time is 7 minutes and 15 seconds.

9.7 During the Spin Cycle the machines lid will automatically lock preventing it from being opened.

9.8 At the end of the spin cycle the machine will emit an auditable sound and the lid will unlock.

9.9 Carefully remove each sample and place it in the tared weighing tray.

9.10 Record the weight.

10. Calculation

Centrifugal Liquid Retention Capacity (CLRC) (grams) = Spun Weight (weight of sample at conclusion of liquid retention capacity test) – dry weight (sample condition after completing the spin cycle).

11. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Laboratory testing conditions if required
e) Number of specimens tested
f) Deviation from the standard test procedure, if any
g) When calculated, the standard deviation or the coefficient of variation
h) Whether or not samples were conditioned prior to testing
i) Anything unusual noted during the testing

12. Precision

The precision for this method is yet to be determined.

STANDARD TEST: WSP 080.1.R4 (12)

Standard Test Method for Surface Wetting Spray Test

The number in parentheses indicates the year of the last revision

1. Scope

This test method is applicable to any nonwoven fabric which may or may not have been given a water-resistant or water-repellent finish. It measures the resistance of fabrics to wetting by water. The portability and simplicity of the instrument, and the shortness and simplicity of the test procedure, make this method of test especially suitable for mill production control work. It is not intended, however, for use in predicting the probable rain penetration resistance of fabrics, since it does not measure penetration of water through the fabric.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.1 ISO test methods

a) ISO 139: Textiles — Standard atmospheres for conditioning and testing
b) ISO 2859-1:1999 Sampling procedures for inspection by attributes
c) ISO 3951-1:2005 Sampling procedures for inspection by variables

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

Water repellency
The characteristic of a fiber or fabric to resist wetting.

Reference number
WSP 080.1.R4 (12) A

Current edition approved WSP 080.1.R4 (12)
Originally published as WSP 80.1 in 2002
Last approved as WSP 80.1 in 2009

4. Principle

Water sprayed against the taut surface of a test specimen under controlled conditions produces a wetted pattern whose size depends on the relative repellency of the fabric. Evaluation is accomplished by comparing the wetted pattern with pictures on a standard chart.

The procedure is intended primarily to evaluate nonwovens. The method is qualitative and measures the surface-water repellency of surface-water resistance to water penetration. It is not intended for use in determining resistance to water penetration. A visual means is given to evaluate the relative effects of materials showing water repellency, but no comparison is possible with conditions found in actual use.

5. Apparatus

5.1 Spray tester

The spray tester (see figures 1 and 2) shall consist of a standard spray nozzle with 19 holes, using a drill bit number 65 or 0.89 mm in diameter, connected by means of a 10 mm diameter rubber tube to the funnel tube of a 150 mm laboratory funnel; and a laboratory ring support which holds the funnel directly over the center of a 150 mm metal embroidery hoop mounted on a block of wood so that the plane of a specimen held on the hoop makes an angle of 45° with the horizontal. The distance of the nozzle to the center of the hoop-mounted specimen shall be 300 mm.

5.2 Rating chart

A suitable spray tester with standard spray nozzles, metal hoops, and copies of the rating chart are available from: American Association of Textile Chemists and Colorists PO Box 12215 Research Triangle Park North Carolina 27709

5.3 Baffle

A baffle 100 x 100 mm cut from 6mm thick polymethyl methacrylate plastic or an equivalent inert material

6. Calibration and Standardization

6.1 Place the 100 x 100 mm plastic baffle

This baffle is placed in the funnel with one of the four corners positioned so that it points to the bottom of the funnel, the placement of the baffle in the funnel is to stop the water from swirling.

6.2 A 250 mL volume of distilled water

Shall be at a temperature of 27 ± 1°C at the time it is poured into the funnel and sprayed on each specimen.

7. Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 2 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

8. Sampling

8.1 Lot Size

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

8.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.
Attributes (1.0 AQL, General Inspection Level II)

Attributes (1.0AQL, General Inspection Level 11

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables (“s” method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 3 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer’s risk, consumer’s risk, acceptable quality level, and limiting quality level.

8.3 Test specimens

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material.

a) Care in handling should be observed so that specimens do not contact any contaminants such as soap, salt, oil etc., which might facilitate or hinder water penetration.
b) Specimens should be cut 180 x 180 mm

9. Procedure

9.1 Secure test specimen

The test specimen, which has been conditioned as directed, is fastened securely in the 150 mm metal hoop so that it presents a taut smooth wrinkle-free surface. The hoop is then placed on the stand of the tester so that the fabric is uppermost in such a position that the center of the spray pattern coincides with the center of the hoop.

9.2 Carefully pour into the funnel of the tester

250 mL of distilled water at 27 ± 1°C and allow it to spray onto the test specimen, which will take approximately 25 to 30 seconds.

9.3 Upon completion of the spraying period

The hoop is taken by one edge and the opposite edge tapped smartly once against a solid object, with the fabric facing the object, then rotated 180° and tapped once more on the point previously held

10. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Number of specimens tested and note CD and/or MD if significant
g) For computer processed data, identify the software used and the version
h) Deviation from the standard test procedure, if any
i) When calculated, the standard deviation or the coefficient of variation
j) Whether or not samples were conditioned prior to testing and, if so, for how long
k) Anything unusual noted during the testing
l) Compare the wet specimen with the rating chart which is reproduced in Figure 1. The test specimen is assigned a rating corresponding to the nearest standard in the rating chart. Intermediate ratings should not be given.

11. Precision

This test method is subjective and cannot have a precision statement.

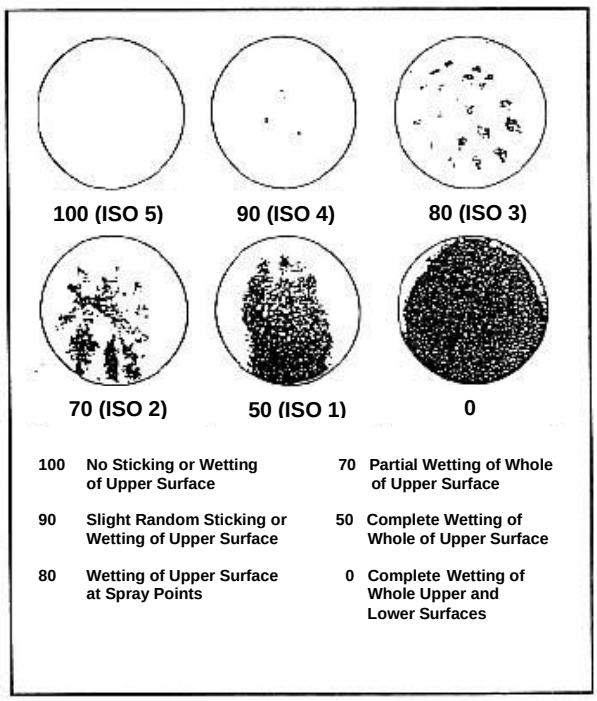


Figure 1 Spray test rating chart

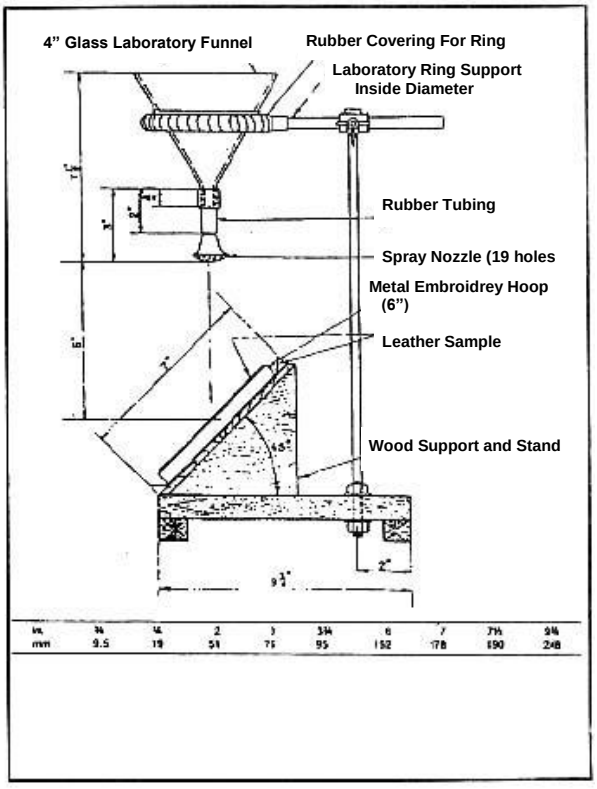


Figure 2 Spray tester details

STANDARD TEST: WSP 080.2.R3 (12)

Standard Test Method for Penetration by Water (Rain Test) for Nonwoven Fabrics

The number in parentheses indicates the year of the last revision

1. Scope

This test measures the resistance of materials to penetration of water by impact, using a standard rain tester. The test is a useful indicator of the probable rain penetration resistance of the material. The results obtained with this method depend on the water repellency on the fibers or the treatment applied to finished material

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.1 ISO test methods

a) ISO 139: Textiles — Standard atmospheres for conditioning and testing
b) ISO 2859-1:1999 Sampling procedures for inspection by attributes
c) ISO 3951-1:2005 Sampling procedures for inspection by variables

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

2.3 Other standard test methods

a) Federal Test Method No. 5524 Standard No. 191-A

Reference number
WSP 080.2.R3 (12) A

Current edition approved WSP 080.2.R3 (12)
Originally published as WSP 80.2 in 2002
Last approved as WSP 80.2 in 2009

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

Water repellency
The characteristic of a fiber or fabric to resist wetting.

4. Principle

The rain penetration test is applicable to any material whether or not it has been treated for water repellency. The test determines the resistance of the material to water penetration and can thus be used to predict the probable resistance to rain penetration of the material; it is especially suitable for measuring the penetration resistance of garment materials, such as those used for raincoats, and of "protection" material such as tent material. The water resistance of the material depends on the repellent properties of individual fibers as well as on the construction of the material as a whole. The material can be tested at different intensities of water impact by changing the hydrostatic pressure head on the column; this would yield an overall picture of the water penetration resistance of the material.

In this procedure a 200 x 200 mm specimen is used as a protective barrier covering a sheet of pre-weighted, absorbent blotter paper. A horizontal water spray, with a predetermined hydrostatic head, is directed against the specimen for five minutes and the blotter then weighed again. The difference between the initial and final weights of the blotter paper is the weight of the water that has penetrated, and passed through the specimen. The greater the difference, the more water that has passed through the material, i.e., the less water repellent the material. Thus, higher numbers indicate a lower water resistance.

5. Material and Reagents

5.1 Blotter paper

a) Must have an absorbent rate of (3) s or less (ISO 9073-6)
b) The Liquid Absorption Capacity, of the paper, as determined by standard WSP 10.1, must at least 480 %.
c) The mass per unit area of paper must be (90 ± 4) g/m² and the air flow resistance, as determined by ISO 5636, must be (1.9 ± 0.3) kPa.

NOTE 2 This pre-cut blotter paper can be purchased in the U.S. from:
W. Fritz Mezger, Inc
155 Hall St.
Spartanburg, SC 29302

NOTE 3 Also this information concerning suitable blotter paper may be obtained from following nonwovens industry associations: EDANA, Avenue Herrmann Debroux, 46 B-1160 Brussels, Belgium Phone +32 2 734 93 10 Fax +32 2 733 35 18 info@edana.org
INDA, 1100 Crescent Green Suite 115, Cary NC 27518 Phone +1 919 233 1210, Fax +1 919 233 1282

5.2 Water
27 ± 3°C

6. Apparatus

6.1 AATCC rain tester see Figure 1
The intensities are produced and controlled by means of a column of water which may be adjusted to 0.6, 0.9, 1.2, 1.5, 1.8, 2.1, and 2.4 m above the nozzle. This is done by means of a glass pressure column to which the nozzle is connected. The adjustment of the height of the water in the glass column is made by a simple setting of a valve at the lower end or the drain or overflow pipe, which extends up through the center of the glass column. A filtering device between the pressure gauge and the glass column may be used to prevent clogging of the nozzle openings. It may be eliminated in localities where the water supply is relatively free from iron, rust, or other suspended matter. A pressure gauge on the supply line also is an accessory, which usually can be eliminated in the interests of economy. The temperature of the supply water may be measured by means of a thermometer, but recent work has shown that it is more conveniently and accurately measured with a thermometer suspended in the glass pressure column or immersed in a beaker placed to catch water from the overflow.

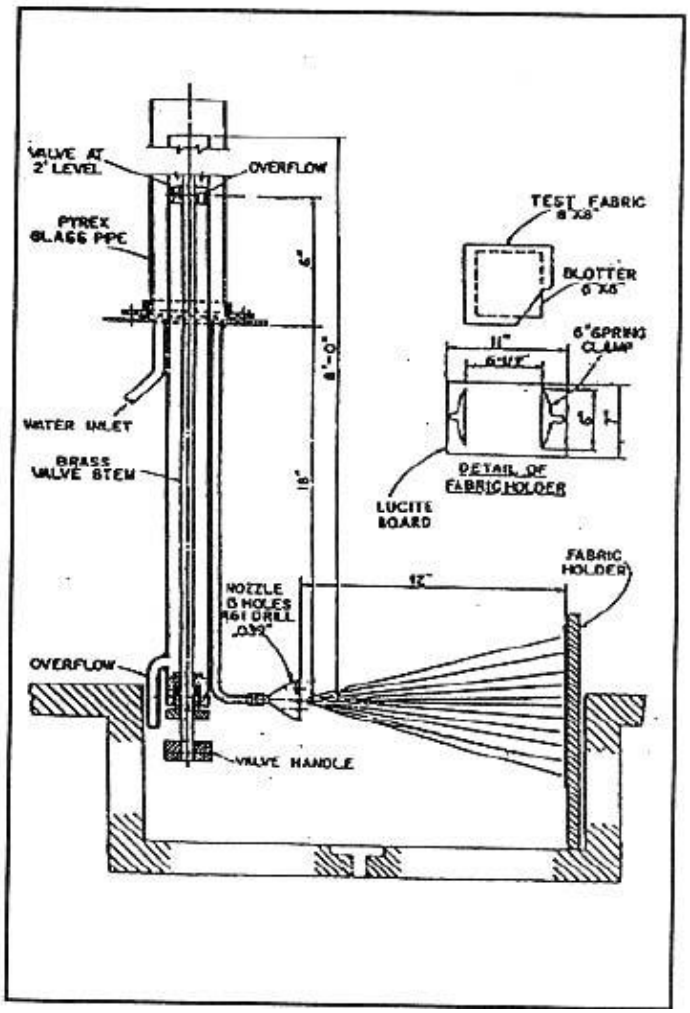


Figure 1
Rain tester (structural details)

6.2 Balance
A laboratory balance capable of weighing the specimen to an accuracy of 0.01 g

6.3 Specimen holder
The specimen holder shall be equipped with clamps suitable for holding the specimen and blotter in a vertical and rigid position during the spray period

6.4 Stopwatch

7. Conditioning
Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen

NOTE 2 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

8. Sampling

8.1 Lot Size

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

8.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 3 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

8.3 Test specimens

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material.

a) Care in handling should be observed so that specimens do not contact any contaminants such as soap, salt, oil etc., which might facilitate or hinder water penetration.
b) Specimens should be cut 200 x 200 mm

9. Procedure

9.1 Weigh a sheet of blotter paper to the

Nearest 0.01 gram and designate this as weight "I"

9.2 Center the blotter between

But not touching, the two clamps of a dry specimen blotter

9.3 Clamp the specimen

Test side up, over the blotter paper.

NOTE 4 The specimen should be clamped tightly enough between the clamps, and exert sufficient pressure on the blotter paper, so as to hold the blotter in place when the specimen holder is in a vertical position.

NOTE 5 Make sure the removable shield is in place on the nozzle.

9.4 Mount the specimen holder

With specimen and blotter in place, vertically in the rigid support frame

9.5 With one hand remove the shield

To start the spray and simultaneously, with the other hand, start the stopwatch

9.6 After five minutes ± 1 second

Replace the shield to stop the spray

9.7 Carefully remove the blotter paper

And weigh it to the nearest 0.01 g. This is weight "F"

9.8 Remove and discard the specimen

9.9 Return to 9.1 for additional test specimens

NOTE 6 In order to obtain a complete over-all picture of the penetration resistance of a nonwoven or nonwoven laminate combination, the average penetration with different pressure heads on the nozzle may be obtained. The pressure head should be varied by 300 mm increments in order to determine.

(a) The maximum head at which no penetration occurs.
(b) The change in penetration with increasing head.
(c) The minimum head required to cause "breakdown" or penetration of more than 10 g of water.

10. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) The final blotter weight "F" minus the initial weight "I" is the impact penetration, in grams for that specimen.
g) The water penetration of the sample unit shall be the average of the results obtained from the specimens tested and shall be reported to the nearest 0.01 g.
h) Number of specimens tested and note CD and/or MD if significant
i) For computer processed data, identify the software used and the version
j) Deviation from the standard test procedure, if any
k) When calculated, the standard deviation or the coefficient of variation
l) Whether or not samples were conditioned prior to testing and, if so, for how long
m) Anything unusual noted during the testing

11. Precision

The precision for this method is yet to be determined.

STANDARD TEST: WSP 080.3.R4 (12)

Standard Test Method for the Evaluation of Water Penetration (Spray Impact Test) of Nonwoven Fabrics

The number in parentheses indicates the year of the last revision

1. Scope

The spray impact penetration test is applicable to fabrics that are expected to exhibit a degree of water resistance or water repellency.

The SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately

This test method is not recommended for highly porous fabrics that are penetrated by large amounts of water.

NOTE 1 The absorbent capacity and absorbent rate of the blotter paper may be exceeded and the results from such tests would be inaccurate. An estimate of the repellency of such products can be obtained by using two plies of blotter paper that are distortion free when wet and have an absorbent rate of 5 seconds or less using 5 cc, but this practice is only recommended as a screening tool.

NOTE 2 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.1 ISO test methods

a) ISO 5725-1 Accuracy (trueness and precision) of measurement methods and results – Part 1: General principles and definitions

b) ISO 5725-2 Accuracy (trueness and precision) of measurement methods and results – Part 2: Basic method for the determination of the repeatability and reproducibility of a standard measurement method

c) ISO 139: Textiles — Standard atmospheres for conditioning and testing

d) ISO 2859-1:1999 Sampling procedures for inspection by attributes

e) ISO 3951-1:2005 Sampling procedures for inspection by variables

Reference number
WSP 080.3.R4 (12) A

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Originally published as WSP 80.3 in 2002
Last approved as WSP 80.3 in 2009

f) ISO 10012 Measurement management systems — Requirements for measurement processes and measuring equipment
g) ISO 9073-6

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Water resistances of nonwoven materials

The characteristics that resist wetting and penetration by water

3.2 Repeatability $_{(r)}$

As determined by this test method is the variability found between the test results of randomly selected homogenous specimens, tested at one laboratory, using one technician, one instrument, and one set of environmental conditions which were found on one given day

3.3 Reproducibility$_{(R)}$

As determined by this test method is the variability found between the test results of randomly selected homogenous specimens, which were tested at different laboratories, one technician at each laboratory, and tested using standard laboratory environmental conditions which were found at each laboratory.

3.4 Purified water

Water that has been through one of three processes; distillation, reverse osmosis, or deionization.

4. Principle

This method measures the resistance of nonwoven fabrics to the penetration of water by impact and can thus be used to predict the probable rain penetration resistance of the fabric. The sample is used as a protective barrier covering a sheet of pre-weighed absorbent blotter paper. A specific volume of purified water is then sprayed onto the sample and the blotter weighed again. The difference in the two weights is a measure of the amount of water passing through the barrier. The greater the difference, the more water that has passed through, i.e., the less water repellent the nonwoven fabric. Thus, higher numbers indicate lower water resistance.

The results obtained with this method depend on the water repellency of the fibers or the treatment applied to the finished material.

5. Materials

5.1 Blotter paper

Spray Impact Penetration: 150 x 225 mm blotter paper. The source of blotter paper must meet all the parameters for this test method. These parameters are as follows:

a) No visible distortion in the paper when wetting while testing
b) An absorbent rate of 5 seconds or less (ISO 9073-6)
c) The liquid absorption capacity, of the (blotter) paper, as determined by standard ISO 9073-6, must have a minimum capacity of 480 %.
d) Exhibits uniform sheet formation
e) Traceable back to production lot
f) A sheet density of 0.24 ± 0.05g/cc
g) The mass per unit area of paper must be (90 ± 4) g/m²

This pre-cut blotter paper can be purchased from
W. Fritz Mezger, Inc
155 Hall Street
Spartanburg, SC 29302

EDANA, Avenue Herrmann Debroux, 46 B-1160 Brussels, Belgium Phone +32 2 734 93 10 Fax +32 2 733 35 18
INDA, 1100 Crescent Green, Suite 115, Cary, NC 27518 Phone +1 919 233 1210, Fax +1 919 233 1282

5.2 Drip catcher

Can be a standard blotter paper or any type of absorbent material to catch the last large drops and keep them from hitting the test specimen

6. Apparatus

6.1 Impact penetration apparatus

This apparatus, (Impact penetration Type II tester as illustrated in Figure 1, Figure 2) is available from:
AATCC
PO Box 12215
Research Triangle Park
North Carolina 27709

6.2 Purified water

27 ± 1˚C (80±2˚F)

6.3 Balance

A laboratory balance capable of weighing the specimen to an accuracy of 0.01 gram

6.4 Stopwatch

6.5 Baffle

A baffle 100 x 100 mm cut from 6mm thick polymethyl methacrylate plastic or an equivalent inert material

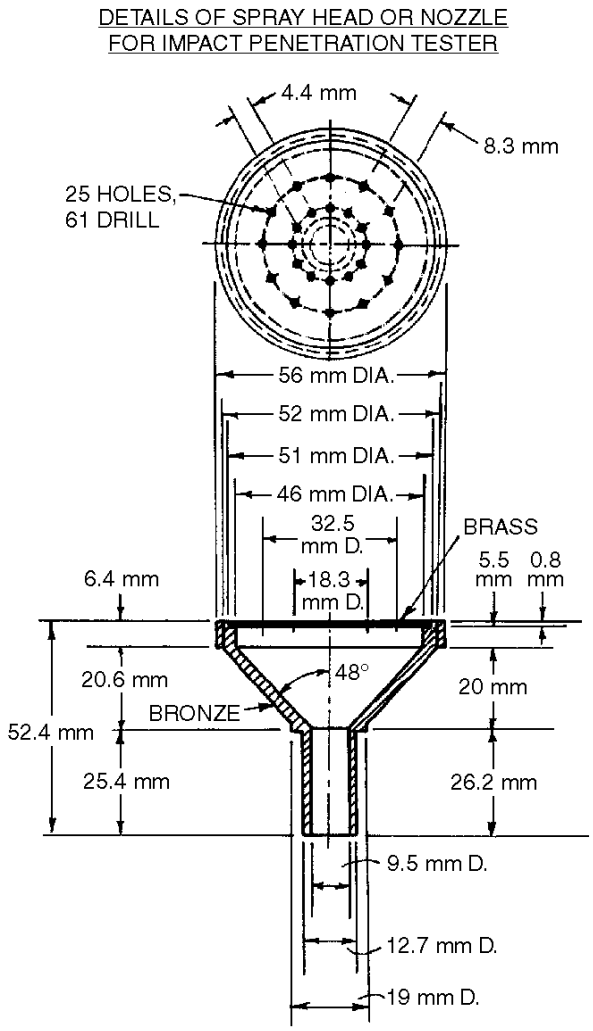

Figure 1 Details of the Spray Head

7. Sampling

7.1 Lot Size

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

7.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established.

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables (“s” method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 3 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer’s risk, consumer’s risk, acceptable quality level, and limiting quality level.

7.3 Test specimens

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material.

a) Care in handling should be observed so that specimens do not contact any contaminants such as soap, salt, oil etc., which might facilitate or hinder water penetration.
b) Specimens should be cut 175 x 325 mm with the long dimension in the machine direction.
c) Unless otherwise specified, cut ten specimens, evenly spaced across the available cross directional width, from each sample.

8. Preparation and Calibration of Test Apparatus

8.1 Position the bottom of spray head
The nozzle face is 60 cm above the center of the test specimen stand.

8.2 Place the 100 x 100 mm plastic baffle
This baffle is placed in the funnel with one of the four corners positioned so that it points to the bottom of the funnel

8.3 Check water flow through spray head
a) Pour 100 mL of purified water in the funnel and observe the flow through the nozzle.
b) If any holes appear clogged, remove the nozzle and clear/clean the holes.

8.4 Measure the flow rate through the nozzle.
a) Pour 500 mL of purified water at 27 ± 1° C into the funnel and measure the time taken for the water to pass through the funnel. The average of three flow rates (time in seconds from flow start to flow termination) should be 22 ± 2 seconds.
b) Start timing from the instant the water starts flowing through the spray head and stop timing 2 seconds after the continuous flow stops.

NOTE 4 At this point if this was an actual test a “drip catcher” blotter paper would be placed between water source and specimen. This blotter paper is put into place to stop any of the last large water drops from hitting the specimen. This drip catcher could catch as much as 5 ± 2 cc. This blotter paper will remain in place until the next specimen is ready to be tested, assuring a good clean start to the next test.

NOTE 5 As with the actual test procedure, the water must be poured into the funnel without imparting any swirling motion. The use of the plastic baffle described in 6.5 and 8.2 inhibits swirling and facilitates this test.

8.5 Clamp a dummy setup
Using a spare specimen and blotter paper, place both in the proper position on the test stand. Then attach the other weighted clamp and let the weighted specimen hang off the end. With this tension on the specimen, the specimen should be laying flat (100% in contact with the blotter paper) on the blotter paper. If the clamps are bent or sprung the specimen will not lay flat and this will be the cause for bad data, and the clamp plus weight should be replaced.

9. Conditioning

Bring the specimens and the blotter papers from the prevailing atmosphere to moisture equilibrium for testing in the standard atmosphere as prescribed in ISO 139. These blotters papers should be exposed to the atmosphere on all sides i.e. hanging the blotters on a clothes line works.

NOTE 6 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

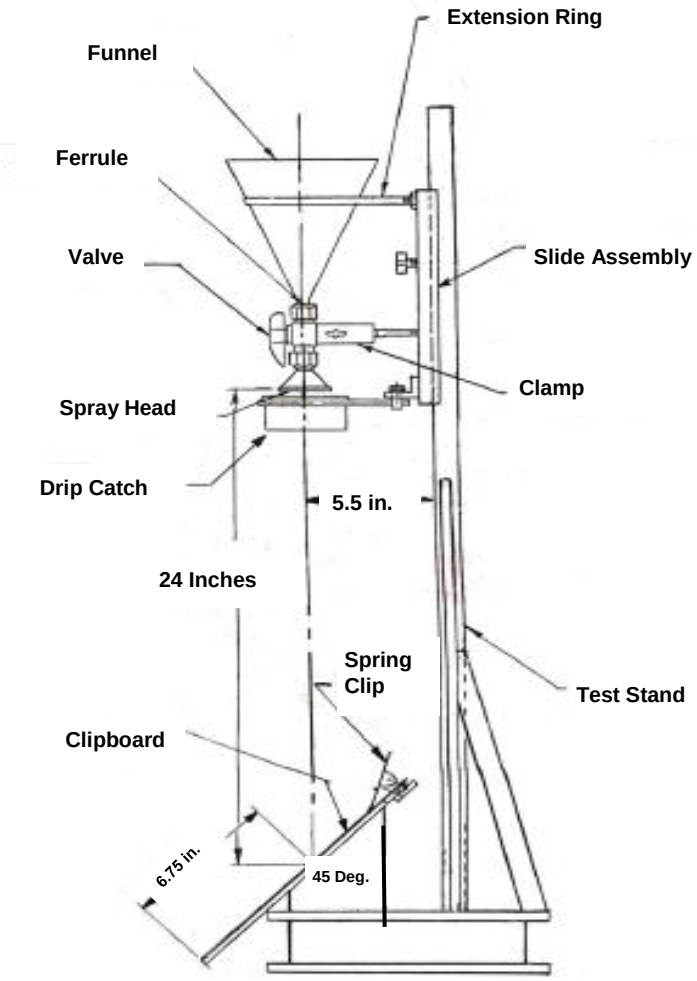

Figure 2 Assembled Apparatus

10. Procedure

10.1 Weigh a 150 x 225 mm piece of blotter paper

To the nearest 0.01 gram and designate this as the initial weight.

10.2 Clamp one end of the test specimen

Using the spring clamp at the top of the inclined stand 150 mm attach the specimen.

10.3 Attach the second 150 mm clamp
To the other end of the test specimen. This clamp has been modified to provide a total weight of 454 grams.

10.4 Position the pre-weighed blotter paper
Beneath the clamped test specimen as shown in Figure 2

10.5 Pour 500 mL of purified water
Which is at 27 ± 1° C into the funnel of the apparatus and allow to spray onto the test specimen.

10.6 Upon completion of the spraying period
At the proper time (2 seconds after the continuous flow stops) insert the "drip catcher" blotter paper to stop the remaining water from hitting the test area

10.7 Lift up test specimen carefully
Carefully remove the blotter paper beneath

10.8 Immediately
Weigh the blotter paper to the nearest 0.01 gram

NOTE 7 Do not allow the blotter to stand un-weighed for a prolonged period since evaporation losses can cause erroneous results.

11. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) The amount of water that penetrated which is calculated by the increased weight of the blotter paper, averaged for the number of specimens tested for each sample
g) Critical information on the blotter paper used, i.e. absorbent capacity, sheet density, and absorbent rate. Also record the manufacturer and lot number
h) Include the average of three flow rates (clause 8.4). Report the timing from the instant the water starts flowing through the spray head, stopping 2 seconds after the continuous flow ends
i) Number of specimens tested
j) For computer processed data, identify the software used and the version
k) Deviation from the standard test procedure, if any
l) When calculated, the standard deviation or the coefficient of variation
m) Whether or not samples were conditioned prior to testing and, if so, for how long
n) Anything unusual noted during the testing
0) When photos are used as the standard, attach copies

12. Precision

This study was based on using six laboratories, 30 specimens of one material and two types of blotter papers. The two blotter papers were (a) Hollingsworth & Vose, (b) blotter paper supplied by AATCC. This table illustrates what the six laboratories found and how the two blotter papers compared. All the observations are taken by well-trained operators using specimens randomly tested from one sample of SMS material. This procedure requires the use of a blotter paper with very tight controls standards as stated in section 6.

12.1 Table 1

Is a summary of the precision parameters, $_{(r)}$ is the repeatability std. Deviation and $_{(R)}$ is the reproducibility std. Deviation.

Grand Average and Component	Blotter (a)	Blotter (b)
Grand average	0.522	4.319
Within-laboratory component $_{(r)}$ – Repeatability	0.607	2.592
Between-laboratory component $_{(R)}$ – Reproducibility	0.607	2.726

Table 1

NOTE 8 The HV blotter paper is more absorbent with a faster absorbent rate yet its test results are lower, because of its density 0.24 ± 0.05g/cc. The density, absorbency and rate of absorbency are very important factors when selecting a blotter paper.

12.2 Table 2

Simply illustrates the variability between blotters and laboratories.

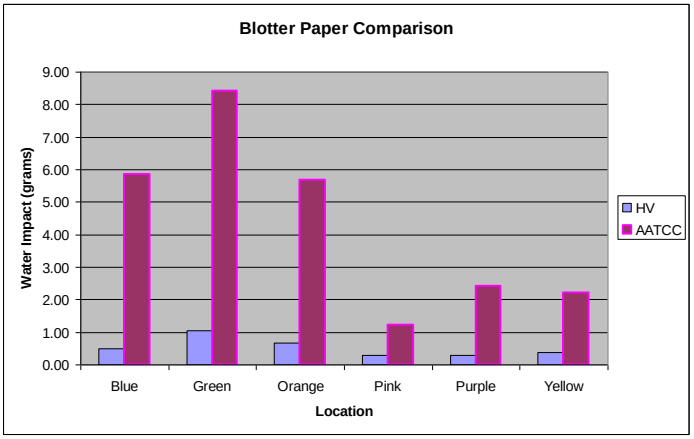

Table 2

STANDARD TEST: WSP 080.5.R4 (12)

Standard Test Method for Saline Repellency Using the Automated Mason Jar End Point Detector

The number in parentheses indicates the year of the last revision

1. Scope

This method describes the procedure for determining the repellency of a nonwoven material by subjecting the specimen to a saline solution under prescribed conditions. The time required for the liquid to penetrate the specimen is measured by an automatic mason jar end point detector.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.1 ISO test methods

a) ISO 139: Textiles — Standard atmospheres for conditioning and testing
b) ISO 2859-1:1999 Sampling procedures for inspection by attributes
c) ISO 3951-1:2005 Sampling procedures for inspection by variables

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Saline solution

Is distilled water containing reagent grade sodium chloride. For this application, it consists of 0.9% saline solution.

Reference number
WSP 080.5.R4 (12) A

Current edition approved WSP 080.5.R4 (12)
Originally published as WSP 80.5 in 2002
Last approved as WSP 80.5 in 2009

3.2 Grid
Is a ridged conductive plate used to detect the saline solution when it penetrates the test specimen.

3.3 Automated Mason jar end point detector
Is an apparatus with an electronic sensing unit with (5) timers capable of automatically detecting any saline solution penetrating through any 1 of 5 specimens by the use of metal grids.

4. Principle

The material to be tested is used to seal an inverted vented mason jar containing saline solution. The time for the saline (0.9%) solution to penetrate is measured. A precision threaded mason jar is filled to obtain a 213 ± 3 mm water-head when the jar is in the test position (inverted position solution against specimen). With the specimen securely sealed at the mouth of the jar, the jar is carefully inverted allowing solution to rest against the surface of the specimen. The Mason jar is then placed onto one of the grids and the time for the saline solution to penetrate the specimen is measured.

Saline repellency is indicative of the ability of a water repellent nonwoven material to resist a saline solution penetration using only the earth's gravity. This is helpful in assessing water repellency needed by nonwovens used in a number of applications.

5. Material and Reagents

Saline Solution
0.9% distilled water and sodium chloride.

a) Preparation of saline solution:
b) Add 9 grams of sodium chloride (NaCl) to 991 g of distilled water. Mix thoroughly.

6. Apparatus

6.1 Mason jar (1 quart)
This standard Mason jar has an air hole drilled into the bottom and a metal ring with a 63mm diameter mouth opening along with fitted gaskets.

6.2 An alternative jar (see figure 1)
This jar meets all the parameters of the mason jar and is much easier to work with. This jar contains the more precisely ground fittings that one would expect in precision threaded test jar and stopper. These tight precision fittings will not tear the specimen while tightening the lid or leak prematurely.
Precision Threaded Test Jar with stopper is available from:

Scientific Machine & Supply Co
PO Box 67
Cedar Ave
Middlesex, NJ 08846
(908) 356-1553

6.3 Rubber gasket
55 mm ID (66 mm OD) supplied by Scientific Machine & Supply Co

6.4 Teflon® gasket
55 mm ID (66 mm OD) supplied by Scientific Machine & Supply Co

6.5 Automated mason jar detector (see figure 1)
This system comes with 5 test stations or plates
Available from: PDS Testing
16 Lord Road
Ellington, CT 06029
(203) 375-1346

Figure 1
Automated mason jar detector with the precision threaded test jars

NOTE 2 To prevent corrosion, wash and dry grids after each use.

6.6 Electolytic tissue
100 x 100 mm, Grade 1797
Available from:

Dexter Nonwovens Division
2 Elm Street
Windsor Locks, CT 06096

NOTE 3 Whatman qualitative grade general use filter paper may be used

7. Sampling

7.1 Lot Size

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

7.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 4 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

7.3 Test specimens

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material.

a) Care in handling should be observed so that specimens do not contact any contaminants such as soap, salt, oil etc., which might facilitate or hinder saline penetration.
b) Specimens should be die cut using a 68 ± 0.8 mm diameter die.

8. Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 5 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

9. Procedure

NOTE 6 Two different types of timers are available, one electromechanical, (type I), and the other digital, (type II)

9.1 Seal the hole in the bottom of the Mason jar with a suitable device

The precision threaded test jars have a factory installed stopper. Fill jar via jar mouth with 0.9% saline solution to give a 213 ± 3 mm head of water after the jar is inverted to the test position

NOTE 7 It has been found that scribing a fill line on the jar and filling to this line expedites the procedure

9.2 Place a circular cut specimen

Between the rubber and Teflon® gasket in the cap

NOTE 8 Single-phase sheets - saline solution can be against either side; Multi-phase sheets, which contain an absorptive surface, such as wood pulp, rayon, cotton, etc., should be tested with the saline solution in contact with the more absorptive surface.

9.3 Turn "on" the main power switch to the automatic Mason jar detector

Allow a 15-minute warm-up before beginning the testing. The supplier provides technical details for checking the calibration of the instrument. Calibration once every three months is recommended.

9.4 Operation of timers on Mason jar detectors:

a) Type I - Turn the "Run/Hold" switch on the individual timers to the "Hold" position. Using the time-reset button, reset display to zero on each timer.
b) Type II - Turn "on" each timer via the toggle switch. Turn the "Test/Hold" switch to "test" mode.

9.5 Place two sheets 100 x 100 mm of electrolytic tissue on each grid to be used for testing

Invert mason jars with specimens for testing onto grids with electrolytic tissue. Immediately thereafter start the test

9.6 Remove stoppers from Mason jars and start timers on each grid.

a) Type I - Turn the "Run/Hold" switch to the "Run" position.
b) Type II - Reset the digital clock display by pressing the "Reset" button.

NOTE 9 This is a pass/fail test and times should be run until one of the following occurs:
a) Penetration. Record the time of penetration as provided by the timer
b) Penetration does not occur during a preselected time period. (The producer and user should agree on the maximum time the test will be run before ruling that penetration does not occur).

9.7 After the completion of each test

Dispose of the electrolytic paper and wash with distilled water and dry each grid.

10. Calculation

Average the results to the nearest whole minute.

11. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) The reading from each individual timer in whole minutes along with an average of the readings
f) Laboratory testing conditions
g) Number of specimens tested
h) For computer processed data, identify the software used and the version
i) Deviation from the standard test procedure, if any
j) When calculated, the standard deviation or the coefficient of variation
k) Whether or not samples were conditioned prior to testing and, if so, for how long
l) Anything unusual noted during the testing

12. Precision

This is a pass/fail test and precision is N/A

STANDARD TEST: WSP 080.6.R4 (12)

Standard Test Method for Evaluation of Water Resistance (Hydrostatic Pressure) Test

The number in parentheses indicates the year of the last revision

1. Scope

This test method applies to any nonwoven fabrics, which are intended for use as a barrier to the penetration of fluids.

The hydrostatic pressure test measures the resistance of nonwoven fabrics to the penetration of water under varied hydrostatic head pressures.

When testing some fabrics, such as meltblown fabrics, a nylon web or net screen may be used to support the specimen. This would simulate the effect from a bonded laminate and prevent the weight of the water from tearing or stretching the material. If this technique is used it must be reported with the test results.

The SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative reference

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.1 ISO test methods

a) ISO 139 Textiles — Standard atmospheres for conditioning and testing
b) ISO 2859-1:1999 Sampling procedures for inspection by attributes
c) ISO 3951-1:2005 Sampling procedures for inspection by variables
d) ISO 811 Textiles fabrics — Determination of Resistance to Water penetration — Hydrostatic pressure test
e) ISO 10012 Measurement management systems—Requirements for measurement processes and measuring equipment (calibrating equipment)
f) ISO 5725 -1Accuracy (trueness and precision) of Measurement Methods and Results – Part 1: General Principles and Definitions

Reference number
WSP 080.6.R4 (12) A

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Last approved as WSP 80.6 in 2009

g) ISO 5725 -2 Accuracy (trueness and precision) of Measurement Methods and Results – Part 2: Basic Method for the Determination of the Repeatability and Reproducibility of a Standard Measurement Method

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terminology

For the purpose of this document, the following terms and definitions apply:

3.1 Millibar

A unit of atmospheric pressure equal to 1/1000 bar, or 1 mbar is equal to 1.02 cm of water pressure.

3.2 Water resistance of nonwoven materials,

The fabric characteristics which are resistant to wetting and penetration by water.

3.3 Purified water

Water that has been through one of three processes: distillation, reverse osmosis, or deionization.

4. Principle

A nonwoven fabric specimen is mounted to form the cover on the test head reservoir. This specimen is subjected to a standardized water pressure increase at a constant rate until leakage appears on the outer surface of the nonwoven. The test results for the hydrostatic water pressure test are measured at the point where the first drops appear in three separate areas on the specimen. The results can be reported in either centimeters per minute or millibars per minute. Ignore any drops which form within 6 mm from the edge of the clamp; these drops may be due to the clamping process. If numerous drops form at the edge of the clamp, repeat the test with another specimen. If a water spout is formed from one of the penetrating holes, according to the criteria, that is still only one hole.

The rate of increase of the water pressure must be 10 ± 0.5 cm or 60 ± 3 cm H_2O/min. Using these two different rates may give different end results. It is important to list in the test results which rate was used.
Do not take into account very fine droplets, which do not grow after being formed and do not count subsequent drops that penetrate through the same location in the nonwoven.

The water pressure may be applied to the test specimen from the below or above. The method used should be stated in the test report.

All standard tests are carried out using the 100 cm^2 test head. But, where there are size limitations on the specimens, the 26 cm^2 or the 10 cm^2 test heads may be used in experimental testing. The different test heads will provide different results and the results should be used only as a relative ranking of materials.

Performance specifications for industrial, medical, and military fabrics have been prepared on the basis of resistance to water penetration and are used in the purchase of fabrics where resistance to water penetration is of interest.

Construction factors and finishing techniques can have an appreciable effect on a finished product's resistance to penetration of water. The quality of seams and stitching may influence the results.

A higher value indicates greater resistance to water penetration.

See Annex A for general information on reproducibility.

5. Apparatus

5.1 Hydrostatic testing apparatus

Must have the following: (See figures 1 and 2 as examples of two different types of hydrostatic head testing equipment)

a) A leveling mechanism that maintains the specimen horizontally
b) A clamping mechanism which does not allow water leakage, specimen damage or specimen slippage.
c) The water that comes in contact (from above or below) with the specimen should be controlled to 23 ± 2° C. If an alternate temperature is used it must be noted with the test results.
d) A rate of increase of the water pressure must be 10 ± 0.5 cm or 60 ± 3 cm H_2O/min. The pressure used must be noted with the test results.
e) A standard 100 cm^2 test head. If another size head is used it must be noted with the test results.

NOTE 2 **SAFETY WARNING**

The light bulbs should be covered with a translucent shield to prevent water splashing on the hot bulb. Using the equipment in figure 2 the technician must be extremely careful not to release the hand lever prematurely because that would cause the lever to rebound with considerable force. With both pieces of equipment, hand injuries could occur when lowering the clamp to the test head

5.2 Nylon netting

20 x 20cm piece of netting with ≈ 3 mm holes. Nylon netting may be obtained from a local fabric store.

NOTE 3 When testing some nonwovens that exhibit low tensile such as a meltblown fabric, a nylon web or net screen may be used to support the sample. This would simulate the effect of a bonded laminate and prevent the weight of the water from tearing or stretching the material. The use of the nylon support must be agreed upon by all parties and all parties must be fully aware of its affects. This standard is normally done without the use of the nylon support.

5.3 Stop watch

Calibrated to 0.1 seconds

5.4 Cutting dies or templates

To cut specimens having dimensions at least equal to the area of the clamping surfaces of the test apparatus (optional) or paper cutter.

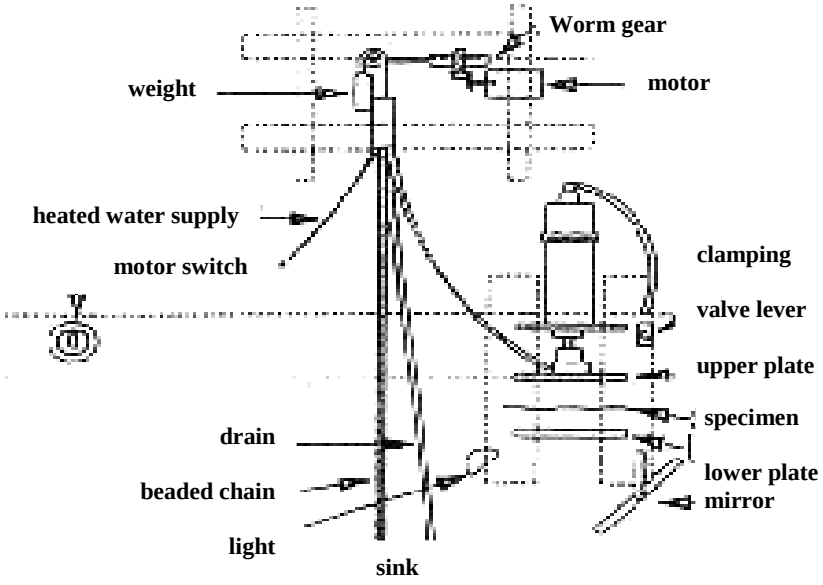

Figure 1

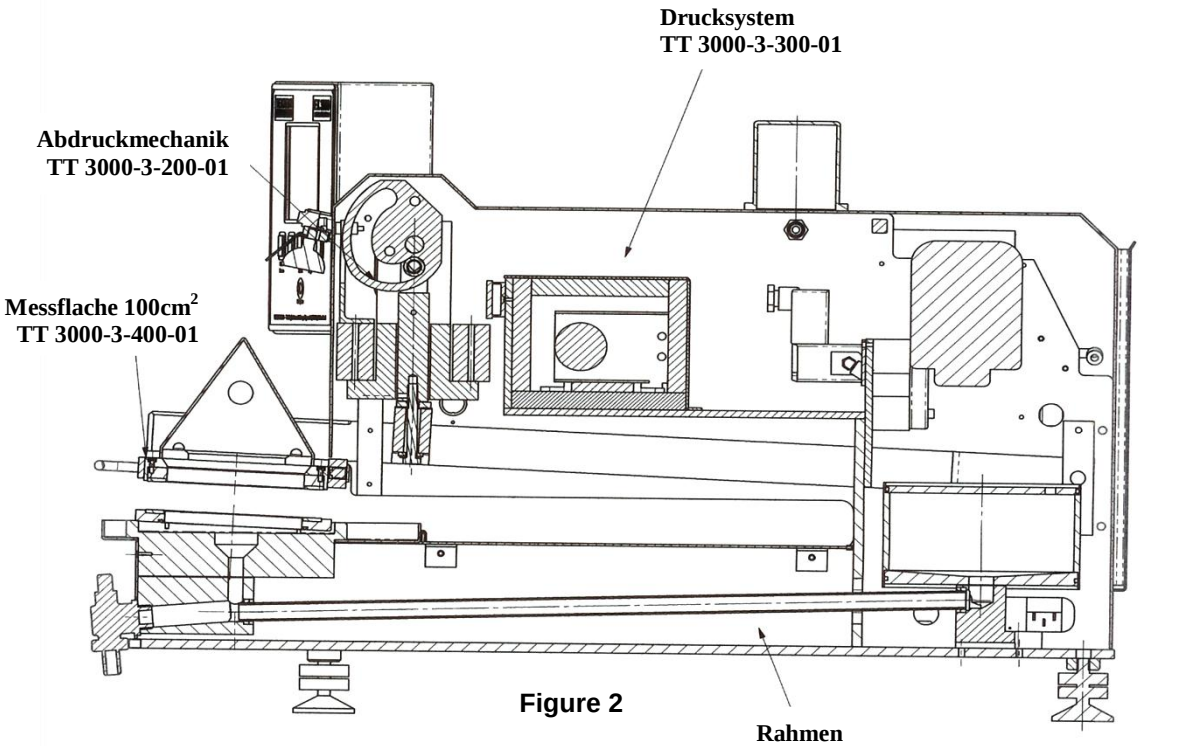

Figure 2

6. Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 4 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing nonwovens for a reasonable period of time before the specimens are tested, i.e. 4 hours.

7. Sampling

Care in handling the materials should be observed so that the finial cut specimens have not contacted any contaminants such as soap, salt, oil etc., which might facilitate or hinder water penetration. No dirt or other foreign material should be allowed on the specimen; also, **do not write on the test area of the specimen**.

7.1 Lot Size

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

7.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

8. Procedure

8.1 Specimens

a) Start test procedure using preconditioned specimens as stated in clause 7.
b) Specimens should be cut large enough to be tested on the 100 cm^2 head or it may be left in long strips if this is compatible with the test equipment.

8.2 Metrological confirmation of the test apparatus

Shall be in compliance with clause 7 and figure 2 and annex A of ISO 10012: 2003. Also, use the following steps:

a) Set-up procedures for machines from different manufacturers may vary. Prepare and verify calibration of the hydrostatic tester as directed in the manufacturer's instructions.
b) For best results, level the test instrument.
c) Verify calibration for the range of water pressure expected for the material to be tested.
d) If a column of water is used be sure to calibrate the incoming water supply for rate (10 ± 0.5 cm or 60 ± 3 cm H_2O/min) and temperature 23 ± 2° C.

NOTE 5 A piece of heavy gauge polyethylene can be used to check the speed or rate of pressure increase. Carefully slide the polyethylene onto the surface of the water so that the polyethylene is in contact with the water and start the test.

8.3 Fresh "purified" water

Should be provided with the testing of each new specimen.

8.4 Carefully clean and dry

All clamping surfaces of all water, debris or anything that could alter a good tight seal.

8.5 Carefully place

The test specimen on the test head, close the clamps and start the test.

NOTE 6 If the test equipment has a water reservoir in the test head, be sure that the water forms a convex surface. Carefully slide the specimen onto the surface of the water in the test head so that the face of the specimen is in contact with the water. Do not allow air to be caught under the specimen.

8.6 Observe the specimen surface

Watch for water droplets passing through the surface specimen. The test is complete when three separate drops are formed on the surface of the specimen. However, these drops must form in three different penetrating holes. Read the water pressure from the display or read the cm from the manometer.

NOTE 7 Ignore any drops which form within 6 mm from the edge of the clamp when using the 100 cm^2 and 3 mm from the edge when using10 or 26 cm^2 test head. If numerous drops form at the edge of the clamp, repeat the test with another specimen.

NOTE 8 If a water spout is formed from one of the penetrating holes, according to the criteria, that is still only one hole. If there are any doubts in the interpretation of the results, repeat with another specimen.

9. Calculation

9.1 Report water penetration of individual specimens

Record in centimeters/millibars the height of the water when penetration of the material took place. If other units are read, convert to centimeters if necessary.

9.2 Report water penetration average

Calculate the average height of the water when penetration took place. This is done for each laboratory sample unit.

9.3 Report the average and standard deviation

Of the results obtained from at least five specimens to the nearest: (See table 1) Also report the individual readings.

Table 1

0.5 mbar	Up to 100 mbar/min	0.5 cm	Up to 1m H_2O
1.0 mbar	Over 100 mbar/min	1.0 cm	Over 1m H_2O

9.4 When data are automatically generated

By a computer process, calculations are generally contained in the associated software. It is recommended that computer processed data is verified against known property values and its software described in the report.

10. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) The water pressure was applied, from above or below the specimen
f) Water temperature used for testing specimens
g) Side of the specimen tested (face or anvil)
h) For computer processed data, identify the software used and the version
i) Laboratory testing conditions
j) Number of specimens tested and note CD and/or MD if significant
k) Deviation from the standard test procedure, if any
l) When calculated, the standard deviation or the coefficient of variation
m) Whether or not samples were conditioned prior to testing and, if so, for how long
n) Anything unusual noted during the testing

11. Precision

In this experiment, six different lab technicians tested three specimens from each of five materials. Results for this test were reported in millibars. Identification of the materials can be made through INDA: (919) 233-1210 ext. 148.

Since this is a destructive test, the estimate is a combination of measurement error and sample-to-sample variation. The material used in this experiment was chosen in such a way as to minimize sample-to-sample variation.

Summary of Precision Parameters, $_{Sr}$. is the repeatability std. Deviation; $_{SR}$ is the reproducibility std. Deviation.

ANNEX A

(informative)

Statistical results of interlaboratory tests

Figures for the repeatability $_{(Sr)}$ and reproducibility $_{(SR)}$ of this method are the result of collaborative studies carried out in 1995 by INDA. The evaluation of the interlaboratory test was carried out in accordance with ISO 5725-2 and results are as follows:

Table A 1.

Material	Average	S_r	S_R
A	103.06	25.89	25.89
B	32.92	3.60	4.59
C	37.11	5.76	5.76
D	11.69	1.03	1.25
E	76.64	5.37	5.91

STANDARD TEST: WSP 080.7.R4 (12)

Standard Test Method for Penetration by Oil (Hydrocarbon Resistance)

The number in parentheses indicates the year of the last revision

1. Scope

This test method is designed for detecting the presence of a flourochemical finish, or other compounds capable of imparting a low energy surface, on all types of nonwovens by evaluating the nonwoven's resistance to wetting by a selected series of liquid hydrocarbons of different surface tensions

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.1 ISO test methods

a) ISO 139 : Textiles — Standard atmospheres for conditioning and testing
b) ISO 2859-1:1999 Sampling procedures for inspection by attributes
c) ISO 3951-1:2005 Sampling procedures for inspection by variables

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Oil repellency

Is the characteristic of a fiber, nonwoven fabric whereby it resists wetting by oily liquids.

Reference number
WSP 080.7.R4 (12) A

Current edition approved WSP 080.7.R4 (12)
Originally published as WSP 80.7 in 2002
Last approved as WSP 80.7 in 2009

4. Principle

Drops of standard test liquids, consisting of a selected series of hydrocarbons with varying surface tensions, are placed on the fabric surface and observed for wetting. The Oil Repellency Rating is the highest numbered test liquid which does not wet the fabric surface.

This test method is not intended to give an absolute measure of the resistance of the fabric to staining by all oily materials; other factors such as composition and viscosity of the oily substances, fabric construction, fiber type, dyes, other finishing agents, etc., also influence stain resistance. This test can, however, provide a rough index of oil stain resistance, in that generally the higher the Oil Repellency Rating, the better resistance to staining by oil materials, especially liquid oily substances. This is particularly applicable when comparing various finishes on a given nonwoven.

5. Material and Reagents

5.1 Nujol™

NOTE 2 Nujol™ is the trademark of Plough, Inc., for a mineral oil meeting the following specifications: Saybolt viscosity 360/390 at 39°C (100°F); specific gravity 0.880 - 0.900 g.cm^3 at 15°C (60°F). Nujol™ is available at most drug stores.

Solvent	Catalog Number	Specified Melting Point or Boiling Point Range
n-hexadecane	03035	17° to 18°C
n-tetradecane	04595	4° to 6°C
n-dodecane	02666	-10.5° to -9.0°C
n-decane	02128	173° to 175°C
n-octane	03980	124° to 126°C
n-heptane	03008	98° to 99°C

NOTE 3 The hydrocarbon liquids should be laboratory quality obtainable through most chemical supply houses. One source is Fisher Scientific Inc. (catalog numbers above).

6. Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 4 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

7. Sampling

7.1 Lot Size

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

7.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established.

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 5 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

7.3 Test specimens

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material.

a) Care in handling should be observed so that specimens do not contact any contaminants such as soap, salt, oil etc.
b) Specimens should be cut 200 x 200 mm

8. Calibration and Standardization

Drop size

Approximately 5 mm in diameter or 0.05 mL volume

9. Procedure

Standard test liquids

Oil Repellency Rating Number	Composition
1	NujolTM
2	65:35 NujolTM: n-hexadecane by volume @ (21°C) 70°F
3	n-hexadecane
4	n- tetradecane
5	n-dodecane
6	n-decane
7	n-octane
8	n-heptane

Table 1

9.1 Place the test specimen

On a flat smooth, horizontal surface.

9.2 Test beginning with the lowest-numbered test liquid

(oil repellency rating No. 1), carefully place a small drop approximately 5 mm in diameter or 0.05 mL volume using a dropping bottle pipette on the test specimen in several locations. Observe the drop for 30 s, from approximately a 45° angle.

9.3 If no penetration or wetting

Of the fabric is seen at the liquid-fabric interface and no wicking around the drop occurs, place a drop of the next higher-numbered test liquid at an adjacent site on the fabric and again observe for 30 seconds.

9.4 Continue this procedure until

One of the test liquids shows obvious wetting of the fabric under or around the drop within 30 s.

10. Interpretation of Results

10.1 Wetting of the fabric

Is normally evidenced by a darkening of the fabric at the liquid-fabric interface. On black or dark shades, wetting can be detected by loss of "sparkle" within the drop.

10.2 Different types of wetting

May be encountered depending on the finish, fiber, construction, etc. and the determination of the end point can be difficult on certain fabrics. Many fabrics will show complete resistance to wetting by a given test liquid (as indicated by a clear drop with a high contact angle) followed by immediate penetration by the next higher-numbered test liquid. In these instances the end point, and oil repellency rating, is obvious. However, some fabrics will show progressive wetting under several test liquids as evidenced by a partial darkening of the fabric at the liquid-fabric interface. For such fabrics the point of failure is considered to be that test liquid which exhibits complete darkening of the interface within 30 seconds.

11. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) The oil repellency rating should be measured on two separate areas of the test specimen. If the two ratings are not in agreement, three additional determinations should be made and the average value reported.
g) Number of specimens tested and note CD and/or MD if significant
h) For computer processed data, identify the software used and the version
i) Deviation from the standard test procedure, if any
j) When calculated, the standard deviation or the coefficient of variation
k) Whether or not samples were conditioned prior to testing and, if so, for how long
l) Anything unusual noted during the testing

12. Precision

The precision for this method is yet to be determined.

STANDARD TEST: WSP 080.8.R4 (12)

Standard Test Method for Alcohol Repellency of Nonwoven Fabrics

The number in parentheses indicates the year of the last revision

1. Scope

This method is used to measure the resistance of nonwoven fabrics to wetting and penetration by alcohol and alcohol/water solutions.

Drops of standard test liquids, consisting of a selected series of water/alcohol solutions, are placed on the test material and observed for penetration or wetting. The alcohol repellency rating is the highest numbered test liquid, which does not penetrate the fabric.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.1 ISO test methods

a) ISO 139 : Textiles — Standard atmospheres for conditioning and testing
b) ISO 2859-1:1999 Sampling procedures for inspection by attributes
c) ISO 3951-1:2005 Sampling procedures for inspection by variables

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

Reference number
WSP 080.8.R4 (12) A

Current edition approved WSP 080.8.R4 (12)
Originally published as WSP 80.8 in 2002
Last approved as WSP 80.8 in 2009

3.1 Alcohol Repellency
The ability to resist wetting when the material comes in contact with a known percentage of alcohol/water solution, i.e. 70%, 50% 30% etc. alcohol

4. Principle

Alcohol solutions have decreasing surface tensions as alcohol concentration increases. The alcohol repellency rating serves as a rough estimate of the surface energy or repellency of the test material surface. This relationship is not linear. Care should be exercised when using these ratings.

Alcohol solutions are also used in industry and alcohol repellency ratings indicate a resistance to wetting by these solutions.

5. Material and Reagents

5.1 Reagent grade methanol, ethanol, or isopropanol

5.2 Deionized or distilled water

NOTE 2 If ethanol is not anhydrous, solutions should be adjusted to give the proper alcohol-water balance.

5.3 Prepare solutions according to table 1

Standard Test Solutions		
Alcohol Repellency Rating No.	Composition by Weight %Alcohol*	%H2O
0	0	100
1	10	90
2	20	80
3	30	70
4	40	60
5	50	50
6	60	40
7	70	30
8	80	20
9	90	10
10	100	0

Table 1

6. Apparatus

6.1 A transparent glass or plastic plate

6.2 A mirror

6.3 Dropping bottles

6.4 A lamp to illuminate samples during the test

7. Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 3 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

8. Sampling

8.1 Lot Size

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

8.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859 -1:1999 (Sampling procedures for inspection by attributes) or ISO 3951 -1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables (“s” method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE4 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer’s risk, consumer’s risk, acceptable quality level, and limiting quality level.

8.3 Test specimens

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material.

a) Care in handling should be observed so that specimens do not contact any contaminants such as soap, salt, oil etc.
b) Specimens should be cut 200 x 200 mm

9. Procedure

9.1 Assemble the equipment as shown below

a) Place the test specimen flat on a smooth, horizontal transparent glass or plastic plate.
b) Beginning with the lowest numbered test liquid (alcohol repellency rating No. 0), with the dropping bottle pipette carefully place a small drop, approximately 5 mm diameter or 0.05 mL volume on the test specimen in at least three locations. After five minutes, observe the test specimen for penetration. If no penetration of the test specimen occurs within five minutes, place drops of the next higher numbered test liquid at an adjacent site on the test specimen and again observe after five minutes.
c) Continue this procedure until one of the test liquids penetrates the test specimen. For expediency two or more test liquid drops may be placed on the sample simultaneously.

Figure 1

10. Interpretation of Results

10.1 The alcohol repellency rating

Of the fabric is the highest numbered test liquid, which will not penetrate the fabric within a period of five minutes.

10.2 Many fabrics will show complete resistance to penetration

By a given test liquid (as indicated by a spherical drop having a high contact angle) followed by immediate penetration of the next higher numbered test liquid. In these instances, the end point and alcohol repellency rating are obvious. However, different degrees of penetration may be encountered depending on the finish, fiber, construction, etc. and the end point determination.

11. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions

f) The alcohol repellency rating should be measured on two separate areas of the test specimen. If the two ratings are not in agreement, three additional determinations should be made and the average value reported.
g) Number of specimens tested and note CD and/or MD if significant
h) For computer processed data, identify the software used and the version
i) Deviation from the standard test procedure, if any
j) When calculated, the standard deviation or the coefficient of variation
k) Whether or not samples were conditioned prior to testing and, if so, for how long
l) Anything unusual noted during the testing

12. Precision

The precision for this method is yet to be determined.

STANDARD TEST: WSP 080.9.R4 (12)

Standard Test Method for Nonwoven Run-Off

The number in parentheses indicates the year of the last revision

1. Scope

This test method measures the amount of test liquid (simulated urine) which runs down a nonwoven test specimen when a specified mass of test liquid is poured on the nonwoven test specimen superimposed on a standard absorbent medium and placed on an inclined plane.

This test method is designed to compare run-off of nonwovens. It is not intended to simulate in use conditions for finished products.

This present method has three options:

a) The **A - basic method** for testing hydrophilic nonwovens
b) The **B - repeated test**, with the same test parameters as the basic method with additional information in (clause B)
c) The **C - modified method** for testing hydrophobic nonwovens specifying another degree of incline (clause C)

SI values are regarded as the official standard system of measurement for this standard test method.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Referenced Documents

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.1 ISO test methods

a) ISO 9073-11: Textiles – Test method for nonwovens – Part 11: Run-Off
b) ISO 139: Textiles — Standard atmospheres for conditioning and testing
c) ISO 2859-1:1999 Sampling procedures for inspection by attributes
d) ISO 3951-1:2005 Sampling procedures for inspection by variables

Reference number
WSP 080.9.R4 (12) A

Current edition approved WSP 080.9.R4 (12)
Originally published as WSP 80.9 in 2002
Last approved as WSP 80.9 in 2009

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Run-off

Is the amount of excess liquid in gram that runs from the test specimen.

3.2 Percent run-off

Is the percent of the original mass of liquid which runs from the test specimen.

3.3 Simulated urine

Consisting of a 9 g/l solution of sodium chloride in distilled water with a surface tension of (70 ± 2) mN/m.

4 Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 2 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing nonwovens for a reasonable period of time before the specimens are tested, i.e. 4 hours.

5. Sampling

5.1 Lot Size

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

5.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can

therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables (“s” method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

Care in handling the materials should be observed so that the final cut specimens have not contacted any contaminants such as soap, salt, oil etc., which might facilitate or hinder absorbency. No dirt or other foreign material should be allowed on the specimen; also, **do not write on the test area of the specimen**.

5.3 Laboratory samples

From each roll or specimen of fabric selected from the lot sample, cut at least one laboratory sample the full width of the fabric and at least 300 mm from each outside edge.

5.4 Laboratory specimens

Cut specimens of the nonwoven, 140 ± 2 mm x 280 ± 2 mm, with the longest side in machine direction (MD),

All three testing modifications use the same size specimen.

A = The basic method for testing hydrophilic nonwovens

A 6. Principle

A specified quantity of simulated urine is discharged at a prescribed rate under specified conditions onto a test specimen of nonwoven which is superimposed on a standard

absorbent medium and placed on an inclined table. Any excess liquid that runs down the test specimen is collected by a standard receiver pad placed below the lower end of the nonwoven test specimen.
The run-off measures the mass of liquid collected by the standard receiver pad.

A.7. Materials and Reagents

A 7.1 Standard absorbent medium

Consists of 2 layers of reference filter (blotter) paper, 140 ± 1 mm x 275 ±1 mm, with the longer side in the MD. The filter (blotter) paper characteristics are:

a) Must have an absorbent rate of (3 ± 0.5) s or less (ISO 9073-6)
b) The Liquid Absorption Capacity, of the paper, as determined by standard WSP 10.1, must at least 480 %.
c) The mass per unit area of paper must be (90 ± 4) g/m² and the air flow resistance, as determined by ISO 5636, must be (1.9 ± 0.3) kPa.

NOTE 3 This pre-cut blotter paper can be purchased in the U.S. from:
W. Fritz Mezger, Inc
155 Hall St.
Spartanburg, SC 29302

NOTE 4 Also this information concerning suitable blotter paper may be obtained from following nonwovens industry associations EDANA, Avenue Herrmann Debroux, 46 B-1160 Brussels, Belgium Phone +32 2 734 93 10 Fax +32 2 733 35 18 info@edana.org
INDA, 1100 Crescent Green Suite 115, Cary, NC 27518 Phone +1 919 233 1210, Fax +1 919 233 1282

The filter (blotter) papers are placed smooth/test sides up. The smooth/test side is determined and indicated by the producer's label, it is generally the side in contact with the conveyor wire during the production process, where the wire mark may be visible.

A.7.2 Standard receiver pad

The absorbing paper (same dimensions as the absorbent medium) is to collect excess test liquid that runs down and off the test specimen, e.g. 2 layers of filter papers or blotter paper.

NOTE 5 The receiver pad can be replaced by a receiver trough, see option (C)

A.7.3 Simulated urine

Consisting of a 9 g/l solution of sodium chloride in distilled water with a surface tension of 70 ± 2 mN/m. This surface tension should be checked before each series of tests, as surface can alter tension during storage.

NOTE 6 The surface tension of adult human urine is published as 69 to 70 mN/m. There is a suggestion that some babies' urine could have a lower surface tension (e.g. 45 mN/m). The surface tension of the simulated urine can be adjusted by the addition of a surfactant. In this case it should be reported as a deviation from standard procedure and the surface tension should be stated in the test report.

A.8. Apparatus

A.8.1. Run-off table

Made of acrylic glass or similar as shown in figure 1:

a) Table marked with two reference black lines at 250 ± 0.2 mm distance (see figure 2).
   The lower line, 3 ± 0.2 mm from the lower end of the table, defines the position of the lower end of the absorbent medium.
   The upper line defines the position of the discharge tube axis (approximately 25 mm from the upper end of the test specimen).
b) Table has an incline of 25º.
c) Clip or similar with symmetrical reference marks at 140 ± 0.2 mm (to adjust the axial position of the test specimen).
d) Spirit level (to ensure axial discharge of the tube).
e) Support for placing the standard receiver pad below the lower end of the test specimen.

A.8.2 Glass tube

With an internal diameter of 5 mm.

A.8.3 Ring stand

A.8.4 Dosing equipment

With the capability of delivering 25 ± 0.5 g mass of test liquid in a continuous stream via the glass tube within 4 ± 0.1 s, e.g. either a funnel, or a syringe with a motorized syringe drive unit, or a hydraulic pump or an other pressurized system, leak free attached to the tube.

NOTE 7 If dosing device graduation is expressed in volume (ml), calculate the liquid density for converting g to ml.

A.8.5 Timer

Which is capable of measuring 60 s to an accuracy of 0.1 s.

A.8.6 Analytical balance

Which is capable of determining a mass of 30 g to an accuracy of 0.01g.

A.8.7 Rigid 25º angle template

A.9 Procedure

A.9.1 Adjust the incline

Of the table to a 25º ± 10' angle.

A.9.2 Use the spirit level

To ensure the top edge of the table is horizontal.

A.9.3 Adjust the dosing equipment
Until it is set for a discharge of 25 ± 0.5 g in 4 ± 0.1 s.

NOTE 8 Verify regularly that the specified mass of liquid is being delivered by performing the following test: Hold under the glass tube a clean dry pre-weighed cylinder capable of containing (25 ± 0.5) g of liquid, activate the timer, collect and weigh the test liquid dispensed. If the mass dispensed is outside the limits (25 – 0.5) g, adjust the flow, e.g. by modifying the speed of the motor using the pump control box, and repeat the test. Continue testing and adjusting until at least three successive collections are within the specified limits.

A.9.4 Position the ring stand
And the glass tube vertically with the outlet about 27 mm above the table, at the center of the upper reference line.

A.9.5 Place the standard absorbent medium
On the table with the filter (blotter) papers smooth/test sides up, just covering the lower reference line and adjust its axial position.

A.9.6 Pick up the test specimen
By the corners in order to avoid the contamination of the test area.

A.9.7 Place the nonwoven test specimen
Test side up, on the absorbent medium so that the nonwoven is (5 ±1) mm longer than the filter paper at the lower end.

A.9.8 Fix the absorbent medium
And nonwoven with the clip centered between axial position marks.

A.9.9 Adjust the vertical distance
Between the glass tube and the test specimen to (25 ± 1) mm.

A9.10 Weigh the standard receiver pad
With an accuracy of 0.01 g and record the mass (W_1).

A.9.11 Place the receiver pad
On its support.

A.9.12 Start the discharge
Of test liquid.

A.9.13 Wait for 5 s
After the discharge is completed.

A.9.14 Weigh the standard receiver pad
With the collected run-off liquid and record the mass (W_2) to an accuracy of 0.01 g.

A.9.15 Make sure the run-off table
Is completely dry before placing the next test specimen and new absorbent medium on it.

A.9.16 Repeat
The run-off test clauses A 9.4 to A 9.16 for the remaining test specimens.

A.10. Calculation

For each of the test specimens, calculate the run-off:

$$RO = W_2 - W_1 \text{ (in g)}$$

Average the run-off: $\overline{RO}$ (to the nearest 0.01 g) and calculate the standard deviation. If requested, using this average, calculate the percent run-off:

$$\%RO = \frac{\overline{RO}}{25} \cdot 100 \quad \text{(to the nearest 0.1\%)}$$

A.11. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Number of specimens tested and note CD and/or MD if significant
g) For computer processed data, identify the software used and the version
h) Deviation from the standard test procedure, if any
i) Individual run-off in g.
j) Average run-off and standard deviation in g.
k) Percent run-off in %, if requested.
l) Whether or not samples were conditioned prior to testing and, if so, for how long
m) Anything unusual noted during the testing

A.11.1 For other options
See attachment annex A

B = The repeated test

B.6 Principle

The principle is the same as described in the basic method clause A 6 but the same test specimen is consecutively submitted 3 times to the same test with the same amount of test solution at each discharge.

The run-off is measured after each test in order to evaluate the performance consistency of the nonwoven after repeated tests.

B.7 Material and reagents

Material and reagents are identical to clause A.7.1 except that 3 sets of standard absorbent medium and 3 sets of standard receiver pad instead of 1 set are necessary.

B.8 Apparatus

Identical to clause A 8

B.9 Procedure

B.9.1 Adjust the incline
Of the table to 25º ± 10' angle.

B.9.2 Use the spirit level
To ensure the top edge of the table is horizontal.

B.9.3 Adjust the dosing equipment
Until it is set for a discharge of 25 ± 0.5 g in 4 ± 0.1 s. (see Note 8).

B.9.4 Position the ring stand
And the glass tube vertically with the outlet about 27 mm above the table, at the center of the upper reference line.

B.9.5 Prepare the 3 sets
Of standard absorbent medium and set aside.

B.9.6 Place the standard absorbent medium
On the laboratory bench with the filter (blotter) papers smooth/test sides up, just covering the lower reference line and adjust its axial position.

B.9.7 Pick up the test specimen
By the corners in order to avoid the contamination of the test area.

B.9.8 Place the nonwoven test specimen
Test side up, on the absorbent medium so that the nonwoven is 5 ± 1 mm longer than the filter paper in the lower end.

B.9.9 Fix the absorbent medium and nonwoven
With the clip centered between axial position marks.

B.9.10 Adjust the vertical distance
Between the glass tube and the test specimen to 25 ± 1 mm.

B.9.11 Weigh the standard receiver pad
With an accuracy of 0.01 g and record the mass (W_1).

B.9.12 Place the receiver pad
On its support.

B.9.13 Start the discharge
Of test liquid.

B.9.14 Wait for 5 seconds
After the discharge is completed.

B.9.15 Weigh the standard receiver pad
With the collected run-off liquid and record the mass (W_2) to an accuracy of 0.01 g.

B.9.16 Wait for 4 minutes
Between the clauses B 9.13 and B.9.17.

B.9.17 Remove the nonwoven test specimen
And place it on a fresh absorbent medium already prepared.

B.9.18 Remove the wet
Standard absorbent medium.

B.9.19 Make sure the run-off table
Is completely dry before each test.

B.9.20 Repeat the run-off test two more times
With 25 g test liquid at each discharge on the same nonwoven test specimen, each time with a fresh absorbent medium.

a) For the 2nd test repeat clauses B.9.3 and B.9.6 to B.9.19
b) For the 3rd test repeat clauses B9.3 and B.9.6 to B.9.15

B.9.21 Repeat the steps
A.6.4.3 to 6.4.21 for the remaining test specimens.

B.10 Calculation

For each of the test specimens, calculate the run-off (in g):

a) 1st test RO1 = W_{21} - W_{11}
b) 2nd test RO2 = W_{22} - W_{12}
c) 3rd test RO3 = W_{23} - W_{13}

Average the run-off for the 5 test specimens:

$\overline{RO}_1$, $\overline{RO}_2$, $\overline{RO}_3$ (to the nearest 0.01 g)

and calculate the standard deviation.
If requested, using these averages, calculate the following percent run-off:

$\overline{\%RO_1}$, $\overline{\%RO_2}$, $\overline{\%RO_3}$ (to the nearest 0.1 %)

With $$\%ROi = \frac{\overline{ROi}}{25} \times 100$$

B.11 Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Number of specimens tested and note CD and/or MD if significant
g) For computer processed data, identify the software used and the version
h) Deviation from the standard test procedure, if any
i) When calculated, the standard deviation or the coefficient of variation
j) Whether or not samples were conditioned prior to testing and, if so, for how long
k) Anything unusual noted during the testing
l) For each test specimen, individual run-off measured in tests nº 1, 2, 3 in g.
m) Average run-off for tests nº 1, 2, 3 in g or percent run-off for tests nº 1, 2, 3 in % and standard deviation.

C = Modified method for testing hydrophobic nonwovens

C.6 Principle

The principle is the same as described in the basic method clause A.6. The only modified parameter is the inclination of the table.
The test method is designed to measure the repellency of hydrophobic nonwovens.

C.7 Material and reagents

Identical to clause A.7

C.8 Apparatus

Identical to clause A.8 except the inclination of the table: 10º ±10' instead of 25º ± 10'.

NOTE 9 Instead of a standard receiver pad to collect liquid that runs down (as specified in 5.2.2), a collecting trough can be used for testing highly hydrophobic nonwovens. The trough can be placed on the balance to allow direct measurement. The collecting trough length should be 20 mm longer than the width (180 mm) of the table.

C.9 Procedure

Identical to clause A.9

C.10 Expression of results

Identical to clause A.10

NOTE 10 When using a collecting trough, instead of clause A.9.11 and A.9.15, read:

a) Weigh the collecting trough, record the mass (W_1) and place it on its support.
b) Weigh the collecting trough containing the run off liquid and record the mass (W_2).

NOTE 11 As an alternative or for checking the results from the above-mentioned procedure, collect and weigh the absorbent medium before and after the test.

C.11 Report

Identical to clause A.11

ANNEX A

(informative)

For R&D purposes, other characteristics could be measured, or some parameters could be modified e.g.:

a) When zero runoff is observed, the length of the wetted surface ("spread length") could be measured. The spread length is the distance measured from the upper reference line to the point where the last drop enters the test specimen.
b) Time to penetrate could also be recorded.
c) For comparison purpose, the starting and end points of the time measurement are specified. Start the timer at the first contact of the liquid with the test specimen, stop when the last drop enters the test specimen.
d) Various table inclinations or discharge tube angles could be used.

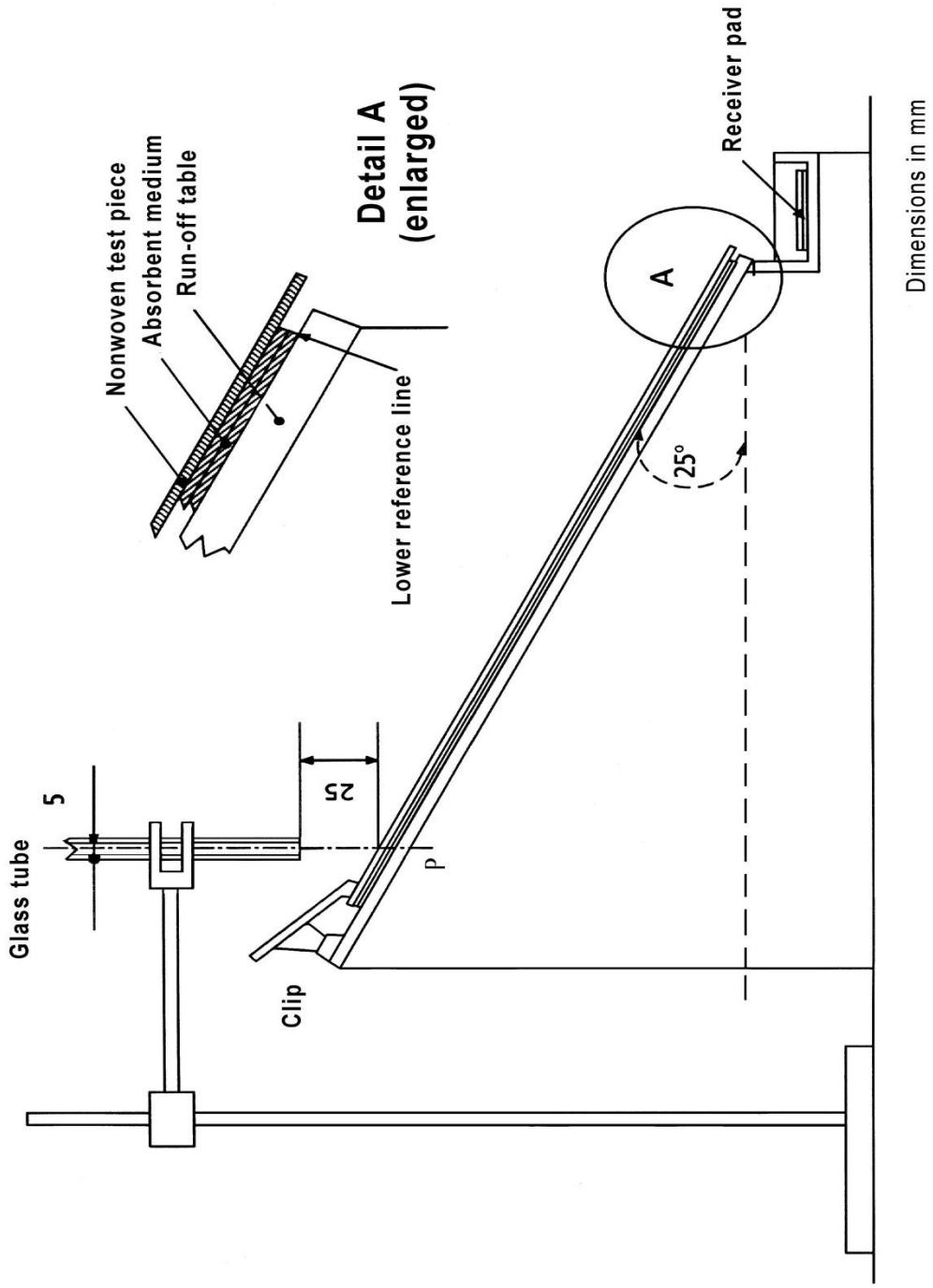
Detail A
(enlarged)
Nonwoven test piece
Absorbent medium
Run-off table
Lower reference line
Receiver pad
A
25°
Dimensions in mm
Glass tube
5
25
P
Clip

Figure 1

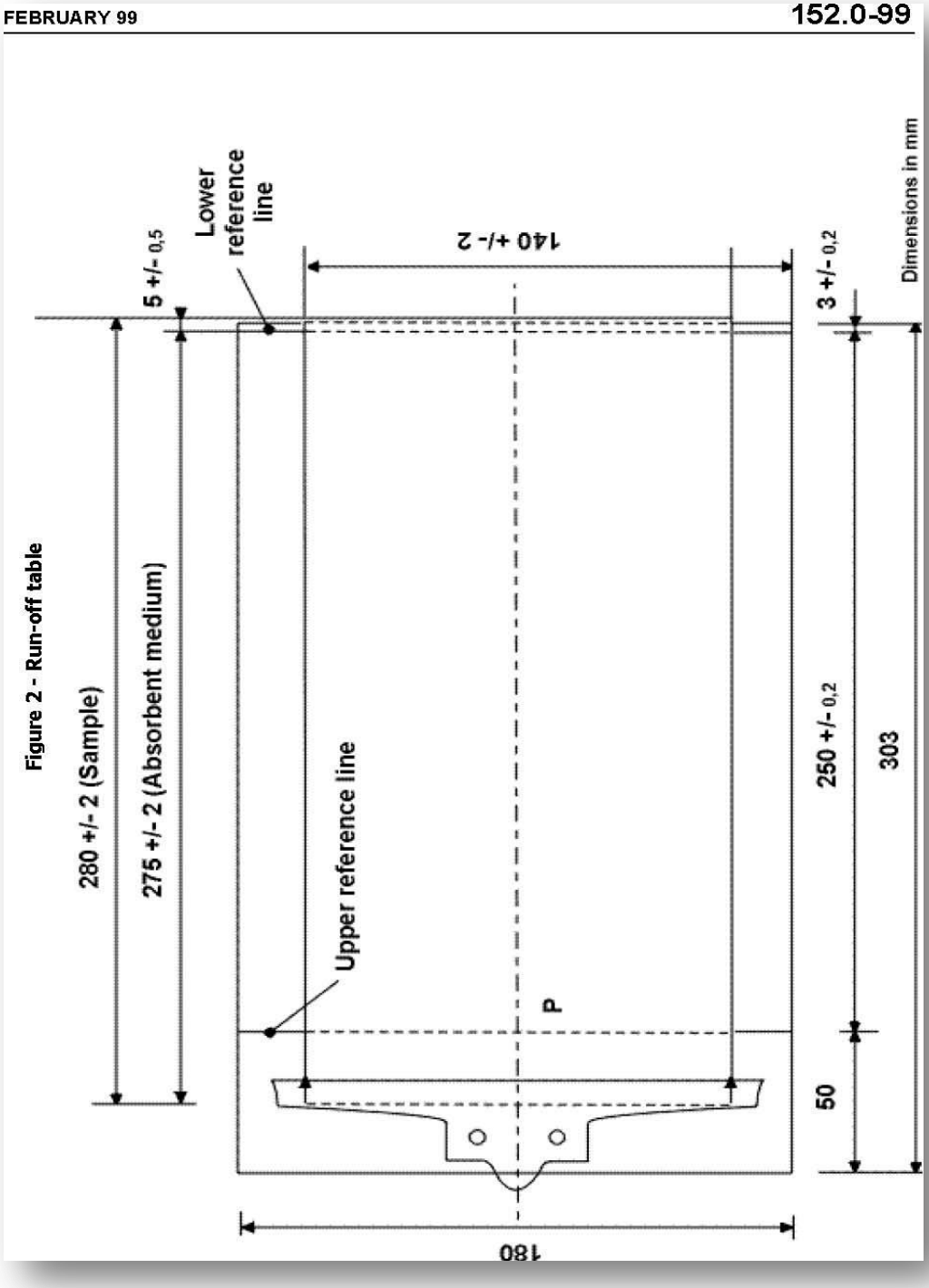

Figure 2 - Run-off table

Figure 2

STANDARD TEST: WSP 080.10.R3 (12)

Standard Test Method for Nonwovens Coverstock Wetback

The number in parentheses indicates the year of the last revision

1. Scope

This test method measures the ability of diaper coverstock to resist the transport back onto the skin of a liquid which has already penetrated the coverstock.

The test method is intended for quality control use only and is designed for comparison of wetback for different nonwoven coverstocks and treatments. It does not simulate in-use conditions for finished products.

SI values are regarded as the official standard system of measurement for this standard test method.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.1 ISO test methods

a) ISO 139: Textiles — Standard atmospheres for conditioning and testing
b) ISO 2859-1:1999 Sampling procedures for inspection by attributes
c) ISO 3951-1:2005 Sampling procedures for inspection by variables

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Sample

Sample is a portion of nonwoven taken from a production lot, roll, case or cases of product, which is taken for testing. The sampling unit shall be identifiable and traceable back to its original source.

Reference number
WSP 080.10.R3 (12) A

Current edition approved WSP 080.10.R3 (12)
Originally published as WSP 80.10 in 2002
Last approved as WSP 80.10 in 2009

3.2 Specimen

A specimen is a specific portion of the identified sample upon which a test is performed. Many specimens may be tested from the same sample, using different locations and different directions (MD and CD).

4. Principle

A coverstock is placed over a standard absorbent medium which is then loaded with a specific quantity of simulated urine. A standard weight is placed onto the coverstock and absorbent medium to ensure even spreading of the liquid.

A pre-weighed pick up (blotter) paper is then placed on the coverstock and the weight is again placed on top. The mass of absorbed liquid by the pick up (blotter) paper is weighed and defined as wetback.

5. Material and Reagents

5.1 Reference absorbent medium

a) Shall consist of five layers of reference filter (blotter) paper 100 mm x 100 mm with the smooth side uppermost and having a mean strike-through time, in 10 determinations without the nonwoven, of 3.0 ± 0.5 s as used in WSP 070.3.R3 Liquid Strike-Through Time
b) The liquid absorption capacity of the (blotter) paper is determined by standard WSP 0010.1.R3 with the additional requirement of the liquid absorbency capacity (LAC) to be 480 ± 30 %.

5.2 Simulated urine

This simulated urine consists of a 9 g/L solution of sodium chloride in distilled water with a surface tension of 70 ± 2 mN/m. This surface tension should be checked before each series of tests, as surface can alter tension during storage.

NOTE 2 The surface tension of adult human urine is published as 69 to 70 mN/m. There is a suggestion that some babies' urine could have a lower surface tension (e.g. 45 mN/m). The surface tension of the simulated urine may be adjusted by the addition of a surfactant. In this case it should be reported as a deviation from standard procedure and the surface tension should be stated in the test report.

5.3 Pick up (blotter) paper 125 mm x 125 mm

Some of the other paper characteristics needed are:

a) Mass per unit area: 90 ± 4 g/m²
b) Air flow resistance: 1.9 ± 0.3 kPa.

NOTE 3 Information concerning suitable filter/pick up (blotter) papers may be obtained from the following nonwoven industry associations:
EDANA, Avenue Herrmann Debroux, 46, B-1160 Brussels, Phone +32-2-734-9310, Fax +32 2 733 35 18
INDA, 1100 Crescent Green, Suite 115, Cary, NC 27518 Phone +1 919 233 1210, Fax +1 919 233 1282

6. Apparatus

6.1 Burette
A burette which has the capacity of 50 ml, and a supporting stand

6.2 Funnel
A funnel fitted with a magnetic valve, giving a rate of discharge of 25 ml in 3.5 ± 0.25 s

6.3 Ring stand
This ring stand is to support the funnel

6.4 Strike-through plate (see figures 2 and 3)
This plate is constructed of a 25 mm thick transparent acrylic sheet, which has a total mass of 500 ± 5 g. This plate is also fitted with corrosion resistant electrodes consisting of 1.6 mm diameter platinum or stainless steel wire set in grooves of cross-section 4.0 mm x 7.0 mm cut in the base of the plate and fixed with quick-setting epoxy resin. These electrodes shall be positioned as shown in figures 1 and 2

6.5 Base plate
This base plate is made of a transparent acrylic sheet, approximately 125 mm x 125 mm square and 5 mm thick.

6.6 Electronic timer
The timer is capable of measuring to the nearest 0.01 s.

6.7 Simulated baby weight (SBW)
This simulated baby weight consists of:

a) A weight: stainless steel base 10 cm x 10 cm including a handle with the total mass of 4000 ± 20 g
b) A polyurethane foam rubber, 10 cm x 10 cm x 2 cm height
c) A polyethylene film 25µm

Wrap the P.E. film, female side out, around the foam, securing the film in place with tape then taping the film and foam to the weight (see figure 1 below).

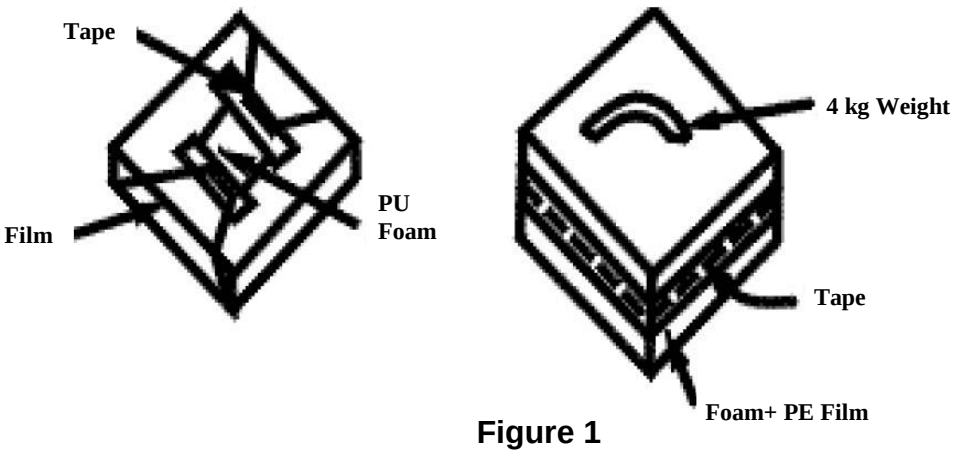

Figure 1

NOTE 4 Information concerning these weights may be obtained from the following nonwoven industry associations:

EDANA, Avenue Herrmann Debroux, 46 B-1160 Brussels, Belgium Phone +32 2 734 93 10 Fax +32 2 733 35 18
INDA, 1100 Crescent Green, Suite 115, Cary NC 27518 Phone +1 919 233 1210, Fax +1 919 233 1282

7. Sampling

7.1 Lot Size

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

7.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 5 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

7.3 Test specimens

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material.

a) Care in handling should be observed so that specimens do not contact any contaminants such as soap, salt, oil etc., which might facilitate or hinder water penetration.
b) Specimens should be cut 125 mm x 125 mm

8. Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 6 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

9. Procedure

This test is conducted in conjunction with the repeated strike-through test WSP 070.7.R3 as follows:

9.1 Set up the ring stand

Which holds the funnel. Position the burette with the tip inside the funnel.

9.2 Weigh 5 layers of filter (blotter) paper

This paper is placed with the smooth/test side upper most on the strike-through baseplate and the screen side against the nonwoven. The mass (W) of the filter (blotter) paper will be used as a parameter to determine the total quantity of liquid (Q) required for the wetback test (see Annex A)

9.3 The quantity of liquid (Q)
The quantity of liquid (Q) will be calculated by multiplying (W) by the loading factor (LF) of the filter paper (Annex A). The recommended loading factor is 3.30.

9.4 Place one nonwoven test specimen
Place one nonwoven test specimen over the set of 5 layers of filter (blotter) paper. Place the strike-through plate on top of the nonwoven with the center of the plate over the center of the test specimen. Center the burette and the funnel over the plate

9.5 Adjust the height of the funnel
Adjust the funnel so that it is 5 ± 0.5 mm above the top of the cavity in the plate (i.e. 30 mm above the test specimen)

9.6 Check that electrodes are connected to the timer
Activate the timer and set the clock to zero.

9.7 Fill the burette with simulated urine
Keep the discharge valve of the funnel closed and run 5.0 ml of liquid from the burette into the funnel.

9.8 Open the magnetic discharge valve of the funnel
This open valve will discharge the 5.0 ml of liquid. The initial flow of liquid will complete the electrical circuit and start the timer. It will stop when the liquid has penetrated into the nonwoven and fallen below the level of the electrodes in the strike-through plate.

9.9 Record the strike-through time

9.10 Add additional liquid
Add the correct amount of liquid in order to reach the specified quantity (Q)

9.11 Remove the baseplate
Remove the baseplate with the specimen and filter paper from the strike-through apparatus

9.12 Gently
Carefully place the 4 kg weight (SBW) assembly onto the specimen

9.13 The weight remains in place for 3 minutes
This will ensure even diffusion of the liquid.

9.14 Remove the weight (SBW)
Carefully without disturbing the nonwoven test specimen

9.15 Weigh
Weigh two layers of pick-up (blotter) paper, record the mass (P_1) and place them on the test specimen, with the smooth / test side against the specimen

9.16 Wipe the contact surface of the weight before gently replacing it over the pick up (blotter) paper
A loading speed should be applied in such a way that the last 5 cm displacement takes (5 ± 1) s (see Annex A.4).

9.17 The weight remains in place for 2 minutes ± 2 s,
During this time wetback has occurred

9.18 Remove the weight
After removing the weight the pick-up (blotter) paper (P_2) should be reweighed

9.19 Calculate
Calculate the wetback value (WB) = P_2 - P_1 (expressed in g)

9.20 Repeat for the required number of test specimens.

10. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Individual strike-through times, in seconds
g) Individual wetback (expressed in g)
h) Average wetback (expressed in g)
i) Standard deviation of results (expressed in g)
j) Number of specimens tested and note CD and/or MD if significant
k) For computer processed data, identify the software used and the version
l) Deviation from the standard test procedure, if any
m) Whether or not samples were conditioned prior to testing and, if so, for how long
n) Anything unusual noted during the testing

11. Precision

The precision for this method is yet to be determined.

Annex A

Additional remarks

A.1 The loading factor (LF) is dependent on the liquid absorbency capacity (LAC) and will change as the LAC changes.

A loading factor of 3.30 was found to be appropriate when using paper (blotters) filters with LAC of 480 ± 30%.

A knowledge of the wetback vs. loading factor curve for a coverstock is useful sometimes, because close to the break point the wetback dispersion increases dramatically.

The use of control nonwoven samples is strongly recommended to monitor the correct functioning of the test. Good wetback samples, one with wetback 0.12 g or less and the other around 0.20 g, are sufficient to monitor the test.

A.2 If the LAC of the paper filter (blotter) used differs from the above value or if a refined procedure is needed for research or for ranking purpose, different loading factors can be used. Modified LAC and LF should be mentioned in the report.

Note A 1 If the LAC differs from the specifications, the filter paper supplier will indicate the recommended LF corresponding to this different LAC.

A.3 It is recommended that the same filter paper batches are used for wetback comparison purpose.

A.4 The application of the weight in 9.16 is a critical step. The training of the operator can be provided by practicing the placement of the weight on a balance without overcharging the balance by more than a few grams (5g).

Alternately an automatic system with a pneumatic piston can be used to apply the weight assembly consistently.

A.5 The repeatability of this test depends on the maintenance of the strike-through plate. In order to avoid the formation of sodium chloride crystals, the creation of a water film or any other contamination on the walls that could modify the strike-through time measurement, see the maintenance instructions from the plate manufacturer.

A.6 The polyurethane foam specifications shall be:

a) Density: 25 – 75 kg/m^2 (ASTM D 3574-86, test A)
b) Hardness 150 – 250 N for 40% compression and 5cm sample (ASTM D 3574-86, test B)

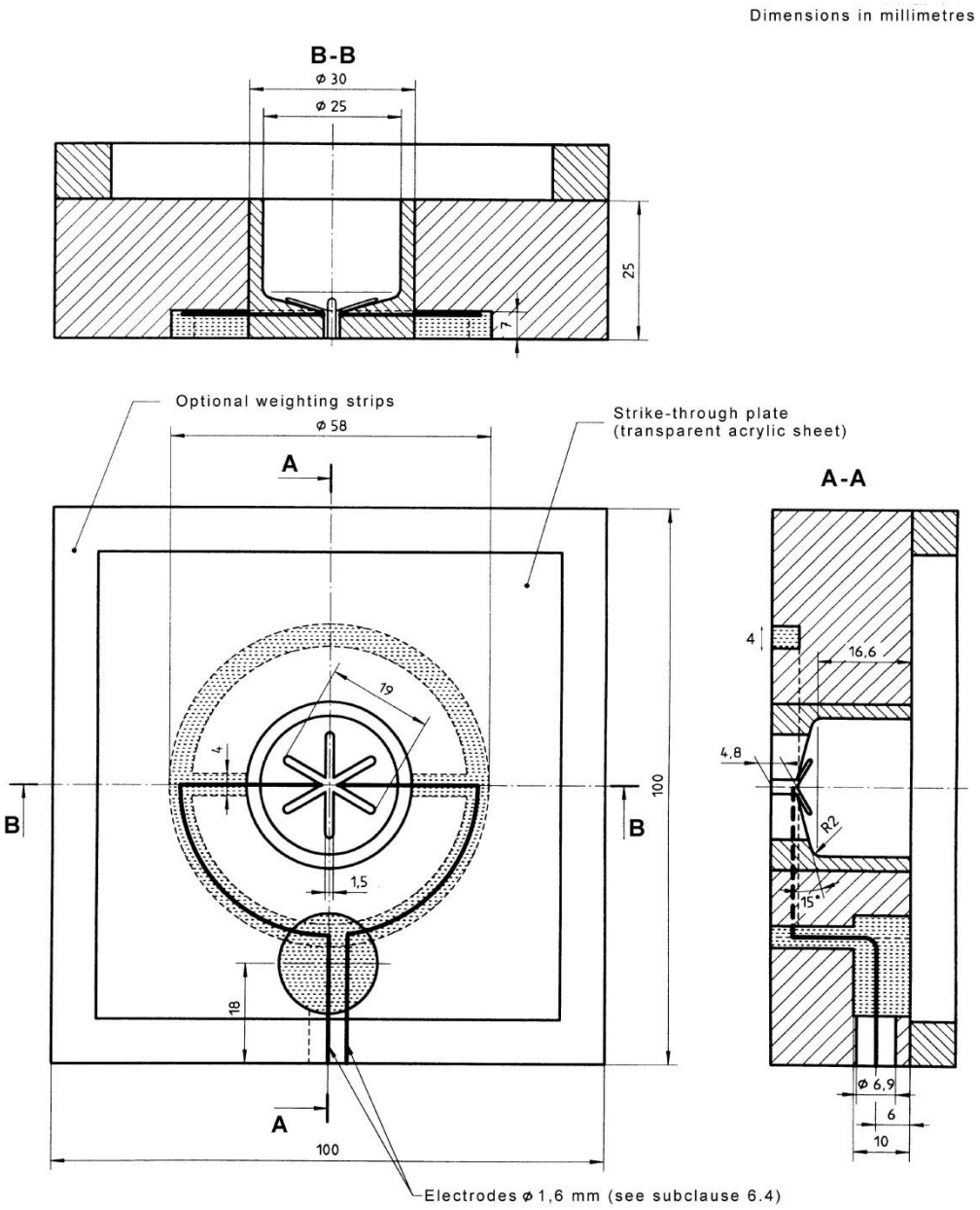

Figure 2
Strike-through plate

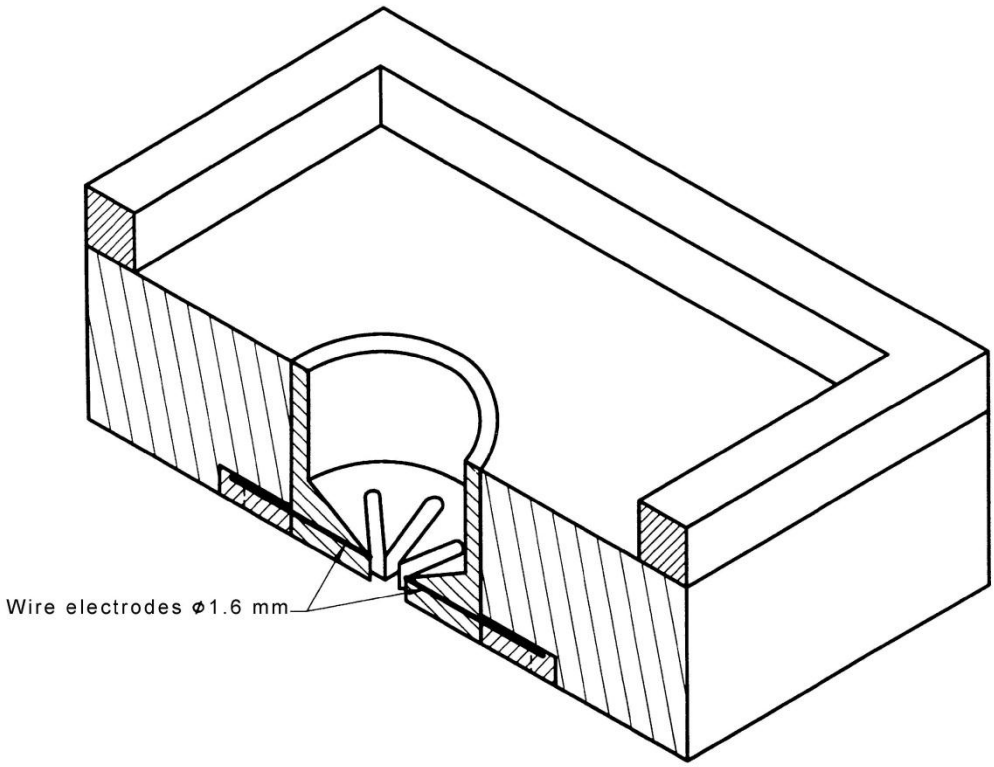

Figure 3
Section across strike-through plate on center line of 25 mm dia. cavity

STANDARD TEST: WSP 080.11.R4 (12)

Standard Test Method for Nonwoven Wet Barrier Mason Jar

The number in parentheses indicates the year of the last revision

1. Scope

This test method is one of two Mason jar tests (WSP 080.5.R4 Automated Mason Jar and WSP 080.11.R4 single and manual). There is another wet challenge procedure also recommended for assessing the resistance to penetration by aqueous liquids of nonwoven fabrics intended for use as sterilization wrapping materials (WSP 080.6.R4, Nonwovens wet barrier hydrostatic head).

Liquid penetration of a barrier material is a major source of pathogen movement from a non-sterile area and materials used as barriers should be impervious to the passage of liquids.

The Mason jar test determines the ability of a fabric to withstand water penetration by applying a constant head of liquid over a period of time with the test material being in contact with a support surface.

Since extended hold-out times are expected to typify adequate performance in use, it is a less serviceable method of test as a routine quality control test for which WSP 080.6.R4 is suggested.

The SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.1 ISO test methods

a) ISO 39: Textiles — Standard atmospheres for conditioning and testing
b) ISO 2859-1:1999 Sampling procedures for inspection by attributes
c) ISO 3951-1:2005 Sampling procedures for inspection by variables

Reference number
WSP 080.11.R4 (12) A

Current edition approved WSP 080.11.R4 (12)
Originally published as WSP 80.11 in 2002
Last approved as WSP 80.11 in 2009

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Principle

The purpose of this test is to simulate an end use condition in which the test piece is subjected to an aqueous challenge on its top side with its bottom side resting on a hard surface. The time required for the liquid to penetrate the test piece is measured by determining the end point while viewing the sample through a glass plate. Aqueous barrier therefore is related to the time over which resistance to liquid penetration is affected.

4. Apparatus

Mason jar, 1125 cc capacity, 63,5 mm diameter mouth, with an air release hole drilled into the bottom side or precision threaded test jar with stopper (see figure 1).

a) A suitable source of deionized water.
b) Glass plate or petri dish.
c) Ring stand.
d) Mirror.
e) Timer.
f) Sample cutter - 65 mm diameter.
g) Rubber gasket 67 mm O.D., 56 mm I.D.
h) Teflon® gasket 68 mm O.D., 56 mm I.D.

5. Sampling

5.1 Lot Size

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

5.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables (“s” method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 2 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer’s risk, consumer’s risk, acceptable quality level, and limiting quality level.

5.3 Test specimens

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material.

a) Care in handling should be observed so that specimens do not contact any contaminants such as soap, salt, oil etc., which might facilitate or hinder water penetration.
b) Specimens should be cut into 65 mm diameter circles

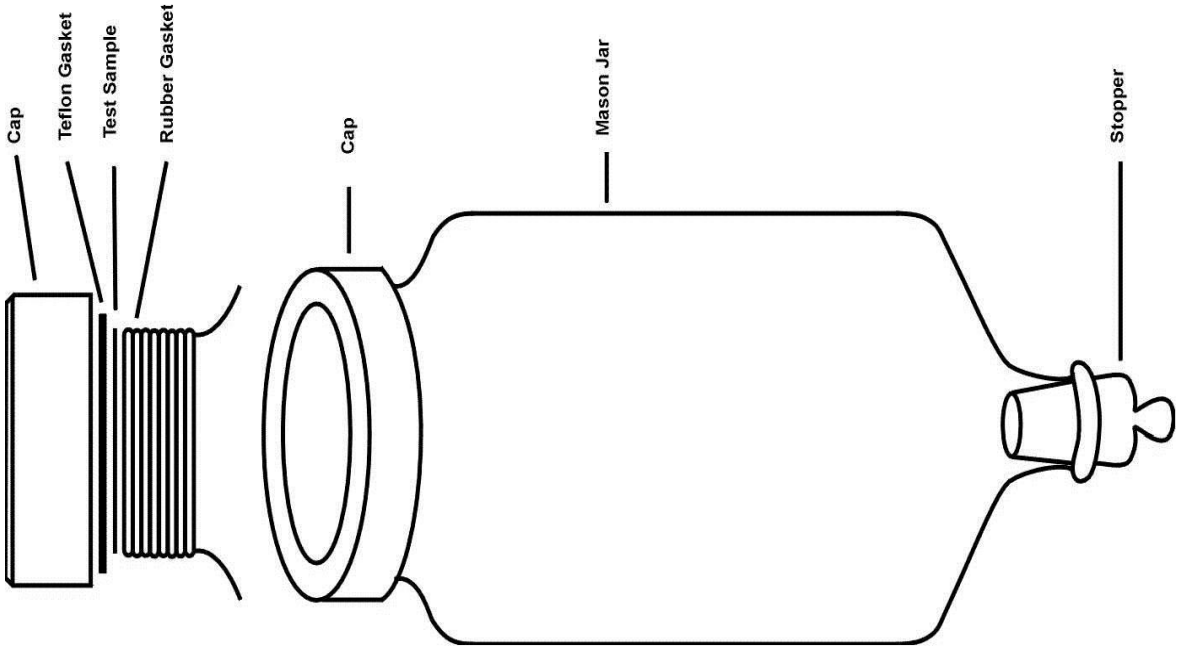

Figure 1
Precision threaded test jar

6. Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 3 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

7. Procedure

Procedure	Worked Example
7.1 Seal the hole in the bottom of the mason jar with a stopper, tape or another suitable device and fill with 600 ml of deionized water. If using a precision threaded test jar approximately 510 ml is equivalent to 115 mm.	
7.2 Place the circular test specimen in the cap of the jar between a Teflon® gasket and a rubber gasket and screw the cap tightly to maintain a seal between the sample and the jar.	
7.3 Place a glass plate on the lower surface of the mason jar ensuring contact is made with the fabric. Invert both plate and jar and simultaneously place on the ring stand. Ensure contact between the plate and the fabric is maintained for the duration of the test.	
7.4 Remove the seal or stopper from the bottom of the mason jar.	
7.5 Adjust solution level to 115 mm and note the time.	
7.6 Measure and record the lapsed time in minutes before the deionized water penetrates the test specimen onto the glass plate as observed through a mirror under the ring stand.	65 minutes
7.7 Occasionally some condensation (a light “fog”) will be observed on the surface of the plate and care must be taken that this is not confused with a testing failure.	
7.8 If a leakage occurs around the seal during the test this is to be considered a mechanical failure and the test should be repeated using another test specimen.	70, 60, 65, 65 minutes
7.9 Repeat with the other test specimens using fresh deionized water with each sample.	65 minutes
7.10 Results calculate the average data.	

8. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Liquid used
f) Average liquid hold-out time
g) Laboratory testing conditions
h) Number of specimens tested
i) For computer processed data, identify the software used and the version
j) Deviation from the standard test procedure, if any
k) When calculated, the standard deviation or the coefficient of variation
l) Whether or not samples were conditioned prior to testing and, if so, for how long
m) Anything unusual noted during the testing

9. Precision

The precision for this method is yet to be determined.

STANDARD TEST: WSP 090.1.R4 (12)

Standard Test Method for Stiffness of Nonwoven Fabrics Using the Cantilever Test

The number in parentheses indicates the year of the last revision

1. Scope

This test method covers stiffness properties of nonwoven fabrics by employing the principle of cantilever bending of the fabric under its own weight. Bending length is measured and flexural rigidity calculated.

This test method applies to most nonwoven fabrics that are treated or untreated, including those that are heavily sized, coated, or resin-treated.

This method and WSP 090.5.R4 (12) are similar methods in that both are checking the same variable, (drapeability, stiffness, or bending length) using the same type of equipment. There are some differences in the testing parameters:

a) Mass of slide: 270 ± 5g
b) Length of slide: 200 mm
c) Read results the instant the edge of the specimen touches the knife edge and record the results.
d) Motorized specimen feed unit is set for a forward movement of 120 mm/min.

The SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.1 ISO test methods

a) ISO 139:Textiles — Standard atmospheres for conditioning and testing
b) ISO 2859-1:1999 Sampling procedures for inspection by attributes
c) ISO 3951-1:2005 Sampling procedures for inspection by variables

Reference number
WSP 090.1.R4 (12) A

Current edition approved WSP 090.1.R4 (12)
Originally published as WSP 90.1 in 2002
Last approved as WSP 90.1 in 2009

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Bending length

Is a measure of the interaction between fabric weight and fabric stiffness as shown by the way in which a fabric bends under its own weight. Bending length reflects the stiffness of a fabric when bent in one plane under the force of gravity and is one component of drape.

3.2 Bonding patterns

have two sides in most nonwovens. The **face side** of the material is the side that has the heated pattern roll applied with pressure. The **anvil side** of the material is the side that rolls over a smooth steel roll while pressure is being applied.

3.3 Cross-machine direction – (CD)

Is the width dimension of the nonwoven within the plane of the fabric that is perpendicular to the direction in which the fabric is being produced by the machine.

3.4 Flexural rigidity

Is the resistance of a fiber to bending; fiber stiffness.

3.5 Machine direction – (MD)

Is the long direction within the plane of the fabric that is in the direction in which the fabric is being produced by the machine.

3.6 Nonwoven fabric

Is a fabric made directly from a web of fiber, without the yarn preparation necessary for weaving and knitting. In a nonwoven, the assembly of textile fibers is held together by: (1). mechanical interlocking in a random web or mat; (2). fusing of the fibers, as in thermoplastic fibers; or (3). bonding with a cementing medium such as starch, casein, rubber latex, a cellulose derivative or synthetic resin. Initially, the fibers may be oriented in one direction or may be deposited in a random manner. This web or sheet is then bonded together by one of the methods described above. Fiber lengths can range from 0.25 inch to 6 inches for crimped fibers up to continuous filament in spunbonded fabrics.

3.7 Stiffness

Is the ability of a fabric to resist bending.

3.8 For other definitions

Of nonwoven terms used in these test methods, refer to WSP 001.0.R3 (12) (Standard Terminology Relating to the Nonwoven Industry and INDA's Standard Test Methods)

4. Principle

A specimen is slid in a direction parallel to its long dimension at a specified rate (motorized specimen feed is set for 120 mm/min), so its leading edge projects from the edge of a horizontal surface. The length of the overhang is measured when the tip of the specimen is depressed under its own weight to the point where the line joining the top to the edge of the platform makes a 0.785 rad (41.5°) angle with the horizontal. The stiffer the fabric, the longer it takes to bend, thus, higher numbers indicate a stiffer fabric.

This test method measures the drape stiffness of the nonwoven fabric. This test is not, however, suitable for very limp fabrics or those that show a marked tendency to curl or twist.

5 Apparatus

5.1 Cantilever bending tester

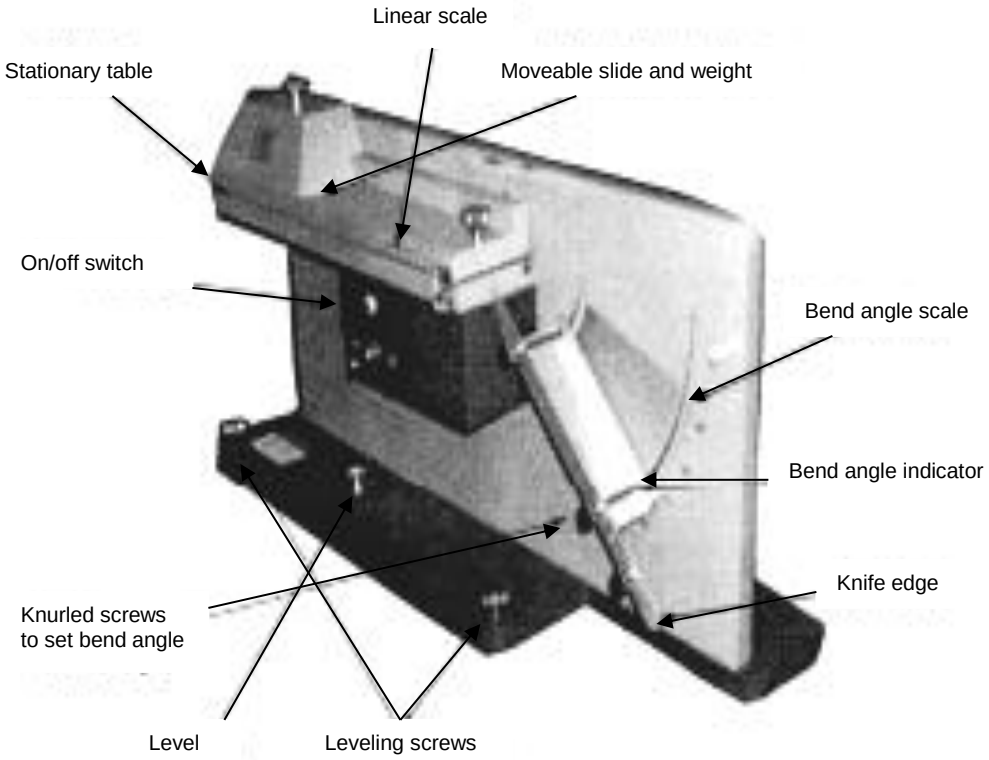

Figure 1
Cantilever bending tester

5.1.1 Horizontal platform

With a minimum area of 38 by 200 mm and having a smooth low-friction, flat surface such as polished metal or plastic. A leveling bubble shall be incorporated in the platform.

5.1.2 Indicator
Must be inclined at an angle of 0.724 rad (41.5°) below the plane of the platform surface.

5.1.3 Moveable slide
Consisting of a metal bar not less than 25 X 200 mm by approximately 3 mm thick and having a mass of 270 ± 5 g.

5.1.4 Scale and pointer
To measure the length of the overhang.

5.1.5 Motorized specimen feed unit
Which is set for a movement of 120 mm/min. The motorized specimen feed unit is preferred over manual units. Manual units are permitted but they **must travel** at the same speed.

5.2 Analytical Balance
Having a capacity and sensitivity to weigh within ± 0.1 % of the weight of the specimens being tested.

5.3 Cutting Die
Specimen size, 25 X 200 mm ± 1mm.

6. Sampling

6.1 Lot Size
A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

6.2 Sampling
If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables (“s” method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 2 An adequate specification or other agreement between the purchaser and the supplier requires taking into account the variability between rolls of material and between specimens. One must provide a sampling plan with a meaningful producer’s risk, consumer’s risk, and have an acceptable quality level.

NOTE 3 Results obtained on small hand samples can only be considered as representative of that sample and cannot be assumed to be representative of the material portion from which the hand sample or swatch was taken.

6.3 Test specimens

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material

a) *Direction of Test* — Consider the long dimension as the direction of the test.
b) *Specimen Size and Direction of Test* —Cut test specimens 25 by 200 mm ± 1mm. Take the specimens for the measurement of the machine direction from different positions across the fabric width with the longer dimension parallel to the machine direction. Take the specimens for the measurement of the cross-machine direction from different positions along the length of the fabric with the longer dimension parallel to the cross-machine direction. Label to maintain specimen identity.
c) Care in handling should be observed so that specimens do not contact any contaminants such as soap, salt, oil etc., which might facilitate or hinder test results.

7. Conditioning

For conditioned testing*:*

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 4 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested.

8. Procedure

8.1 Set the tester on a table or bench
While observing the inclined reference line at eye level. Adjust the platform to horizontal as indicated by the leveling bubble.

8.2 Remove the moveable slide
Place the specimen (face side up) on the stationary table with the length of the specimen parallel to the edge of the table. Align the edge of the specimen with the line scribed 6 mm from the right-hand edge of the table.

8.3 Replace the moveable slide
On the specimen being careful not to change its initial position.

8.4 Verify that the bend angle indicator
Is at the 0.785 rad (41.5°) angle marked on the scale.

8.5 For automatic testers
Turn the tester switch ON and watch the leading edge of the specimen closely. Turn the switch OFF the instant the edge of the specimen touches the knife edge.

8.6. For manual testers
Try to move the clamped specimen by hand at the same rate as the automated equipment. The movement of the specimen should be in a smooth even manner trying to follow the same rate for a movement which is 120 mm/min until the edge of the specimen touches the knife edge.

8.7 Read and record
The overhang length from the linear scale to the nearest 1 mm.

NOTE 5 If the specimen has a tendency to twist, take the reference point at the center of the leading edge. Do not measure specimens that twist more than 0.785 rad (45°).

8.8 Test the face and back of both ends
For each specimen for a total of four readings per specimen.

8.9 Weigh
The individual test specimens to the nearest 0.001 g.

8.10 Continue as directed
In 8.2 – 8.9 until all the specimens have been tested for each principal direction from each laboratory sampling unit.

9. Calculation

9.1 Bending Length Individual Specimens

a) Calculate the overhang length, *O*, for individual specimens by averaging the four readings obtained to the nearest 1 mm, unless otherwise agreed upon between the purchaser and the supplier.
b) Calculate the bending length for each principal direction to the nearest 1 mm, using the following Eq:

$$C = O/2$$

where:
C = bending length, mm,
O = overhang length, mm.

9.2 In some cases

It may be of interest to differentiate between the sides of the nonwoven by averaging those readings made with the face side up separately from those with the reverse side up. If this is done, specify the direction of bending.

9.3 Mass per Unit Area (g/m^2)

Calculate the mass per unit area by dividing the weight (see NOTE 6) in grams by 5000 mm^2 (area of the specimen) and multiplying the result by 10^6, for each principal direction.

NOTE 6 In 9.3 the phrase mass per unit area is retained because the unit g (gram) is a mass unit in the SI system. This does cause some confusion because colloquially phrases like “weigh the sample” and “weight in grams” are frequently used. In the following calculations, gram is used as a mass unit.

9.4 Flexural Rigidity Individual Specimens

Calculate the flexural rigidity for each principal direction to three significant digits, using the following Eq.

$$G = 9.809 \times 10^6 M^3$$

where:
G = flexural rigidity, µN·m, and
M = fabric mass per unit area, g/m^2.

9.5 Average Values

Calculate the average bending length and flexural rigidity, as applicable, for each principal direction for the laboratory sample and the lot.

9.6 Standard Deviation, Coefficient of Variation

Calculate when requested.

10. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Bending length results for each specimen and the average
g) Flexural rigidity results for each specimen and the average
h) Number of specimens tested and note CD and/or MD if significant
i) For computer processed data, identify the software used and the version
j) Deviation from the standard test procedure, if any
k) When calculated, the standard deviation or the coefficient of variation
l) Whether or not samples were conditioned prior to testing and, if so, for how long
m) Anything unusual noted during the testing

11. Precision and Bias

The precision for this method is yet to be determined.

STANDARD TEST: WSP 090.2.R4 (12)

Standard Test Method for Stiffness of Nonwoven Fabrics Using the Gurley Tester

The number in parentheses indicates the year of the last revision

1. Scope

This method is intended to evaluate the stiffness of nonwoven fabrics by measuring the force required to bend the sample.

The SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.1 ISO test methods

a) ISO 139: Textiles — Standard atmospheres for conditioning and testing
b) ISO 2859-1:1999 Sampling procedures for inspection by attributes
c) ISO 3951-1:2005 Sampling procedures for inspection by variables

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Cross direction stiffness

The stiffness of a specimen, clamped with the cross direction of the nonwoven fabric perpendicular to the specimen clamp.

Reference number
WSP 090.2.R4 (12) A

Current edition approved WSP 090.2.R4 (12)
Originally published as WSP 90.2 in 2002
Last approved as WSP 90.2 in 2009

3.2 Machine direction stiffness
The stiffness of a specimen, clamped with the machine direction of the nonwoven fabric perpendicular to the specimen clamp.

3.3 Fabric stiffness
A materials resistance to bending.

4. Principle

This method measures the ability of a nonwoven fabric to resist an applied bending force. The equipment used in this method can be adapted to measure the stiffness of a wide variety of products by adjusting the width of the test specimen and by modifying the force applied to bend them. This method is useful in evaluating the stiffness of nonwoven fabrics. It is not recommended for soft or limp fabrics or for fabrics with a pronounced degree of curl.

The specimen is clamped in a motor driven arm. The specimen overlaps the end of a pendulum by 6 mm and deflects the pendulum by an amount, which depends upon the stiffness of fabric, before is slips past the end of the pendulum. The deflection of the pendulum is noted and used to calculate the stiffness.

5. Apparatus

The equipment was to perform this standard method is commonly called a “gurley tester” see figure 1.

6. Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 2 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

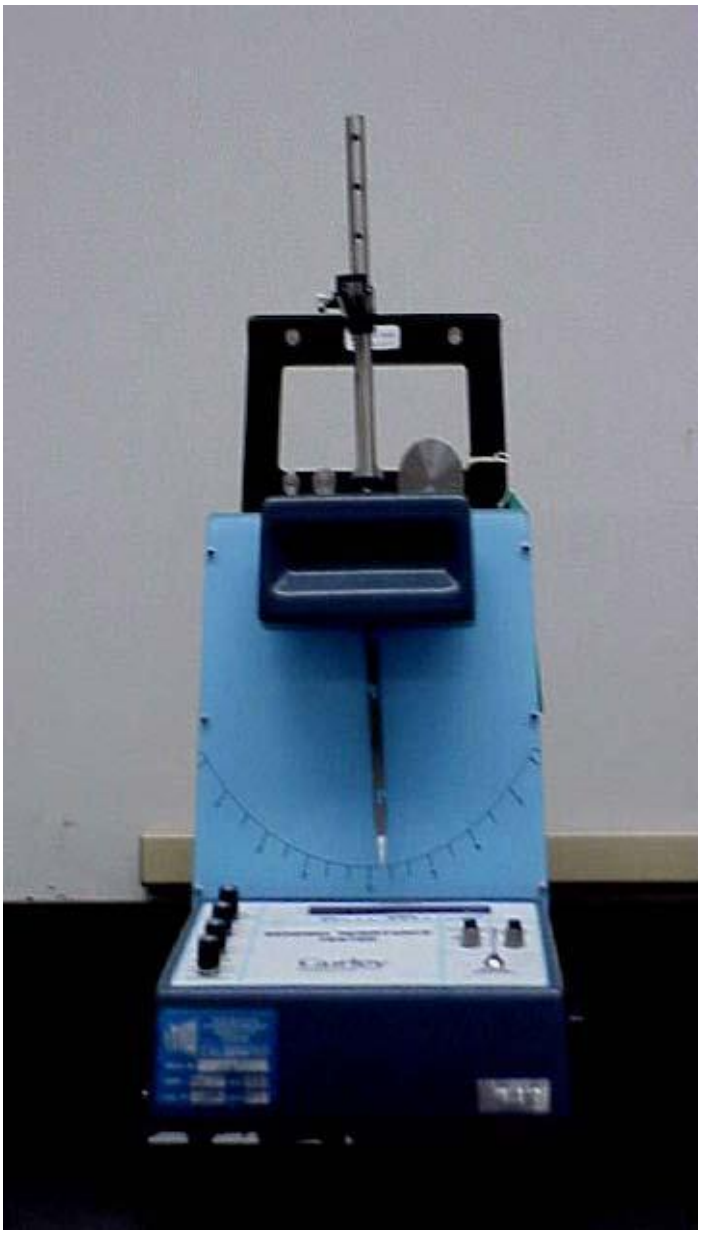

Figure1
Gurley type stillness tester

7. Sampling

7.1 Lot Size

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

7.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
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151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 3 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

7.3 Test specimens

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material.

a) Care in handling should be observed so that specimens do not contact any contaminants such as soap, salt, oil etc.

b) Cut each specimen cleanly and accurately ± 0.4 mm on a sharp paper cutter or a die cutter. The specimens are cut 63 mm long by 50mm width. The longer dimension is the direction to be tested.
c) The width of 50 mm should be used wherever possible, but the width may be varied to provide a test reading between two and six on the scale. Specimen width between 13 mm and 50 mm can be used. If a width other than the preferred width of 50 mm is used, this should be recorded with the results.

8. Procedure

8.1 Level the base of the instrument
So that the pendulum pointer will indicate zero after the attachment of the required weight

8.2 Adjust the holding clamp
So that its bottom edge is 50 mm above the top edge of the pendulum vane.

8.3 Clamp an end of the test specimen in the specimen clamp
Being certain that it is fully seated and the bottom end is parallel with, and overlaps the top of the pendulum vane by exactly 6 mm

8.4 Select an appropriate weight and a hole
To give a satisfactory deflection between two and six on the scale.

8.5 Press the reversing switch
To cause the clamp arm to press the specimen against the top of the pendulum. Record the reading to the nearest 0.1 unit at the point where the specimen clears the pendulum.

8.6 Pressing the opposite direction switch
Load the test specimen from the reverse direction.

8.7 Repeat clause 8.1 - 8.6 for the remaining specimens.

9. Calculations

9.1 Record the scale readings in each direction
Average the values of the two readings obtained in clause 8.5 - 8.7.

9.2 Calculate the stiffness
By following the formula which applies only to the nominal testing length of 50 mm

$$S = \frac{R \times M \times D \times 8.89}{W}$$

where:

S = Stiffness in Gurley Units
R = Average pendulum deflection
M = Weight used, gram
D = Distance of weight from pivot, mm
W = Specimen width, mm

10. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Number of specimens tested and average stiffness for each direction CD and MD
g) For computer processed data, identify the software used and the version
h) Deviation from the standard test procedure, if any
i) When calculated, the standard deviation or the coefficient of variation
j) Whether or not samples were conditioned prior to testing and, if so, for how long
k) Anything unusual noted during the testing
l) Test width if different from 50mm standard.

11. Precision

The precision for this method is yet to be determined.

STANDARD TEST: WSP 090.3.R4 (12)

Standard Test Method for Handle-O-Meter Stiffness of Nonwoven Fabrics

The number in parentheses indicates the year of the last revision

1. Scope

This test method covers the evaluation of the stiffness or "hand" of nonwovens. The quality of "hand" is considered to be the combination of resistance due to the surface friction and the flexural rigidity of a sheet material (see ANNEX A).

All of the instruments operate on the principle of deforming the nonwoven through a restricted opening. It is a flexibility test in which the force required to deform a loop of nonwoven is measured.

The SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.1 ISO test methods

a) ISO 139: Textiles — Standard atmospheres for conditioning and testing
b) ISO 2859-1:1999 Sampling procedures for inspection by attributes
c) ISO 3951-1:2005 Sampling procedures for inspection by variables

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

Reference number
WSP 090.3.R4 (12) A

Current edition approved WSP 090.3.R4 (12)
Originally published as WSP 90.3 in 2002
Last approved as WSP 90.3 in 2009

3. Principle

The nonwoven to be tested is deformed through a restricted opening by a plunger and the requi1000

Handle-O-Meter
available from:

Thwing-Albert Instrument Co.
14 West Collings Avenue
West Berlin, NJ 08091
856-767-1000

5. Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 2 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

NOTE 3 It should be noted that high relative humilities tend to give lower Handle-O-Meter readings than low relative humilities. This effect is more pronounced with certain fibers than with others. Therefore, the softness ranking of webs made from different fibers could change as the relative humidity changes.

6. Sampling

6.1 Lot Size
A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

6.2 Sampling
If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 4 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

6.3 Test specimens

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material.

a) Care in handling should be observed so that specimens do not contact any contaminants such as soap, salt, oil etc.
b) Specimens should be cut 200 X 200 mm

NOTE 5 - In cases where the full 200 mm width of the specimen gives a reading in excess of the meter range of the instrument, cut the sample to 100 x 100 mm. Test as directed in the above procedure. Double all readings.

In cases where the 100 mm is still too great, the sample may be cut to a minimum width of 25 mm In this case, two specimens should be cut in the machine direction and two in the cross direction each 200 mm long by the width being used. The specimens should each be tested in one direction, on both sides. Readings should be multiplied by a factor, the value of which is 200 mm divided by the width used.

7. Calibration and Standardization

Calibrate the instrument according to manufacturer's instructions.

8. Procedure

8.1 Set slot on the testing machine to the width of 6 mm.

NOTE 6 In cases where the material is too thick to be tested with the 6 mm slot, a wider slot may be used. When this is done, the results cannot be compared to those with a 6 mm slot. This modification in specimen size must be included in the final test report. See ANNEX A.

8.2 Place the specimen under the blade on the specimen platform

With side one facing up and machine direction perpendicular to the slot. Arrange the specimen so that about 1/3 of the specimen is to the right of the slot and 2/3 to the left.

8.3 Activate the tester and record the maximum reading

NOTE 7 If the maximum reading is in excess of the meter range of the instrument, augmenting weights can be used. If the reading is still off scale refer to the equipment manual.

8.4 Remove the specimen from the slot

Keeping side one up, rotate the specimen 90° counterclockwise so that the cross direction is perpendicular to the slot. Arrange the specimen so that about 1/3 of the specimen is to the right of the slot and 2/3 to the left.

8.5 Activate the tester and record the maximum reading

8.6 Remove the specimen from the slot

And turn it over so that side two is up. Do this by flipping the specimen along an axis parallel to the slot. This will keep the cross direction perpendicular to the slot. Arrange the specimen so that about 1/3 of the specimen is to the right of the slot and 2/3 to the left. This will expose a fresh area of the specimen for testing.

8.7 Activate the tester

and record the maximum reading

8.8 Remove the specimen from the slot

Keeping side two up, rotate the specimen 90° counterclockwise so that the machine direction is perpendicular to the slot. Arrange the specimen so that about 1/3 of the specimen is to the right of the slot and 2/3 to the left.

8.9 Activate the tester

and record the maximum reading

8.10 Repeat 8.2 through 8.9 for the second specimen

9. Calculation of Result

9.1 Calculate the average
Of the MD readings and the average of the CD readings.

9.2 Calculate the sum
For all four readings to obtain the total “hand”, average the total “hand” numbers for the three specimens.

NOTE 8 To convert grams-force to millinewtons, multiply by 9.807. Remember to make adjustment for sample size as stated in the equipment manual.

10. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Number of specimens tested and note CD and MD and include total “hand” averages in millinewtons
g) For computer processed data, identify the software used and the version
h) Deviation from the standard test procedure, if any
i) When calculated, the standard deviation or the coefficient of variation
j) Whether or not samples were conditioned prior to testing and, if so, for how long
k) Anything unusual noted during the testing
l) The specimen dimensions and slot width if different from the conditions specified

11. Precision

The precision for this method is yet to be determined.

ANNEX A
(information)

A.1 A Softness-Hand research study was conducted by INDA and published in 1974. Materials evaluated were absorber cover (a lightweight material used to cover the absorbent material in diapers, feminine hygiene and similar products) and surgical drape (a heavier weight material used as a microbial barrier in surgical procedures). Although other materials were not evaluated, it was felt that conclusions reached on these two materials were probably applicable to other nonwoven fabrics.

The instruments that had equally high correlation with subjective evaluation in this study were Handfeel Comparator, Handle-O-Meter, Loop Softness Tester and Ring & Rod Softness Device.

The Handfeel Comparator is not presently commercially available.

The Handle-O-Meter has been chosen as the preferred instrument because of its wide availability, and the fact that it is a self-contained portable device.

The Loop Softness Test is primarily a flexibility measurement and, unlike the other three tests, does not utilize all the parameters of the principles.

The Ring & Rod Softness Device must be used with an Instron tensile tester, which is not available in all laboratories.

A.2 The 6 mm slot width and the 200 x 200 mm sample size was recommended by the Handle-O-Meter manufacturer and used by all the participants who used the Handle-O-Meter in the INDA Softness-Hand Research study. TAPPI T498 also recommends a 6 mm slot.

However, it should be noted that the Handle-O-Meter has slot widths other than 6 mm and that other size specimens can be used. Contractual or agency requirements may specify slot widths and sample sizes different from those recommended in this test method.

For example, MIL-F-36901A - Fabrics, Nonwovens, Surgical Packs, Disposables, calls for a 10 mm slot width and a 100 x 100 mm specimen.

STANDARD TEST: WSP 090.4.R4 (12)

Standard Test Method for Nonwovens Cusick Drape

The number in parentheses indicates the year of the last revision

1. Scope

This test method measures the drape coefficient of nonwovens.

SI values are regarded as the official standard system of measurement for this standard test method.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Referenced Documents

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.1 ISO test methods

a) ISO 9073-9:1995 Textiles-Test methods for nonwovens-Determination of drape coefficient (EN 29073 part 9)
b) ISO 139:Textiles — Standard atmospheres for conditioning and testing
c) ISO 2859-1:1999 Sampling procedures for inspection by attributes
d) ISO 3951-1:2005 Sampling procedures for inspection by variables

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

Drape
The ability of a fabric to fold on itself and to conform to the shape of the article it covers.

Reference number
WSP 090.4.R4 (12) A

Current edition approved WSP 090.4.R4 (12)
Originally published as WSP 90.4 in 2002
Last approved as WSP 90.4 in 2009

4. Principle

Drape is the ability of a fabric to deform in space under gravity, thereby forming natural folds. Under the conditions of the present method, the drape is the shape assumed by a circular sample of nonwoven when suspended, under specified conditions.

The circular specimen of nonwoven being tested is held concentrically between smaller horizontal discs, and the exterior ring of nonwoven is allowed to drape into folds around the lower supporting disc. The shadow of the draped test specimen is cast from below onto a ring of paper of known mass and of the same size as the unsupported part of the test specimen. The outline of the shadow is traced onto the ring of paper, the paper is then cut along the trace of the shadow and the mass of the inner part representing the shadow is determined. The drape coefficient is the mass of that part of the paper ring representing the shadow expressed as a percentage of the mass of the whole paper ring.

5. Apparatus

Test equipment

Comprised of a box-like apparatus with translucent lid, containing: (see fig. 1)

a) Two horizontal discs, of diameter 18 cm, between which the test specimen is held, the lower disc having a central locating pin;
b) Point source of light positioned centrally beneath the discs and at a focus of a concave parabolic mirror which reflects parallel light vertically past the discs onto the lid of the instrument;
c) A centerplate, on the lid, to locate the paper ring.
d) Three circular templates, of diameter 24, 30 and 36 cm respectively adapted to facilitate marking the center of the test specimen.
e) Rings of translucent paper, of internal diameter 18 cm and external diameter 24 cm, 30 cm and 36 cm respectively.
f) Balance, capable of determining mass to an accuracy of 0.01 g.
g) A stop watch calibrated to 0.1 seconds

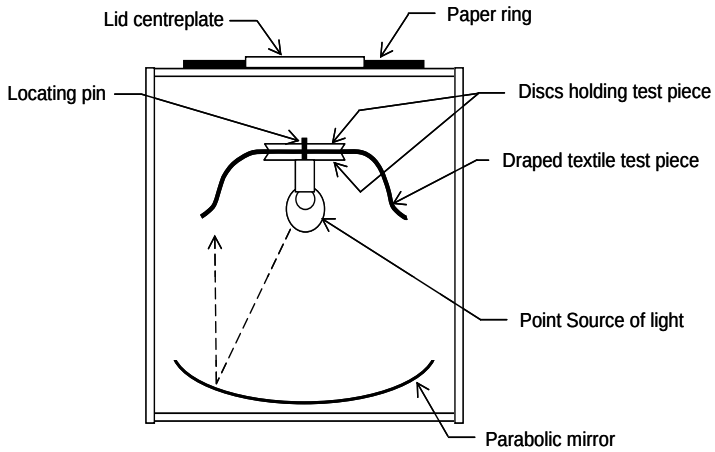


Figure 1

6. Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 2 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing nonwovens for a reasonable period of time before the specimens are tested, i.e. 4 hours.

7. Sampling

Care in handling the materials should be observed so that the finial cut specimens have not contacted any contaminants such as soap, salt, oil etc., which might facilitate or hinder drapeability. No dirt or other foreign material should be allowed on the specimen; also, **write only in the center on the test area of the specimen (A, B)**.

7.1 Lot Size

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

7.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

8. Calibration and Standardization

8.1 Test Specimens

a) Perform a preliminary test using a test specimen of 30 cm diameter and calculate the drape coefficient for this diameter (D_{30}).
b) If the drape coefficient is in the range 30% to 85%, use test specimens of 30 cm diameter for all the tests.
c) If the drape coefficient is outside the range 30% to 85%, in addition to testing 30 cm diameter test specimens, carry out tests in accordance with 6.3.1 and 6.3.2 as appropriate:
d) For limp nonwovens characterized by a drape coefficient (D_{30}) of less than 30%, use test specimens of 24 cm diameter;
e) For stiff nonwovens characterized by a drape coefficient (D_{30}) of greater than 85%, use test specimens of 36 cm diameter.

NOTE 3 Results obtained on test specimens of different diameters are not directly comparable, thus in all cases tests also need to be carried out on 30 cm diameter test specimens, regardless of drape coefficient.

f) Marking and Cutting:
g) Place the test nonwoven, free from creases, on a flat horizontal surface and using a template trace two test specimens, mark the center of each, and cut them out.
h) On each test specimen, mark the two faces as A and B.

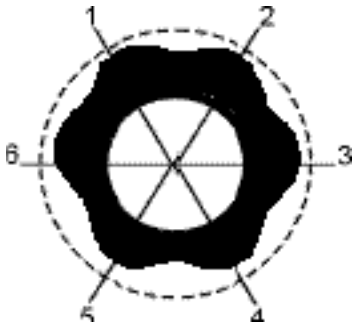
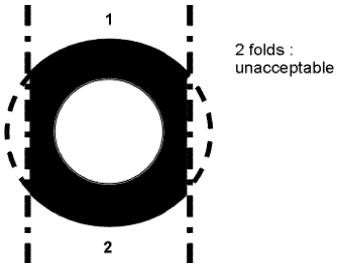
8.2 Ensure that the centerplate on the apparatus lid is horizontal

By making adjustments using leveling feet in the base of the apparatus or other suitable means.

8.3 Switch on the light

Ensure that the filament of the light source is at the focus of the parabolic mirror, by placing the 30 cm diameter template centrally on the lower support disc of the apparatus. A centrally situated shadow of diameter 30 cm should be cast on a 36 cm diameter paper ring placed in position on the lowered lid of the apparatus.

9. Procedure

Procedure	Worked Example
9.1 Preliminary evaluation	
9.1.1 Place one nonwoven test specimen, with face A downwards on the lower horizontal disc of the testing equipment.	
9.1.2 If the sample drapes to form folds at regular intervals around its circumference, the measurement can be carried out.	
9.1.3 If the test specimen has a predisposition to bend in line with two planes located on either side of the support disc, do not carry out the measurement, but mention this fact in the test report.	
9.2 Test Measurement	
9.2.1 Place a ring of paper, of the same outside diameter as the test specimen on the apparatus lid.	Annular rings of translucent paper, of internal diameter 18 cm and external diameter 30 cm, may be obtained from the manufacturer of the apparatus.
9.2.2 Place the test specimen on the lower horizontal disc of the apparatus so that the locating pin passes through the center of the test specimen. Then position the top disc on the test specimen with the pin fitting into the hole in the top disc.	
9.2.3 Lower the lid of the apparatus and start the stopwatch.	The light source must not heat the draped test specimen.
9.2.4 After 30 s switch on the light source and without delay draw around the periphery of the shadow cast on the paper ring.	M_{pr}^{1A} = total mass of the paper ring = 4.35g
9.2.5 Remove the paper ring, fold it so that it will fit on the balance and determine the mass, M_{pr}, of the paper ring to the nearest 0.01 g.	M_{sa}^{1A} = mass of the shaded area of the paper ring = 4.01 g
9.2.6 Cut the paper ring around the periphery of the shadow, which was drawn on the paper, discard the area of the paper ring, which was not shaded, and determine the mass, M_{sa}, of the residual portion of the paper ring to the nearest 0.01 g.	M_{pr}^{1B} = 4.36 g M_{sa}^{1B} = 3.96 g
9.2.7 Repeat 9.2.1 to 9.2.6 on the same test specimen but with the other	M_{pr}^{2A} = 4.72 g

surface uppermost, using a fresh paper ring. 9.2.8 Repeat 9.2.1 to 9.2.7 on the remaining test specimen. 9.2.9 Repeat the procedures twice more on each test specimen, to give a total of six measurements on each test specimen (three for each face).	M_{sa}^{2A} = 4.23 g M_{pr}^{2B} = 4.67 g M_{sa}^{2B} = 4.20 g Mpr Msa 1A.2 4.29g 3.88g 1B.2 4.67g 4.25g 1A.3 4.33g 3.83g 1B.3 4.51g 3.99g 2A.2 4.39g 4.02g 2B.2 4.29g 4.00g 2A.3 4.79g 4.38g 2B.3 4.35g 3.98g D1A.1 = 4.01 x 100/4.35 = 91.95

10. Calculation and expression of results

Calculation	Expression of results
10.1 Calculation For each of the six readings on each test specimen, calculate the drape coefficient, D, expressed as a percentage, using the following equation: $D = \frac{M_{sa}}{M_{pr}} \times 100$ where M_{pr} is the initial mass of the paper ring, in grams; where M_{sa} is the mass of the part of the paper ring representing the shadow, in grams. 10.1.2 The number of folds for each test. 10.1.3 Calculate the mean drape coefficients for face A and face B. 10.1.4 Calculate the overall mean drape coefficient.	Face A Face B D1.1 91.95 90.90 D1.2 90.45 91.00 D1.3 88.47 88.63 D2.1 89.68 89.96 D2.2 91.44 93.07 D2.3 91.47 91.34 e.g. 6 Face A Face B 90.59 90.81 D_{30} = 90.70

10.2 Limp nonwovens	
10.2.1 For limp nonwovens characterized by a drape coefficient D_{30} < 30% measured with a 30 cm diameter test specimen, the tests will be repeated with a diameter 24 cm. Results will be recorded for both diameters 30 and 24 cm.	
10.3 Stiff nonwovens	
10.3.1 For stiff nonwovens, characterized by a drape coefficient D_{30} > 85% measured with a 30 cm diameter test specimen, the test will be repeated with a diameter 36 cm. Results will be recorded for both diameters 30 and 36 cm..	D_{30} = 90.70; D_{36} = 45.40

11. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Diameter of the template
g) Number of specimens tested and note CD and/or MD if significant
h) For computer processed data, identify the software used and the version
i) Deviation from the standard test procedure, if any
j) When calculated, the standard deviation or the coefficient of variation
k) Whether or not samples were conditioned prior to testing and, if so, for how long
l) Anything unusual noted during the testing

12. Precision

The precision for this method is yet to be determined.

STANDARD TEST: WSP 090.5.R4 (12)

Standard Test Method for Nonwovens Bending Length

The number in parentheses indicates the year of the last revision

1. SCOPE

This test method for determining the bending length of a nonwoven fabric. An equation is given for calculating the flexural rigidity of the fabric from the bending length.

This method and WSP 090.1.R4 are similar methods in that both are checking the same variable, (drapeability, stiffness, or bending length) using the same type of equipment. There some differences in the testing parameters:

a) Mass of slide: 250 g
b) Length of slide: 350 mm
c) An interval of (8 ± 2) s should be allowed before reading.
d) Manual specimen feed unit has no set time for forward movement

The method is not applicable to combination-type materials (composites or laminates) in which there can be a natural twist.

SI values are regarded as the official standard system of measurement for this standard test method.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.1 ISO test methods

a) ISO/DIS 9073-7 Test methods for nonwovens Part 7: Determination of bending length (EN 29073 part 7)
b) ISO 139:Textiles — Standard atmospheres for conditioning and testing
c) ISO 2859-1:1999 Sampling procedures for inspection by attributes
d) ISO 3951-1:2005 Sampling procedures for inspection by variables

Reference number
WSP 090.5.R4 (12) A

Current edition approved WSP 090.5.R4 (12)
Originally published as WSP 90.5 in 2002
Last approved as WSP 90.5 in 2009

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Bending length

Length of a rectangular strip of fabric which is fixed at one end and free at the other and that will bend under its own weight to an angle of 41.5°.

3.2 Flexural rigidity

Ratio of the small changes in bending moment per unit width of the material to the corresponding small changes in curvature.

NOTE 2 Flexural rigidity can be calculated from the bending length (see Annex A).

4. Principle

A rectangular strip of fabric is supported on a horizontal platform with the long axis of the strip parallel to the long axis of the platform. The strip is advanced in the direction of its length so that an increasing part overhangs and bends down under its own weight. The overhang is free at one end and fixed at the other due to the pressure applied by a slide on the part of the test specimen still on the platform. When the leading edge of the test specimen has reached a plane passing through the edge of the platform and inclined at an angle of 41.5° below the horizontal, the overhanging length will equal twice the bending length of the test specimen (see Annex A), and thus the bending length can be calculated.

5. Conditioning

For conditioned testing*:*

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 3 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested.

6. Apparatus

6.1 A suitable apparatus is shown

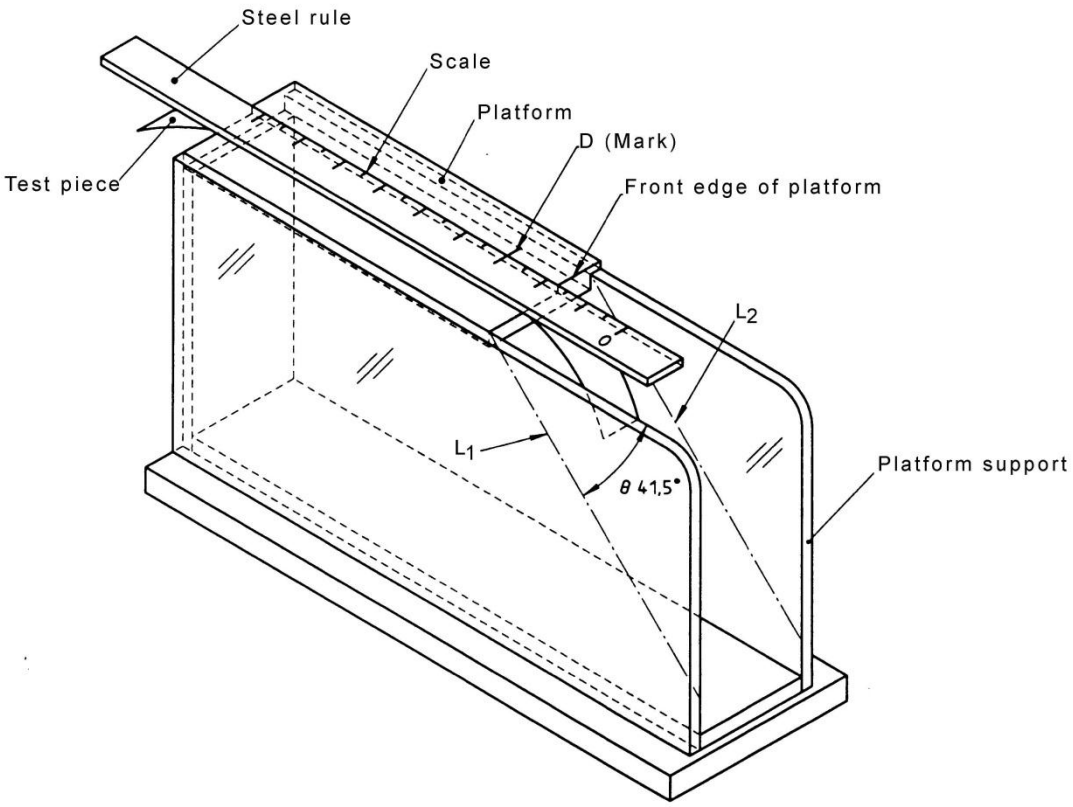


Figure 1
Apparatus for measuring bending length

6.2 Level table
Or laboratory bench

6.3 Specimen platform
Having the width of 40 ± 2 mm and length 200 ± 2 mm, supported at a height of at least 150 mm above the surface of the table (7.1). Each side of the platform support shall be transparent and marked with a line (L1 and L2 respectively; see figure 1) running from the end of the platform at an angle of 41.5° below the horizontal.

A mark (D) is made on the platform at 10 ± 1 mm from the front edge (see figure 1).

NOTE 4 To avoid adherence of the test specimen, the platform should be coated or covered with polytetrafluoroethylene (PTFE).

6.4 Steel rule
Whose width is 25 ± 1 mm, length 350 ± 1 mm and mass 250 ± 10 g, accurately graduated in millimeters, and with a rubber-covered underside.

NOTE 5 A rule made of steel plate 3.5 mm thick will have the correct mass.

7. Procedure

Procedure	Worked example
7.1 Cut out 6 test specimens (25 ± 1) mm x (250 ± 1) mm with their long edges parallel to the machine direction (MD) and an equal number of test specimens in the perpendicular, or cross machine direction (CD). The test specimens shall be taken at least 50 mm from the edge of the fabric and shall be handled as little as possible NOTE 6 Fabrics which tend to curl or twist should be conditioned before cutting out the test specimens. If the test specimens curl or twist seriously, they can often be made to lie flat long enough for testing by pressing them lightly between flat surfaces for several hours. NOTE 7 Additional samples may be taken at an angle of 45° to the machine direction. NOTE 8 For production control, the number of test specimens may be limited to 3 in each (MD and CD)	
7.2 Weigh the test specimens and calculate mass per unit area in accordance with ERT 40	M = 0.56 g A = 25 mm x 205 mm = 6250 mm² = 6.25 10^{-3} m² Mass per unit area (M/A) = 90 g/m²
7.3 Place the apparatus on the level table. Place the test specimen on the platform with one end coinciding with the front edge of the platform. Place the steel rule on the test specimen with the zero of the scale in line with the mark D on the platform.	
7.4 Push the steel rule forward so that the test specimen projects over the front edge of the platform and bends down under its own weight. Move the rule forward at a constant speed (this can be facilitated by using an apparatus fitted with a motorized drive) until the overhanging end of the test specimen reaches the two lines on the platform support L1 and L2. After an interval of 8 ±2 s, read on the scale on the steel rule the overhanging length of the test specimen. The bending length (C) is half the overhanging length.	Test specimen n° 1 MD C_1 = 7.1cm C_2 = 6.8 cm C_3 = 7.3 cm C_4 = 68 cm $\overline{C}_{MD} = 7.0cm$
7.5 Repeat the operation in 8.3 and 8.4 with the other face of the test specimen up (C2), and again at the other end of the test specimen, first with the original face up (C3) and then with the specimen turned over (C4).	Repeat for test specimens n° 2 to 6

NOTE 9 It may be helpful to place the apparatus so that the zero of the scale lies towards the observer and at a level that enables the scale to be read with comfort. The position of the end of the test specimen relative to L1 and L2 may be observed in a mirror suitably placed or attached to one side of the instrument.	Test specimen n° 7 CD C_1 = 3.3 cm C_2 = 3.1 cm C_3 = 3.3 cm C_4 = 3.5 cm $\overline{C}_{CD} = 3.3cm$
7.6 Repeat this procedure with the other test specimens cut in machine direction (MD) and cross direction (CD).	Repeat for test specimens n°8 to 12
7.7 Expression of results	
7.7.1 Taking the bending length to be half the length of the overhang, record the four values of the bending length for each test specimen and from these calculate the mean bending length for each test specimen.	6 test specimens (MD) n° 1 to 6 $\overline{C}_{6-CD} = 7.2cm$ 6 test specimens (CD) n° 7 to 12 C6-CD = 3,5 cm $\overline{C}_{6-CD} = 3.5cm$
7.7.2 Calculate the overall mean bending length for the 6 test specimens cut in the machine direction. Calculate the same parameter separately for the 6 test specimens cut in the cross-machine direction.	
7.7.3 Calculate the mean flexural rigidity per unit width (G) in millinewton centimeters, separately for MD and CD, using the following equation: G = m x C3 10-3 (mN cm) where m = mass of the test specimen per unit area in g/m² C = bending length, in cm, of the test specimen	G_{MD} = 90 x 7.2^3 x 10^{-3}mN cm = 33.6 mN cm G_{CD} = 90 x 3.5^3 x 10^{-3} = 3.9 mN cm
NOTE 10 In determining this equation, the acceleration due to gravity, 9.81 m/s², has been rounded to 10 m/s².	
7.7.4 Calculate the coefficient of variation (ratio of the standard deviation to the average) for C and G in both MD and CD.	

8. Report

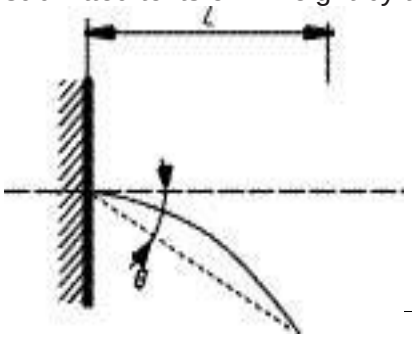
In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions

f) Number of specimens tested, indicate both CD and MD measurements
g) Number of measurements taken
h) For computer processed data, identify the software used and the version
i) Deviation from the standard test procedure, if any
j) Overall mean bending length with the standard deviation and the coefficient of variation of the test material MD
k) Overall mean bending length with the standard deviation and the coefficient of variation of the test material CD
l) Whether or not samples were conditioned prior to testing and, if so, for how long
m) Anything unusual noted during the testing

Annex A
Flexural rigidity, bending length and overhanging length

A.1 Flexural rigidity can be expressed as a function of the deflection of a cantilever submitted to its own weight by the following formula (only valid for small deformations)



$$G = \frac{1}{\frac{\tan\theta}{\cos\frac{\theta}{2}}} \quad \frac{pl_3}{8}$$

Where:

G = flexural rigidity (per unit width)
θ = angular deflection of the cantilever end
ρ = own weight per unit area (= mass per unit area x acceleration due to gravity)
l = cantilever length.

A.2 For θ = 7.1: $\frac{\tan\theta}{\cos\frac{\theta}{2}} = \frac{1}{8}$

Let l = C (bending length)
Then G = pC³ (1)

A.3 For ease of the measurement, the method uses the cantilever length corresponding to the angular deflection θ = 41.5°

For □ = 41.5°: $\frac{\tan\theta}{\cos\frac{\theta}{2}} = 1$

1 = l (overhanging length)

Then $G = \frac{pl^3}{8}$

Compared with (1), we see that $G = \frac{pl^3}{8} = pC^3$

and $C = \frac{l}{2}$ (2)

Therefore the bending length is half the overhanging length.

NOTE A1 The reader is referred to the following articles:

1. Peirce, FT - «The Handle of cloth as a measurable quantity » Journal of the Textile Institute, Transactions 21 (1930) T 377

2. Bickley, WG - «The Heavy Elastica» Philosophical Magazine 17 (1934) : 603-622

STANDARD TEST: WSP 090.6.R4 (12)

Standard Test Method for the Evaluation of Drapeability Including Drape Coefficient of Nonwoven Fabrics

The number in parentheses indicates the year of the last revision

1. Scope

This test method is for determining the drapeability of nonwovens and woven materials using two methods.

Method A Cusick manual method
Method B Cusick automated method using image processing technology

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.1 ISO test methods

a) ISO 9073 Textiles - Test methods for nonwovens - Part 9: Determination of drape coefficient
b) ISO 139 Textiles — Standard atmospheres for conditioning and testing
c) ISO 2859-1:1999 Sampling procedures for inspection by attributes
d) ISO 3951-1:2005 Sampling procedures for inspection by variables
e) ISO 9073-1:1989, Textiles - Test methods for nonwovens - Part 1: Determination of mass per unit area.
f) ISO 9073-9 Textiles – Test Methods for Nonwovens –Part 9: Evaluation of Drapeability including Drape Coefficient
g) ISO 9073-1:1989, Textiles - Test methods for nonwovens - Part 1: Determination of mass per unit area.

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

Reference number
WSP 090.6.R4 (12) A

Current edition approved WSP 090.6.R4 (12)
Originally published as WSP 90.6 in 2002
Last approved as WSP 90.6 in 2009

3. Definition

For the purpose of this document, the following terms and definitions apply:

3.1 Drape
Is the ability of a circular specimen of fabric of known size to deform when suspended under specified conditions.

3.2 Node Number
Is one of the drape shape parameters expressed in the number of drape waves/folds.

3.3 Wave Amplitude
Is one of the drape shape parameters indicating the most dominant drape waves/folds size (in centimeters).

3.4 Wavelength
Is one of the drape shape parameters indicating the wavelength of the most dominant drape waves/folds expressed in degrees of a circle (0° to 360°).

3.5 Minimum Amplitude
Is one of the statistics indicating the smallest size drape wave/folds present, expressed in centimeters.

3.6 Maximum Amplitude
Is one of the statistics indicating largest size drape wave/folds present, expressed in centimeters.

3.7 Average Amplitude
Is one of statistics indicating the mean drape wave/folds present, expressed in centimeters.

3.8 Variance
Is one of the statistics indicating the difference of the drape wave/folds amplitude distribution, expressed in centimeters.

3.9 Fourier Transform/Original and Dominant/Original
Are the three fitness factors to verify the fit of the Fourier transformation and to determine the dominant wave, expressed in percentages.

4. Principle

The circular specimen of the fabric being tested is held horizontally between smaller concentric discs, and the exterior ring of fabric is allowed to drape into folds around the lower supporting disc. Both of the following evaluation methods are available in this procedure and are listed as methods a) and b).

a) **Method using rings of paper:** The shadow of the draped specimen is cast from below onto a ring of paper of known mass and of the same size as the unsupported part of the test specimen. The outline of the shadow is traced onto the ring of paper and the paper is then cut along the trace of the shadow. The drape coefficient is the mass of that part of the paper ring representing the shadow expressed as a percentage of the mass of the whole paper ring.

b) **Method using an image processing technology:** The shadow of the draped specimen is cast from below onto white sheeting covering the top translucent lid and center plates. Detailed quantitative information on drapeability of the test specimen is obtained from digital images captured with a commercial digital camera (or a scanner) after cutting the paper around its shadow contour. The captured images, initially having gray levels, are transformed into monochrome images through noise filtering and thresholding. The two-dimensional monochrome images of draped shadows described above are firstly transformed into polar (Ø,r) coordinates as shown in Figure 1, where X-axis from 0° to 360° is the angle (in degrees) from the baseline passing through the center of the circle and r (Y-axis) is the amplitude (cm). The shape parameters of a two-dimensional geometric drape model defined as the number of nodes (or folds), the positions of nodes, frequency (or wavelength) and amplitude data and various statistical information can then be obtained using image processing technology and frequency analysis as well as the traditional drape coefficient. A three-dimensional drape shape can be regenerated from its captured two-dimensional drape images with a three-dimensional simulator.

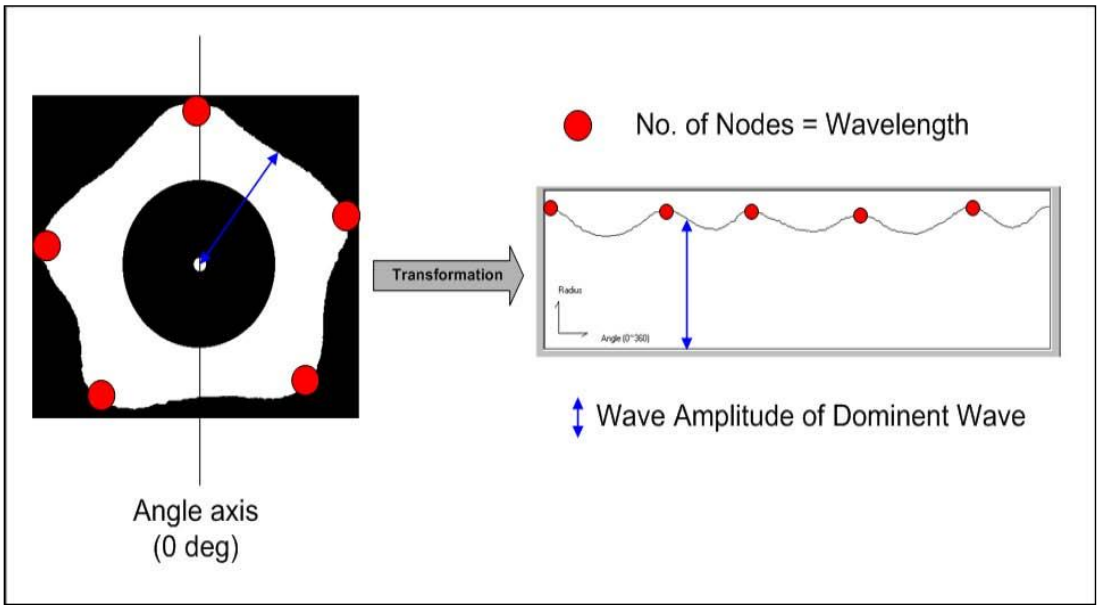


Figure 1
Drape shape parameters

5. Apparatus

5.1 Test equipment (options A & B)
Comprising a box-like apparatus with translucent lid, see Figure 2.

a) Two horizontal discs – 18 cm in diameter between which the test specimen is held, the lower disc having a central locating pin.
b) Point source of light – positioned centrally beneath the discs and at the focus of a concave parabolic mirror which reflects parallel light vertically past the discs onto the lid of the instrument.
c) Center plate – on the apparatus lid to locate the paper ring (or a white high thread count sheeting material)

5.2 Three circular templates (options A & B)
With diameters of 24 cm, 30 cm, and 36 cm respectively, adapted to facilitate marking the center of the test specimen.

5.3 Stopwatch (options A & B)
Traceable to ISO standards.

5.4 Rings of translucent paper (option A)
With an internal diameter of 18 cm and external diameter of 24 cm, 30 cm, and 36 cm respectively.

5.5 Balance (option A)
Capable of determining the mass to an accuracy of 0.01g.

5.6 A frame cover and stand (option B)
To attach the digital camera to the original testing equipment.

5.7 Metal stand (option B)
80cm high to support the digital camera just above the cover plate of the testing equipment.

5.8 Digital camera (option B)
Supporting a direct (or USB) communication with PC, and capable of capturing images of test fabrics digitally.

5.9 Evaluation software (option B)
Operated under Microsoft Windows 98 or above.

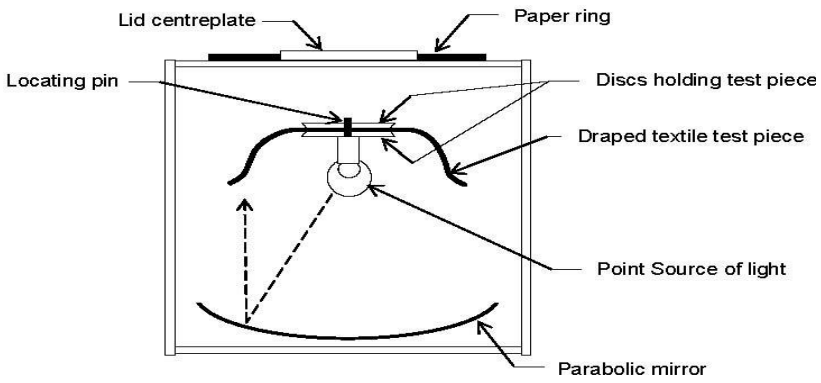


Figure 2
Test equipment

6. Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 2 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

7. Sampling

7.1 Lot Size

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

7.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 3 Results obtained on test specimens of different diameter are not directly comparable, thus in all cases tests also need to be carried out on 30 cm diameter test specimen, regardless of drape coefficient.

7.3 Test specimens

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material. Care in handling should be observed so that specimens do not contact any contaminants such as soap, salt, oil etc.

7.4 Selection of test specimen diameter

Perform a preliminary test (see clause 8) using a test specimen of 30 cm in diameter and calculate the drape coefficient (or drape ratio) for this diameter (D_{30}).

a) If the drape coefficient is in the range of 30% to 85%, use test specimens of 30cm diameter for all the tests.
b) If the drape coefficient is outside the range of 30% to 85%, in addition to testing 30cm diameter test specimens, carry out tests in accordance with c) or d) below as appropriate:
c) For limp fabrics of less than 30%, use test specimens of 24cm diameter; characterized by a drape coefficient of D30
d) For stiff fabrics of greater than 85%, use test specimens of 36 cm diameter, characterized by a drape coefficient of D30.
e) Place the test specimens on a flat horizontal surface and using a template trace the test specimens, mark the center of each and cut them out. All specimens should be free from creases or folds because they will distort the test results.
f) On each test specimen mark both sides, (a) and (b).

NOTE 4 Results obtained on test specimens of different diameter are not directly comparable, thus in all cases tests also need to be carried out on 30 cm diameter test specimen, regardless of drape coefficient.

8. Preliminary procedures

8.1 Checking the apparatus

a) Ensure that the center plate on the apparatus lid is horizontal. Adjustments can be made using a bubble level and the leveling feet on the base of the apparatus.
b) Switch on the light to verify that the filament of the light source is focused at the parabolic mirror by placing the 30 cm diameter template centrally on lower support disc of the apparatus. A centrally situated shadow of 30 cm diameter should be cast on a 36 cm diameter paper ring (or white sheeting) which is placed on the top surface of the box lid of the apparatus.

8.2 Preliminary evaluation

a) Place one fabric test specimen, face (a) downward on the lower horizontal disc of the test equipment.
b) If the specimen drapes to form folds at regular intervals around its circumference, the measurement can be carried out,
c) If the specimen has a predisposition to bend in line with two planes located on either side the support disc, do not carry out the measurement but record this fact in the test report.

9. Test procedure method - (A) using rings of paper

9.1 Apparatus

The following equipment is needed in addition to the Apparatus described in clause 5

a) Rings of translucent paper with an internal diameter of 18 cm and external diameter of 24 cm, 30 cm, and 36 cm respectively.
b) Balance, capable of determining mass to an accuracy of 0.01g

9.2 Procedure

a) Place a ring of paper of the same outside diameter as the test specimen on the apparatus lid.
b) Place the test specimen on the lower horizontal disc of the apparatus so that the locating pin passes through the center of the test specimen. Then position the top disc on the test specimen with the pin fitting into the hole in the top disc.
c) Lower the lid of the apparatus and start the stopwatch.
d) After 30s switch on the light source and without delay draw around the periphery of the shadow cast on the paper ring.
e) Remove the paper ring. Fold it so that it will fit on the balance and determine the mass, mpr of the paper ring to the nearest 0.01g.
f) Cut the paper ring around the periphery of the shadow which was traced on the paper. Discard the area of the paper ring which was not shaded, and determine the mass, msa of the residual portion of the paper ring to the nearest 0.01g.
g) Repeat procedures 9.2.a to 9.2.f on the same fabric test specimen but with the other surface (b) uppermost, using a fresh paper ring.
h) Repeat the procedures twice more on each test specimen. Three specimens tested on both sides for a total of six measurements on each test sample is the minimum number of data points for each variable.

9.3 Calculations

a) For each test specimen diameter used, carry out separate calculations in accordance with 9.3 c to 9.3 d (below).

b) For each of the six readings on each test specimen, calculate the drape coefficient, D, expressed as a percentage, using the following equation:

$$D = \frac{m_{sa}}{m_{pr}} \quad x \quad 100$$

Where

m_{pr} is the initial mass (before cutting) of the paper ring in grams;
m_{sa} is the mass of the part of the paper ring representing the shadow, in grams.

c) Calculate the mean drape coefficient, expressed as a percentage for both surfaces separately, (a) and (b).

d) Calculate the overall mean drape coefficient, expressed as a percentage.

9.4 Test report

In addition to the precise test results, the report shall include the following information:

a) Reference WSP 90.6. R4 (12)
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Diameter of template used (i.e. 30 cm, 24m or 36 cm)
f) Laboratory testing conditions
g) Number of specimens tested for each test sample
h) For computer processed data, identify the software used and the version
i) Deviation from the standard test procedure, if any
j) When calculated, the standard deviation or the coefficient of variation
k) Whether or not samples were conditioned prior to testing and, if so, for how long
l) Anything unusual noted during the testing
m) Test results for 30 cm diameter test specimens and, if appropriate, also for 24 cm or 36 cm diameter test specimens, Include the following information;
    - individual drape coefficients for each (a) and (b) side of each test specimen
    - mean drape coefficients for (a) and (b)
    - overall mean drape coefficient for each test sample
    - number of folds present in each test specimen and the overall mean for each sample

10. Procedure method (B) using an image processing technology

10.1 Apparatus

The following equipment is needed in addition to the Apparatus described in clause 5. See figures 3 and 4.

NOTE 5 The drape meter User's Manual is essential in performing this test method (B).This manual is provided with the camera and the software interface from D&M FT Corp. Ltd.

a) A frame cover and a support stand, used to attach the digital camera to the testing equipment. The stand is equipped with an 80 cm high support to hold the digital camera just above the center of the cover plate on the test equipment.
b) Digital camera supporting a direct (or USB) communication with PC and capable of capturing images of test fabrics digitally.
c) Evaluation software, operated with Microsoft Windows 98 or above. This software is capable of viewing the fabric shadow on the white sheet which is laid on the machine's top surface and then capturing and producing a three-dimensional image while transforming into the monochrome image and automatically searching the contour of the image. This software calculates the Fourier transformation and determines the drape shape parameters, while showing the various statistical results, and issues a final report.
d) A white sheet material which has a high thread count can be used as a covering for the center plate and translucent lid. This white material will catch the shadow of the specimen below. This material should be made from fibers that resist wrinkling and which lay flat on the surface.

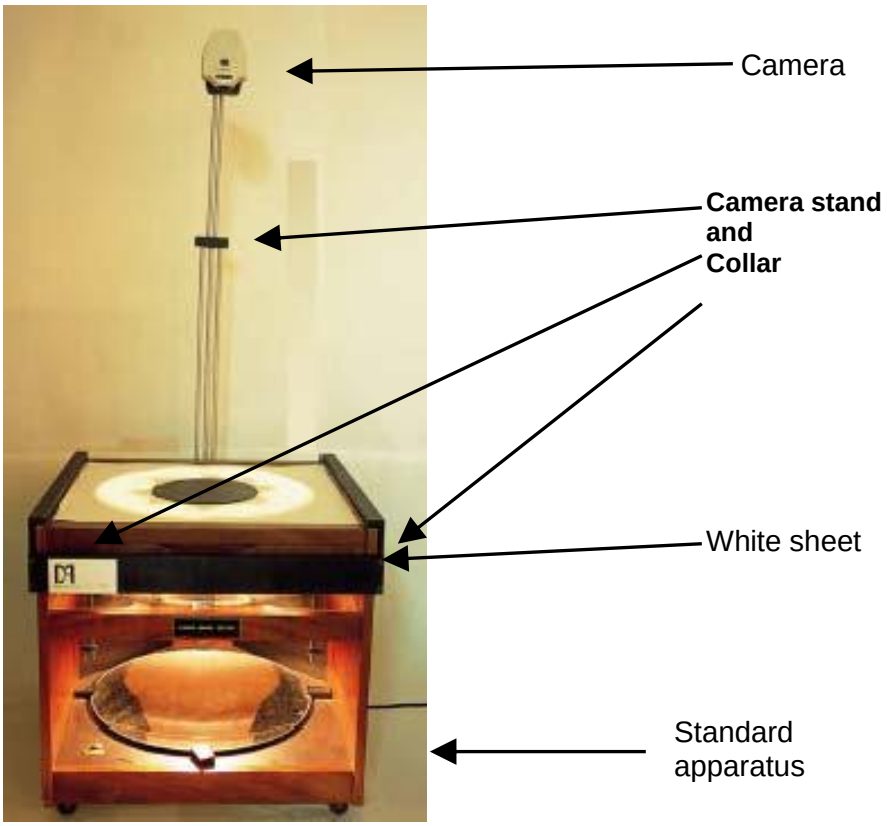


Figure 3
Drape instrument for the imaging process

NOTE 6 This image processing technology eliminates the need for rings of translucent paper and for operator to be marking, cutting, weighing and calculating.

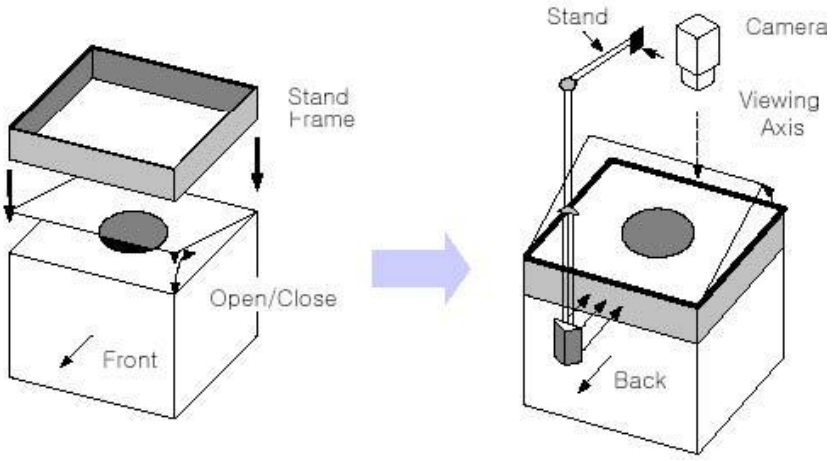


Figure 4
Drape instrument for image process

10.2 Procedure

a) Cover the lid of the drape apparatus completely with white sheeting.
b) Place the prepared test specimen on the lower 18 cm supporting plate of the apparatus so that the locating pin passes through the center of the test specimen. Then position the top 18 cm disc on the test specimen with the pin fitting into the hole in the top disc.
c) Lower the lid of the apparatus and start the stopwatch.

NOTE 7 Lowering the lid will remove the support from the test specimen. This will allow the specimen to drape, making the timing critical.

NOTE 8 Care should to be taken to center the camera image before the image is saved

d) After 30s switch on the light source.
e) Without delay execute the evaluation software. Capture the digital shadow image which is present on the white sheeting by clicking the camera icon
f) Input the parameter setting by selecting the diameter of the test specimen.
g) Click “Image capture” and make camera adjustments on the “View Finder” screen. First click the adjustments setting and set the settings as shown on page 18 of the owner’s manual.
h) Click to save the captured image using the same “View Finder” screen.
i) On the “Threshold Determination” screen
    - Check [√] Overlay Move both slides all the way to the left or Ø
    - Move the slide marked “darker than” until the draped image is completely blue
    - Move the slide marked “brighter than” until the supporting plate becomes completely black. See page 20 of the user’s manual.
    - Turn off the Overlay
    - Click [OK]
j) At the “processed image” screen the noise can be edited

k) If the black and white image (after the calibration step 10.2.i) is noisy (spots of white in the black or black spots in the white) use the tools on the left side of the screen to clear the image. Press the desired shape button [i.e. O, 0, □].Use the left side of the mouse to fill in space and the right side of the mouse to erase space. See pages 22 – 24 of the user's manual.

l) To perform drape analysis, press the "3-D model" icon. This will bring out the fabric shape generator.
   - Press the left side of the mouse and drag to move the 3-D images.
   - Press the "texture" button and select the desired pattern to add pattern to the original image.

m) Click the "results" button to bring up the "Measurement result screen". See Figure 5 below.

n) The drape shape parameters and statistics are all calculated automatically.

o) Print the testing report.

p) Repeat the steps 10.2 (b) to 10.2 (o) on the same test specimen but turn the specimen over and test the other surface.

q) Repeat the procedures twice more on each test specimen. Three specimens tested on both sides for a total of six measurements on each test sample is the minimum number of data points for each variable.

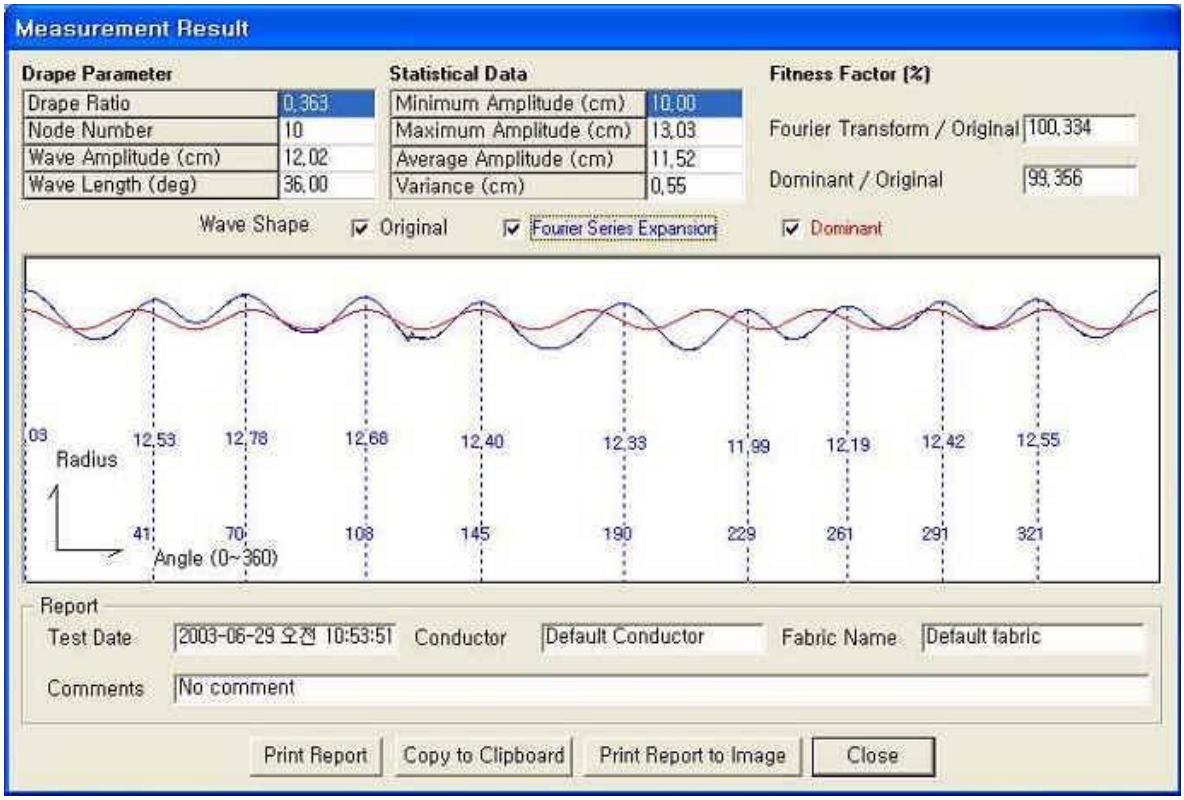


Figure 5
Example

10.3 Calculations

10.3.1 For each test specimen diameter used

Carry out separate calculations

10.3.2 For each of the six readings on each test specimen

Calculate the following, which is automatically obtained from the evaluation software (10.1 c) (Figure 5);

a) Drape Ratio, the drape coefficient, D, expressed as a percentage, using the following equation;

$$DrapeCoefficient(\%) = \frac{A_s - A_d}{A_o - A_d} \times 100$$

Where
A_o A_d and A_s are the original area of an undraped specimen, the area of a supporting plate, and the projected shadow area of the specimen after draping, respectively.

b) Node number is one of the drape shape parameters expressed in the number of drape waves/folds.
c) Wave amplitude is one of the drape shape parameters indicating the size (in centimeters) of the most dominant drape waves/folds.
d) Wavelength is one of the drape shape parameters indicating the wavelength of the most dominant drape waves/folds expressed in degrees of a circle (0° to 360°).
e) Minimum Amplitude is one of the statistics indicating the smallest size drape waves/folds, expressed in centimeters.
f) Maximum Amplitude is one of the statistics indicating the largest size drape waves/folds present, expressed in centimeters.
g) Average Amplitude is one of the statistics indicating the mean drape waves/folds present, expressed in centimeters
h) Variance is one of the statistics indicating the difference of the drape waves/folds amplitude distribution, expressed in centimeters.
i) Fourier Transform/Original and Dominant/Original are the three fitness factors to verify the fit of the Fourier transformation and to determine the dominant wave, expressed in percentages, using the following equation:

$$FourierTransform/Original(\%) = \frac{B_f}{B_o} \times 100$$

$$Dominant/Original(\%) = \frac{B_d}{B_o} \times 100$$

Where:
B_o and B_f and B_d are areas of the original captured draped image, its Fourier transformed shape, and the ideal shape re-composed from a determined dominant wave, respectively, as shown in Figure 5.

j) Graph, in polar coordinate, where (X-axis from 0° to 360°) is the wavelength (degrees) from the baseline passing through the center of the center plate (5.1.c) and r (Y-axis) is the amplitude (cm), representing each value of wave amplitude and wavelength at each node.

10.3.3 Calculate the mean drape coefficient

Calculate the mean drape coefficient, drape shape parameters, statistics and fitness factors for face A and for face B.

10.3.4 Calculate the overall mean drape coefficient

Calculate the overall mean drape coefficient, drape shape parameters, statistics and fitness factors.

10.4 Test report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method WSP 90.6
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) For computer processed data, identify the software used and the version
g) Deviation from the standard test procedure, if any
h) When calculated, the standard deviation or the coefficient of variation
i) Whether or not samples were conditioned prior to testing and, if so, for how long
j) Anything unusual noted during the testing
k) Diameter of template (i.e. 30cm and, if appropriate, 24cm or 36cm);
l) Test results (see clause 7.4) for 30cm diameter test specimens, if appropriate, also for 24cm or 36cm diameter test specimens, as follows;
    - individual drape coefficients, drape shape parameters, statistics and fitness factors for each face of each test specimen,
    - mean drape coefficients, drape shape parameters, statistics and fitness factors for face A and for face B,
    - overall mean drape coefficient, drape shape parameters, statistics and fitness factors,

11. Precision

The precision for this method is yet to be determined.

STANDARD TEST: WSP 100.1.R3 (12)

Standard Test Method for Tearing Strength of Nonwoven Fabrics by Falling-Pendulum (Elmendorf) Apparatus

The number in parentheses indicates the year of the last revision

1. Scope

This test method covers the measurement of the average force required to propagate a single-rip tear starting from a cut in a nonwoven fabric using a falling-pendulum (Elmendorf) apparatus.

This Elmendorf tearing apparatus is supplied with interchangeable pendulums. This apparatus normally has the capability of determining tearing strength up to 6400 grams-force, for tearing strengths above 6400 grams-force, a high-capacity test instrument is available and is equipped with augmenting weights to increase the capacity.

It is recognized that some of these older test instruments with augmenting weights still continue to be useful standards in the nonwoven industry.

This test method is applicable to most nonwoven fabrics that are treated or untreated, provided the fabric does not tear in the direction crosswise to the direction of the force applied during the test. If the tear does not occur in the direction of the test, the fabric is considered untearable in that direction by this test method.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Reference number
WSP 100.1.R3 (12) A

Current edition approved WSP 100.1.R3 (12)
Originally published as WSP 100.1 in 2002
Last approved as WSP 100.1 in 2009

2.1 ISO test methods

a) ISO 139-2005 Textiles — Standard atmospheres for conditioning and testing
b) ISO 2859-1:1999 Sampling procedures for inspection by attributes
c) ISO 3951-1:2005 Sampling procedures for inspection by variables
d) ISO 10012 Measurement management systems — Requirements for measurement processes and measuring equipment (calibrating equipment)

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Length of tear

In tensile testing, the length of valuable fabric to be torn, as measured on the fabric before tearing.

3.2 Tearing energy

In tensile testing of fabrics, the work done in tearing the specimen.

3.3 Tearing force

The average force required to continue a tear previously started in a fabric. For nonwovens, the tearing force is recorded as the maximum force required to continue a tear previously started in a fabric.

3.4 Tearing strength

The force required either to start or to continue or spread a tear in a fabric under specified conditions.

4. Principle

The force required to continue a slit previously cut in a nonwoven fabric is determined by measuring the work done in tearing it through a fixed distance. The tester consists of a sector-shaped pendulum carrying a clamp which is in alignment with a fixed clamp when the pendulum is in the raised, starting position with maximum potential energy. The specimen is fastened in the clamps and the tear is started by cutting a slit in the specimen between the clamps. The pendulum is then released and the specimen is torn as the moving jaw moves away from the fixed one. The scale attached to the pendulum is graduated to read the tearing force of the specimen.

Compared to other methods for testing tearing strength this test method has the advantage of simplicity and speed since specimens are cut with a die and results are read directly from the scale on the pendulum. The specimens are relatively small in area, thus require less fabric. The reading obtained is directly proportional to the length of the material torn, therefore, it is essential that the specimen be prepared to the exact size

specified. For best results, the recommended capacity of the tester selected is the one where the specimens tear between 20 and 80 % of the full-scale value.

Instrument models are available with pneumatically operated clamps and removable pendulums and are recommended for this test. In addition, laboratory software systems for automatic collection of data can provide economical and reliable results when properly calibrated.

5. Apparatus

5.1 Falling-Pendulum-(Elmendorf) Type Tester

The tester includes: a stationary clamp, a movable clamp carried on a pendulum formed by a sector of a circle that is free to swing on a bearing, means for leveling, knife mounted on a stationary post for starting a tear, means for holding the pendulum in a raised position, means for instantly releasing the pendulum, and means for registering the maximum arc through which the pendulum swings when released, and a graduated scale mounted on the pendulum.

a) The tester may have a pointer mounted on the same axis as the pendulum that is used to register the tearing force, or it may be substituted by means of calculating and displaying the required results without the use of a pointer, such as digital display and computer-driven systems. The clamps may preferably be air actuated, but manual clamping is permitted. The pendulum must have a cutout above the clamp that prevents the specimen from coming in contact with the sector during the test.
b) The standard test instrument should be equipped with an interchangeable pendulum of the required capacity. Interchangeable pendulum models are available in capacities of 1960, 3920, 7840, 15680, 31360, and 62720 mN (200, 400, 800, 1600, 3200, and 6400 gf). The pendulum is equipped with a scale reading directly in percentage of its capacity.
c) The high-capacity instruments have a 62720-mN (6400-gf) capacity pendulum with available augmenting weights to increase the capacity to 125540, and 250880 mN (12 800 and 25 600 gf). The tester is equipped with scales reading directly in hectograms (100-gf units) for each capacity.

5.2 Calibration weight

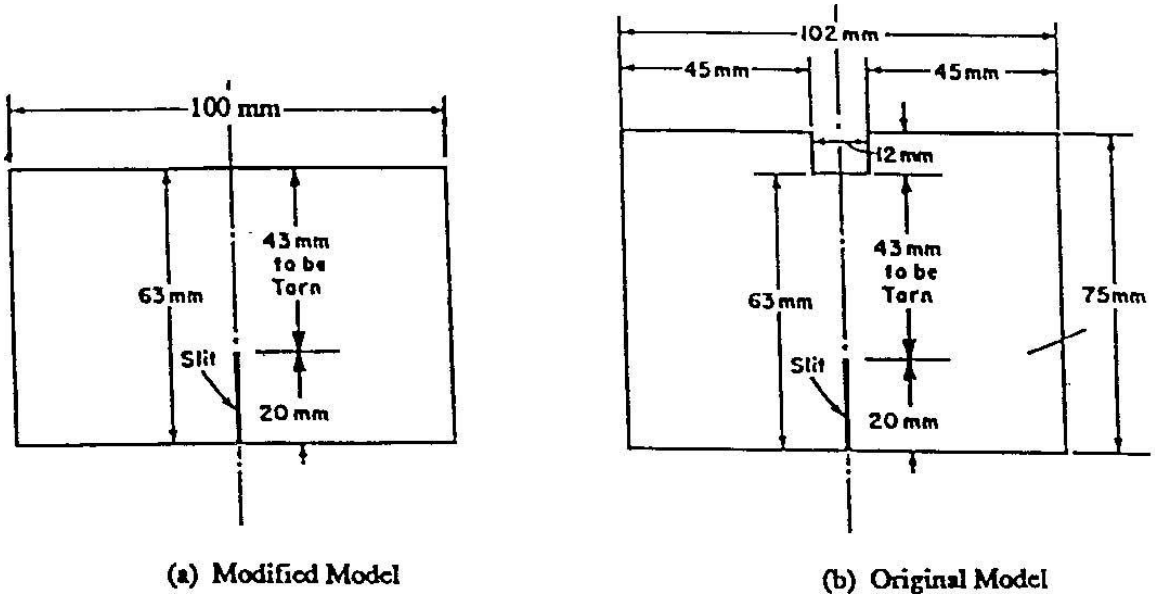
For graduation of 50 % of scale, one required for each capacity pendulum, or,

Optional, Three-Check-Weight Set, for 20, 50, and 80 % of scale. Each capacity requires its own set of weights. When required, calibration weights are available from the manufacturer for high-capacity instruments.

NOTE 2 While calibration weights are made with scale values of 20, 50, and 80 % of scale, it is not absolutely necessary to utilize a complete set. It is acceptable to use one calibration weight which is in the range of the expected test results, generally 50 % of the scale in use.

5.3 Cutting die

Having essentially the shape and dimensions shown in figure. 1(*a*) or 1(*b*). Either die provides the basic rectangular test specimen 100 ± 2 mm long by 63 ± 0.15 mm wide. The critical dimension of the test specimen is the distance 43.0 ± 0.15 mm that is to be torn during the test.



All tolerances are ± 0.5%

Figure 1

Example of die for cutting notched specimens

NOTE 3 The modified die model shown in figure 1(a) is typically used for nonwoven fabric testing. The original die model shown in figure 1(b) was that used in woven fabric testing. Either die may be used. These dies can be made to order by most die manufacturers.

5.4 Air pressure regulator

Capable of controlling air pressure between 410 and 620 kPag, when applicable, for air clamps.

5.5 Setting gage

Cutting blade that will provide a cut slit that leaves a 43 ± 0.15 mm specimen tearing distance for a 63 ± 0.15 mm wide specimen, or equivalent.

5.6 Jaw spacing gage

2.8 ± 0.3 mm width or equivalent

5.7 Oil

Lightweight, non-gumming clock type

5.8 Silicone grease

When applicable, for air clamp lubrication

5.9 Vacuum cleaner

When applicable, for cleaning dust and fiber from pendulum scale sensor, or equivalent

6. Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 4 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

7. Sampling

7.1 Lot Size

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

7.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 4 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

7.3 Test specimens

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material.

a) Care in handling should be observed so that specimens do not contact any contaminants such as soap, salt, oil etc., which might facilitate or hinder water penetration.
b) Specimens should be cut in accordance with figures 1a and 1b.
c) Unless otherwise specified, cut specimens in each direction (MD and CD), evenly spaced across the available width of each sample.

8. Preparation of Apparatus and Calibration

8.1 For the standard test instrument

Select the pendulum that will cause the tear to occur between 20 and 80 % of the full-scale range. Secure the pendulum to the instrument, set the jaw spacing to 2.8 ± 0.3 mm. Loosen the shoulder head screw on top of the pendulum support. With both clamps in the open position, gently pull the pendulum out until the jaw spacer gage will fit into the grips. Gently push the pendulum in until the jaw spacer gage has just enough clearance to slide out the top of the clamps. With the jaw spacer in place, tighten the shoulder head screw on the pendulum support. Remove the jaw spacer gage.

For the high-capacity test instrument, when required, select the augmenting weight such that the tear occurs between 20 and 80 % of the full-scale range. Secure the augmenting weight to the pendulum.

8.2 When equipped with a registering sensor

Examine the scale and the complementary black sensor strip along the bottom edge of the pendulum. Using care and without touching the sensor, vacuum away any loose fibers and dust.

8.3 Examine the knife edge for sharpness, alignment and tearing distance

If the knife is dull it will produce a V-notch near the top of the cut and push the material outward. When the knife is determined to be dull, sharpen it with a rough stone, alternately, continuing specimen knife cuts, until no V-notch is observed. Replace the knife blade as necessary.

a) Knife alignment—Check that the knife position is centrally located between the clamps. If the knife cannot be positioned centrally, replace one or any combination thereof: the pendulum bearing and shaft assembly, the cutter handle bearing pin, knife blade.
b) Specimen tearing distance—Check the specimen tearing distance with the knife setting gage. Place the gage in the stationary specimen clamp in the usual manner for testing material. Ensure the gage is positioned with the wide dimension upwards and the projection extending over the edge of the stationary clamp far enough so that the knife can be adjusted to the bottom edge of the gage. Adjust the knife position such that the highest point of the blade just touches the bottom edge of the gage and then secure it in place. Replace the knife when it no longer can be adjusted to the gage. Also the use of a go-no-go gage available from the manufacturer of the instrument can be used. If necessary, adjust the height of the knife

8.4 For air clamps

Set the air pressure to the clamps to about 550 kPag.

Maximum pressure should be no more than 620 kPag and minimum pressure no less than 410 kPag.

8.5 When using computer automatic data gathering system

Set the appropriate parameters as defined in the manufacturer's instructions.

8.6 Verify the calibration of the selected capacity pendulum scale

Use ISO 10012 as a guidance document when calibrating equipment.

Use one check weight calibrated for a value of 50 % of the Elmendorf tester scale. Each capacity scale requires its own check weight, for example, at 800 g of the 1600-g scale. The check weight shall be constructed such that each weight can be inserted in the clamps by the procedure used for a fabric specimen and having the bulk of the check weight mass facing downward. The useable portion of the scale is 20 to 80 %.

8.7 The scale may be verified

By a relatively simple procedure which uses one Elmendorf check weight, the single-weight procedure described in this section has been recommended for use to 80 % of scale.

a) Position the pendulum in its cocked position against the stop and set the digital readout, or pointer, to zero.
b) Depress the pendulum stop downward to its limit and hold it until the pendulum has completed its forward swing. Catch the pendulum by hand just after the threshold of its backward swing and return it to its locked starting position. The pointer, or when equipped, the digital readout should read 0.00. In any event, do not change the level of the instrument to adjust the zero.

c) For the pointer system, if zero (0.00) and 50 % readings are not obtained, clean and oil the bearing and sleeve per manufacturers instructions..
d) For digital readout systems, if zero (0.00) and 50 % readings are not obtained, loosen the thumb screw securing the photo sensor to the base and move the whole assembly “Right” to increase reading, or “Left” to decrease reading, as required. Continue alternating making small adjustments of the photo sensor until the target values of 00.0 and 50 % are obtained

9. Procedure

9.1 Raise the pendulum to the starting position

Set the pointer against its stop.

9.2 For tester slit specimens

a) Place the long sides of the specimen centrally in the clamps with the bottom edge carefully set against the stops and the upper edge parallel to the top of the clamps. Close the clamps, securing the specimen with approximately the same tension on both clamps. The specimen should lie free with its upper area directed toward the pendulum to ensure a shearing action.
b) Push down on the handle of the built-in knife blade cutting a 20 ± 0.15 mm slit in the specimen using the pendulum knife extending from the bottom edge and leaving a balance of fabric 43.0 ± 0.15 mm remaining to be torn.

9.3 For die cut or manually slit specimens

a) If a die without a slit is used, manually cut a 20 ± 0.15-mm long slit in the center of one edge of the long direction of the specimen. Ensure that the balance of the fabric remaining to be torn is 43 ± 0.15 mm. The length of the cut is important when tearing energy is determined.
b) Place the parallel, unslit sides of the specimen in the clamps with the bottom edge carefully set against the stops, the upper edge parallel to the top of the clamp and the slit centrally located between the clamps. Close the clamps, securing the specimen with approximately the same tension on both clamps. The specimen should lie free with its upper area directed toward the pendulum to ensure a shearing action.

9.4 For wet specimens

Remove the specimens from the water and immediately mount it on the testing machine in the normal set up. Perform the test within two minutes after removal of the specimen from the water.

9.5 Depress the pendulum stop downward

To its limit and hold it until the tear is completed and the pendulum has completed its forward swing. Catch the pendulum by hand just after the threshold of its backward swing and return to its locked starting position for additional test. When equipped, be careful not to disturb the position of the pointer.

a) The decision to discard the results of a tear shall be based on observation of the specimen during a test and upon the inherent variability of the material. In the

absence of other criteria, such as in a material specification, if an unusual cause is detected, the value may be discarded and another specimen tested.

b) Reject readings obtained where the specimen slips in the jaw or where the tear deviates more than 6 mm away from the projection of the original slit. Note when puckering occurs during test.

c) When using a computer data collection system, follow the manufacturer's directions for removing values from memory when the decision to discard a tear value has been made, otherwise for some test instruments, manual calculation of the average is required.

d) If, during application of the tearing force to the specimen, the force does not reach 20 % or reaches over 80 % of full-scale range, change to the next lower or higher full-scale range, as applicable. See 8.6.

e) Record if the tear was crosswise to the normal (parallel) direction of tear and describe that specimen, or that sample, as applicable, as untearable.

9.6 Remove the torn specimen

Continue until the proper number of tears have been recorded for each direction (MD and CD), as required, from each laboratory sampling unit.

9.7 When all samples

Have been tested and calculations completed, place the pendulum in the rest position (free hanging).

10. Calculation

10.1 Tearing force, individual specimens

10.1.1 Standard test instrument

Determine the Elmendorf tearing force for individual specimens to the nearest millinewton (gram-force) using Eq 1:

$$F = R \times C/100 \quad (1)$$

Where:

F = tearing force, mN (gf)
R = scale reading, and
C = full-scale capacity, mN (gf)

10.1.2 High capacity test instrument

Determine the Elmendorf tearing force for individual specimens to the nearest mN (gf) using Eq 2:

$$F = R \times 1000 \quad (2)$$

Where:

F = tearing force, mN (gf), and
R = scale reading, mN (gf).

NOTE 4 mN = gf/9.81.

10.2 Tearing strength

Calculate elmendorf tearing strength as the average tearing force for each principal direction of the laboratory sampling unit and for the lot.

10.3 Standard deviation and coeffıcient of variation

Calculate when required.

10.4 Computer processed data

When data is automatically computer processed, calculations are generally contained in the associated software. Record values as read from the direct reading scale to the nearest millinewton (gram-force). In any event, it is recommended that computer processed data be verified against known values and its software described in the report.

11. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make, model, and capacity of testing machine
e) Laboratory testing conditions
f) Number of specimens tested and note CD and/or MD if significant
g) For computer processed data, identify the software used and the version
h) Deviation from the standard test procedure, if any
i) When calculated, the standard deviation or the coefficient of variation
j) Whether or not samples were conditioned prior to testing and, if so, for how long
k) Anything unusual noted during the testing
l) Puckering, if it occurs during the test
m) Number of tests rejected because of crosswise tearing
n) Type of clamps used
0) Test condition of the specimens (dry or wet)

12. Precision

The precision for this method is yet to be determined.

STANDARD TEST: WSP 100.2.R3 (12)

Standard Test Method for Tearing Strength of Nonwoven Fabrics by the Trapezoid Procedure

This version (05) includes both INDA IST 110.2 (01) and EDANA ERT 70.4-99 as a harmonized method

The number in parentheses indicates the year of the last revision

1. Scope

This test method covers the measurement of the tearing strength of nonwoven fabrics by the trapezoid procedure using a recording constant-rate-of-extension (CRE) tensile testing machine.

The CRE-type tensile testing machine has become the preferred test apparatus for determining trapezoid tearing strength. It is recognized that some constant-rate-of-traverse (CRT) tensile testing machines continue to be used. As a consequence, these test instruments may be used when agreed upon between the purchaser and the supplier. The conditions for the CRT-type tensile tester as used with this test are included in Annex 1.

This test method applies to most nonwoven fabrics, treated or untreated, heavily sized, coated or resin-treated. This test method may not be useful for highloft nonwoven fabrics.

Trapezoid tear strength as measured in this test method is the maximum tearing force required to continue or propagate a tear started previously in the specimen. The reported value is not directly related to the force required to initiate or start a tear. This test method provides values in SI units.. The International System of Units (SI units) are the customary metric units used in most of the rest of the world.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document:

Reference number
WSP 100.2.R3 (12) A

Current edition approved WSP 100.2.R3 (12)
Originally published as WSP 100.2 in 2002
Last approved as WSP 100.2 in 2005

2.1 ISO test methods

a) ISO 5725-1 Accuracy (trueness and precision) of measurement methods and results – Part 1: General principles and definitions

b) ISO 5725-2 Accuracy (trueness and precision) of measurement methods and results – Part 2: Basic method for the determination of the repeatability and reproducibility of a standard measurement method

c) ISO 139:Textiles — Standard atmospheres for conditioning and testing

d) ISO 3951-1:2005 Sampling procedures for inspection by variables

e) ISO 2859-1:1999 Sampling procedures for inspection by attributes

f) ISO 9073 – 4:1997 Textiles – Test methods for Nonwovens – Part 4 Determination of Tear Resistance

2.2 WSP test methods

a) WSP 001.0.R3.(12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Machine direction (MD)

The long direction within the plane of the fabric that is in the direction in which the fabric is being produced by the machine

3.2 Cross machine direction (CD)

The width dimension within the plane of the fabric that is perpendicular to the direction in which the fabric is being produced by the machine

3.3 Tearing force

For nonwovens, the tearing force is recorded as the maximum force required to continue a tear previously started in a fabric. The tearing force may appear as a single peak or a series of peaks on a force-extension curve, depending on the nature of the material. Typically for nonwoven fabrics, if a small decrease in force occurs at a time when the applied force is increasing, it is not considered as a peak unless the indicated force exceeds the force required to break, individually or collectively, the fibers, fiber bonds, or fiber interlocks. Lower shifts corresponding to fiber movement do not qualify as peaks since the fibers, fiber bonds, or fiber interlocks are not broken. The trapezoid tearing force may be calculated from a single-peak or multiple-peak force-extension curve.

3.4 Tearing strength

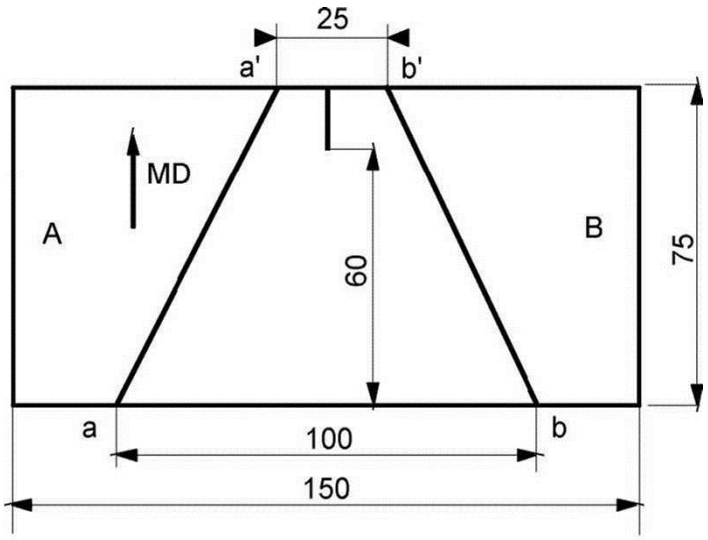
The force required either to start or to continue or propagate a tear in a fabric.

4. Principle

An outline of an isosceles trapezoid is marked on a rectangular specimen cut for the determination of tearing strength (see Figure 1). The specimen is slit at the center of the smallest base of the trapezoid to start the tear. The nonparallel sides of the trapezoid marked on the specimen are clamped in parallel jaws of a tensile testing machine. The

separation of the jaws is continuously increased to apply a force to propagate the tear across the specimen. At the same time, the force developed is recorded. The maximum force to continue the tear is calculated from autographic chart recorders, or microprocessor data collection systems.

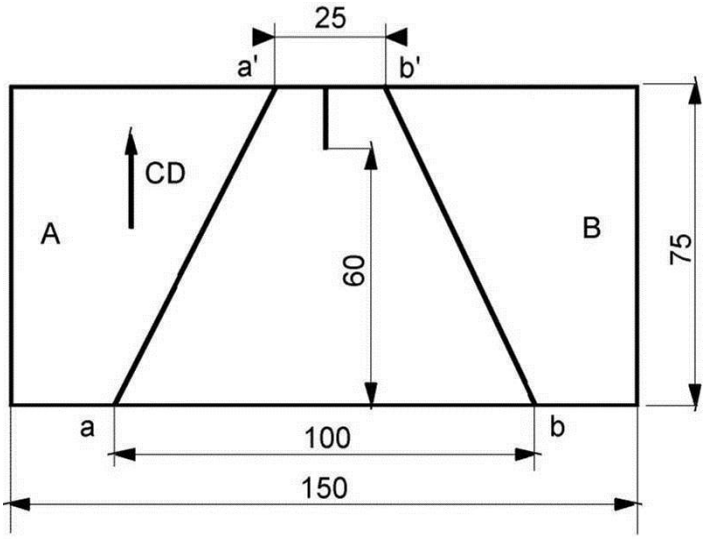
Figure 1



MD Tear

NOTE 2 **When preparing the test specimen remember** that the long direction of the specimen, 150 mm side is the opposite direction of the tear. A specimen with the CD cut at 150 mm and the MD cut at 75 mm will be a MD specimen and the reverse is true for the CD specimen.

Figure 2



CD Tear

5. Apparatus

5.1 Tensile testing machine,

The constant-rate-of-extension (CRE) type conforms to the requirements of this test method with autographic recorder, or automatic microprocessor data gathering systems.

5.2 Clamps

The clamps shall have all gripping surfaces parallel, flat, and capable of preventing slipping of the specimen during a test, and measure at least 50 x 75 mm, with the longer dimension perpendicular to the direction of application of the force.

a) The use of hydraulic pneumatic clamping systems shall have a minimum of 50 x 75-mm serrated or rubber jaw faces having a clamping force at the grip faces of 13 to 14 kN is recommended. Manual clamping is permitted providing no slippage of the specimen is observed.

b) For some materials, to prevent slippage when using jaw faces other than serrated, such as rubber-faced jaws, they may be covered with a No. 80 to 120 medium-grit emery cloth. Secure the emery cloth to the jaw faces with pressure sensitive tape.

5.3 Cutting die or template

By whatever means the specimens are cut and marked out they shall have the dimensions shown in Figures 1 and 2 with tolerances of ± 0.5 %.).

6. Sampling

6.1 Lot Size

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

6.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables (“s” method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 3 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer’s risk, consumer’s risk, acceptable quality level, and limiting quality level.

6.3 Test specimens

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material.

a) Care in handling should be observed so that specimens do not contact any contaminants such as soap, salt, oil etc., which might facilitate or hinder water penetration.
b) Specimens shall be cut 75 x 150 mm and marked as illustrated in Figures 1 and 2.
c) Unless otherwise specified, cut 5 specimens in each direction MD and CD, evenly spaced across the available width of each sample.
d) It is important that the cutting out of the specimen including the start of the tear is perfect to avoid any negative influence on the result and that the specimen is cut perfectly squire with the direction of the test (MD and CD).

7. Preparation of Apparatus

7.1 Set the distance between the clamps

At the start of the test the distance between clamps shall be at 25 ± 1mm. Select the full-scale force range of the testing machine such that the maximum force occurs between 15 and 85 % of full-scale force.

7.2 Setting the constant rate of speed

This speed setting has two options:

a) To set the testing speed at 100 mm/min
b) To set the testing speed at 300 ± 10 mm/min.

7.3 Verify calibration

Calibrate the tensile testing machine as directed in the manufacturer’s instructions.

7.4 When using microprocessor automatic data gathering systems

Set the appropriate parameters as defined in the manufacturer’s instructions.

8. Conditioning

8.1 Standard testing conditioning:

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 4 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

8.2 Wet specimen conditioning testing

Place the specimens in a container and submerge in distilled or deionized water at ambient temperature until thoroughly soaked. The time of immersion must be sufficient to wet the specimens, as indicated by no significant change in tearing force followed by longer periods of immersion. For most fabrics this time period will be about one hour. For fabrics not readily wet with water, such as those treated with water-repellent or water-resistance materials, add a 0.1 % solution of a nonionic wetting agent to the water bath.

8.3 Unspecified testing conditioning

No preconditioning of test specimens is done only if all parties agree and this deviation is noted on the test report.

9. Procedure

9.1 Condition the test specimens

Test the specimens in one of the three atmospheres located in clause 9 and include that condition in the final report.

9.2 Secure the test specimen in the machine

Clamping along the nonparallel sides of the trapezoid such that the end edges of the clamps are in line with the 25 mm long side of the trapezoid, and the cut is halfway between the clamps. Hold the short edge taut and let the remaining fabric lie in folds. See figure 3.

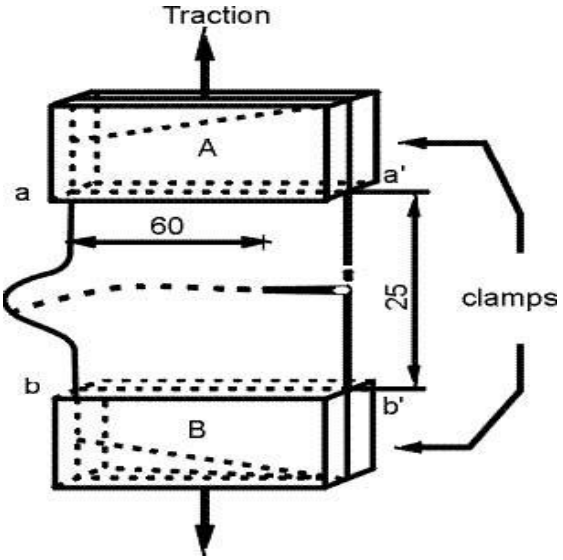


Figure 3

9.2.1 For wet specimens

If the tear resistance in the wet state is required, soak the test pieces, without conditioning, for at least 1 h in a solution containing 1 g of a non-ionic wetting agent per liter of distilled water. Remove a test piece, shake off excess water, and test immediately. Repeat the operation for each of the other test pieces. If another liquid is used this must be mentioned. If more than 2 min elapse between taking the wet specimen from the water bath and starting a tensile testing machine, discard the specimen and take another.

9.3 Start the machine

And record the tearing force on the recording device. The tearing force may increase to a simple maximum value, or may show several maxima and minima, as shown in figure 4.

9.3.1 After the crosshead has moved to produce approximately 6 mm of fabric tear

Record the maximum tearing force and continue until the test specimen is fully torn through. Stop the crosshead motion after a total clamp separation of approximately 75 mm or the fabric has torn completely across and return the crosshead to its starting position.

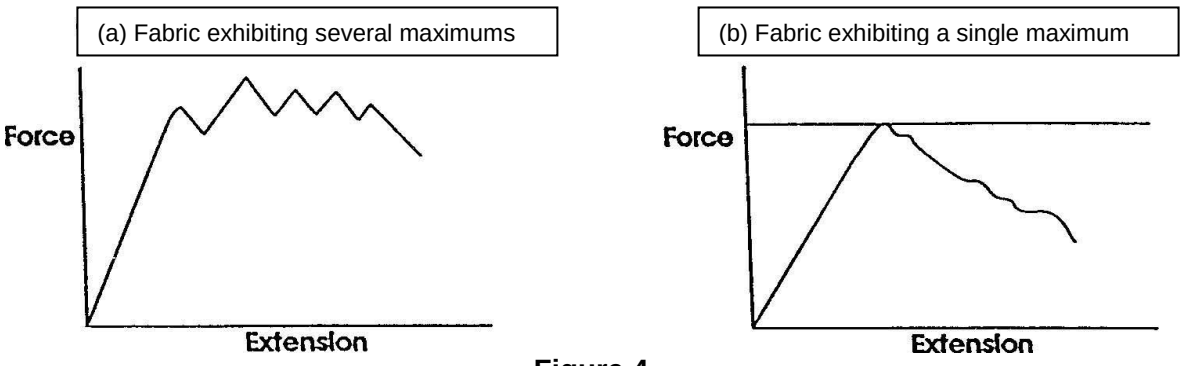


Figure 4

Typical Trapezoid Tearing Force-Extension Curves for Individual Test Specimens

NOTE 5 Do not include the measurement if the test specimen does not tear at the cut.

9.3.2 If a fabric slips in the jaws

Or if 25 % or more of the specimens break at a point within 6 mm of the edge of the jaw, then that specimen measurement is disregarded. To alleviate these problems: the jaws may be padded, the fabric may be coated under the jaw face area, or the jaw face may be modified. If any of these modifications are used, state the method of modification in the report.

NOTE 6 If 25% or more of the specimens break at a point within 6 mm of the edge of the jaw after making the modifications described in 10.3.2 consider the fabric un-tearable by this test method.

9.4 Remove the tested specimen

And continue as directed in 10.2-10.3.2 until five specimens have been tested for each principal direction (MD and CD) from each laboratory sampling unit.

NOTE 7 The following two notes (note 8 and note 9) are from EDANA's ERT 70.4-99 and are included in this procedure because of the difference in the jaw displacements in the two procedures. The WSP 100.2.R3 method indicates approximately 75 mm and WSP 070.4 indicates displacement of the clamps reaching 64 mm. Both options are valid.

NOTE 8 The displacement of the clamps is measured with the starting distance between the clamps at 25 mm. The tear propagation resistance is recorded until the test specimen breaks completely, but the results are only valid up to the displacement of the clamps reaching 64 mm. Beyond this value, the measured tear force is reduced by the proximity of the border of the test piece. For this reason, the significant peak loads to be considered are those corresponding to the displacement of the clamps below the limit of 64 mm.

NOTE 9 Where electronic recording machines are used, it is possible to obtain a mean force for each test specimen, which is then averaged to give the final result.

10. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model and capacity of testing machine
e) Laboratory testing conditions
f) Number of specimens tested and note CD and MD
g) For computer processed data, identify the software used and the version
h) Deviation from the standard test procedure, if any
i) When calculated, the standard deviation or the coefficient of variation
j) Whether or not samples were conditioned prior to testing and, if so, for how long
k) Anything unusual noted during the testing
l) Test condition of the specimens (dry or wet)
m) Type of clamps used

11. Precision

11.1 Precision summary

Preliminary interlaboratory test data have shown that the variance in testing tearing strength of nonwoven fabrics by this test method is dependent upon the nominal tearing strength and to some extent the manufacturing method of the material under evaluation. Therefore, no general statement can be made concerning least critical differences. The following data were generated during the interlaboratory test and are presented for reference. In comparing two averages of five observations, the difference between averages should not exceed the following values in 95 out of 100 cases when all the observations are taken by the same well-trained operator using the same piece of equipment and specimens are randomly drawn from the same sample having a nominal tearing strength indicated.

Nominal Tearing Strength (lbf) (Critical Differences)	Tearing Strength (lbf) (Critical Differences)
Machine Direction	
0.50	0.09
2.30	0.42
3.15	0.82
18.60	3.52
Transverse Direction	
0.45 (Meltblown)	011
0.50 (Wet Laid)	0.06
0.55 (Dry Laid)	0.12
0.70 (Resin Bonded)	0.16
0.84 (Thermal)	0.29
7.75 (Hydroentangled)	0.83

Table 1

ANNEX A
(Informative)

STATISTICAL RESULTS OF INTERLABORATORY TESTS

Figures for the repeatability and reproducibility of this method are the result of collaborative studies carried out in 1992 by INDA. The evaluation of the interlaboratory test was carried out in accordance with ISO 5725-2 and results as follows:

An interlaboratory test was run in 1992 in which randomly drawn samples of six materials were tested in each of six laboratories utilizing the dry condition. Data from two laboratories was deleted as obvious outliers when procedural errors were found to be present. Two operators in each laboratory tested five specimens of each material. The six materials used in this evaluation were all manufactured by different processes. Analysis of the data was completed using ISO 5725 -2. It suggested reporting the components of variance and least critical differences based upon nominal tearing strength, with some interaction based on the manufacturing method. The components of variance, expressed as standard deviations, for each nominal tearing strength, and where appropriate the method of manufacturing, are listed in table A 1 (see Note A 1).
For the components of variance listed in table A 1, the average of two observed values should be considered significantly different at 95% probability level if the difference equals or exceeds the critical differences listed in table A 2. See Note A 2.

Components of variance as standard deviations*

Tearing strength expressed in pounds-force

Nominal Tearing Strength	Single Operator Component	Within Laboratory Component	Between Laboratory Component
Machine Direction			
0.50	0.07	0.06	0.06
2.30	0.33	0.44	0.57
3.15	0.66	0.46	0.76
18.60	2.84	1.89	2.00
Transverse Direction			
0.45 (Meltblown)	0.09	0.08	0.06
0.50 (Wet laid)	0.05	0.10	0.03
0.55 (Dry laid)	0.10	0.10	0.06
0.70 (Resin bonded)	0.13	0.16	0.12
0.84 (Thermal)	0.23	0.13	0.08
7.75 (Hydroentangled)	0.67	1.25	0.00

*lbf x 4.45 = newtons

Table A 1

Due to the dependence of the components of variance on nominal tearing strength and to some extent the manufacturing process no meaningful statement can be made at this time relative to between material comparisons.

NOTE A 1 The square roots of the components of variance are listed in Table A 1 so that the variability is expressed in the appropriate units of measure rather than as the square of those units of measure.

NOTE A 2 The square roots of the components of variance are listed in Table 2 so that the variability is expressed in the appropriate units of measure rather than as the square of those units of measure.

NOTE A 3 The values of the tabulated differences should be considered to be a general statement, particularly with respect to between-laboratory precision. Before a meaningful statement can be made about two specific laboratories, the amount of statistical bias, if any, between them must be established with each comparison being based on recent data obtained on specimens taken from a lot of material of the type being evaluated so as to be as homogeneous as possible, and then randomly assigned in equal numbers to each of the laboratories.

Critical difference for conditions noted 95% probability level*

Tearing strength expressed in pounds-force

Nominal Tearing Strength	Observations in Each Average	Single Operator Component	Within Laboratory Component	Between Laboratory Component
Machine Direction				
0.50	5	0.09	0.19	0.26
	10	0.06	0.18	0.25
2.30	5	0.42	1.30	2.06
	10	0.29	1.26	2.03
3.15	5	0.82	1.52	2.59
	10	0.58	1.40	2.53
18.60	5	3.52	6.31	8.40
	10	2.49	5.79	8.02
Transverse Direction				
0.45 (Meltblown)	5	0.11	0.25	0.29
	10	0.08	0.23	0.28
0.50 (Wet laid)	5	0.06	0.28	0.29
	10	0.05	0.27	0.29
0.55 (Dry laid)	5	0.12	0.31	0.35
	10	0.09	0.30	0.34
0.70 (Resin bonded)	5	0.16	0.48	0.58
	10	0.12	0.47	0.57
0.84 (Thermal)	5	0.29	0.46	0.51
	10	0.20	0.41	0.47
7.75 (Hydroentangled)	5	0.83	3.58	3.58
	10	0.59	3.53	3.53

* lbf x 4.45 = newtons

Table A 2

Annex B

B1. Possible causes of low precision when trapezoid tear strength testing

B1.1 Following are some of the causes for low precision

When evaluating test results between and/or within laboratories

B1.1.1 Using different makes and models of tensile machines, i.e. the age and style of the machine can make a difference

B1.1.2 Using different sized load cells to test similar specimens

B1.1.3 Using different software to calculate the test results

B1.1.4 Using different laboratory conditions

B1.1.5 Using different pre-conditioning times for the test samples

B1.2 Following are some of the technician sources of error

B1.2.1 Failure to recheck the zero after changing the load cell, or other machine conditions

B1.2.2 Failure to maintain proper and timely calibration on the machines and all load cells

B1.2.3 Failure to properly train and maintain that training verified through periodic proficiency testing

STANDARD TEST: WSP 100.3.R3 (12)

Standard Test Method for Tearing Strength on Nonwoven Fabrics by the Tongue (Single Rip) Procedure using the (Constant-Rate-of-Extension Tensile Testing Machine)

The number in parentheses indicates the year of the last revision

1. Scope

This test method deals with the measurement of the tearing strength of nonwoven fabrics by the tongue (single rip) procedure using a recording constant-rate-of-extension (CRE) tensile testing machine.

The CRE-type tensile testing machine has become the preferred test apparatus for determining tongue tearing strength. It is recognized that some constant-rate-of-traverse (CRT) tensile testing machines continue to be used. As a consequence, these test instruments may be used when agreed upon between the purchaser and the supplier.

This test method applies to most nonwoven fabrics including those that have been treated or left untreated. This test method may not be useful for highloft nonwoven fabrics. If the tear is not substantially in the machine direction (MD), the fabric shall be described as untearable in that direction by this test.

Tongue tear strength as measured in this method is the maximum single-peak force required to continue or propagate a tear started previously in the specimen. The reported value includes the simultaneous force required to break fibers, break fiber bonds or break fiber web in nonwoven fabric. The reported value is not directly related to the force required to initiate or start a tear.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document:

Reference number
WSP 100.3.R3 (12) A

Current edition approved WSP 100.3.R3 (12)
Originally published as WSP 100.3 in 2002
Last approved as WSP 100.3 in 2009

2.1 ISO test methods

a) ISO 139:Textiles — Standard atmospheres for conditioning and testing
b) ISO 3951-1:2005 Sampling procedures for inspection by variables
c) ISO 2859-1:1999 Sampling procedures for inspection by attributes

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Tearing force

The average force required to continue a tear previously started in a fabric. When testing nonwovens, the tearing force is recorded as the maximum force required to continue a tear previously started in a fabric. The tearing force may appear as a single peak or a series of peaks on a force-extension curve, depending on the nature of the nonwoven process used. For nonwoven fabrics, if a small decrease in force occurs at a time when the applied force is increasing, it is not considered as a peak unless the indicated force exceeds the force required to break, individually or collectively, the fibers, fiber bonds, or fiber interlocks. Lower shifts corresponding to fiber movement do not qualify as peaks since the fibers, fiber bonds, or fiber interlocks are not broken. The tongue tearing force may be calculated from a single-peak or multiple-peak force-extension curve.

3.2 Tearing strength

Is the force required either to start or to continue a tear in a fabric under standard specified conditions.

4. Principle

A specimen 200 x 75 mm is cut down the center of the shorter edge to form a split-tongue specimen. One tongue of the specimen is gripped in the upper jaw and the other tongue is gripped in the lower jaw of a (CRT) tensile testing machine. The separation of the jaws is continuously increased to apply a force to the cut and cause a ripping action. The force which is developed is being recorded. The maximum force to continue ripping the specimen is either calculated from chart recorders, or processed by the data collection system.

5. Apparatus

5.1 Tensile testing machine, of the constant-rate-of-extension (CRE) type

a) Clamps shall have all jaw surfaces parallel, flat, and capable of preventing slippage of the specimen during a test, and must measure at least 25 x 75 mm with the longer dimension perpendicular to the direction of application of the force.
b) The use of hydraulic pneumatic clamping systems with a minimum of 50 x 75 mm serrated or rubber jaw faces having a clamping force at the grip faces of 13 to 14 kN is recommended.

5.2 Cutting die or template

Shall be 200 x 75 mm, with tolerances of 0.5 % as illustrated in figure 1.

6. Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139 Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 2 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

7. Sampling

7.1 Lot Size

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

7.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables (“s” method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 3 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer’s risk, consumer’s risk, acceptable quality level, and limiting quality level.

7.3 Test specimens

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material.

a) Care in handling should be observed so that specimens do not contact any contaminants such as soap, salt, oil etc., which might facilitate or hinder water penetration.
b) Specimens should be cut 200 x 75 mm (8 x 3 in)
c) Unless otherwise specified, cut 5 specimens in each direction (MD) and (CD) evenly spaced across the available width of each sample.
d) When specimens are to be tested wet, take the specimens from adjacent areas to the dry test specimens. Label both specimens to maintain their identity.

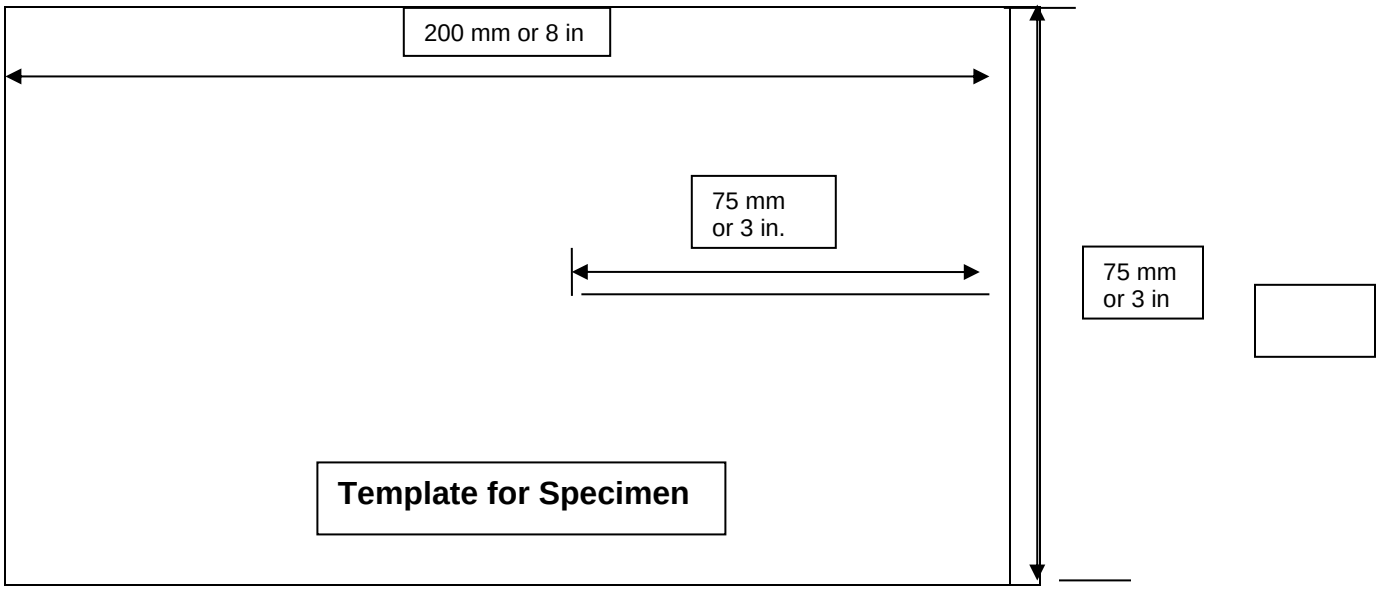


Figure 1

8. Preparation of Apparatus

8.1 Set the distance between the clamps
Start of the test at 75 ± 1mm. Select the full-scale force range of the testing machine such that the maximum force occurs between 15 and 85 % of full-scale force.

8.2 Set the testing speed
Set to 50 ± 2 mm/min. When agreed upon by all parties the testing speed may be set to 300 ± 10 mm/min.

8.3 Verify calibration of the tensile testing machine
As directed in the manufacturer's instructions

9. Procedure

9.1 Place the specimens in the clamps
With the slit centered in the jaw and one of the tongues held in each clamp in such a manner that the originally adjacent cut edges of the tongues form a straight line joining the centers of the clamps and the two tongues show both face and anvil sides of the nonwoven to the operator.

a) For wet specimens, remove the specimens from the water and immediately mount it on the testing machine in the normal set-up. Perform the test within two minutes after removal of the specimen from the water. If more than 2 min elapse between taking the wet specimen from the water bath and starting a tensile testing machine, discard the specimen and take another.
b) Start the machine and record the tearing force on the recording device. The tearing force may increase to a simple maximum value, or may show several maxima and minima, as shown in (WSP 100.2.R3 Trap Tear)

9.2 After the crosshead has moved
To produce approximately 6 mm of fabric tear, record the maximum tearing force. Stop the crosshead motion after a total clamp separation of approximately 75 mm or the fabric has torn completely across and return the crosshead to its starting position.

a) If a fabric slips in the jaws or if 25 % or more of the specimens break at a point within 5 mm of the edge of the jaw, then the jaws may be padded; the fabric may be coated under the jaw face area; or the jaw face may be modified. If any of the modifications listed above are used, state the method of modification in the report.
b) If 25 % or more of the specimens break at a point within 5 mm of the edge of the jaw or does not tear substantially lengthwise after making the modifications described in 9.4.a, consider the fabric untearable by this test method.
c) Report if the tear occurs crosswise to the direction of applied force.

9.3 Remove the tested specimen
Continue as directed in 9.1 - 9.2 until five specimens have been tested for each principal direction from each laboratory sampling unit.

10. Calculation

10.1 Tearing Force, Individual Specimens

Calculate the tongue tearing force for individual specimens using readings directly from the data collection system. Record the maximum tearing force to the nearest .05 N.

10.2 Tearing Strength

Calculate the average tongue tearing strength for each direction (MD and CD) of the laboratory sample and the lot.

11. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Number of specimens tested and note CD and MD
g) For computer processed data, identify the software used and the version
h) Deviation from the standard test procedure, if any
i) When calculated, the standard deviation or the coefficient of variation
j) Whether or not samples were conditioned prior to testing and, if so, for how long
k) Anything unusual noted during the testing
l) Test condition of the specimens (dry or wet)
m) Type of clamps used

12. Precision

The precision for this method is yet to be determined.

STANDARD TEST: WSP 110.1.R4 (12)

Standard Test Method for Breaking Strength and Elongation of Nonwoven Materials (Grab Strength Test)

The number in parentheses indicates the year of the last revision

1. Scope

This test method covers the grab strength test procedure for determining the breaking strength and elongation of most nonwoven materials. Provisions are made for wet testing. The grab tensile procedure is applicable for nonwovens and felted fabrics. This test method is not recommended for materials which have a high percentage of stretch.

This procedure is applicable for testing nonwoven materials in either a dry or wet condition. Comparing test results from tensile testing machines operating on different principles is not recommended.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document

2.1 ISO test methods

a) ISO 139-2005 Textiles — Standard atmospheres for conditioning and testing
b) ISO 2859-1:1999 Sampling procedures for inspection by attributes
c) ISO 3951-1:2005 Sampling procedures for inspection by variables
d) ISO10012 Measurement management systems — Requirements for measurement processes and measuring equipment (calibrating equipment)

2.3 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

Reference number
WSP 110.1.R4 (12) A

Current edition approved WSP 110.1.R4 (12)
Originally published as WSP 110.1 in 2002
Last approved as WSP 110.1 in 2005

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Breaking force
The maximum force applied to a material carried to rupture. (Compare breaking point, breaking strength. Syn. force-at-break.) Materials that are brittle usually rupture at the maximum force. Materials that are ductile usually experience a maximum force before rupturing.

3. 2 Constant-rate-of-extension (CRE) tensile testing machine
A testing machine in which the rate of increase of specimen length is uniform with time.

3. 3 Constant-rate-of-load (CRL) tensile testing machine
A testing machine in which the rate of increase of the load being applied to the specimen is uniform with time after the first 3 seconds

—

3.4 Constant-rate-of-traverse (CRT) tensile testing machine
A testing machine in which the pulling clamp moves at a uniform rate and the load is applied through the other clamp which moves appreciably to actuate a weighing mecha-nism, so that the rate of increase of load or elongation is dependent upon the extension characteristics of the specimen.

3.5 Elongation
The deformation in the direction of load caused by a tensile force. Elongation is generally expressed as a ratio of the length of the stretched material as a percentage to the length of the unstretched material. Elongation may be determined by the degree of stretch under a specific load or the point where the stretched material breaks.

3.6 Extension
The change in length of a material due to stretching. (Compare elongation.)

3.7 Grab strength test
A measure of the “effective strength” of a fabric; i.e., the strength of fibers in a specific width together with the additional strength contributed by adjacent fibers. Typically, grab strength is determined on a 200 mm wide strip of fabric, with the tensile load applied at the midpoint of the fabric width through 25 mm wide jaw faces that are used to clamp the fabric.

3.8 Tensile strength
Is the strength of a material when subjected to either pulling or to compressive stress test. It measures the stress a material can bear without breaking or tearing. High precision electronic test instrument that measures the elongation, tensile strength, tear strength or resistance to compression of materials while pulling or compressing forces are applied to the material

3.9 Nonwoven fabric
Is a fabric made directly from a web of fiber, without the yarn preparation necessary for weaving and knitting. In a nonwoven, the assembly of textile fibers is held together by: (1).

mechanical interlocking in a random web or mat; (2). fusing of the fibers, as in thermoplastic fibers; or (3). bonding with a cementing medium such as starch, casein, rubber latex, a cellulose derivative or synthetic resin. Initially, the fibers may be oriented in one direction or may be deposited in a random manner. This web or sheet is then bonded together by one of the methods described above. Fiber lengths can range from 6 mm to 150 mm for crimped fibers up to continuous filament in spunbonded fabrics.

4. Principle

A 100-mm wide specimen is mounted centrally in clamps of a tensile testing machine and force applied until the specimen breaks. Values for the breaking force and the elongation of the test specimen are obtained from test instrument; scales, dials, autographic recording charts, or a computer interfaced.

This test method describes procedures for carrying out nonwoven material grab tensile test and three alternative types of testing machines. When reporting results indicate which type of tensile machine was used.

The grab test procedure is applicable to the determination of the effective strength of the nonwoven material. There is no simple relationship between grab tests and strip tests.

5. Materials and Reagents

5.1 Distilled water

Used in wet testing.

5.2 Nonionic wetting agent

Used in wet testing.

5.3 Container

Used in wetting out specimens.

6. Apparatus

6.1 Tensile testing machine

Could be any one of the three types, (CRE, CRL, or CRT). All three types have the capabilities with respect to force indication, working range, capacity, and elongation indicator. All are designed for operation at a speed of 300 ± 10 mm/min or, a variable speed drive, change gears, or interchangeable weights as required to obtain the 20 ± 3s time-to-break. Comparison of results from tensile testing machines operating on different principles is not recommended, but when different types of machines are used for comparison testing, constant time-to-break at 20 ± 3 seconds is the established way of producing data. Even then the data may differ significantly. The constant-rate-of-extension tensile testing machine is preferred for this method.

6.2 Clamps and jaw faces

a) Each jaw face shall be smooth, flat, and metallic, or any other agreed upon gripping surface. The faces shall be parallel and have matching centers with respect to one another in the same clamp and to the corresponding jaw face of the other clamp.

b) For grab tests, each clamp shall have a front (or top) jaw face measuring 25 ± 1 mm perpendicular to the direction of the application of the force, and not less than 25 nor more than 50 mm parallel to the direction of the application of force. The back, or bottom, jaw face of each clamp shall be at least as large as its mate. Use of a larger face for the second jaw reduces the problem of front and back jaw face misalignment.

7. Sampling

7.1 Lot Size

A lot should be established based on a logical break in the process or as prescribed by a regulation or traceability requirements.

7.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (*Sampling procedures for inspection by attributes)* or ISO 3951-1:2005 (*Sampling procedures for inspection by variables)* can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE.2 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

7.3 Laboratory sample

From each roll or portion of material taken from the lot sample, cut at least one laboratory sample the full width of the fabric and 1m in the machine direction.

NOTE 3 Results obtained on small hand samples can only be considered as representative of that sample and cannot be assumed to be representative of the material portion from which the hand sample or swatch was taken.

7.4 Test specimens

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material

8. Conditioning

8.1 For conditioned testing*:*

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139 Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 4 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested.

8.2 Wet testing

Specimens to be tested in the wet condition shall be immersed in water at room temperature until thoroughly wetted. To thoroughly wet a specimen, it may be necessary to add not more than 0.05 % of a nonionic wetting agent to the water. A test of any specimen shall be completed within two minutes after its removal from the water.

9. Preparation of Specimens

9.1 General:
Cut specimens with their long dimensions parallel either to the machine direction or to the cross direction.

9.2 Grab Test
Cut each specimen 100 ± 1mm wide by at least 150 mm long (NOTE 5) with the long dimension parallel to the direction of testing and force application.

NOTE 5 The length of the specimen depends on the type of clamps being used. The specimen should be long enough to extend through the clamps and project at least 10 mm at each end

10. Preparation, Calibration, and Verification of Apparatus

10.1 Tensile Testing Machine
Prepare the machine according to the manufacturer's instructions and using the conditions given in clause 10.1.1-10.1.3. (See Annex A)

10.1.1 Set the distance between the clamps
(Gage length) at 75 ± 1 mm

10.1.2 Select the force range of the testing machine
For the break to occur between 10 and 90 % of full-scale force. Calibrate or verify the testing machine for this range.

10.1.3 Set the testing machine
For a loading rate of 300 ± 10 mm/min unless otherwise specified.

10.2 Clamping system
Check the jaw face surfaces for flatness and parallelism.

NOTE 6 Some sources of clamping irregularities are surface contact, metal surface, or jaw coating-cover surface, condition, and pressure application.

10.3 Verification of the total operating system of the apparatus
a) Verify the total operating system (loading, extension, clamping, and data collecting) by testing specimens of a standard material for breaking force and elongation and comparing that data with historical data from that same standard material. This verification of the system is recommended on a daily basis before use, but at a minimum should be done on a weekly basis. In addition, the total operating system should be verified whenever there are changes in the load cells or change in grips (clamping system).
b) Select and prepare the standard material which has breaking force and elongation in the range of interest.
c) Check for adequacy of clamping pressure by mounting a specimen and marking the inner jaw face-to-material junctions. Break the specimen and watch for movement of either line away from the junction to indicate slippage. If slippage occurs, adjust the air pressure of pneumatic clamps or be prepared to tighten manual clamps more when testing. If pressures cannot be increased without

causing jaw breaks, other techniques for eliminating slippage, such as jaw cushioning or specimen tabbing, will be necessary.

d) Test the standard material specimens as directed in clause 11.
e) Calculate the breaking force and elongation, the averages and the standard deviations as directed in clause 12.
f) Compare the data with previous data. If the average is outside the tolerances established, recheck the total system to locate the cause for the deviation.

11. Procedure

11.1 Mount the specimen in the top and bottom clamps (jaws)

So that the front 25mm clamps are centered across the width of the specimen

11.2 Carefully mount the specimen

So that all the slack in the material is removed, but care should be taken so that pretension is not applied to the specimen.

NOTE 7 Placing of the specimen into the upper and lower jaws of the tensile machine can be a large source of error in performing this method. The elongation measurement is taken from the point where the force curve leaves the zero line. Mounting the specimens carefully and methodically into the jaws can reduce some of the technician error.

11.3 Mark across the specimen

At the front inner edge of each jaw to check for specimen slippage. When slippage occurs, the mark will move away from the jaw edge and the results of this specimen should be discarded.

11.4 Engage the machine

To run and break the specimen.

11.5 Read the breaking force

And elongation if required, from the mechanism provided for such purpose. Record machine and cross direction results separately.

For most testing machines, data will be obtained using an interfaced computer.

11.6 If a specimen slips in the jaws

Or breaks at the edge of or in the jaws, or if for any reason the result falls markedly below the average for the set of specimens, discard the result and take another specimen. Continue this until the required number of acceptable breaks has been obtained.

NOTE 8 The decision to discard a break should be based on observation of the specimen during the test and upon the inherent variability of the material. In the absence of other criteria for rejecting a jaw break, any break occurring within 5 mm of the jaws which results in a value below 50 % of the average of all the other breaks should be discarded. No other break should be discarded unless it is known to be faulty.

11.7 If a material manifests any slippage

In the jaws or if more than 25% of the specimens break at a point within 5 mm of the edge of the jaw, one of the modifications listed below may be tried. If any of these modifications are used, state the method of modification in the report.

a) The jaws may need to have rubber pads applied to each jaw surface.
b) The surface of the jaws may be serrated or notched to better hold the material.
c) Carefully check the surface of the jaws for any sharp edges that could be causing these breaks.

NOTE 9 It is difficult to determine the precise reason for certain specimens to break near the edge of the jaws. If such a break is caused by damage to the specimen by the jaws, then the results should be discarded. If, however, the break is due merely to randomly distributed weak places, it is a legitimate result. In some cases, it may also be caused by a concentration of stress in the area adjacent to the jaws because the jaws prevent the specimen from contracting in width as the force is applied. In such cases, a break near the edge of the jaw is inevitable and should be accepted as a characteristic of the particular material and the test method.

12. Calculation

12.1 Breaking Force

For each laboratory sample and testing condition, calculate the average of the breaking force observed for all acceptable specimens, that is, the maximum force exerted on the specimen as read directly from the testing machine.

12.2 Measurement of Apparent Elongation

Unless some other force is specified, measure the apparent elongation of acceptable specimens at the breaking force. Measure the increase in length from the start of the force-extension curve to a point corresponding with the breaking force, or other specified force. Calculate the apparent elongation as the percentage increase in length based on the gage length.

12.3 For each testing situation

Calculate the average apparent elongation at the breaking force.

13. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Size of the jaw faces used
f) Size of the load cell used to perform the test
g) Average breaking force for specimens giving acceptable breaks specimens for each testing condition
h) Average percent apparent breaking elongation of acceptable specimens for each test condition if requested
i) Maximum force obtainable in the range used for testing
j) Pretension if used
k) Types of modification used in the jaws if needed
l) Laboratory testing conditions
m) Number of specimens tested for each condition and note CD and/or MD if significant
n) For computer processed data, identify the software used and the version
o) Deviation from the standard test procedure, if any

p) When calculated, the standard deviation or the coefficient of variation
q) Whether or not samples were conditioned prior to testing and, if so, for how long
r) Anything unusual noted during the testing

14. Precision and Bias

14.1 Precision

The precision for this method is yet to be determined.

14.2 Bias

The bias for this method is yet to be determined.

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ANNEX A

A1. Possible Causes of Low Precision When Grab Strength Testing

A1.1 Following are some of the causes for low precision

When evaluating test result between and/or within laboratories

A1.1.1 Using 2 different makes and models of tensile machines, i.e. the age and style of the machine can make a difference

A1.1.2 Using different sized load cells to test similar specimens

A1.1.3 Using different software to calculate the test results

A1.1.4 Using different laboratory conditions

A1.1.5 Using different pre-conditioning times for the test samples

A1.2 Following are some of the technician sources of error

A1.2.1 Failure to recheck the zero after changing load cells, or other machine conditions

A1.2.2 Failure to maintain proper and timely calibration on the machines and all load cells

A1.2.3 Failure to properly train and maintain that training which is verified through periodic proficiency testing

STANDARD TEST: WSP 100.2.R3 (12)

Standard Test Method for Tearing Strength of Nonwoven Fabrics by the Trapezoid Procedure

This version (05) includes both INDA IST 110.2 (01) and EDANA ERT 70.4-99 as a harmonized method

The number in parentheses indicates the year of the last revision

1. Scope

This test method covers the measurement of the tearing strength of nonwoven fabrics by the trapezoid procedure using a recording constant-rate-of-extension (CRE) tensile testing machine.

The CRE-type tensile testing machine has become the preferred test apparatus for determining trapezoid tearing strength. It is recognized that some constant-rate-of-traverse (CRT) tensile testing machines continue to be used. As a consequence, these test instruments may be used when agreed upon between the purchaser and the supplier. The conditions for the CRT-type tensile tester as used with this test are included in Annex 1.

This test method applies to most nonwoven fabrics, treated or untreated, heavily sized, coated or resin-treated. This test method may not be useful for highloft nonwoven fabrics.

Trapezoid tear strength as measured in this test method is the maximum tearing force required to continue or propagate a tear started previously in the specimen. The reported value is not directly related to the force required to initiate or start a tear. This test method provides values in SI units.. The International System of Units (SI units) are the customary metric units used in most of the rest of the world.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document:

Reference number
WSP 100.2.R3 (12) A

Current edition approved WSP 100.2.R3 (12)
Originally published as WSP 100.2 in 2002
Last approved as WSP 100.2 in 2005

2.1 ISO test methods

a) ISO 5725-1 Accuracy (trueness and precision) of measurement methods and results – Part 1: General principles and definitions

b) ISO 5725-2 Accuracy (trueness and precision) of measurement methods and results – Part 2: Basic method for the determination of the repeatability and reproducibility of a standard measurement method

c) ISO 139:Textiles — Standard atmospheres for conditioning and testing

d) ISO 3951-1:2005 Sampling procedures for inspection by variables

e) ISO 2859-1:1999 Sampling procedures for inspection by attributes

f) ISO 9073 – 4:1997 Textiles – Test methods for Nonwovens – Part 4 Determination of Tear Resistance

2.2 WSP test methods

a) WSP 001.0.R3.(12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Machine direction (MD)

The long direction within the plane of the fabric that is in the direction in which the fabric is being produced by the machine

3.2 Cross machine direction (CD)

The width dimension within the plane of the fabric that is perpendicular to the direction in which the fabric is being produced by the machine

3.3 Tearing force

For nonwovens, the tearing force is recorded as the maximum force required to continue a tear previously started in a fabric. The tearing force may appear as a single peak or a series of peaks on a force-extension curve, depending on the nature of the material. Typically for nonwoven fabrics, if a small decrease in force occurs at a time when the applied force is increasing, it is not considered as a peak unless the indicated force exceeds the force required to break, individually or collectively, the fibers, fiber bonds, or fiber interlocks. Lower shifts corresponding to fiber movement do not qualify as peaks since the fibers, fiber bonds, or fiber interlocks are not broken. The trapezoid tearing force may be calculated from a single-peak or multiple-peak force-extension curve.

3.4 Tearing strength

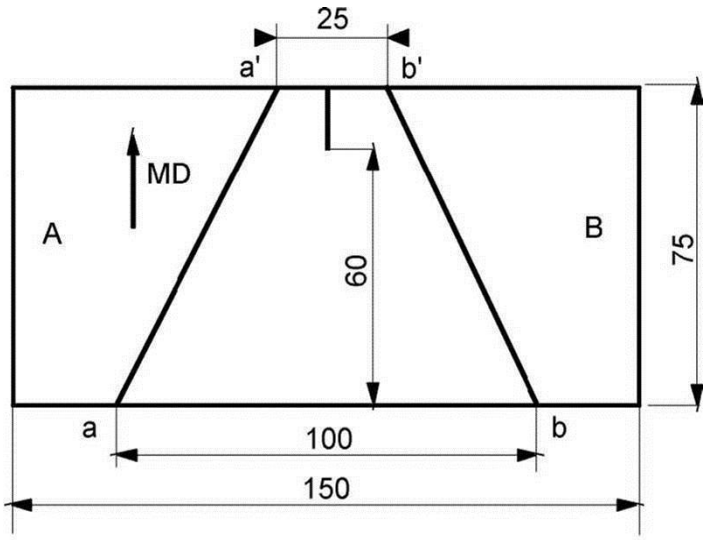
The force required either to start or to continue or propagate a tear in a fabric.

4. Principle

An outline of an isosceles trapezoid is marked on a rectangular specimen cut for the determination of tearing strength (see Figure 1). The specimen is slit at the center of the smallest base of the trapezoid to start the tear. The nonparallel sides of the trapezoid marked on the specimen are clamped in parallel jaws of a tensile testing machine. The

separation of the jaws is continuously increased to apply a force to propagate the tear across the specimen. At the same time, the force developed is recorded. The maximum force to continue the tear is calculated from autographic chart recorders, or microprocessor data collection systems.

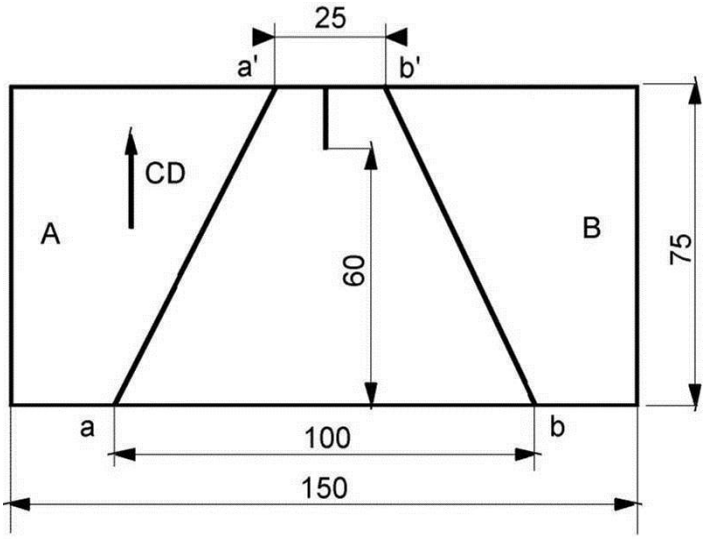
Figure 1



MD Tear

NOTE 2 **When preparing the test specimen remember** that the long direction of the specimen, 150 mm side is the opposite direction of the tear. A specimen with the CD cut at 150 mm and the MD cut at 75 mm will be a MD specimen and the reverse is true for the CD specimen.

Figure 2



CD Tear

5. Apparatus

5.1 Tensile testing machine,

The constant-rate-of-extension (CRE) type conforms to the requirements of this test method with autographic recorder, or automatic microprocessor data gathering systems.

5.2 Clamps

The clamps shall have all gripping surfaces parallel, flat, and capable of preventing slipping of the specimen during a test, and measure at least 50 x 75 mm, with the longer dimension perpendicular to the direction of application of the force.

a) The use of hydraulic pneumatic clamping systems shall have a minimum of 50 x 75-mm serrated or rubber jaw faces having a clamping force at the grip faces of 13 to 14 kN is recommended. Manual clamping is permitted providing no slippage of the specimen is observed.

b) For some materials, to prevent slippage when using jaw faces other than serrated, such as rubber-faced jaws, they may be covered with a No. 80 to 120 medium-grit emery cloth. Secure the emery cloth to the jaw faces with pressure sensitive tape.

5.3 Cutting die or template

By whatever means the specimens are cut and marked out they shall have the dimensions shown in Figures 1 and 2 with tolerances of ± 0.5 %.).

6. Sampling

6.1 Lot Size

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

6.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables (“s” method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 3 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer’s risk, consumer’s risk, acceptable quality level, and limiting quality level.

6.3 Test specimens

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material.

a) Care in handling should be observed so that specimens do not contact any contaminants such as soap, salt, oil etc., which might facilitate or hinder water penetration.
b) Specimens shall be cut 75 x 150 mm and marked as illustrated in Figures 1 and 2.
c) Unless otherwise specified, cut 5 specimens in each direction MD and CD, evenly spaced across the available width of each sample.
d) It is important that the cutting out of the specimen including the start of the tear is perfect to avoid any negative influence on the result and that the specimen is cut perfectly squire with the direction of the test (MD and CD).

7. Preparation of Apparatus

7.1 Set the distance between the clamps

At the start of the test the distance between clamps shall be at 25 ± 1mm. Select the full-scale force range of the testing machine such that the maximum force occurs between 15 and 85 % of full-scale force.

7.2 Setting the constant rate of speed

This speed setting has two options:

a) To set the testing speed at 100 mm/min
b) To set the testing speed at 300 ± 10 mm/min.

7.3 Verify calibration

Calibrate the tensile testing machine as directed in the manufacturer’s instructions.

7.4 When using microprocessor automatic data gathering systems

Set the appropriate parameters as defined in the manufacturer’s instructions.

8. Conditioning

8.1 Standard testing conditioning:

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 4 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

8.2 Wet specimen conditioning testing

Place the specimens in a container and submerge in distilled or deionized water at ambient temperature until thoroughly soaked. The time of immersion must be sufficient to wet the specimens, as indicated by no significant change in tearing force followed by longer periods of immersion. For most fabrics this time period will be about one hour. For fabrics not readily wet with water, such as those treated with water-repellent or water-resistance materials, add a 0.1 % solution of a nonionic wetting agent to the water bath.

8.3 Unspecified testing conditioning

No preconditioning of test specimens is done only if all parties agree and this deviation is noted on the test report.

9. Procedure

9.1 Condition the test specimens

Test the specimens in one of the three atmospheres located in clause 9 and include that condition in the final report.

9.2 Secure the test specimen in the machine

Clamping along the nonparallel sides of the trapezoid such that the end edges of the clamps are in line with the 25 mm long side of the trapezoid, and the cut is halfway between the clamps. Hold the short edge taut and let the remaining fabric lie in folds. See figure 3.

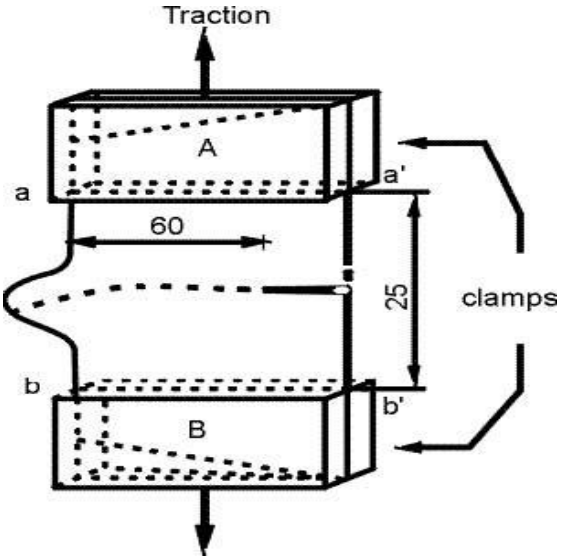


Figure 3

9.2.1 For wet specimens

If the tear resistance in the wet state is required, soak the test pieces, without conditioning, for at least 1 h in a solution containing 1 g of a non-ionic wetting agent per liter of distilled water. Remove a test piece, shake off excess water, and test immediately. Repeat the operation for each of the other test pieces. If another liquid is used this must be mentioned. If more than 2 min elapse between taking the wet specimen from the water bath and starting a tensile testing machine, discard the specimen and take another.

9.3 Start the machine

And record the tearing force on the recording device. The tearing force may increase to a simple maximum value, or may show several maxima and minima, as shown in figure 4.

9.3.1 After the crosshead has moved to produce approximately 6 mm of fabric tear

Record the maximum tearing force and continue until the test specimen is fully torn through. Stop the crosshead motion after a total clamp separation of approximately 75 mm or the fabric has torn completely across and return the crosshead to its starting position.

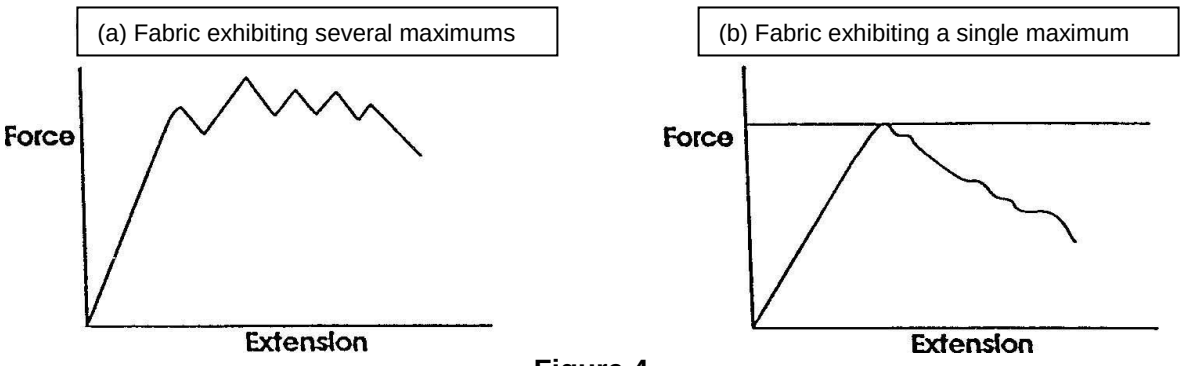


Figure 4

Typical Trapezoid Tearing Force-Extension Curves for Individual Test Specimens

NOTE 5 Do not include the measurement if the test specimen does not tear at the cut.

9.3.2 If a fabric slips in the jaws

Or if 25 % or more of the specimens break at a point within 6 mm of the edge of the jaw, then that specimen measurement is disregarded. To alleviate these problems: the jaws may be padded, the fabric may be coated under the jaw face area, or the jaw face may be modified. If any of these modifications are used, state the method of modification in the report.

NOTE 6 If 25% or more of the specimens break at a point within 6 mm of the edge of the jaw after making the modifications described in 10.3.2 consider the fabric un-tearable by this test method.

9.4 Remove the tested specimen

And continue as directed in 10.2-10.3.2 until five specimens have been tested for each principal direction (MD and CD) from each laboratory sampling unit.

NOTE 7 The following two notes (note 8 and note 9) are from EDANA's ERT 70.4-99 and are included in this procedure because of the difference in the jaw displacements in the two procedures. The WSP 100.2.R3 method indicates approximately 75 mm and WSP 070.4 indicates displacement of the clamps reaching 64 mm. Both options are valid.

NOTE 8 The displacement of the clamps is measured with the starting distance between the clamps at 25 mm. The tear propagation resistance is recorded until the test specimen breaks completely, but the results are only valid up to the displacement of the clamps reaching 64 mm. Beyond this value, the measured tear force is reduced by the proximity of the border of the test piece. For this reason, the significant peak loads to be considered are those corresponding to the displacement of the clamps below the limit of 64 mm.

NOTE 9 Where electronic recording machines are used, it is possible to obtain a mean force for each test specimen, which is then averaged to give the final result.

10. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model and capacity of testing machine
e) Laboratory testing conditions
f) Number of specimens tested and note CD and MD
g) For computer processed data, identify the software used and the version
h) Deviation from the standard test procedure, if any
i) When calculated, the standard deviation or the coefficient of variation
j) Whether or not samples were conditioned prior to testing and, if so, for how long
k) Anything unusual noted during the testing
l) Test condition of the specimens (dry or wet)
m) Type of clamps used

11. Precision

11.1 Precision summary

Preliminary interlaboratory test data have shown that the variance in testing tearing strength of nonwoven fabrics by this test method is dependent upon the nominal tearing strength and to some extent the manufacturing method of the material under evaluation. Therefore, no general statement can be made concerning least critical differences. The following data were generated during the interlaboratory test and are presented for reference. In comparing two averages of five observations, the difference between averages should not exceed the following values in 95 out of 100 cases when all the observations are taken by the same well-trained operator using the same piece of equipment and specimens are randomly drawn from the same sample having a nominal tearing strength indicated.

Nominal Tearing Strength (lbf) (Critical Differences)	Tearing Strength (lbf) (Critical Differences)
Machine Direction	
0.50	0.09
2.30	0.42
3.15	0.82
18.60	3.52
Transverse Direction	
0.45 (Meltblown)	011
0.50 (Wet Laid)	0.06
0.55 (Dry Laid)	0.12
0.70 (Resin Bonded)	0.16
0.84 (Thermal)	0.29
7.75 (Hydroentangled)	0.83

Table 1

ANNEX A
(Informative)

STATISTICAL RESULTS OF INTERLABORATORY TESTS

Figures for the repeatability and reproducibility of this method are the result of collaborative studies carried out in 1992 by INDA. The evaluation of the interlaboratory test was carried out in accordance with ISO 5725-2 and results as follows:

An interlaboratory test was run in 1992 in which randomly drawn samples of six materials were tested in each of six laboratories utilizing the dry condition. Data from two laboratories was deleted as obvious outliers when procedural errors were found to be present. Two operators in each laboratory tested five specimens of each material. The six materials used in this evaluation were all manufactured by different processes. Analysis of the data was completed using ISO 5725 -2. It suggested reporting the components of variance and least critical differences based upon nominal tearing strength, with some interaction based on the manufacturing method. The components of variance, expressed as standard deviations, for each nominal tearing strength, and where appropriate the method of manufacturing, are listed in table A 1 (see Note A 1).
For the components of variance listed in table A 1, the average of two observed values should be considered significantly different at 95% probability level if the difference equals or exceeds the critical differences listed in table A 2. See Note A 2.

Components of variance as standard deviations*

Tearing strength expressed in pounds-force

Nominal Tearing Strength	Single Operator Component	Within Laboratory Component	Between Laboratory Component
Machine Direction			
0.50	0.07	0.06	0.06
2.30	0.33	0.44	0.57
3.15	0.66	0.46	0.76
18.60	2.84	1.89	2.00
Transverse Direction			
0.45 (Meltblown)	0.09	0.08	0.06
0.50 (Wet laid)	0.05	0.10	0.03
0.55 (Dry laid)	0.10	0.10	0.06
0.70 (Resin bonded)	0.13	0.16	0.12
0.84 (Thermal)	0.23	0.13	0.08
7.75 (Hydroentangled)	0.67	1.25	0.00

*lbf x 4.45 = newtons

Table A 1

Due to the dependence of the components of variance on nominal tearing strength and to some extent the manufacturing process no meaningful statement can be made at this time relative to between material comparisons.

NOTE A 1 The square roots of the components of variance are listed in Table A 1 so that the variability is expressed in the appropriate units of measure rather than as the square of those units of measure.

NOTE A 2 The square roots of the components of variance are listed in Table 2 so that the variability is expressed in the appropriate units of measure rather than as the square of those units of measure.

NOTE A 3 The values of the tabulated differences should be considered to be a general statement, particularly with respect to between-laboratory precision. Before a meaningful statement can be made about two specific laboratories, the amount of statistical bias, if any, between them must be established with each comparison being based on recent data obtained on specimens taken from a lot of material of the type being evaluated so as to be as homogeneous as possible, and then randomly assigned in equal numbers to each of the laboratories.

Critical difference for conditions noted 95% probability level*

Tearing strength expressed in pounds-force

Nominal Tearing Strength	Observations in Each Average	Single Operator Component	Within Laboratory Component	Between Laboratory Component
Machine Direction				
0.50	5	0.09	0.19	0.26
	10	0.06	0.18	0.25
2.30	5	0.42	1.30	2.06
	10	0.29	1.26	2.03
3.15	5	0.82	1.52	2.59
	10	0.58	1.40	2.53
18.60	5	3.52	6.31	8.40
	10	2.49	5.79	8.02
Transverse Direction				
0.45 (Meltblown)	5	0.11	0.25	0.29
	10	0.08	0.23	0.28
0.50 (Wet laid)	5	0.06	0.28	0.29
	10	0.05	0.27	0.29
0.55 (Dry laid)	5	0.12	0.31	0.35
	10	0.09	0.30	0.34
0.70 (Resin bonded)	5	0.16	0.48	0.58
	10	0.12	0.47	0.57
0.84 (Thermal)	5	0.29	0.46	0.51
	10	0.20	0.41	0.47
7.75 (Hydroentangled)	5	0.83	3.58	3.58
	10	0.59	3.53	3.53

* lbf x 4.45 = newtons

Table A 2

Annex B

B1. Possible causes of low precision when trapezoid tear strength testing

B1.1 Following are some of the causes for low precision

When evaluating test results between and/or within laboratories

B1.1.1 Using different makes and models of tensile machines, i.e. the age and style of the machine can make a difference

B1.1.2 Using different sized load cells to test similar specimens

B1.1.3 Using different software to calculate the test results

B1.1.4 Using different laboratory conditions

B1.1.5 Using different pre-conditioning times for the test samples

B1.2 Following are some of the technician sources of error

B1.2.1 Failure to recheck the zero after changing the load cell, or other machine conditions

B1.2.2 Failure to maintain proper and timely calibration on the machines and all load cells

B1.2.3 Failure to properly train and maintain that training verified through periodic proficiency testing

STANDARD TEST: WSP 100.3.R3 (12)

Standard Test Method for Tearing Strength on Nonwoven Fabrics by the Tongue (Single Rip) Procedure using the (Constant-Rate-of-Extension Tensile Testing Machine)

The number in parentheses indicates the year of the last revision

1. Scope

This test method deals with the measurement of the tearing strength of nonwoven fabrics by the tongue (single rip) procedure using a recording constant-rate-of-extension (CRE) tensile testing machine.

The CRE-type tensile testing machine has become the preferred test apparatus for determining tongue tearing strength. It is recognized that some constant-rate-of-traverse (CRT) tensile testing machines continue to be used. As a consequence, these test instruments may be used when agreed upon between the purchaser and the supplier.

This test method applies to most nonwoven fabrics including those that have been treated or left untreated. This test method may not be useful for highloft nonwoven fabrics. If the tear is not substantially in the machine direction (MD), the fabric shall be described as untearable in that direction by this test.

Tongue tear strength as measured in this method is the maximum single-peak force required to continue or propagate a tear started previously in the specimen. The reported value includes the simultaneous force required to break fibers, break fiber bonds or break fiber web in nonwoven fabric. The reported value is not directly related to the force required to initiate or start a tear.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document:

Reference number
WSP 100.3.R3 (12) A

Current edition approved WSP 100.3.R3 (12)
Originally published as WSP 100.3 in 2002
Last approved as WSP 100.3 in 2009

2.1 ISO test methods

a) ISO 139:Textiles — Standard atmospheres for conditioning and testing
b) ISO 3951-1:2005 Sampling procedures for inspection by variables
c) ISO 2859-1:1999 Sampling procedures for inspection by attributes

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Tearing force

The average force required to continue a tear previously started in a fabric. When testing nonwovens, the tearing force is recorded as the maximum force required to continue a tear previously started in a fabric. The tearing force may appear as a single peak or a series of peaks on a force-extension curve, depending on the nature of the nonwoven process used. For nonwoven fabrics, if a small decrease in force occurs at a time when the applied force is increasing, it is not considered as a peak unless the indicated force exceeds the force required to break, individually or collectively, the fibers, fiber bonds, or fiber interlocks. Lower shifts corresponding to fiber movement do not qualify as peaks since the fibers, fiber bonds, or fiber interlocks are not broken. The tongue tearing force may be calculated from a single-peak or multiple-peak force-extension curve.

3.2 Tearing strength

Is the force required either to start or to continue a tear in a fabric under standard specified conditions.

4. Principle

A specimen 200 x 75 mm is cut down the center of the shorter edge to form a split-tongue specimen. One tongue of the specimen is gripped in the upper jaw and the other tongue is gripped in the lower jaw of a (CRT) tensile testing machine. The separation of the jaws is continuously increased to apply a force to the cut and cause a ripping action. The force which is developed is being recorded. The maximum force to continue ripping the specimen is either calculated from chart recorders, or processed by the data collection system.

5. Apparatus

5.1 Tensile testing machine, of the constant-rate-of-extension (CRE) type

a) Clamps shall have all jaw surfaces parallel, flat, and capable of preventing slippage of the specimen during a test, and must measure at least 25 x 75 mm with the longer dimension perpendicular to the direction of application of the force.
b) The use of hydraulic pneumatic clamping systems with a minimum of 50 x 75 mm serrated or rubber jaw faces having a clamping force at the grip faces of 13 to 14 kN is recommended.

5.2 Cutting die or template

Shall be 200 x 75 mm, with tolerances of 0.5 % as illustrated in figure 1.

6. Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139 Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 2 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

7. Sampling

7.1 Lot Size

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

7.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables (“s” method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 3 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer’s risk, consumer’s risk, acceptable quality level, and limiting quality level.

7.3 Test specimens

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material.

a) Care in handling should be observed so that specimens do not contact any contaminants such as soap, salt, oil etc., which might facilitate or hinder water penetration.
b) Specimens should be cut 200 x 75 mm (8 x 3 in)
c) Unless otherwise specified, cut 5 specimens in each direction (MD) and (CD) evenly spaced across the available width of each sample.
d) When specimens are to be tested wet, take the specimens from adjacent areas to the dry test specimens. Label both specimens to maintain their identity.

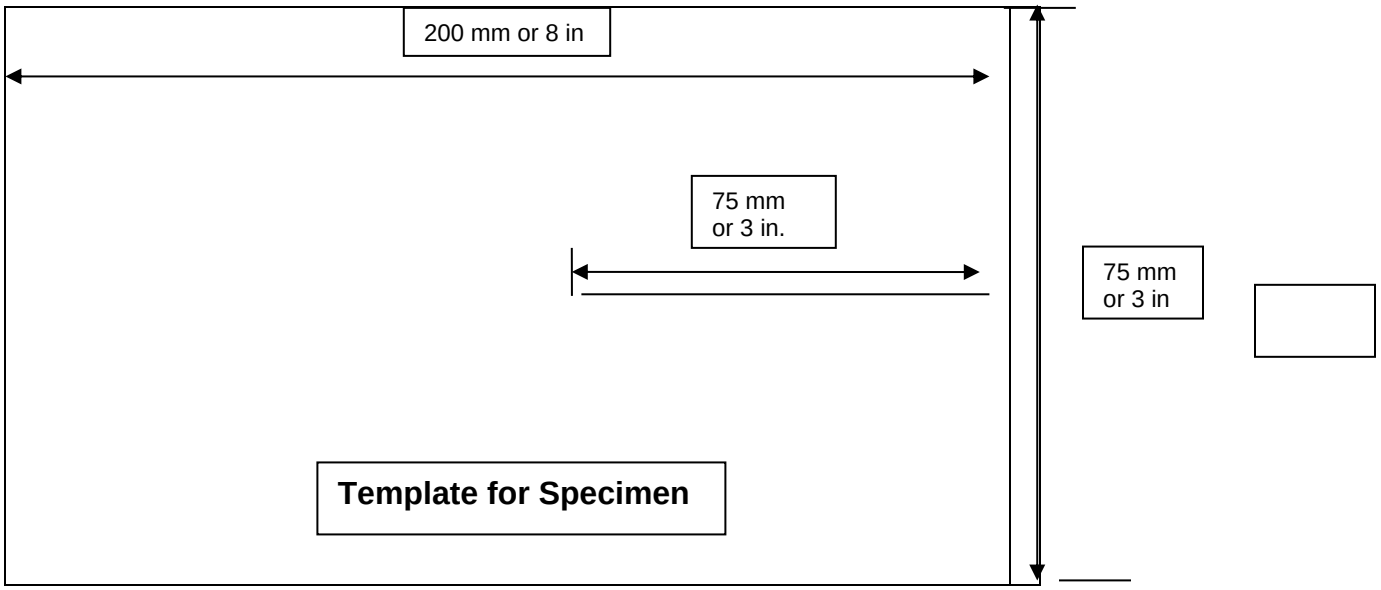


Figure 1

8. Preparation of Apparatus

8.1 Set the distance between the clamps
Start of the test at 75 ± 1mm. Select the full-scale force range of the testing machine such that the maximum force occurs between 15 and 85 % of full-scale force.

8.2 Set the testing speed
Set to 50 ± 2 mm/min. When agreed upon by all parties the testing speed may be set to 300 ± 10 mm/min.

8.3 Verify calibration of the tensile testing machine
As directed in the manufacturer's instructions

9. Procedure

9.1 Place the specimens in the clamps
With the slit centered in the jaw and one of the tongues held in each clamp in such a manner that the originally adjacent cut edges of the tongues form a straight line joining the centers of the clamps and the two tongues show both face and anvil sides of the nonwoven to the operator.

a) For wet specimens, remove the specimens from the water and immediately mount it on the testing machine in the normal set-up. Perform the test within two minutes after removal of the specimen from the water. If more than 2 min elapse between taking the wet specimen from the water bath and starting a tensile testing machine, discard the specimen and take another.
b) Start the machine and record the tearing force on the recording device. The tearing force may increase to a simple maximum value, or may show several maxima and minima, as shown in (WSP 100.2.R3 Trap Tear)

9.2 After the crosshead has moved
To produce approximately 6 mm of fabric tear, record the maximum tearing force. Stop the crosshead motion after a total clamp separation of approximately 75 mm or the fabric has torn completely across and return the crosshead to its starting position.

a) If a fabric slips in the jaws or if 25 % or more of the specimens break at a point within 5 mm of the edge of the jaw, then the jaws may be padded; the fabric may be coated under the jaw face area; or the jaw face may be modified. If any of the modifications listed above are used, state the method of modification in the report.
b) If 25 % or more of the specimens break at a point within 5 mm of the edge of the jaw or does not tear substantially lengthwise after making the modifications described in 9.4.a, consider the fabric untearable by this test method.
c) Report if the tear occurs crosswise to the direction of applied force.

9.3 Remove the tested specimen
Continue as directed in 9.1 - 9.2 until five specimens have been tested for each principal direction from each laboratory sampling unit.

10. Calculation

10.1 Tearing Force, Individual Specimens

Calculate the tongue tearing force for individual specimens using readings directly from the data collection system. Record the maximum tearing force to the nearest .05 N.

10.2 Tearing Strength

Calculate the average tongue tearing strength for each direction (MD and CD) of the laboratory sample and the lot.

11. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Number of specimens tested and note CD and MD
g) For computer processed data, identify the software used and the version
h) Deviation from the standard test procedure, if any
i) When calculated, the standard deviation or the coefficient of variation
j) Whether or not samples were conditioned prior to testing and, if so, for how long
k) Anything unusual noted during the testing
l) Test condition of the specimens (dry or wet)
m) Type of clamps used

12. Precision

The precision for this method is yet to be determined.

STANDARD TEST: WSP 110.3.R4 (12)

Standard Test Method for Internal Bond Strength of Nonwoven Fabrics

The number in parentheses indicates the year of the last revision

1. Scope

This test method determines the internal bond strength of a nonwoven fabric by measuring the average energy required to separate it into two plies.

This test is useful when measuring the internal bond strength of nonwovens used for applications such as wall covering. It is also useful for measuring the internal bond strength of laminates, thick coatings, or plied materials.

SI values are regarded as the official standard system of measurement for this standard test method.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are used in the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.1 ISO test methods

a) ISO 139 : Textiles — Standard atmospheres for conditioning and testing
b) ISO 2859-1:1999 Sampling procedures for inspection by attributes
c) ISO 3951-1:2005 Sampling procedures for inspection by variables

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Principle

A nonwoven specimen is bonded on both sides with double-sided adhesive tape to a metal test fixture as shown in Fig. 1. The right angle arm is impacted by means of a pendulum. This impact results in delamination. The force required is indicated by the pointer on the internal bond strength tester.

Reference number
WSP 110.3.R4 (09) A

Current edition approved WSP 110.3.R4 (12)
Originally published as WSP 110.3 in 2002
Last approved as WSP 110.3 in 2009

4. Apparatus

4.1 Double sided adhesive

Double-sided adhesive paper tape, 25.4 mm wide (Scotch type 400). Tape used should require 0.47 to 0.68 joules of energy to separate two layers tested by this method.

4.2 Internal Bond Tester 3 consisting of:

a) A stationary anvil and separable plate in which the pendulum strikes at the same point for each test.
b) A pendulum of dual capacity and free to swing on ball bearing or similar low-friction-type bearing. The range changing weights must be placed so as not to alter the center of gravity of the pendulum.
c) A means of holding the pendulum in a raised position with provision for instantaneous release.
d) A means of registering the maximum area through which the pendulum swings when released.
e) A scale on both ranges, with a reference point for calibrating the pointer in free swing to compensate for friction and windage.
f) A multiple specimen preparation station, which will allow for variations of specimen thicknesses, with optional clamping pressures on the specimen from 345 to 1379 kPa in 345 kPa increments.

5. Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 2 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of

6. Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

7. Preparation of Specimens

7.1 Cut specimens

Die or scissor cut specimens 25.4 x 152 mm. For MD or CD specimens have the long dimension parallel to the direction tested.

7.2 Mount specimens

Using direction and equipment supplied with the tester, mount five specimens as shown in Fig. 1.

7.3 Use double-sided adhesive

Using double-sided adhesive tape on both sides of the nonwoven specimen, adhere it to the specimen mounts. Use the minimum pressure necessary since excess pressure will force adhesive through the sample and give erroneous results. Discard sample if tape wrinkles.

7.4 Trial tests

Trial tests may be necessary to determine the minimum pressure required.

7.5 Spacer washers

Spacer washers are used with the assembly jig. These are selected by trial to result in minimum pressure mounting.

7.6 Hold

Hold assembly for one to two seconds before releasing the clamp.

7.7 Separate specimens

Separate the five assembled specimens with a knife or razor trimming each to remove fabric or tape protruding beyond the 25.4 mm square angle and base plate.

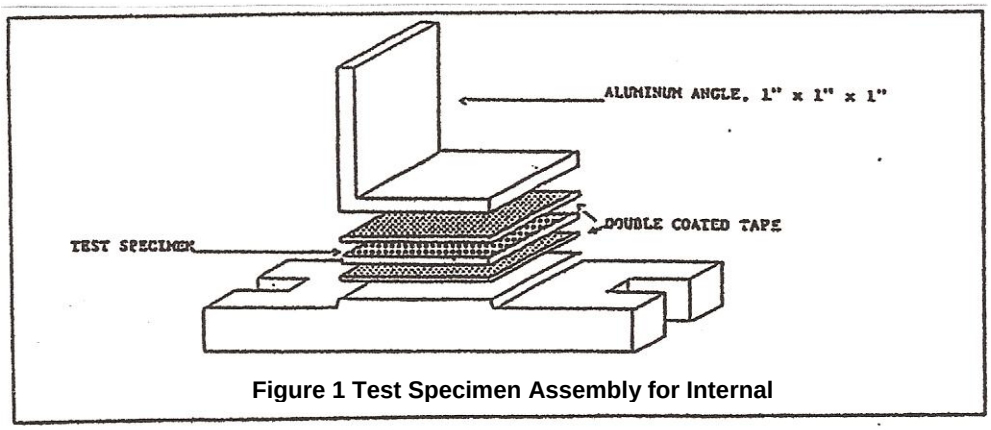


Figure 1 Test Specimen Assembly for Internal

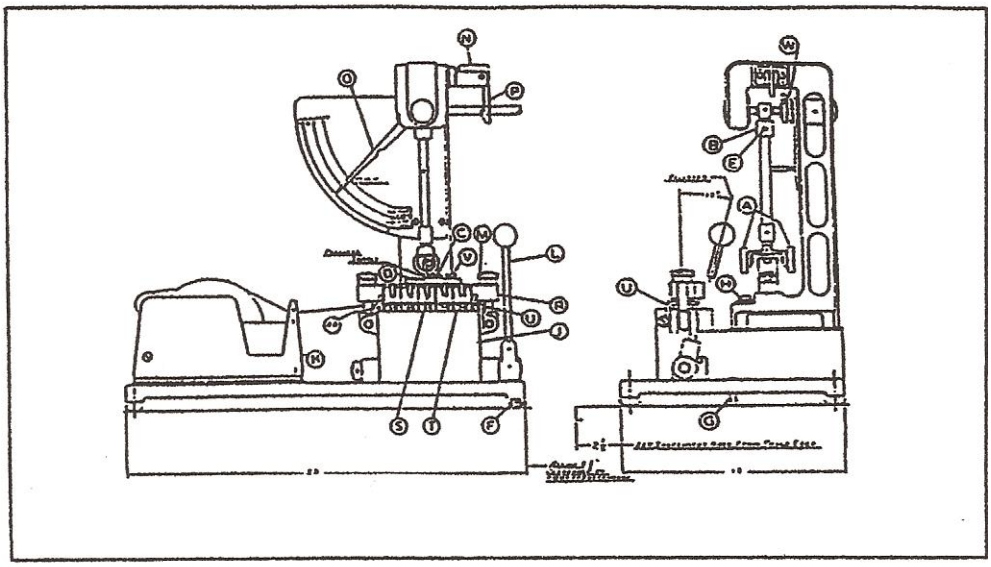


Figure 2 Internal Bond Tester Model B

8. Procedure

8.1 Swing the pendulum
Swing the pendulum 90º to the right until it latches. Mount the base plate containing the specimen and right angle upper plate on the tester as shown in Fig. 2. Secure by tightening the knuckled thumbscrew.

8.2 Swing pointer
Swing pointer to this position also until it touches the pin on the pendulum.

8.3 Release the latch
Test by releasing the latch on the pendulum.

8.4 Read the results
Read the results from the pointer to the nearest 0.5 division and record the results.

8.5 Remove the specimen holder and examine
Remove the specimen holder and examine to be sure that no tape peeled from the specimen. If there is peeling rather than delamination, discard that result and test a second specimen. If peeling occurs again, prepare five new assemblies using thinner spacers to obtain increased surface tape bonding. Additional clamp pressure and anvil cleaning may be necessary to prevent peeling.

8.6 If no peeling occurs
If no peeling occurs, proceed with testing the remainder of the specimens.

9. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Number of specimens tested and note CD and/or MD
g) If a computer processed data, identify the software used and the version
h) Deviation from the standard test procedure, if any
i) When calculated, the standard deviation or the coefficient of variation
j) Whether or not samples were conditioned prior to testing and, if so, for how long
k) Anything unusual noted during the testing

STANDARD TEST: WSP 110.4.R4 (12)

Standard Test Method for Breaking Force and Elongation of Nonwoven Materials (Strip Method)

This (04) version includes both INDA IST 110.4 (02) (Option A) and EDANA ERT 20.2-89 (Option B)

The number in parentheses indicates the year of the last revision

1. Scope

This test method covers cut strip test procedures for determining the breaking force and elongation of most nonwoven materials. Instructions are included for wet testing.

This test method describes two procedures Option A – IST 110.4 -02 and Option B – ERT 20.2 – 89 for carrying out nonwoven material tensile tests. These two procedures use two types of specimens which are listed below and three alternative types of testing machines are also listed below. CRE is the instrument of choice.

Types of specimen

a) Option A – 25 mm strip tensile
b) Option B – 50 mm strip tensile

Style of tensile testing machine

a) Constant-rate-of-extension (CRE)
b) Constant-rate-of-load (CRL)
c) Constant-rate-of-traverse (CRT)

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies

Reference number
WSP 110.4.R4 (12) A

Current edition approved WSP 110.4.R4 (12)
Originally published as WSP 110.4 in 2002
Last approved as WSP 110.4 in 2005

2.1 ISO test methods

a) ISO 139-2005 Textiles — Standard atmospheres for conditioning and testing
b) ISO 2859-1:1999 Sampling procedures for inspection by attributes
c) ISO 3951-1:2005 Sampling procedures for inspection by variables

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Breaking force

The maximum force applied to a material carried to rupture. (Compare breaking point, breaking strength. Syn. force-at-break). Materials that are brittle usually rupture at the maximum force. Materials that are ductile usually experience a maximum force before rupturing

3.2 Constant-rate-of-extension (CRE) tensile testing machine

A testing machine in which the rate of increase of specimen length is uniform with time.

3.3 Constant-rate-of-load (CRL) tensile testing machine

A testing machine in which the rate of increase of the load being applied to the specimen is uniform with time after the first 3 seconds.

3.4 Constant-rate-of-traverse (CRT) tensile testing machine

A testing machine in which the pulling clamp moves at a uniform rate and the load is applied through the other clamp which moves appreciably to actuate a weighing mechanism, so that the rate of increase of load or elongation is dependent upon the extension characteristics of the specimen.

3.5 Cut strip test

In nonwovens, a strip test in which the specimen is cut to the specified testing width, i.e. 25 or 50mm wide

3.6 Elongation

The deformation in the direction of load caused by a tensile force. Elongation is generally expressed as a ratio of the length of the stretched material as a percentage to the length of the unstretched material. Elongation may be determined by the degree of stretch under a specific load or the point where the stretched material breaks.

3.7 Extension

The change in length of a material due to stretching.

3.8 Strip test

In nonwovens, a tensile test in which the full width of the specimen is gripped in the clamps.

3.9 Tensile strength

Is the strength of a material when subjected to either pulling or to compressive stress test. It measures the stress a material can bear without breaking or tearing. High precision electronic test instrument that measures the elongation, tensile strength, tear strength or resistance to compression of materials while pulling or compressing forces are applied to the material.

4. Principle

A test specimen is clamped in a tensile testing machine and a force applied to the specimen until it breaks. Values for the breaking force and elongation of the test specimen are obtained from machine scales, dials, autographic recording charts, or a computer interface.

The strip test method is considered satisfactory for acceptance testing of commercial shipments of most nonwoven materials.

This procedure is applicable for testing nonwoven materials in either a dry conditioned or wet state.

Comparison of results from tensile testing machines operating on different principles is not recommended. When different types of machines are used for comparison testing, constant time-to-break at 20 ± 3 seconds is the established way of producing data. Even then the data may differ significantly. The constant-rate-of-extension tensile testing machine is preferred for this method.

5. Reagents and Materials

5.1 Distilled water

For wet testing.

5.2 Nonionic wetting agent

For wet testing.

5.3 Container

For wetting out specimens.

6. Apparatus

6.1 Tensile testing machine (CRE, CRL, or CRT)

Must include: force indication, working range, capacity, and elongation indicator and designed for operation at:

a) Option A, a speed of 300 ± 10 mm/min
b) Option B, a speed of 100 mm/min

6.2 Clamps and jaw faces

Each jaw face shall be smooth, flat, and with a metallic or other agreed upon surface. The faces shall be parallel and have matching centers with respect to one another in the same clamp and to the corresponding jaw face of the other clamp.

For all strip tests each jaw face shall measure at least 10 mm wider than the specimen being tested and at least 25 mm in the direction of the applied force.

7. Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 2 An adequate specification or other agreement between the purchaser and the supplier requires taking into account the variability between rolls of material and between specimens. One must provide a sampling plan with a meaningful producer's risk, consumer's risk, and have an acceptable quality level.

7.1 Laboratory sample

From each roll or portion of material taken from the lot sample, cut at least one laboratory sample the full width of the fabric and 1m in the machine direction.

NOTE 3 Results obtained on small hand samples can only be considered as representative of that sample and cannot be assumed to be representative of the material portion from which the hand sample or swatch was taken.

7.2 Test specimens

From each laboratory sample, test five specimens from the machine direction and five specimens from the cross direction.

8. Conditioning

8.1 Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25% of the mass of the specimen.

NOTE 4 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested.

8.2 Wet testing

Specimens to be tested in the wet condition shall be immersed in water at room temperature until thoroughly wetted. To thoroughly wet a specimen, it may be necessary to add not more than 0.05% of a nonionic wetting agent to the water. A test of any specimen shall be completed within two minutes after its removal from the water.

9. Preparation of Specimens

9.1 General

a) Cut specimens with their long dimensions parallel either to the machine direction or to the cross direction specimen.
b) Narrow specimens of material which are 50 mm or less wide are tested full width and the size noted on the test report.

NOTE 5 The length of the specimen depends on the type of clamps being used. The specimen should be long enough to extend through the clamps and project at least 10 mm at each end.

9.2 Strip test — Option – A

a) Cut each specimen 25 ± 1mm wide and at least 150 mm long with the long dimension **must be parallel** to the direction of testing and force application (Note 5).

9.3 Strip test — Option – B

a) Cut each specimen 50 ± 0.5mm wide by at least 200 mm long so that the material will fit into testing jaws which are set at 200 mm apart (cutting the specimen 275 mm would aide in placing the specimens into the jaws). The long dimension **must be parallel** to the direction for which the breaking force is required (Notes 5).

9.4 When the breaking force of wet fabric

Is required in addition to that of conditioned fabric, cut one set of specimens with each test specimen twice the normal length (Note 5 and clauses 9.2 and 9.3). Number each specimen at both ends and then cut the specimens in half cross-wise, to provide one set for determining the conditioned breaking force, and another set for determining the wet breaking force. This allows for breaks on paired specimens which leads to more direct comparison of conditioned vs. wet breaking force because both specimens of a pair contain the same test material location.

10. Preparation, Calibration, and Verification of Apparatus

10.1 Tensile testing machine

Prepare the testing machine according to the manufacturer's instructions and using the conditions given in 10.1.1 – 10.1.3 (see Annex A).

10.1.1 Set the distance between the clamps

(gage length) according to the option used;

a) Option A — set at 75 ± 1mm.
b) Option B — set at 200 ± 1 mm

10.1.2 Select the force range of the testing machine

So that the break will occur between 10 and 90 % of full scale force. Calibrate or verify the testing machine for this range.

10.1.3 Set the testing machine constant rate of extension

According to the option used:

a) Option A — set at 300 ± 10 mm/min.
b) Option B — set at 100 mm/min

10.2 Clamping system

Check the jaw face surfaces for flatness and parallelism.

NOTE 6 Some sources of clamping irregularities are surface contact, metal surface, or jaw coating-cover surface, condition, and pressure application.

10.3 Verification of the total operating system of the apparatus

a) Verify the total operating system (loading, extension, clamping, and data collecting) by testing specimens of a standard material for breaking force and elongation and comparing that data with historical data from that same standard material. This verification of the system is recommended on a daily basis before use, but at a minimum should be done on a weekly basis. In addition, the total

operating system should be verified whenever there are changes in the load cells or change in grips (clamping system).

b) Select and prepare the standard material which has breaking force and elongation in the range of interest.
c) Check for adequacy of clamping pressure by mounting a specimen and marking the inner jaw face-to-material junctions. Break the specimen and watch for movement of either line away from the junction to indicate slippage. If slippage occurs, adjust the air pressure of pneumatic clamps or be prepared to tighten manual clamps more when testing. If pressures cannot be increased without causing jaw breaks, other techniques for eliminating slippage, such as jaw cushioning or specimen tabbing will be necessary.
d) Test the standard material specimens as directed in clause 11.
e) Calculate the breaking force and elongation, the averages and the standard deviations as directed in clause 12.
f) Compare the data with previous data. If the average is outside the tolerances established, recheck the total system to locate the cause for the deviation.

11. Procedure

11.1 Mount the specimen securely in the clamp of the testing machine

Take care that the specimen is centrally located and that the long dimension is as parallel as possible to the direction of force application. Be sure that the tension on the specimen is uniform across the clamped width.

NOTE 7 Carefully mount the specimen so that all the slack in the material is removed, but care should be taken so that pretension is not applied to the specimen.

NOTE 8 Placing of the specimen into the upper and lower jaws of the tensile machine can be a large source of error in performing this method. The elongation measurement is taken from the point where the force curve leaves the zero line. Mounting the specimens carefully and methodically into the jaws can reduce some of the technician error.

11.2 Mark across the specimen at the front inner edge

Of each jaw to check for specimen slippage. When slippage occurs, the mark will move away from the jaw edge and the results of this specimen should be discarded.

11.3 Engage the machine

To run and break the specimen.

11.4 Read the breaking force

And elongation if required, from the mechanism provided for such purpose. Record machine and cross direction results separately.

NOTE 9 For most testing machines, data will be obtained using an interfaced computer.

11.5 If a specimen slips in the jaws or breaks at the edge of or in the jaws

Or if for any reason the result falls markedly below the average for the set of specimens, discard the result and take another specimen. Continue this until the required number of acceptable breaks has been obtained.

NOTE 10 The decision to discard a break should be based on observation of the specimen during the test and upon the inherent variability of the material. In the absence of other criteria for rejecting a jaw break, any break occurring within 5 mm of the jaws which results in a value below 50 % of the average of all the other breaks should be discarded. No other break should be discarded unless it is known to be faulty.

11.6 If a material manifests any slippage in the jaws

Or if more than 25 % of the specimens break at a point within 5 mm of the edge of the jaw, one of the modifications listed below may be tried. If any of these modifications are used, state the method of modification in the report.

a) The jaws may need to have rubber pads applied to each jaw surface.
b) The surface of the jaws may be serrated or notched to better hold the material.
c) Carefully check the surface of the jaws for any sharp edges that could be causing these breaks.

NOTE 11 It is difficult to determine the precise reason for certain specimens to break near the edge of the jaws. If such a break is caused by damage to the specimen by the jaws, then the results should be discarded. If, however, the break is due merely to randomly distributed weak places, it is a legitimate result. In some cases, it may also be caused by a concentration of stress in the area adjacent to the jaws because the jaws prevent the specimen from contracting in width as the force is applied. In such cases, a break near the edge of the jaw is inevitable and should be accepted as a characteristic of the particular material and the test method.

12. Calculation

12.1 Breaking force

For each laboratory sample and testing condition, calculate the average of the breaking force observed for all acceptable specimens, that is, the maximum force exerted on the specimen as read directly from the testing machine.

12.2 Measurement of apparent elongation

Unless some other force is specified, measure the apparent elongation of acceptable specimens at the breaking force. Measure the increase in length from the start of the force-extension curve to a point corresponding with the breaking force, or other specified force. Calculate the apparent elongation as the percentage increase in length based on the gage length.

12.3 For each testing situation

Calculate the average apparent elongation at the breaking force or other specified force, of acceptable specimens.

NOTE 12 The elongation calculated as a percentage of the gage length for the specimen should be referred to as the apparent elongation because the actual length of fabric between the jaws is usually greater than the initial gage length. This difference in length is frequently due to material slippage from between the jaws. Thus, elongation, calculated on the gage length, has an error which is dependent upon the amount of slippage.

13. Report

13.1 State that the specimens were tested

As directed in either Option A INDA 110.4 – 03 or Option B EDANA 20.2 – 89 or some combination of the two methods. Describe the material or product sampled and the method of sampling used.

NOTE 13 INDA has sponsored studies comparing both methods (IST 110.4 and ERT 20.2-89) and the studies indicated that if the INDA test method Option A was performed using Option B's 50 mm wide material, the result for both test methods would harmonize, giving the same results, regardless of the other machine settings.

13.2 In addition to the precise test results

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Number of specimens tested and note CD and/or MD if significant
g) For computer processed data, identify the software used and the version
h) Deviation from the standard test procedure, if any
i) When calculated, the standard deviation or the coefficient of variation
j) Whether or not samples were conditioned prior to testing and, if so, for how long
k) Anything unusual noted during the testing
l) Average time required to break, if applicable, for all specimens giving acceptable breaks.
m) Type of tensile testing machine used.
n) Size of jaw faces used
o) Size of the load cell used to perform the test.
p) Average breaking force for specimens giving acceptable breaks for each testing condition.
q) Average percent apparent elongation of the acceptable specimens for each testing condition.
r) Maximum force obtainable in the range used for testing
s) Pretension if used,
t) Types of modification used in the jaws if needed.

14. Precision

The precision for this method is yet to be determined.

Annex A

A1. Possible Causes of Low Precision When Strip Tensile Testing

A1.1 Following are some of the causes for low precision

When evaluating test result between and/or within laboratories

A1.1.1 Using different makes and models of tensile machines, i.e. the age and style of the machine can make a difference

A1.1.2 Using different sized load cells to test similar specimens

A1.1.3 Using different software to calculate the test results

A1.1.4 Using different laboratory conditions

A1.1.5 Using different pre-conditioning times for the test samples

A1.2 Following are some of the technician sources of error

A1.2.1 Failure to recheck the zero after changing the load cell, or other machine conditions

A1.2.2 Failure to maintain proper and timely calibration on the machines and all load cells

A1.2.3 Failure to properly train and maintain that training verified through periodic proficiency testing

STANDARD TEST: WSP 110.5.R4 (12)

Standard Test Method for Resistance to Mechanical Penetration (Ball Burst Procedure) of Nonwoven Fabrics

The number in parentheses indicates the year of the last revision

1. Scope

This test method is applicable for determining the puncture strength of nonwoven fabrics. This method can also be used with other materials or fabrics, but they are not included in this method.

This method is primarily designed to be used on nonwovens with some degree of elasticity (cross laid fibers).

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.1 ISO test methods

a) ISO 139:Textiles — Standard atmospheres for conditioning and testing
b) ISO 2859-1:1999 Sampling procedures for inspection by attributes
c) ISO 3951-1:2005 Sampling procedures for inspection by variables
d) ISO 5725-1 Accuracy (trueness and precision) of Measurement Methods and Results – Part 1:General Principles and Definitions
e) ISO 5725-2 Accuracy (trueness and precision) of Measurement Methods and Results – Part 2: Basic Method for the Determination of the Repeatability and Reproducibility of a Standard Measurement Method

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

Reference number
WSP 110.5.R4 (12) A

Current edition approved WSP 110.5.R4 (12)
Originally published as WSP 110.5 in 2002
Last approved as WSP 110.5 in 2005

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Constant-rate-of-traverse tensile testing machine (CRT)
A testing machine in which the pulling clamp moves at a uniform rate and the load is applied through the other clamp which moves appreciably to actuate a weighing mechanism, so that the rate of increase of load or elongation is dependent upon the extension characteristics of the specimen.

3.2 Bursting strength
The force or pressure required to rupture a nonwoven fabric by distending it with a force, applied at right angles to the plane of the fabric, under specified conditions.

3.3 Elongation
The distance the crosshead travels from the plane of the sample at the start of the test to the point of peak load.

3.4 Repeatability $_{(r)}$
As determined by this test method is the variability found between the tests results of randomly selected homogenous specimens, tested at one laboratory, using one technician, one instrument, and one set of environmental conditions which were found on one given day

3.5 Reproducibility$_{(R)}$
As determined by this test method is the variability found between the tests results of randomly selected homogenous specimens, which were tested at different laboratories, using more than one technician at each laboratory, and tested over a two day period using standard laboratory environmental conditions which were found at each laboratory.

4. Principle

A specimen from a roll of nonwoven material or garment is securely clamped with tension between grooved, circular plates of the ball burst attachment secured to the non-movable jaw location of the constant-rate-of-traverse (CRT) testing machine. A force is exerted against the specimen by a polished hardened steel ball that is attached to the upper movable jaw. The test is terminated when the ball ruptures the material.

5. Apparatus

5.1 Constant-rate-of-traverse tensile testing machine (CRT)
With a ball burst attachment replacing the clamp assembly.

5.2 Ball burst attachment
Consisting of an attachment having a polished steel ball that replaces the top moving clamp of the tensile tester and the ring-clamp mechanism that replaces the fixed clamp of

the tensile tester (see Figure.1). The downward movement of the polished steel ball pushes against the fabric which is being held in the ring clamp.
The polished steel ball shall have a diameter of 25.400 ± 0.005 mm and shall be spherical within. The ring clamp shall have an internal diameter of 44.450 ± 0.025 mm. If the size of the ball differs from the standard, then that size deviation must be reported with the results

Figure 1

6. Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 2 An adequate specification or other agreement between the purchaser and the supplier requires taking into account the variability between rolls of material and between specimens. One must provide a sampling plan with a meaningful producer's risk, consumer's risk, and have an acceptable quality level.

6.1 Laboratory sample

From each roll or portion of material taken from the lot sample, cut at least one laboratory sample the full width of the fabric and 1m in the machine direction.

NOTE 3 Results obtained on small hand samples can only be considered as representative of that sample and cannot be assumed to be representative of the material portion from which the hand sample or swatch was taken.

6.2 Test specimens

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material

From each laboratory sample, test five specimens.

7. Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 4 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

8. Calibration and Verification

8.1 Tensile testing machine

a) Prepare the machine according to the manufacturer's instructions and using the conditions given in 9.1.2-9.1.4. (See Annex A)
b) Set the distance for the travel of the ball so that it penetrates the test material but does not come in contact with the lower stage.
c) Set the testing machine for a loading rate of 300 ± 13 mm/min unless otherwise specified.

8.2 Verification of the total operating system:

a) Verify the total operating system by testing specimens of a standard material for ball burst and comparing that data with historical data from that same standard material. This verification of the system is recommended on a daily basis before use, but at a minimum should be done on a weekly basis. In addition, the total operating system should be verified whenever there are changes in the load cells.
b) Select and prepare the standard material which has ball burst in the range of interest.
c) Test the standard material specimens as directed in clause 9.
d) Calculate the breaking force, the averages and the standard deviations as directed in clause 10.
e) Compare the data with previous data. If the average is outside the tolerances established, recheck the total system to locate the cause for the deviation.

9. Procedure

Place the specimen with tension in the ring clamp and fasten securely by means of the screws, or pneumatic mechanism. Start the CRT machine, using crosshead speed of 300 ± 13 mm/min. and continue at that speed until the specimen bursts. Record to the nearest 0.5 N the ball-bursting strength of the specimen.

10. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) The bursting strength of each specimen and the average bursting strength of the five specimens from each laboratory sample to the nearest 0.5 N
f) Elongation at peak load to the nearest mm
g) Laboratory testing conditions
h) Number of specimens tested and note CD and/or MD if significant
i) For computer processed data, identify the software used and the version

j) Deviation from the standard test procedure, if any
k) When calculated, the standard deviation or the coefficient of variation
l) Whether or not samples were conditioned prior to testing and, if so, for how long
m) Anything unusual noted during the testing

11. Precision

11.1 Summary

Based upon limited information from three laboratories, within laboratory, and between laboratories standard deviations (S_r and S_R) shown in Table 1 are approximate. This table illustrates what the three laboratories found when all the observations are taken by well-trained operators using specimens randomly tested from three different samples of material.

Grand Average and Component	Material #1	Material #2	Material #3
Grand average	16.533	6.800	114.57
Within-laboratory component (S_r – Repeatability)	2.217	0.864	19.059
Between-laboratory component (S_R – Reproducibility)	2.217	0.864	19.059

TABLE 1

11.2 Precision

Because tests were conducted in only three laboratories, estimates of between the laboratories precision may be either underestimated or overestimated to some extent and should be used with special caution. However, when agreed upon between the contractual parties, for the approximate analysis of variance reported in Table 1 may be used.

Annex A

A1. Possible Causes of Low Precision When Ball Burst Testing

A1.1 Following are some of the causes for low precision

Between and within laboratories when performing this test all of these variables should be noted on your report

A1.1.1 Use of different makes and models of tensile machines
A1.1.2 Use of different size load cells
A1.1.3 Use of different software to calculate the results
A1.1.4 Use of different laboratory conditions
A1.1.5 Use of different pre-conditioning times for the test samples

A1.2 Following are some of the technician sources of error

A1.2.1 Failure to recheck the zero after changing the load cell, or other machine conditions
A1.2.2 Failure to maintain proper and timely calibration on the machines and all load cells
A1.2.3 Failure to properly train and maintain that training verified through periodic proficiency testing

STANDARD TEST: WSP 120.1.R4 (12)

Standard Test Method for Thickness of Nonwoven Fabrics

The number in parentheses indicates the year of the last revision

1. Scope

This test method covers the measurement of the thickness of most nonwoven fabrics. This test method also applies to either nonwoven fabrics that are treated or untreated, including those heavily sized, coated or resin-treated.

This test method may not be useful for highloft nonwoven fabrics. For thickness of highloft nonwoven fabric refer to test method WSP 120.2.R4 (12)

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.1 ISO test methods

a) ISO 5725-1 Accuracy (trueness and precision) of Measurement Methods and Results – Part 1:General Principles and Definitions

b) ISO 5725-2 Accuracy (trueness and precision) of Measurement Methods and Results – Part 2:Basic Method for the Determination of the Repeatability and Reproducibility of a Standard Measurement Method

c) ISO 139-2005 Textiles — Standard atmospheres for conditioning and testing

d) ISO 2859-1:1999 Sampling procedures for inspection by attributes

e) ISO 3951-1:2005 Sampling procedures for inspection by variables

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

Reference number
WSP 120.1.R4 (12) A

Current edition approved WSP 120.1.R4 (12)
Originally published as WSP 120.1 in 2002
Last approved as WSP 120.1 in 2009

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Pressure

The force or load per unit area. Pressure may be expressed in any appropriate or specified units, such as Pascals (Pa), Newtons per square meter (N/m^2).

3.2 Thickness

In nonwovens thickness is the distance between the upper and lower surfaces of the material, measured under a specified pressure. Thickness is usually determined as the distance between an anvil, or base, and a presser foot used to apply the specified pressure.

4. Principle

Thickness is one of the basic physical properties of nonwoven fabrics. In certain industrial applications, the thickness may require rigid control within specified limits. Bulk and warmth properties of nonwoven fabrics are often estimated from their thickness values, and thickness is also useful in measuring performance characteristics, such as, before and after abrasion and shrinkage.

The thickness values of most nonwoven fabrics will vary considerably depending on the pressure applied to the specimen at the time the thickness measurement is taken. In all cases, the apparent thickness varies inversely with the pressure applied. For this reason, it is essential that the pressure be specified when discussing or listing any thickness value.

5. Apparatus

5.1 Thickness testing gage

Consisting of a dead-weight, calibrated spring force, or string gage type and having dimensions and capabilities specified below, unless otherwise agreed upon between the purchaser and the supplier.

a) Presser foot, circular presser foot 25.40 ± 0.02 mm diameter.
b) Anvil, 38 mm diameter or greater.
c) Anvil/presser foot parallelism, 0.01 mm.
d) Foot surface parallelism, 0.002 mm.).
e) Applied force, 4.14 ± 0.21 kPa.
f) Readability, 0.02 mm.
g) Automatic, microprocessor data gathering systems, (optional).

5.2 Cutting dies

Dies to cut specimens having linear dimensions of at least 20 % greater than the presser foot to be used in measuring the thickness, (optional).

6. Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 2 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

7. Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 3 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material.

a) Care in handling should be observed so that specimens do not contact any contaminants such as soap, salt, oil etc. that could alter its thickness.
b) When cutting specimens, cut having linear dimensions at least 20 % greater in size than the presser foot to be used. Label to maintain specimen identity.
c) Unless otherwise specified, cut 10 specimens, evenly spaced across the available width of each sample.

8. Procedure

8.1 Verify calibration of the thickness gage

As directed in the manufacturer's instructions.

8.2 When using microprocessor automatic data gathering systems

Set the appropriate parameters as defined in the manufacturer's instructions.

8.3 Place the specimen on the anvil

Of the test apparatus and bring the presser foot into contact with the opposite side of the material (often referred to as the "face").

8.4 Gradually increase the pressure

To the specified level allowing approximately 5 s to apply the full pressure. Release the platen and record the thickness value to the nearest 0.02 mm 5 to 6 s after the full pressure has been applied.

NOTE 4 For most nonwoven materials, 5 s after the full pressure is applied will represent a stable condition.

8.5 Continue as directed in 8.3 and 8.4

Until ten specimens have been tested from each laboratory sample.

9. Calculation

9.1 Thickness average
Calculate the average thickness for each the laboratory sample and the lot.

9.2 Both standard deviation
And coefficient of variation – calculate when requested.

9.3 Computer processed data
When data are automatically computer processed, calculations are generally contained in the associated software. Record values as read from the direct reading scale to the nearest 0.02 mm unless otherwise specified. In any event, it is recommended that computer processed data be verified against known property values and its software described in the report.

10. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Number of specimens tested and note CD and/or MD if significant
g) For computer processed data, identify the software used and the version
h) Deviation from the standard test procedure, if any
i) When calculated, the standard deviation or the coefficient of variation
j) Whether or not samples were conditioned prior to testing and, if so, for how long
k) Anything unusual noted during the testing
l) Thickness average for each test sample

11. Precision

Summary
Preliminary interlaboratory test data have shown that the variance in testing thickness of nonwoven fabrics by this test method is dependent upon the nominal thickness and the manufacturing method of the material under evaluation; therefore, no general statement can be made concerning least critical differences. The following data were generated during the interlaboratory test and are presented for reference. In comparing two averages of five observations, the difference between averages should not exceed the following values in 95 out of 100 cases when all the observations are taken by the same well-trained operator using the same piece of equipment and specimens are randomly drawn from the same sample having a nominal thickness as indicated:

Nominal Thickness (inches) (critical differences)	Manufacturing Process	Thickness (inches) (Critical Differences
0.005	Resin Bonded	0.0007
0.007	Wet Laid	0.0004
0.008	Meltblown	0.0006
0.008	Thermal Bonded	0.0010
0.014	Hydroentangled	0.0009
0.016	Spunbonded	0.0017
0.074	Dry Laid	0.0063
0.117	Needlepunch	0.0154

Table 1
Precision data

Larger differences are likely to occur under all other circumstances. This procedure for determining thickness has no other known bias and is considered a referee method.

Annex A

(Informative)

Statistical results of interlaboratory tests

A preliminary interlaboratory test was run in 1992 in which randomly drawn samples of eight materials were tested in each of five laboratories utilizing the “dry” conditions. Two operators in each laboratory tested five specimens of each material. The eight materials used in this evaluation were all manufactured by different processes. The pressure on the presser foot was varied according to the classification of the material under evaluation in accordance with the following:

Manufacturing Process	Classification	Presser Foot Pressure (psi)
Resin Bonded	Soft	0.1
Wet Laid	Firm	3.0
Meltblown	Soft	0.1
Thermal Bonded	Soft	0.1
Hydroentangled	Moderate	1.0
Spunbonded	Firm	3.0
Dry Laid	Moderate	1.0
Needlepunch	Moderate	1.0

Table A 1
Pressure on the presser foot

Analysis of the data using ISO 5725-2 Accuracy (trueness and precision) of measurement methods and results, suggested reporting the components of variance and least critical differences for each material. The components of variance, expressed as standard deviations, for material evaluated are listed in Table A 2 (see Note A 1). Further testing is in progress to elucidate the ruggedness of this test method, including the effect of presser foot dimensions and pressure during testing.

NOTE A 1 The square roots of the components of variance are listed in Table A 1 so that the variability is expressed in the appropriate units of measure rather than as the square of those units of measure.

For the components of variance listed in Table A 2, the averages of two observed values should be considered significantly different at the 95 % probability level if the difference equals or exceeds the critical differences listed in Table A 3 (see Note A 2). Due to the dependence of the components of variance on the manufacturing process no meaningful statement can be made at this time relative to between material comparisons.

Components of Variance as Standard Deviations (Thickness in inches)

Nominal Thickness- Manufacturing Process		Single Operator Component	Within Laboratory Component	Between Laboratory Component
0.005	Resin Bonded	0.0006	0.0007	0.0007
0.007	Wet Laid	0.0004	0.0002	0.0006
0.008	Meltblown	0.0005	0.0011	0.0004
0.008	Thermal Bonded	0.0008	0.0006	0.0014
0.014	Hydroentangled	0.0007	0.0006	0.0016
0.016	Spunbonded	0.0014	0.0006	0.0000
0.074	Dry Laid	0.0051	0.0000	0.0126
0.117	Needlepunched	0.0124	0.0054	0.0113

Table A 2

NOTE A 2 The values of the tabulated differences should be considered to be a general statement, particularly with respect to between-laboratory precision. Before a meaningful statement can be made about two specific laboratories, the amount of statistical bias, if any, between them must be established with each comparison being based on recent data obtained on specimens taken from a lot of material of the type being evaluated so as to be as homogeneous as possible, and then randomly assigned in equal numbers to each of the laboratories.

Critical Differences for Conditions Noted 95 % Probability Level
(Thickness in inches)

Nominal Thickness	Manufacturing Process	Observations In Each Average	Single Operator	Within Laboratory Precision	Between Laboratory Precision
0.005	Resin Bonded	5	0.0007	0.0020	0.0029
		10	0.0005	0.0019	0.0028
0.007	Wet Laid	5	0.0004	0.0007	0.0017
		10	0.0003	0.0006	0.0017
0.008	Meltblown	5	0.0006	0.0032	0.0034
		10	0.0004	0.0032	0.0034
0.008	Thermal Bonded	5	0.0010	0.0018	0.0043
		10	0.0007	0.0017	0.0042
0.014	Hydro entangled	5	0.0009	0.0020	0.0058
		10	0.0006	0.0019	0.0058
0.016	Spunbonded	5	0.0017	0.0023	0.0023
		10	0.0012	0.0020	0.0020
0.074	Dry Laid)	5	0.0063	0.0063	0.0354
		10	0.0045	0.0045	0.0351
0.117	Needlepunched	5	0.0154	0.0215	0.0381
		10	0.0109	0.0186	0.0365

TABLE A 3

STANDARD TEST: WSP 120.2.R4 (12)

Standard Test Method for Thickness of Highloft Nonwoven Fabrics

The number in parentheses indicates the year of the last revision

1. Scope

This test method describes the measurement of thickness of highloft nonwoven fabrics. For thickness of nonwoven fabrics other than highloft, see WSP 120.1.R4 (12)

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.1 ISO test methods

a) ISO 5725-1 Accuracy (trueness and precision) of Measurement Methods and Results – Part 1:General Principles and Definitions

b) ISO 5725 2 Accuracy (trueness and precision) of Measurement Methods and Results – Part 2: Basic Method for the Determination of the Repeatability and Reproducibility of a Standard Measurement Method

c) ISO 139-2005 Textiles — Standard atmospheres for conditioning and testing

d) ISO 2859-1:1999 Sampling procedures for inspection by attributes

e) ISO 3951-1:2005 Sampling procedures for inspection by variables

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

Current edition approved WSP 120.2.R4 (12)
Originally published as WSP 120.2 in 2002
Last approved as WSP 120.2 in 2009

3.1 Highloft nonwoven fabric
A low-density fiber network structure characterized by a high ratio of thickness to mass per unit area. (Syn. highloft).

3.2 Nonwoven fabric
A textile structure produced by bonding or interlocking of fibers, or both, accomplished by mechanical, chemical, thermal, or solvent means, or combination thereof.

3.3 Pressure
The force per unit area. Pressure may be expressed in any appropriate or specified units, such as pascals (Pa), newtons per square meter (N/m2).

3.4 Thickness
The distance between one surface and its opposite.

4. Principle

The thickness of a highloft nonwoven fabric is determined by observing the linear distance that a movable plane is displaced from a parallel surface by the specimen while under a specified pressure.

Thickness is one of the basic physical properties of highloft nonwoven fabrics. In certain industrial applications, the thickness may require rigid control within specified limits. Bulk and warmth properties of highloft nonwoven fabrics are often estimated from their thickness values, and thickness is also useful in measuring performance characteristics, such as before and after abrasion or shrinkage.

The thickness value of highloft nonwoven fabrics will vary considerably depending on the pressure applied to the specimen at the time the thickness measurement is taken. In all cases, the apparent thickness varies inversely with the pressure applied. For this reason, it is essential that the pressure be specified when discussing or listing any thickness value.

5. Apparatus

5.1 Thickness testing gage
Having dimensions appropriate to the highloft nonwoven material to be tested and shall permit the gradual application of the specified pressure within 65 %. The anvil and presser foot shall be plane and parallel within 0.13 mm and provided with a scale for indicating the distance between the anvil and the presser foot, having a readability of 0.02 mm with an accuracy of at least 0.1 mm. The length and width of the anvil shall be at least 10 mm greater than the presser foot. The presser foot shall be 300 by 300 mm. The tester shall be equipped with a counter balance to balance the platen as specified.

Because of the linkage ratios, the dial indicator movement will represent a tenfold movement of the platen. For example, a reading of 0.25 mm on the dial indicator indicates a travel of the platen of 2.5 mm. The dial indicator is typical for measurements of

thickness and includes two indicators. The small indicator counts the revolution of the large indicator pointer. A specimen whose thickness is, for example, 90 mm will read 75 mm on the small indicator and 13 mm on the larger indicator.

5.2 Cutting dies or template

To cut specimens 300 x 300 ± 2 mm. Dies are recommended.

NOTE 2 A study of the impact of the sample size on the accuracy of the method indicated that because of the large specimen size it is not necessary to cut specimens larger than the anvil.

5.3 Mass

An appropriate size weight with a mass of 288 g ± 1 %

6. Conditioning

6.1 Condition 1, standard testing conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

6.2 Condition 2, unspecified testing conditioning

No conditioning is required unless otherwise specified in a material specification or contact order.

NOTE 3 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

7. Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE4 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material.

a) Care in handling should be observed so that specimens do not contact any contaminants such as soap, salt, oil etc.
b) Specimens should be cut 300 x 300 mm
c) Unless otherwise specified, cut 5 specimens, evenly spaced across the available width of each sample.

8. Procedure

8.1 Test the specimens in the environment

As directed in an applicable material specification or contract order. See clause 6.1 or 6.2.

8.2 Verify calibration of the thickness gage

As directed in the manufacturer's instructions.

8.3 With the platen and base separated

By 50 mm adjust the counter balance at the rear of the apparatus until the platen will remain at rest.

8.4 Raise the platen

And place a specimen of the material to be tested on the base plate. Add the mass to the platen and gradually lower the platen until it contacts the surface of the specimen. Release the platen and read the thickness to the nearest 0.02 mm, 9 to 10 s after release of the platen.

9. Calculation

9.1 Thickness, individual specimens

Record the thickness for individual specimens to the nearest 0.02 mm as read directly from the data collection system unless otherwise specified in a material specification or contract order.

9.2 Average values

Calculate the average thickness for each of the laboratory sample units and the lot.

9.3 Standard deviation, coefficient of variation

Calculate when requested.

10. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Number of specimens tested and note CD and/or MD if significant
g) For computer processed data, identify the software used and the version
h) Deviation from the standard test procedure, if any
i) When calculated, the standard deviation or the coefficient of variation
j) Whether or not samples were conditioned prior to testing and, if so, for how long
k) Anything unusual noted during the testing
l) When photos are used as the standard, attach copies

11. Precision

Summary

Interlaboratory test data have shown that the variance in thickness testing is dependent upon the nominal thickness of the material under evaluation; therefore, no general statement can be made concerning least critical differences. The following data were generated during the interlaboratory test and are presented for reference. In comparing two averages of five observations, the difference between averages should not exceed the following values in 95 out of 100 cases when all the observations are taken by the same well-trained operator using the same piece of equipment and specimens are randomly drawn from the same sample having a nominal thickness in the range indicated. Larger differences are likely to occur under all other circumstances.

Nominal Thickness, mm	Thickness, mm
6.35 to 12.70	0.25
12.70 to 25.40	0.53
25.40 to 63.50	1.37
63.50 to 101.60	1.37

Table 1

ANNEX A
(Informative)

Precision

An interlaboratory test was run in 1992 in which randomly drawn samples of six materials were tested in each of five laboratories. Two operators in each laboratory tested five specimens of each material. The six materials used in this evaluation were resin-bonded polyester highloft nonwovens produced at nominal thicknesses of: 6.35 mm, 12.70 mm, 19.05 mm, 38.1 mm, 69.85 mm, and 101.60 mm. Data was collected in inch-pound units as shown in the research report and the results of statistical analysis were then converted to SI units for inclusion in this test method. Analysis of the data using the ISO 5725 -2 Accuracy (trueness and precision) of Measurement Methods and Results – Part 2: Basic Method for the Determination of the Repeatability and Reproducibility of a Standard Measurement Method suggested grouping of the materials based on residual variances. The components of variance, expressed as standard deviations, for each group are listed in Table A 1.

Components of variance as standard deviations Thickness in mm

Nominal Thickness Range	Single Operator Component	Within Laboratory Component	Between Laboratory Component
6.35 to 12.70	0.20	0	0.20
12.70 to 25.40	0.43	0	1.07
25.40 to 63.50	1.09	0	1.45
63.50 to 101.60	1.93	0	0.71

Table A 1

Critical differences for conditions noted 95% probability level Thickness in mm

Nominal Thickness Range	Observations In Each Average	Single Operator Precision	Within Laboratory Precision	Between Laboratories Precision
6.35 to 12.70	1	0.56	0.56	0.79
	5	0.25	0.25	0.61
	10	0.18	0.18	0.58
12.70 to 25.40	1	1.19	1.19	3.18
	5	0.53	0.53	2.97
	10	0.38	0.38	2.95
25.40 to 63.50	1	3.05	3.05	5.03
	5	1.37	1.37	4.24
	10	0.97	0.97	4.11
63.50 to 101.60	1	5.33	5.33	5.72
	5	2.39	2.39	3.12
	10	1.70	1.70	2.62

Table A 2

STANDARD TEST: WSP 120.3.R4 (12)

Standard Test Method for Measuring Compression and Recovery of Highloft Nonwoven Fabrics

The number in parentheses indicates the year of the last revision

1. Scope

This method for measuring compression and recovery is applicable to all types of highloft nonwovens.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document:

2.1 ISO test methods

a) ISO 139-2005 Textiles — Standard atmospheres for conditioning and testing
b) ISO 2859-1:1999 Sampling procedures for inspection by attributes
c) ISO 3951-1:2005 Sampling procedures for inspection by variables

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Compression

The act of compressing or the state of being compressed.

Reference number
WSP 120.3.R4 (12) A

Current edition approved WSP 120.3.R4 (12)
Originally published as WSP 120.3 in 2002
Last approved as WSP 120.3 in 2009

3.2 Highloft
A lofty nonwoven having no more than 10% solids by volume and greater than 3 mm in thickness.

3.3 Recovery
The act of recovering or the state of being or having recovered from compression.

4. Principle

The average compression and recovery of a highloft nonwoven is determined by observing the linear distance that a movable plane is displaced from a parallel surface by the highloft nonwoven while under a specified pressure and after a specified time interval the pressure is removed and the recovery of the linear distance measured.

Compression and recovery are two of the basic physical properties of highloft nonwovens. In certain applications these properties must be controlled within specified limits. The performance of highloft nonwovens in furniture, clothing, and insulation applications is often estimated from their compression and recovery values.

The compression and recovery of most highloft nonwovens will vary considerably depending on the type of fiber used, the method of bonding, and other processing conditions.

5. Apparatus

5.1 Thickness testing gage
Having dimensions appropriate to the highloft nonwoven material to be tested and shall permit the gradual application of the specified pressure within 65 %. The anvil and presser foot shall be plane and parallel within 0.13 mm and provided with a scale for indicating the distance between the anvil and the presser foot, having a readability of 0.02 mm with an accuracy of at least 0.1 mm. The length and width of the anvil shall be at least 10 mm greater than the presser foot. The presser foot shall be 300 by 300 mm. The tester shall be equipped with a counter balance to balance the platen as specified.

Because of the linkage ratios, the dial indicator movement will represent a tenfold movement of the platen. For example, a reading of 0.25 mm on the dial indicator indicates a travel of the platen of 2.5 mm. The dial indicator is typical for measurements of thickness and includes two indicators. The small indicator counts the revolution of the large indicator pointer. A specimen whose thickness is, for example, 90 mm will read 75 mm on the small indicator and 13 mm on the larger indicator.

5.2 Cutting dies or template
To cut specimens 300 x 300 ± 2 mm dies are recommended.

6. Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 2 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

7. Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 3 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material.

a) Care in handling should be observed so that specimens do not contact any contaminants such as soap, salt, oil etc.
b) Specimens should be cut 300 x 300 mm
c) Unless otherwise specified, cut 5 specimens, evenly spaced across the available width of each sample.

8. Procedure

8.1 Determine the original thickness

T1, in mils, as prescribed in WSP 120.2.R4

8.2 Raise the presser foot from the specimen

And replace the 288g presser foot weight used in the thickness test (WSP 120.2.R4) with a weight of 16.4 Kg per 929 square cm

8.3 Lower the anvil

And apply this pressure for 30 minutes and measure the compressed thickness, T2.

8.4 Raise the presser foot

And replace the 36 pound weight with the 288 gram weight. After five minutes, lower the anvil and measure the thickness recovered, T3, after this recovery period.

9. Calculation

Calculate the percent compression and recovery using the following equations

Percent compression

$$\frac{T1-T2}{T1} \quad X \quad 100 = \quad percent\ compression$$

Percent recovery

$$\frac{T3}{T1} \quad X \quad 100 = \quad percent\ recovery$$

Where:

T1= Original thickness
T2= Compressed thickness
T3= Recovered thickness

10. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Number of specimens tested
g) Average percent compression
h) Average percent recovery
i) For computer processed data, identify the software used and the version
j) Deviation from the standard test procedure, if any
k) When calculated, the standard deviation or the coefficient of variation
l) Whether or not samples were conditioned prior to testing and, if so, for how long
m) Anything unusual noted during the testing

11. Precision

The precision for this method is yet to be determined.

STANDARD TEST: WSP 120.4.R4 (12)

Standard Test Method for the Determination of Compression and Recovery of Highloft Nonwoven Fabrics at Room Temperature Using Weights and Plates

The number in parentheses indicates the year of the last revision

1. Scope

This test method covers a procedure for determining compression and recovery for any type of highloft nonwoven at room temperature using a simplistic and economical “weights and plates” technique.

The highloft batting can be of any construction and tested as manufactured or as an end use article.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.1 ISO test methods

a) ISO 139-2005 Textiles — Standard atmospheres for conditioning and testing
b) ISO 2859-1:1999 Sampling procedures for inspection by attributes
c) ISO 3951-1:2005 Sampling procedures for inspection by variables

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA’s and INDA’s Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply

Reference number
WSP 120.4.R4 (12) A

Current edition approved WSP 120.4.R4 (12)
Originally published as WSP 120.4 in 2002
Last approved as WSP 120.4 in 2009

3.1 Batting
A nonwoven filling material consisting of a continuous web of fibers formed by carding, garnetting, air laying or other means.

3.2 Compression
The act of compressing or the state of being compressed

3.3 Highloft
A low density fiber network structure characterized by a high ratio of thickness to weight per unit area. The fibers may be continuous or discontinuous, bonded or unbonded. Highloft battings have no more than 10% solids, by volume, and are greater than 3 mm in thickness.

3.4 Plates
Pieces of smooth, thin and light material, preferably 225 x 225 x 6 mm plywood, used to distribute the mass of the weights over the entire area of the highloft battings.

3.5 Recovery
The act of recovering or the state of being recovered from compression

3.6 Weights
Pieces of metal, etc. of a specific mass to equal 7.26 Kg used to compress highloft battings.

4. Principle

Specimens of the highloft batting are piled in a stack, preferably four in number. A weight, 7.26 Kg, is applied for a certain period of time. The initial height, the heights with and without the weight, and the heights after relaxation of the webs are measured. The relationship of the measurements shows the ability of the battings to resist compression and recover after compression and further relaxation.

The ability to resist compression and recover after compression are two basic physical properties of a highloft nonwoven. The properties of compression and recovery must be measurable so that specification can be set for certain end use applications. This test provides an inexpensive alternative for highloft producers, their suppliers and customers to determine compression and recovery properties and better predicting their performance in the finished product.

5. Apparatus

5.1 A meter ruler
For measuring the web height

5.2 An accurate timer

5.3 Base plates
225 x 225 x 6 mm plywood plate covered with aluminum foil or an aluminum plate.

5.4 Cover plate
225 x 225x 6 mm plywood plate covered with aluminum foil weighing 187 ± 2 g

5.5 Weight
7.26 Kg

6. Conditioning (special)

The number of pieces of sample required to make 1 specimen is dependent on the initial thickness of the highloft nonwoven. The specimen must have a total height of 100 mm. The pieces (specimen) are placed in a stack on a base plate (without cover plate) in a 100°F/68% relative humidity environmental chamber. The samples should condition under these conditions for 24 hours. A shorter time is possible if agreed to by all parties involved in the evaluation.

The specimens are then tested at normal laboratory room temperature

7. Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 2 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material.

a) Care in handling should be observed so that specimens do not contact any contaminants such as soap, salt, oil etc.

b) Specimens should be cut 200 x 200 mm

c) The number of pieces of sample required to make 1 specimen is dependent on the initial thickness of the highloft nonwoven. A minimum height of 100 mm (4 in) is required for the test to be significant, typically four to six pieces are required to obtain the proper web height of the specimen.

d) Unless otherwise specified, test 1 specimen 4 times (once, in the middle of each side).

8. Procedure

8.1 Then, measure the web heights by following the procedure alphabetically

The height of the web is the average of four measurements taken at the mid point of each side of the cover plate. Keep the cover plate on the webs throughout the test. It should be noted that the time mentioned below is total testing time.

a) Initial height with cover plate on samples but no additional weight.
b) Height with weight added.
c) Height with weight added after ten minutes
d) Height with weight removed after ten minutes.
e) Height with weight removed after 20 minutes
f) Height with weight added after 20 minutes
g) Height with weight added after 30 minutes.
h) Height with weight removed after 30 minutes
i) Height with weight removed after 40 minutes
j) Height with weight added after 40 minutes
k) Height with weight added after 50 minutes.
l) Height with weight removed after 50 minutes
m) Height with weight removed after 60 minutes.

n) Height with weight removed after 8 hours.
o) Height with weight added after 8 hours
p) Height with weight added after 24 hours.
q) Height with weight removed after 24 hours.
r) Height with weight removed after 25 hours (1 hour recovery time). Samples reach most of their recovery in one hour.
s) Height with weight removed after 32 hours.
t) Height with weight removed after 48 hours.
u) Height with weight removed after 56 hours.

8.2 With agreement of all parties involved

The number of measurements taken during the test can be reduced. A test protocol which has reduced measurements and would allow for all calculations follows:

a) Initial height with cover plate on samples but no additional weight.
b) Height with weight added.
c) Height with weight added after ten minutes.
d) Height with weight removed after ten minutes.
e) Height with weight removed after 20 minutes.
f) Height with weight added after 20 minutes.
g) Height with weight added after 60 minutes.
h) Height with weight removed after 60 minutes.
i) Height with weight removed after 8 hours.
j) Height with weight added after 8 hours.
k) Height with weight added after 24 hours.
l) Height with weight removed after 24 hours.
m) Height with weight removed after 25 hours (1 hour recovery time). Samples reach most of their recovery in one hour.

9. Calculation

9.1 Calculate the following

Compression and recovery parameters using the following equations:

% Compression Resistance = (C/A) x 100% %
Elastic Loss = [(A-E)/A]c100%

This loss in the height of the highloft nonwoven is attributed to the fiber elasticity. Under most conditions, this loss is never regained.

% Immediate Recovery = (N/E) x 100%
% Long Term Recovery = (U/E) x 100%
Use (R/E) x 100% for shortened test.

9.2 The performance of the highloft nonwoven can also be graphically illustrated

A typical plot is shown in ANNEX A Graph A 1. Graphs are helpful in comparing the performance of webs.

10. Report

In addition to the precise test results, the report shall include the following information:

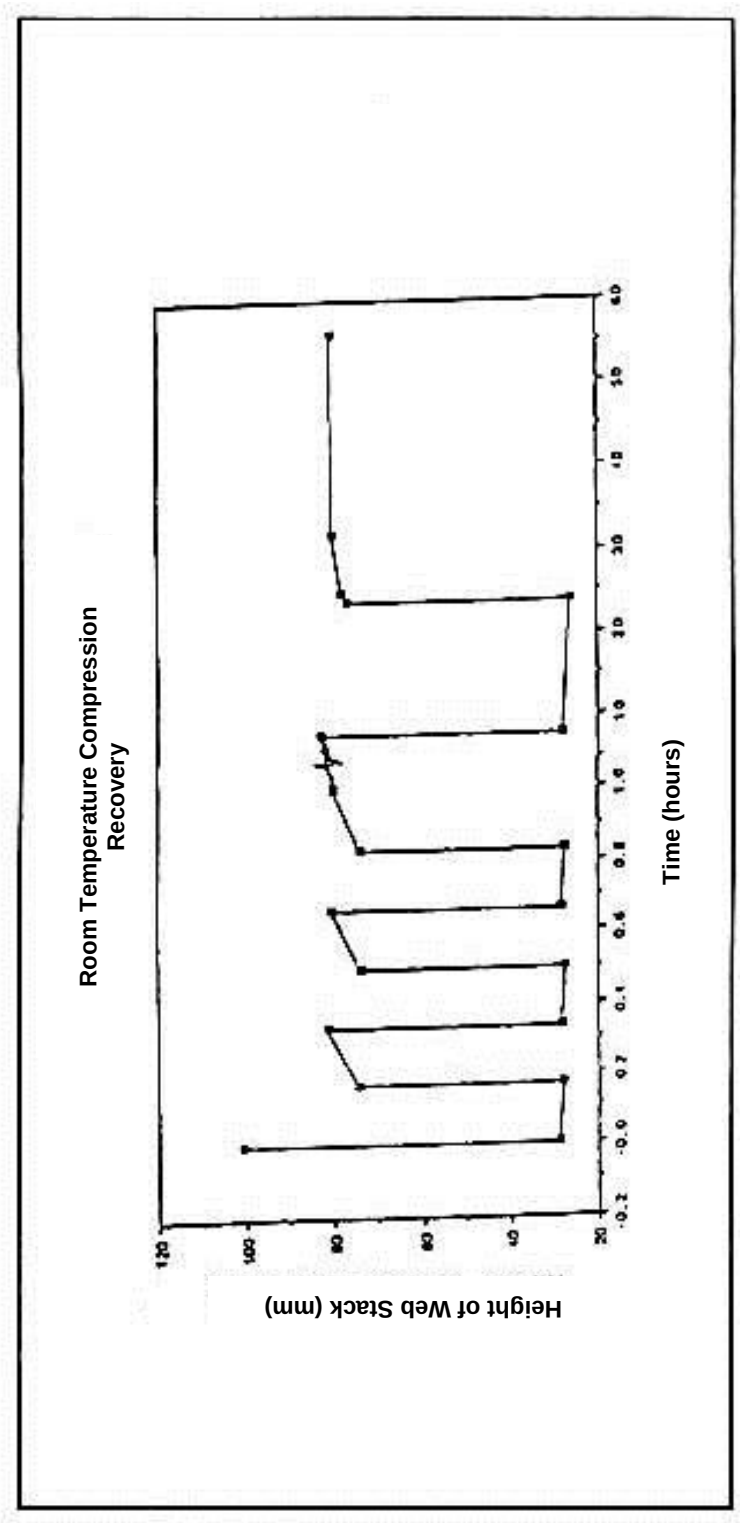
a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory **special** testing conditions
f) The average % Compression Resistance
g) The average % Elastic Loss
h) The average % Immediate Recovery
i) The average % Long Term Recovery
j) A graphical illustration of the performance of the sample (optional)
k) Number of specimens tested
l) For computer processed data, identify the software used and the version
m) Deviation from the standard test procedure, if any
n) Anything unusual noted during the testing

11. Precision

The precision for this method is yet to be determined.

ANNEX A

Graph A 1



STANDARD TEST: WSP 120.5.R4 (12)

Standard Test Method for the Determination of Compression and Recovery of Highloft Nonwoven Fabrics at High Temperature/High Humidity Using Weights and Plates

The number in parentheses indicates the year of the last revision

1. Scope

This test method covers a procedure for determining compression and recovery for any type of highloft nonwoven at high temperature and high humidity, simulating conditions in summer months or warm climate conditions, using a "weights and plates" technique.

The highloft batting can be of any construction and tested as manufactured or an end use article.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.1 ISO test methods

a) ISO 139-2005 Textiles — Standard atmospheres for conditioning and testing
b) ISO 2859-1:1999 Sampling procedures for inspection by attributes
c) ISO 3951-1:2005 Sampling procedures for inspection by variables

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

Reference number
WSP 120.5.R4 (12) A

Current edition approved WSP 120.5.R4 (12)
Originally published as WSP 120.5 in 2002
Last approved as WSP 120.5 in 2009

3.1 Batting
A nonwoven filling material consisting of a continuous web of fibers formed by carding, garneting, air laying or other means.

3.2 Compression
The act of compressing or the state of being compressed

3.3 Highloft
A low density fiber network structure characterized by a high ratio of thickness to weight per unit area. The fibers may be continuous or discontinuous, bonded or unbonded. Highloft battings have no more than 10% solids, by volume, and are greater than 3 mm in thickness.

3.4 Plates
Pieces of smooth, thin and light material, preferably 225 x 225 x 6 mm plywood, used to distribute the mass of the weights over the entire area of the highloft battings.

3.5 Recovery
The act of recovering or the state of being recovered from compression

3.6 Weights
Pieces of metal, etc. of a specific mass to equal 7.26 Kg used to compress highloft battings.

4. Principle

Specimens of the highloft batting are piled in a stack, preferably four in number, in a chamber or room where conditions are controlled at 37°C and 68% Relative Humidity. A weight, 7.26 Kg, is applied for a certain period of time. The initial height, the heights with and without the weight, and the heights after relaxation of the webs are measured. The relationship of the measurements shows the ability of the battings to resist compression and recover after compression and further relaxation.

The ability to resist compression and recover after compression are two basic physical properties of a highloft nonwoven. These properties must be consistent throughout the year under a wide variety of climatic conditions and measurable so that specification can be set for certain end use applications. High temperature and high humidity typical during summer months and in warm climates can adversely affect Compression and Recovery performance of highloft battings. This is especially important for outdoor furniture applications and where vacuum packing of highloft nonwovens is employed, immediately following manufacturing, to increase shipping efficiency.

5. Apparatus

5.1 A meter ruler
For measuring the web height

5.2 An accurate timer

5.3 Base plates
225 x 225 x 6 mm plywood plate covered with aluminum foil or an aluminum plate.

5.4 Cover plate
225 x 225x 6 mm plywood plate covered with aluminum foil weighing 187 ± 2 g

5.5 Weight 7.26 Kg

6. Conditioning (special)

The number of pieces of sample required to make 1 specimen is dependent on the initial thickness of the highloft nonwoven. The specimen must have a total height of 100 mm minimum. The pieces (specimen) are placed in a stack on a base plate (without cover plate) in a 100°F/68% relative humidity environmental chamber. The samples should condition under these conditions for 24 hours. A shorter time is possible if agreed to by all parties involved in the evaluation.

7. Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 2 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material.

a) Care in handling should be observed so that specimens do not contact any contaminants such as soap, salt, oil etc.
b) Specimens should be cut 200 x 200 mm
c) The number of pieces of sample required to make 1 specimen is dependent on the initial thickness of the highloft nonwoven. A minimum height of 100 mm is required for the test to be significant, typically four to six pieces are required to obtain the proper web height of the specimen.
d) Unless otherwise specified, test 1 specimen 4 times (once, in the middle of each side).

8. Procedure

8.1 Then, measure the web heights by following the procedures alphabetically

The web height is the average of the measurements taken from the mid point of each side of the highloft stack. It should be noted that the time mentioned below is total testing time after the first 24 hour conditioning.

a) Initial height with no cover plate in the conditioned chamber.
b) Height with cover plate and weight added in the chamber. (Optional)
c) Height with cover plate and weight added after 24 hours in the chamber.
d) Height with weight and cover plate removed after 24 hours in the chamber.

Remove the samples from the conditioned chamber.

e) Height with weight and cover plate removed after 25 hours. (Optional)
f) Height with weight and cover plate removed after 26 hours. (Optional)
g) Height with weight and cover plate removed after 27 hours. (Optional)
h) Height with weight and cover plate removed after 32 hours.
i) Height with weight and cover plate removed after 48 hours.
j) Height with weight and cover plate removed after 56 hours.

8.2 With agreement of all parties

Involved the number of measurements taken during the test can be reduced. This can be best accomplished by reducing the number of readings after removal from the Humidity Chamber such as H, I and J.

9. Calculation

9.1 The actual height of the stack of highloft battings

For measurements B and C must be calculated using the following equation.

Actual Height	=	Average of measured heights
The thickness of the cover plate	=	B or C mm – 6.4 mm

9.2 Calculate the following compression and recovery

Parameters using the following equations
% Compression Resistance = (C/A) x 100%
% Immediate Recovery = (D/A) x 100%
% Long Term Recovery = (J/A) x 100%
(or (the last reading/A) x 100%)

9.3 The performance of the highloft nonwoven fabrics

Can also be graphically illustrated using the optional measurement. A typical plot is shown on Graph 1

10. Report

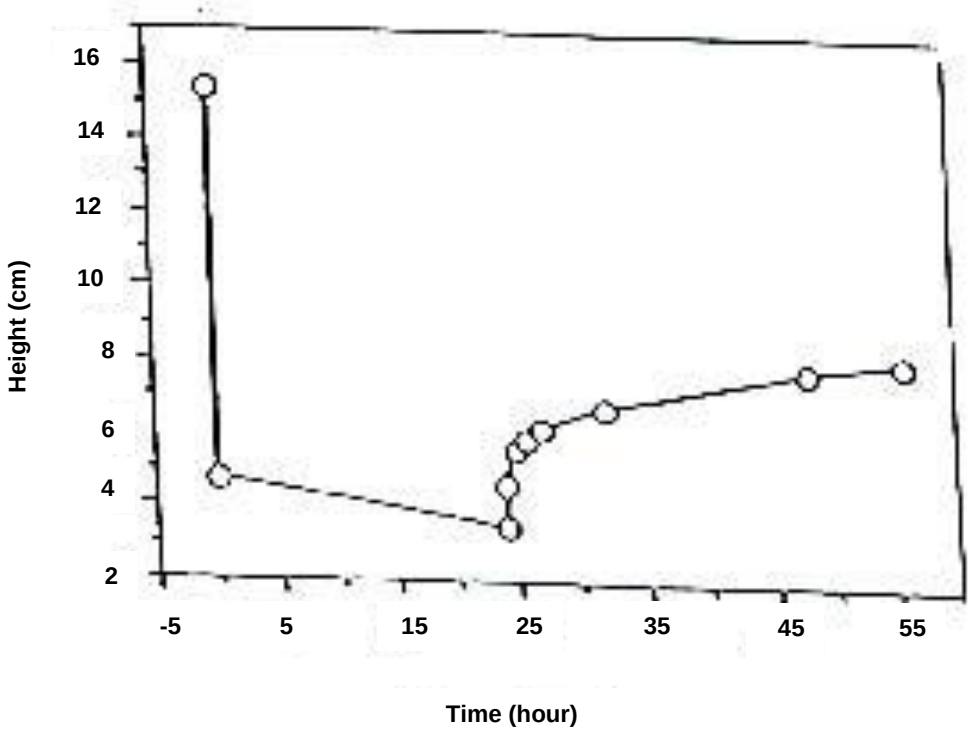
In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory **special** testing conditions
f) The average % Compression Resistance
g) The average % Elastic Loss
h) The average % Immediate Recovery
i) The average % Long Term Recovery
j) A graphical illustration of the performance of the sample (optional)
k) Number of specimens tested
l) For computer processed data, identify the software used and the version
m) Deviation from the standard test procedure, if any
n) Anything unusual noted during the testing

11. Precision

The precision for this method is yet to be determined.

Graph 1
Compression Recovery Plot
High Temperature/High Humidity



STANDARD TEST: WSP120.6.R4 (12)

Standard Test Method for Nonwoven Thickness

The number in parentheses indicates the year of the last revision

1. Scope

This test method covers the measurement of the thickness of normal and bulky nonwovens. The distance between the face and the back surfaces of the material is measured when under specific pressure. It can also measure bulk, which is thickness divided by mass per unit area (cm^3/g), and bulk density which is mass per unit area divided by thickness (g/cm^3).

This test method covers three testing options for different types of nonwovens:

a) Normal nonwovens, method option A
b) For bulky nonwovens with maximum thickness of 20 mm, method option B (see figure 1)
c) For bulky nonwovens with a thickness greater than 20 mm, method option C (see figure 2)

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.1 ISO test methods

a) ISO 9073-2:1995 Textiles – Test Methods for Nonwovens - Determination of thickness (EN 29073 part 2)
b) ISO 139-2005 Textiles — Standard atmospheres for conditioning and testing
c) ISO 2859-1:1999 Sampling procedures for inspection by attributes
d) ISO 3951-1:2005 Sampling procedures for inspection by variables

Reference number
WSP 120.6.R4 (12) A

Current edition approved WSP 120.6.R4 (12)
Originally published as WSP 120.6 in 2002
Last approved as WSP 120.6 in 2009

2.3 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Principle

Thickness is one of the basic physical properties of nonwoven fabrics. In certain industrial applications, the thickness may require rigid control within specified limits. Bulk and warmth properties of nonwoven fabrics are often estimated from their thickness values, and thickness is also useful in measuring performance characteristics, such as, before and after abrasion and shrinkage.

The thickness values of most nonwoven fabrics will vary considerably depending on the pressure applied to the specimen at the time the thickness measurement is taken. In all cases, the apparent thickness varies inversely with the pressure applied. For this reason, it is essential that the pressure be specified when discussing or listing any thickness value.

4. Apparatus

4.1 For normal nonwovens

The thickness of the nonwoven is determined by measuring the distance between the reference plate on which the nonwoven rests and a parallel presser-foot (or plate) that exerts a specified pressure on the area under test. The upper plate or presser-foot shall be capable of moving vertically.

a) The upper plate shall have an area of approximately 2500 mm².
b) The reference plate shall have a plane surface of diameter at least 50 mm greater than that of the presser-foot.
c) Measuring device, having a scale with 0.01 mm graduations.

4.2 For bulky nonwovens with a maximum thickness of 20 mm (see figure 1)

a) Vertical reference plate with an area of 1000 mm²
b) A presser-foot, with an area of 2500 mm²
c) Equipment to suspend the test specimen vertically between them.
d) Elbow lever, with both arms of equal length, attached to the reference plate and capable of being balanced using a counter weight so that it exerts a very small load to the left when the balance weight is not in position.
e) Electrical contacts, which, when closed, cause a small bulb to become illuminated.
f) Balance weight with a mass of (2.05 ± 0.05) g, which, when in position, causes the contacts to separate and extinguish the bulb. This gives a measuring pressure of 0.02 kPa.
g) Screw, which, when turned, drives the presser-foot to the left and presses the test specimen with increasing pressure against the reference plate until the force on the balance is overcome and the bulb becomes illuminated again.
h) Dual-gauge, to indicate the distance between the reference plate and the presser-foot corresponding to the thickness of the test specimen at the pressure applied.
i) The size of the test specimen shall be (130 ± 5) mm x (80 ± 5) mm.

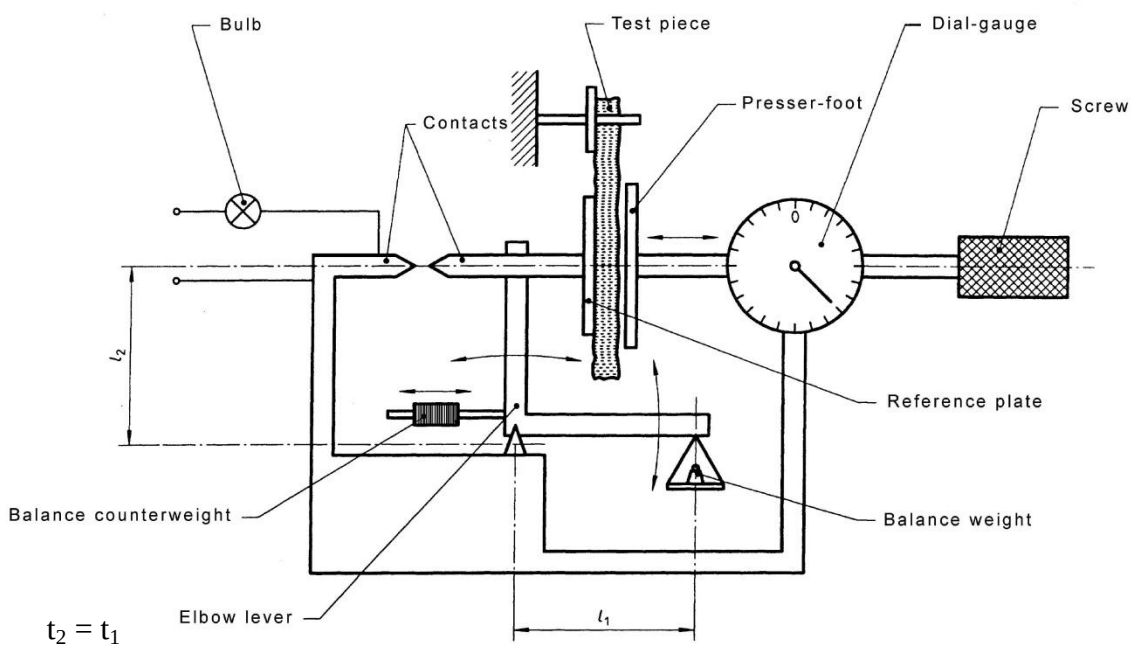


Figure 1
Test apparatus for bulky nonwovens with a maximum thickness of 20 mm

4.3 For bulky nonwovens with a thickness greater than 20 mm (figure 2)

The testing apparatus consists of a horizontal, square base plate with a side length of 300 mm.

a) This base plate shall have a smooth surface
b) In the middle of one side is a vertical scale with graduations in mm, on which is placed a horizontal measuring bar, movable in the vertical direction
c) This bar supports an adjustable vertical probe at a distance of 100 mm from the vertical scale.
d) The measuring plate is square with a side length of 200 mm ± 0.2 mm and a mass of 82 g ± 2 g. The plate is made of glass with a thickness of 0.7 mm which can be brought to the required mass by the addition of weight-specimens to give a measuring pressure of 0.02 kPa
e) Stopwatch
f) The testing area is 200 mm x 200 mm.

NOTE 2 **SPECIAL Regarding the procedure for calibrating the pressure applied**
The pressure applied to the fabric, when measuring thickness with a dial gauge, is composed of:

a) Force induced by the mass of the piston
b) Force induced by the spring
c) Less the losses from the internal friction of the dial gauge.

The force induced by internal friction can be erratic. Therefore force applied by the dial gauge should be measured using a balance.
For example: If we find the force applied by the gauge is due to the weight of 20.4 g, the resultant "pressure applied on an area of 20 cm²" is:

$$\frac{20.4x9.8}{20x100} = 0.1kPa$$

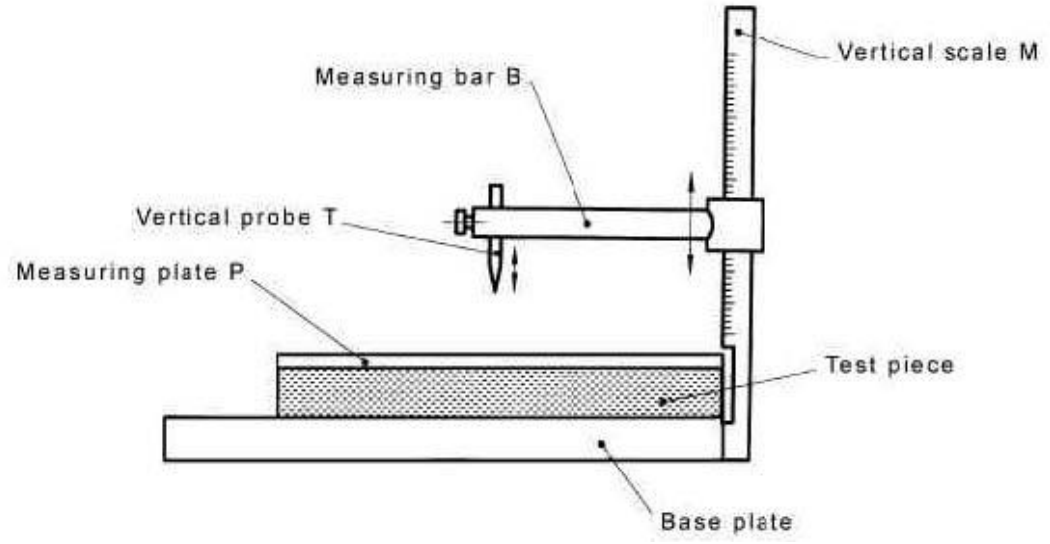


Figure 2
Test apparatus for bulky nonwovens with a thickness greater than 20 mm

5. Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes(1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 3 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material.

a) Prepare the fabric for testing after having established whether the nonwoven fabric is to be considered as a normal or as a bulky nonwoven.
b) Use uncreased fabric and do not smooth, iron or tension fabric in any way. Test specimens can be cut from bulk material as required.
c) They should be larger than the area of the presser-foot
d) Unless otherwise specified, cut 10 specimens, evenly spaced across the available width of each sample.

6. Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 4 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

7.Procedure

Procedure	Worked Example
7.1 Preliminary procedure	
7.1.1 Prepare the fabric for testing after having established whether the nonwoven fabric is to be considered as a normal or as a bulky nonwoven. Use uncreased fabric and do not smooth, iron or tension fabric in any way. Test specimens can be cut from bulk material as required. They should be larger than the area of the presser-foot.	
7.1.2 Using the apparatus as specified in 4.1. Adjust the load on the presser-foot to give a uniform pressure of 0.1 kPa. Set the measuring device to zero.	
7.1.3 Raise the presser-foot and place the test specimen carefully, without tension, on the reference plate. Ensure the test specimen is positioned centrally with respect to the presser-foot.	
7.1.4 Lower the presser-foot carefully until contact is made with the test specimen.	
7.1.5 Leave in contact for 10 s, adjust the measuring device to measure the thickness of the sample, and note the reading, in mm.	
7.1.6 Repeat the procedure with 9 test specimens.	
7.1.7 Adjust the load on the pressure-foot to give a uniform pressure of 0.5 kPa and adjust the measuring device to zero. Repeat the measurements with the same 10 test specimens.	
7.1.8 Calculate the difference between the results at pressures of 0.1 kPa and 0.5 kPa for each test specimen, and determine the mean.	
7.1.9 Test the nonwovens which were compressed by less than 20% in accordance with the procedure given in 7.2 (Option A), and others in accordance with either 7.3 (Option B) or 7.4 (Option C), depending upon whether they have a thickness of less than or greater than 20 mm.	
7.2 Option A for normal nonwovens	
7.2.1 Using the apparatus specified in 4.1, adjust the load on the presser-foot to give a uniform pressure of 0.5 kPa. Set the measuring device to zero.	
7.2.2 Raise the presser-foot and position the test specimen centrally with respect to the presser-foot, and without tension, on the reference plate.	
7.2.3 Lower the presser-foot carefully until contact is made with the test specimen, and leave in contact for 10 s.	
7.2.4 Adjust the measuring device and note the reading, in mm.	0.18 mm (0.18; 0.19; 0.19; 0.18; 0.185;
7.2.5 Repeat the procedure on the other 9 test specimens.	0.18: 0.175; 0.18; 0.185) mm
7.2.6 Calculate the mean thickness, in mm, and, if required, the coefficient of variation.	0.1825 mm
7.3 Option B for bulky nonwovens with a maximum thickness of lower than 20 mm	
7.3.1 Using the apparatus specified in 4.2, check that the sensitivity and zero are adjusted correctly, when the	

balance weight of (2.05 ± 0.05) g is in position.

7.3.2 Move the pressure-foot to the right and fasten the test specimen on the bearer pin so that it is suspended between the reference plate and the presser-foot.

7.3.3 Move the pressure-foot slowly to the left by means of the screw until the bulb is illuminated.

7.3.4 After 10 s, read the thickness, in mm, from the dial-gauge, to the nearest 0.1 mm.

7.3.5 Repeat the procedure for the other 9 test specimens.

7.3.6 Calculate the mean thickness, in mm, and, if required, the coefficient of variation.

Note:5 If further compression of the test specimen during the 10s period causes the contact to separate, the presser-foot should be adjusted to illuminate the bulb again before the thickness is read from the gauge.

7.4 Option C for bulky nonwovens with a thickness greater than 20 mm

7.4.1 Using the apparatus specified in 4.3, place the measuring plate on the base plate and, if necessary, adjust the height of the probe so that the reading on the scale is zero when the probe just touches the center of the measuring plate.

7.4.2 Place the test specimen on the base plate, centrally under the probe.

7.4.3 Place the measuring plate squarely on top of the test specimen without applying excess pressure.

7.4.4 After 10 s, move the measuring bar downwards until the probe touches the surface of the measuring plate and read the thickness from the scale, to the nearest 0.5 mm.

7.4.5 Repeat the procedure for the other 9 test specimens.

7.4.6 Calculate the mean thickness in mm and if required, the coefficient of variation.

8. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Number of specimens tested
g) For computer processed data, identify the software used and the version
h) Deviation from the standard test procedure, if any
i) The mean thickness in mm or in µm (thin fabric), and, if required, the coefficient of variation.
j) Pressure applied.
k) Whether or not samples were conditioned prior to testing and, if so, for how long
l) Anything unusual noted during the testing

9. Precision

The precision for this method is yet to be determined.

STANDARD TEST: WSP 130.1.R4 (12)

Standard Test Method for Mass per Unit Area

The number in parentheses indicates the year of the last revision

1. Scope

This test method measures the mass per unit area of a nonwoven.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document:

2.1 ISO test methods

a) ISO 139-2005 Textiles — Standard atmospheres for conditioning and testing
b) ISO 2859-1:1999 Sampling procedures for inspection by attributes
c) ISO 3951-1:2005 Sampling procedures for inspection by variables
d) ISO 9073-1:1989 Textiles - Test Methods for Nonwovens - Determination of mass per unit area
e) (EN 29073 part 1)

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Weight

When used with nonwovens materials = Mass per Unit Area

Reference number
WSP130.1.R4 (12) A

Current edition approved WSP 130.1.R4 (12)
Originally published as WSP 130.1 in 2002
Last approved as WSP 130.1 in 2009

4. Apparatus

4.1 Apparatus for cutting the test specimens, chosen from among the following:

a) Die, which cuts a test specimen of an area of at least 50.000 mm^2.
b) Template, with an area of at least 50.000 mm2 (e.g. 250 mm x 200 mm), and a razor blade.
c) Steel rule, accurately graduated in mm, and a razor blade.

4.2 Balance

A laboratory balance that is accurate to 0.1% of the mass of the test specimen.

5. Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 2 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material.

NOTE 3 For cutting, it is recommended to use either the template and a sharp razor blade, or die and a die press.

NOTE 4 Attention is drawn to the fact that with Nonwovens, sampling errors may be greater than testing error.

6. Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 5 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested.

7. Procedure

The mass per unit area of nonwovens
Is expressed in grams per square meter. It should be determined by cutting test specimens from a larger sample of nonwoven and measuring the area and mass of each test specimen. If there is insufficient material available to allow this, cut the largest rectangle possible of the available nonwoven and measure its area and mass. This should be noted in the result.

Procedure	Worked Example
7.2 Mass measurement done by cutting test specimens the proper size 50,000 mm^2	
7.2 1 Determine the mass of each test specimen, using the balance, to an accuracy of at least 0.1% of the mass.	
7.2.2 Calculate the mass per unit area of each test specimen, the mean value in g/m^2 and, if required, the coefficient of variation, as a percentage.	
7.3 Mass measurement of unique test specimens	
7.3.1 Cut the largest rectangle possible.	3600 mm^2
7.3.2 Using the accurate rule, determine the total area of the test specimen in mm^2.	0.9 g
7.3.3 Determine the mass of the test specimen, using the balance, to an accuracy of at least 0.1% of its mass.	$\frac{0.9}{3600} \times 10^6 = 250\ g/m^2$
7.3.4 Calculate the mass per unit area (g/m^2).	

8. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Number and size of specimens tested
g) Mean value in g/m^2 and, if required, the coefficient of variation, as a percentage
h) For computer processed data, identify the software used and the version
i) Deviation from the standard test procedure, if any
j) Whether or not samples were conditioned prior to testing and, if so, for how long
k) Anything unusual noted during the testing
l) When photos are used as the standard, attach copies

9. Precision

The precision for this method is yet to be determined.

STANDARD TEST: WSP 150.1.R4 (12)

Standard Test Method for Resin Binder Distribution and Binder Penetration Analysis of Polyester Nonwoven Fabrics

The number in parentheses indicates the year of the last revision

1. Scope

This test method covers the analysis of polyester highloft nonwoven fabrics for resin binder distribution and binder penetration.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are used in the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.1 ISO test methods

a) ISO 5725-1 Accuracy (trueness and precision) of Measurement Methods and Results – Part 1:General Principles and Definitions

b) ISO 5725-2 Accuracy (trueness and precision) of Measurement Methods and Results – Part 2:Basic Method for the Determination of the Repeatability and Reproducibility of a Standard Measurement Method

c) ISO 139-2005 Textiles — Standard atmospheres for conditioning and testing

d) ISO 2859-1:1999 Sampling procedures for inspection by attributes

e) ISO 3951-1:2005 Sampling procedures for inspection by variables

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

Reference number
WSP 150.1.R4 (12) A

Current edition approved WSP 150.1.R4 (12)
Originally published as WSP 150.1 in 2002
Last approved as WSP 150.1 in 2009

3. 1 Batting
A nonwoven filling material consisting of a continuous web of fibers formed by carding, garnetting, air laying or other means

3.2 Highloft nonwoven fabric
A low density fiber network structure characterized by a high ratio of thickness to mass per unit area

3.3 Needle-punched batting
A textile filling material that is stabilized by mechanically entangling the fibers

3.4 Resin binder
Emulsion polymer used for bonding

3.5 Resin bonded batting
A nonwoven filling material that is stabilized by spraying it with an acrylic, polyvinyl acetate, or other suitable resin emulsion after which the batting is dried and cured.

3.6 Thermal bonded batting
A nonwoven filling material that contains low-melting point fibers or polymer which, when heated, fuse the batting materials together.

4. Principle

A specimen of batting, either manufactured or from an end use product, is dyed with a dye that subjectively stains the resin binder. The stained specimen is examined for binder distribution on the batting surface and binder penetration through the batting by comparison to photographic rating standards.

This test method is used to assess the distribution of resin binder application. The distribution of resin binder relates to batting performance.

5. Material and Reagents

Dye
C.I. Basic Red 14.

6. Apparatus

6.1 Dyebath container
Plastic or metal, of sufficient volume for a dyebath.

6.2 Rubber gloves and safety glasses

6.3 Stirrer

6.4 Photographic rating standards

a) Binder Surface Distribution Photographic Rating Standards
b) Binder Penetration Photographic Rating Standards.

7. Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 2 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

8. Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 3 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

8.1 Test specimens

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material.

a) Care in handling should be observed so that specimens do not contact any contaminants such as soap, salt, oil etc.
b) Consider the laboratory sample the test specimen. Using indelible ink, mark the sample with machine direction (MD), edge (left or right), surface (upper or lower) and proper sample identification.

9. Procedure

9.1 Add C.I. basic red 14 dye

To approximately 60 L of tap water at 49 to 60°C to give a concentration of 0.2 % based on the total mass of the dyebath. Stir until completely dissolved.

9.2 Immerse the full-width specimen

In the dyebath and allow to remain for 15 ± 1 min.

9.3 Remove specimen from dyebath

Gently squeeze out excess dye. Rinse specimen until no further color bleeding is noted.

9.4 Allow specimen to dry

9.5 Place the specimen on a dark background

9.6 Rate the specimen

Using the binder distribution rating scale below or the surface distribution photographic rating standards and record the ratings.

Binder Surface Distribution Rating Scale

Rating	Description
5	No undyed portions, uniform coverage and shade
4	Majority of web dyed, slight variation in shade
3	Small undyed areas indicative of lack of binder
2	Large undyed areas, apparent streaks
1	Majority of web undyed, narrow width streaks

Table 1

9.7 Select three positions across

A width-wise edge of the specimen, the center and 25 cm from each machine- direction edge. For each position, rate the specimen using the Binder Penetration Rating Scale or the Binder Penetration Photographic Rating Standards and record the rating.

Binder Penetration Rating Scale

Rating	Description
5	Uniform dye shade throughout batting thickness
4	Dye penetration through the thickness, shade varies
3	Thin undyed layer in the center
2	Surface dyeing with slight penetration
1	Surface dyeing only

Table 2

10. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Binder surface distribution rating for each specimen
g) Binder penetration rating for each specimen
h) Stained specimens or photographs of specimens indicating locations of observed may be included for clarity
i) Number of specimens tested and note CD and/or MD if significant
j) For computer processed data, identify the software used and the version
k) Deviation from the standard test procedure, if any
l) When calculated, the standard deviation or the coefficient of variation
m) Whether or not samples were conditioned prior to testing and, if so, for how long
n) Anything unusual noted during the testing
o) When photos are used as the standard, attach copies

11. Precision

Calculation of components of variance and least critical differences is not appropriate due to the restricted and discontinuous rating scale for the distribution and penetration of the resin binder in polyester highloft nonwoven fabrics. An interlaboratory evaluation has been conducted and observations are summarized and reported in annex A.

ANNEX A

(Informative)

An interlaboratory test was run in 1994 in which randomly drawn samples of three materials were tested in each of seven laboratories. Each laboratory used two operators, each of whom evaluated one specimen of each material using the same set of photographic standards for rating purposes. The materials were made by three different manufacturers and all had square meter weights in the range of 270 to 475 g and containing 15 to 20 % added resin. The following data were extracted and are reported for reference purposes.

Range of Average Laboratory Ratings				
	Distribution		Penetration	
	Min	Max	Min	Max
Material A	3.0	5.0	2.0	4.5
Material B	2.0	5.0	3.0	4.0
Material C	3.0	4.8	2.5	4.5

Table A 1

Overall Average Ratings		
	Distribution	Penetration
Material A	4.2	3.0
Material B	4.4	3.4
Material C	3.8	3.9

Table A 2

STANDARD TEST: WSP 150.2.R4 (12)

Standard Test Method for Appearance and Integrity of Highloft Batting After Refurbishing

The number in parentheses indicates the year of the last revision

1. Scope

This test method covers procedures for determining the tactile appearance and integrity of a highloft nonwoven batting after machine washing or drycleaning when tested in a finished product or a panel assembly simulating the construction of the finished product.

This test method is not intended for use on wool/wool blend and cotton/cotton blend batting and needle-punched structures.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.1 ISO test methods

a) ISO 139-2005 Textiles — Standard atmospheres for conditioning and testing

2.2 WSP test methods

a) WSP 001.0.R3.(12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

Reference number
WSP 150.2.R4 (12) A

Current edition approved WSP 150.2.R4 (12)
Originally published as WSP 150.2 in 2002
Last approved as WSP 150.2 in 2009

3.1 Batting
A nonwoven filling material consisting of a continuous web of fibers formed by carding, garnetting, air laying, or other means.

3.2 Batting integrity
The ability of a textile filling material to resist distortion or change when subjected to multiple home launderings or drycleanings.

3.3 Distortion
In nonwoven battings, defects such a holes, lumps, or thin areas caused by movement of fibers.

3.4 Fiberfill
Manufactured fibers especially engineered as to linear density, cut-length, and crimp for use as a textile filling material.

3.5 Microfiber batting
A nonwoven filling material containing fibers, such as polyester or olefin, that have a diameter of less than [10 µm].

3.6 Needle-punched batting
A nonwoven filling material that is stabilized by mechanically entangling the fibers.

3.7 Resin bonded batting
A nonwoven filling material that is stabilized by spraying it with an acrylic, polyvinyl acetate, or other suitable resin emulsion after which the batting is dried and cured.

3.8 Thermal bonded batting
A nonwoven filling material that contains low-melting point fibers or polymers that, when heated, fuse the batting materials together. Thermal bonded batting may also be resin bonded.

3.9 Non-bonded batting
A nonwoven filling material that is neither needle-punched, resin bonded, or thermal bonded (see also needle-punched batting, resin bonded batting, thermal bonded batting).

4. Principle

Specimens in an end use product or in a test panel assembly are laundered or drycleaned in a prescribed cycle. The treated specimens are evaluated for integrity by comparing with photographic rating standards and for changes in tactile appearance.

This test method is used to determine the integrity of the batting or to identify the need for an alternative fiberfill batting or construction technique to meet performance requirements. Maintaining batting integrity is important to the insulating properties and appearance retention over the life of the item.

5. Material and Reagents

5.1 Perchloroethylene
A commercial drycleaning solution containing perchloroethylene solvent and a drycleaning detergent or a standard detergent/drycleaning solution

NOTE 2 **SAFETY WARNING**

Perchloroethylene is toxic, and the usual precautions for handling chlorinated solvents should be taken. It should be used only under well-ventilated conditions.

5.2 Detergent, home laundry type.

5.3 Photographic rating standard.

6. Apparatus

6.1 Drycleaning machine
A single unit, coin-operated or professional type machine, capable of providing a complete automatic dry-to-dry cycle using perchloroethylene.

6.2 Domestic automatic washer
Top loading, spin extracting type

6.3 Domestic automatic tumble dryer
Front loading type

7. Sampling

7.1 Acceptance testing for end use products:

7.1.1 Laboratory sample
As a laboratory sample for acceptance testing select a minimum of two finished products at random for each lot sample.

7.1.2 Test specimens
Use the largest unsewn or unrestricted portion of the laboratory sample for evaluation of the durability of the batting.

7.2 Prototype sampling

7.2.1 Perform tests on prototypes
Before they will reach the consumer.

7.2.2 It is desirable to have two samples
Available for testing, one being a control.

7.3 Panel assemblies
Use two panel assemblies, minimum size of 450 x 600 mm simulating the construction of the finished product.

NOTE 3 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

7.4 Specimen preparation

7.4.1 Using indelible ink
Mark one specimen with the type and frequency of laundering or drycleaning and proper sample identification. Retain the remaining specimen as a control.

7.4.2 Spread the specimen on a flat surface
In such a manner, (for example, unzipped), that only one thickness of the largest surface area is exposed.

7.4.3 Applying light pressure
Press the palm of the hand over the surface of the specimen feeling for clumps, depressions, and voids in the batting. Using indelible ink, mark on the specimen surface the location of any defects noted.

8. Procedure

8.1 Perform three refurbishing cycles
Following the instructions on the care label attached to the end use product.

8.2 In the absence of a care label
Use the following procedure: machine wash 50 ± 3°C with high water level, tumble dry according to instructions but do not iron.

8.3 If the fiber content, construction, or trim of the shell fabric
Is subject to damage by machine washing, dryclean the specimen according to instructions, but do not press.

9. Interpretation of Results

9.1 Repeat 7.4.2 and 7.4.3
But do not remark the specimens.

9.2 Record the nature and locations
Of the observed changes comparing them with those noted before refurbishing (see 7.4.2). Rate these changes using Table 1.

9.3 Using the same test area

As that used in 9.2, cut any cover, lining, or any other fabric that may be encountered, to expose as large an area of the batting as possible. Visually compare the batting specimen directly against the photographic rating standard. Rate and record the integrity rating using the photographic rating standard number that most closely compares to the batting in the specimen.

9.4 Average the visual ratings and integrity

Ratings for the laboratory sample.

Ratings for Changes in Batting

Rating	Visual Rating Description
5	No detectable change
4	Slight change
3	Moderate change
2	Significant change
1	Extreme change

Table 1

10. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Observations and visual ratings noted in 9.2 and 9.3,
g) Integrity ratings determined in 9.3,
h) If desired for clarity, include a photograph or sketch of specimens indicating the locations of observed conditions,
i) Type of refurbishing done to the material
j) Number of specimens tested
k) For computer processed data, identify the software used and the version
l) Deviation from the standard test procedure, if any
m) Anything unusual noted during the testing
n) When photos are used as the standard, attach copies

11. Precision

Doing a precision analysis on this method is not applicable because of the subjective nature of the procedure.

STANDARD TEST: WSP 160.1.R4 (12)

Standard Test Method for Resistance to Linting of Nonwoven Fabrics (Dry)

The number in parentheses indicates the year of the last revision

1. Scope

This test method is applicable for determining the relative propensity of fabrics to generate particles when flexed and twisted by a particle generator. The size and number of these particles are then counted by a particle counter

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.1 ISO test methods

a) ISO 139-2005 Textiles — Standard atmospheres for conditioning and testing
b) ISO 2859-1:1999 Sampling procedures for inspection by attributes
c) ISO 3951-1:2005 Sampling procedures for inspection by variables

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Clean room,
A room and/or area that is maintained at a high level of cleanliness by special means

Reference number
WSP 160.1.R4 (12) A

Current edition approved WSP 160.1.R4 (12)
Originally published as WSP 160.1 in 2002
Last approved as WSP 160.1 in 2009

3.2 Gate time
The time between start and stop of system and/or timing device

3.3 Particles
Minute fragments (dust, lint, etc.) which are capable of being detached from the fabric

3.4 Sample
A portion of a lot of material which is taken for testing or for record purposes

3.5 Specimen
A specific portion of a material or a laboratory sample upon which a test is performed or which is selected for that purpose.

3.6 Type "A" background count
The particle count taken of the empty test chamber with the Gelbo flex unit turned **off** and the back chamber panel **removed**.

3.7 Type "B" background count
The particle count taken of the empty test chamber with the Gelbo flex unit turned **on** and the back chamber panel **in place**.

4. Principle

This procedure should be conducted in a laminar flow hood or in a room where the air is class 100 clean room quality or better.

This procedure describes a test to determine the relative number of particles released from a fabric when it is subjected to a continuous flexing and twisting movement. During the flexing, air is withdrawn from the flexing chamber at 1 CFM and examined for particulates using a laser particle counter. The particle counter differentiates the particles by size using six or more channels. These channels will capture various ranges of particle sizes from 0.3 to 10 micrometers. These particles can be reported using three methods: (1) Counting the total particles over ten consecutive 30 s periods; (2) Reporting the average of the ten data points. The particles may originate as air-borne debris (dust) or as fragments from fibers, binders or process treatments. The test is applicable to both woven and nonwoven fabrics and may be used to assess the lint generating potential of the fabric or its composites.

In this procedure a 23 x 23 cm specimen is clamped between two holders which have a flexing stroke of 119.8 mm. There is a twist to the shaft of 180° and a stroke rate of about 60 cycles per minute. An isokinetic intake probe is affixed to the base of the Gelbo unit directly under the specimen. The probe is connected to the particle counter by a 102 cm long section of tubing (provided with the machine).

Generally, dry flexing results in release of only a small part of the total available particles, so individual results can be variable. However, multiple sampling/testing allows good relative measurements of products and processes and their tendency to generate

particles. This means that lab to lab and time to time reproducibility is only fair in absolute numbers but very good in rankings.

It was found that many types of fabrics using different kinds of fibers have similar particle generation characteristics, indicating that a common mechanism governs the process of particle generation and counting. It is believed that particle generation originates from one of two mechanical processes. The first process demonstrates that particles are released from the fabric as it is being flexed, which slowly diffuse to the particle counter inlet. Diffusion reaches a maximum then diminishes as the five minute test time elapses. The second process results in particle generation by destruction of the fabric itself as it is being flexed. In general this component continues to increase with time.

Since almost all of the fabrics tested peaked out within five minutes, it was decided to use five minutes as the standard flexing time and count particles every 30 s to obtain a total of ten data points per specimen. Because of the nature of particle collection, it appears that one or more of the following three methods would be the appropriate way to report the total count of particles from a fabric:

a) Report the highest count of the ten data points minus the average type "B" background count.

b) Report the combined total of the ten data points minus the total type "B" background count for a given time period 30 s x 10 = 5 minutes.

c) Report the average and the range of the ten data points minus the average type "B" background count.

NOTE 2 During the course of testing, cleaning the tester and the housing thoroughly between each specimen is important. This is to maintain the type "A" background count at an acceptable level (about 1% of the total particle count) and keep "B" background count at a reasonable testing level.

5. Apparatus

5.1 Laminar flow hood

A clean test environment is required. It is preferred that the equipment be set up in a clean air station with horizontal laminar flow that has been filtered through HEPA filter and/or in class 100 clean room. Work stations, HEPA filters and clean rooms can be purchased from a number of suppliers such as:

Clean Room Products, Inc.
1800 Ocean Avenue
Ronkonkoma, NY 11779-6528
and/or
Air Control,Inc.
352 Easy Airy Street
Norristown, PA 19401

5.2 Modified Gelbo flex unit (figure1)

Flexing is done on a modified Gelbo unit. The parameters include an internal volume in the sample area of one cubic foot. A flexing stroke of 119.4 mm will be set on the unit from US Testing Co., Inc. This unit has a flexing twist of 180 degrees, and flexing rate of 60 cycles/minute. This unit may be purchased from:

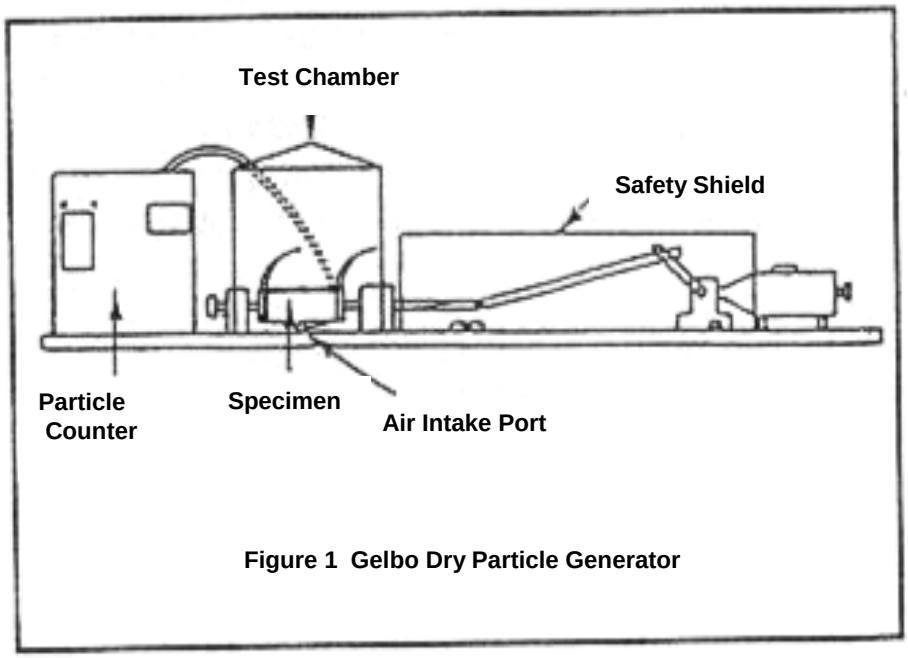


Figure 1 Gelbo Dry Particle Generator

US Testing Co., Inc.
PO Box 3189
1415 Park Avenue
Hoboken, NJ 07030

5.3 The flexing chamber (figure 2)

The flexing unit is enclosed in a Plexiglas® box measuring 30 x 30 x 30 cm. This chamber has removable front and back panels for cleaning and purging with filtered clean air. The back and the two sides each have two 0.6 cm holes located 2.5 cm from the top of the chamber and spaced equally across the 30 cm. The isokinetic intake probe (air collector) is affixed to the center of the flexing chamber as demonstrated in figure2.

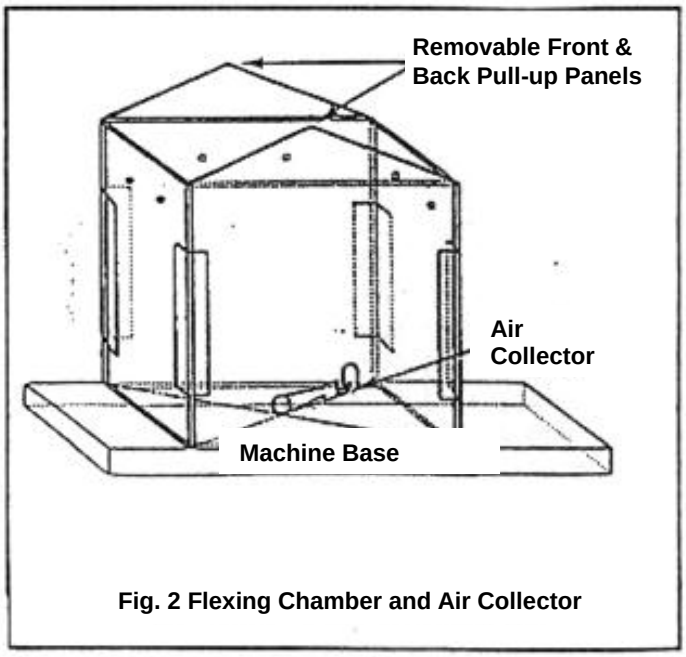


Fig. 2 Flexing Chamber and Air Collector

5.4 Laser particle counter (figure 1)

Counting is done with a laser particle counter with an air flow of one cubic foot per minute through it. The counter also has six or more channels which provide the capability to size particles from 0.3 to 10 microns. (Some models may have different ranges, i.e. 0.5 to 25 microns). Programmable sample/hold times and printing/computer interfacing capabilities are preferred features of the counter. The following instruments are acceptable:

Model - 200 L
Met One, Inc.
481 California Avenue
Grants Pass, OR 97526

Model C1 - 7350
Climet Instrument Co.
PO Box 1760
Redlands, CA 92373

NOTE 3 **SAFETY WARNING**

Be aware of the reciprocal nature of the shaft on the Gelbo Flex Tester and keep hands away from all moving parts.

6. Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 4 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

7. Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 5 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

7.1 Laboratory sample

7.1.1 Rubber gloves
Should be utilized when preparing samples, specimens and performing the test

7.1.2 Collect from each roll or portion
Of material taken from the lot sample, cut at least one laboratory sample the full width of the fabric and 1 m in the machine direction. This is done after removing the first outside wrap or discarding the first 1 m length. For nonwoven fabric components of fabricated systems use the entire system.

7.2 Test specimens

7.2.1 Rubber gloves
Should be utilized when preparing samples, specimens and performing the test

7.2.2 Collect test specimens
From areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material.

a) Care in handling should be observed so that specimens do not contact any contaminants such as soap, salt, oil etc.
b) Specimens should be cut 23 x 23 cm
c) Five replicates are required for any sample determination. Seven should actually be collected, reserving the top and bottom layers for specimen protection only. They should be collected evenly spaced across the available width of each sample. After the samples are collected, they shall be maintained in a clean environment (plastic bag) with minimal subsequent handling.

8. Calibration and Standardization

8.1 The laser particle counters
Described in this procedure are calibrated by the manufacturer and this calibration is automatically maintained. Each manufacturer has designed a maintenance schedule for recalibration and this schedule must be adhered to.

8.2 The calibration of the air quality in the flexing chamber
Is a vital part of this procedure, thus two types of background particle counts are needed. Before either of these counts are taken, the chamber and the equipment must be clean.

a) This is accomplished by first cleaning the inside of the flex chamber with a natural bristle brush and wiping the inside with a clean room wiper moistened with a diluted commercial clean room cleaning solution. Take special care to clean the shaft and its grooved area. Lastly, wipe the inside of the flexing chamber with a dry clean room wiper.

b) The type "A" background particle count must be taken with the Gelbo Flex unit turned off and the Flex panel removed to allow clean air to flow into the empty chamber. After the type "A" count has been completed, replace the back panel.

NOTE 6 The type "A" background count should be less than 100 particles of ≥ 0.5 micrometers in a 30 second counting period. Sufficient cleaning may be attained between samples by a thorough vacuuming with a clean room vacuum.

c) The type "B" background particle count is achieved by completely closing both front and back panels and turning on the Gelbo flex unit and running the system without a specimen. This type "B" background count is done twice daily, and the appropriate average of ten 30 s counts are subtracted from the actual specimen counts.

8.3 The flow rate of the air sampling system

Is monitored by a mass flow meter. The mass flow meter measures standard cubic feet/minute (SCFM) of air at sea level. Using the flow adjustment on the back panel, set the flow rate, which can be read in Display 3 to 100% (1 SCFM). If the user is interested in a volumetric cubic foot, refer to Table 1 to determine the flow rate for a specific altitude.

ALT. FEET	SET FLOW TO	SCFM
0000 (San Francisco)	100%	1.0
500 (Memphis)	99%	.986
1000 (Atlanta)	98%	.971
2000	96%	.943
2500 (Tucson)	95%	.929
3000	94%	.915
4000	92%	.888
5000	90%	.862
6000	87%	.836
7000	85%	.810
8000	81%	.786
9000 (Crested Butte, CO)	78%	.762

Table 1 - Flow Rate Settings

As the altitude increases, the air mass decreases. Therefore, a volumetric cubic foot of air has less mass in a given sample. The mass flow meter in the CI-7350 measures mass regardless of altitude differences. The flow rate of the particle counter should be set at the appropriate percent flow as indicated in Table 1 with an acceptable tolerance of ± 0.1%.

NOTE 7 Air sampling systems without mass flow meters should disregard this section.

9. Procedure

9.1 Check the air quality in the counting chamber (figure 3)

To determine the two background particle counts before running the specimens. The type "A" count should be less than 100 particles of ≥ 0.5 micrometers in a 30 s counting period.

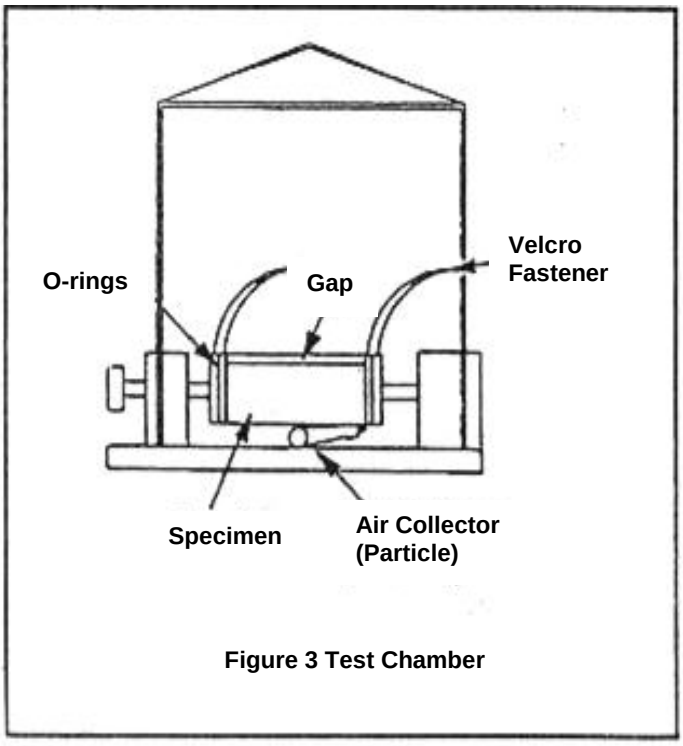


Figure 3 Test Chamber

The type "B" background count is used in calculating test results. The type "B" background count should be done twice daily. Cleaning and checking may be required before running each sample; these instructions can be found in section 8.2.

9.2 Remove from the package

At least seven preconditioned fabric specimens 23 x 23 cm. Never use the top or bottom sheets for particle determination; they serve only as protection to the test specimens.

9.3 With the flexing heads extended to their maximum distance

Carefully and with minimal handling mount the fabric around the heads to form a tube. (Elastic tourniquets with Velcro fasteners work well for mounting the fabric). Mounted correctly the specimen will have its gap or opening at the top position of the tube. The specimen should be mounted to produce the maximum number of particles on flexing; this will normally be with the machine direction of the fabric in the long axis of the tube and the "face" of the fabric on the outside of the tube.

9.4 The particle counter

Is set for 30 s gate time and one 2 reset time.

9.5 Turn the flexing unit on

Put the particle counter into the "run" mode. Run the unit until you have obtained ten consecutive 30 s counts or data points.

9.6 Stop both the flexing unit and the particle counter

Remove the specimen, prepare and clean the chamber for the next specimen or sample.

9.7 The results may be read directly from the tape printout

Produced by the laser particle counter

9.8 Repeat the procedure until at least five specimens

Have been tested to characterize the sample (roll, package, etc.). To represent a "lot" (run, load, etc.) at least four samples should be run (20 specimens).

10. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Number of specimens tested and note CD and/or MD if significant
g) For computer processed data, identify the software used and the version
h) Deviation from the standard test procedure, if any
i) When calculated, the standard deviation or the coefficient of variation
j) Whether or not samples were conditioned prior to testing and, if so, for how long
k) Anything unusual noted during the testing
l) Time run or total time run
m) Indicate which of the three methods as demonstrated in section 4.a, b, c was used to calculate the test results (see note number 8)
n) Individual results e.g. maximum number of particles of $\geq$ 0.5 micrometers in a 30 s period or double the 30 s count for the number of particles per cubic foot of air

NOTE 8
4.a Report the highest count of the ten data points minus the average type "B" background count.

4.b Report the combined total of the ten data points minus the total type "B" background count for a given time period 30 s x 10 = 5 minutes.

4.c Report the average and the range of the ten data points minus the average type "B" background count.

11. Precision

The precision for this method is yet to be determined.

Standard Test: WSP 160.2.R4 (12)

Aqueous Method for Determining Release of Particulates (Wet)

The number in parentheses indicates the year of the last revision

1. Scope

This procedure is designed to test the relative propensity of a fabric to generate minute particles when submerged in water and stressed by a biaxial shaker. The size and number of these particles is measured.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document:

2.1 ISO test methods

a) ISO 139-2005 Textiles — Standard atmospheres for conditioning and testing
b) ISO 2859-1:1999 Sampling procedures for inspection by attributes
c) ISO 3951-1:2005 Sampling procedures for inspection by variables

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Aliquot

Exact portion of a larger volume of liquid to be used for testing.

3.2 Background

The number of particles present in the test system which did not originate from the specimen being tested.

Reference number
WSP 160.2.R4 (12) A

Current edition approved WSP 160.2.R4 (12)
Last approved as WSP 160.2 in 2009
Originally published as WSP 160.2.in 2002

3.3 Clean room
A room that is maintained at a high level of cleanliness by special means.

3.4 Particle
A readily detachable entity which has no linear dimension greater than 175 microns.

3.5 Sample
A representative part of a lot of material which is taken for testing.

3.6 Specimen
A single item from a sample upon which a test is performed.

3.7 Ultrapure water
Water that has been filtered and deionized and is relatively free from particle contamination.

4. Principle

Particles which are carried on or in a fabric structure can be classified into two distinct categories based on the origin of each particle. The first class consists of particles which are indigenous to the fabric structure. These particles are made of materials, which were designed to form the fabric structure (fiber, binder, and other chemical additives). The second category contains particles that originated outside the intended fabric structure. These particles (lint, dust, etc.) became attached to the fabric structure during exposure to the environment during manufacturing, handling, storage, etc. Both particle types share the potential to break free and contaminate an environment.

This test method seeks to stimulate the release of these particles in a consistent and repeatable manner. Once released, particles of various sizes can be counted to allow the characterization of a fabric with regard to the relative propensity to generate particles.

The ultrapure water in which the fabric specimens are submerged serves two purposes. First, it transmits the energy of the biaxial shaker directly to the fabric so as to stimulate the release of particles. Second, ultrapure water serves as a medium to capture and suspend the particles released during the procedure.
This test method is designed to provide a basis for ranking fabrics according to the relative propensity to generate particles during end use applications. It is likely that this method results in the release of more particles than would be released under normal end use circumstances. Thus the method allows conservative characterizations of various fabric types according to the potential to generate particles.

NOTE 2 **SAFETY WARNING**

Automatic Bottle Sampler- Eye protection must be worn during the use of contained pressure in the pressure cylinder of the automatic bottle sampler.

Biaxial Shaker/Flask- The tester should be aware of the mechanical shaking action of the biaxial shaker. If the flask is not secured properly in the shaker, the potential exists for glass breakage.

Electric Shock Hazard - Observe all recommended safety precautions for use of electric devices (such as the ABS) near water.

5. Apparatus

5.1 Laminar flow hood with sink/water delivery system

Portions of this procedure must be conducted under a laminar flow hood which provides air certified at Class 100 or better. To avoid contamination of results, the filtered water used in this test must not be exposed to air outside the laminar flow. For this reason the laminar flow hood must be equipped with a sink and an outlet capable of delivering ultrapure water. Laminar flow hoods are available from:

Laminar Flow, Inc.
102 Richard Road
Ivyland, Pennsylvania

(800) 553 - FLOW
(215) 672-0232
(215) 441-0426 FAX
www.laminarflowinc.com

NOTE 3 If a clean room of Class 100 or better is to be used for this procedure, a laminar flow hood is not necessary.

5.2 Water filtration system

The water used in this procedure to remove and capture particles for counting must be deionized and highly pure to provided acceptable background particle levels. A filtration system that provides at least 15 megohms of resistance and has a 0.1 micron post filter will provide acceptable water.
Such systems are available from:

Ultra Water Systems
P.O Box 2561
Stafford, TX 77447

(281) 449-9997
(281) 449-3529 FAX
www.ultrawatersystems.com

Continental Water Systems Corp.
PO Box 40369
San Antonio, Texas 78229

(800) 426-3426

5.3 Biaxial shaker

The biaxial shaker must provide timed shaking action at 300-700 rpms. It must be capable of accommodating a water-filled 2000 mL Erlenmeyer flask. Tyler Model RX-86 is recommended and may be purchased from:

W.S. Tyler, Inc. (800) 321-6188
8570 Tyler Blvd.
Mentor, OH 44060

5.4 Automatic bottle sampler

The automatic bottle sampler is used to deliver multiple aliquots of 50 mL to the liquid sensor for particle counting. The HIAC/ROYCO model ABS is recommended and is available from:

HIAC/ROYCO (641) 479-1242
Pacific Scientific Instruments (641) 479-3057 FAX
481 California Avenue
Grants Pass, OR 97526

5.5 Liquid sensor

The liquid sensor used in this test procedure should have a sensitivity range of at least 0.5 to 200 micrometers and a concentration limit of at least 7000 particles/mL. The HIAC/ROYCO Model 325 liquid sensor is recommended. This system uses the principles of near-forwarding light scattering and light extinction to detect particles. The Model 325 is available from:

HIAC/ROYCO (641) 479-1242
Pacific Scientific Instruments (641) 479-3057 FAX
481 California Avenue
Grants Pass, OR 97526

5.6 Particle counter

The particle counter allows control of the volume and flow rate for the particle laden water through the liquid sensor. The counter automatically converts electric pulses from the liquid sensor into particle size and number data. The HIAC/ROYCO Model 8000A particle counter is available from:

HIAC/ROYCO (641) 479-1242
Pacific Scientific Instruments (641) 479-3057 FAX
481 California Avenue
Grants Pass, OR 97526

5.7 Glassware

The glassware used in this procedure includes one 2000 mL wide mouth erlenmeyer flask (No. 13 stopper size), one 300 mL beaker, one graduated cylinder of at least 250 mL, and one graduated cylinder of no more than 25 mL.

5.8 Aluminum foil
Heavy duty

5.9 Clean room gloves

5.10 Long tweezers

6. Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 4 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

7. Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 5 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

7.1 Test specimens

7.1.1 Specimen dimensions

Each specimen should not exceed a 230 x 230 mm square since larger sizes become difficult to handle within the constraints of this test method.

7.1.2 Collection

Specimens should be cut, if possible, from layers of sample fabric so as to expose test specimen surfaces as little as possible. The two outermost specimens in a sample provide protection from exposure of the usable specimens. Thus at least seven specimens must be cut to provide the minimum of five specimens required for testing. The specimens should immediately be sealed in a zip-lock type plastic bag and handled as gently as possible.

8. Procedure

The following procedure assumes the use of a laminar flow hood in a laboratory environment of 21°C and 65% RH. If the procedure is carried out in a clean room of Class 100 or better, all references to laminar flow hoods and aluminum foil should be ignored.

8.1 Pretest preparations

a) This procedure demands that care be taken to avoid exposure of the filtered test water to air outside the laminar flow. For this reason the automatic bottle sampler must be positioned under the laminar flow hood. The other equipment may be positioned outside the laminar flow hood if contamination of the test water is avoided. Heavy duty aluminum foil which has been rinsed with filtered water seems to work well in preventing contamination by exposure to unclean air.

b) The calculation of results in this test method depends in part on the exact volume of ultrapure water used as the test medium for each specimen. It is, therefore, necessary to determine the exact amount of water that is removed by the automatic bottle sampler for each aliquot. This volume may be determined as follows: Fill a 25 mL graduated cylinder with 20 mL of ultrapure water. Position

this graduated cylinder in the automatic bottle sampler (ABS). Set the ABS to extract a 10 mL aliquot and activate the system. The water remaining in the graduated cylinder reveals the true volume, which is extracted for each aliquot. For example, if 4.5 mL remains after the above test, then the ABS extracts a volume of water equal to the aliqot size plus 5.5 mL.

c) The particle counter used in this procedure should be calibrated according to manufacturer standards. The size of the particles counted (bin size) can range from 0.5 to 200 micrometers.

8.2 Background particle count determination

a) For each specimen tested, the number of particles present in the test system which did not originate from the test specimen must first be determined. These particles will not be included in the reported data.
b) Clean room gloves must be worn during the following procedure.
c) The test system (glassware, tubing, liquid sensor, ABS, etc.) must first be cleaned to remove as many unwanted particles as possible. The glassware should be cleaned with a laboratory type cleaner (Ex. Fisher Sparkleen), warm water, and a bottle brush. If background counts are repeatedly unacceptable, an ultrasonic bath treatment can be used to dislodge particles from the glassware. The ABS and liquid sensor must be flushed out with ultrapure water from a clean beaker. The ABS liquid sensor must be flushed out with ultrapure water to remove any contaminants. This is accomplished by sampling multiple aliquots of ultrapure water from a clean beaker. The ABS, liquid sensor, and tubing are considered clean if a particle count of less than 200 >=0.5 micrometers in a 50 mL aliquot is obtained.
d) Under the laminar flow, fill the 2000 mL flask with 1000 mL of ultrapure water. Carefully seal the flask opening with rinsed aluminum foil.
e) Position the flask in the biaxial shaker and ensure that it is firmly secured. Activate the biaxial shaker and shake for five minutes.
f) Remove the flask in the biaxial shaker and place under the laminar flow near the ABS. Carefully remove the foil from the flask. Pour at least 200 mL of the test liquid into the 300 mL beaker.
g) Seal the beaker into the pressure cylinder of the ABS and sample 4-50 mL aliquots at a flow rate compatible with the calibration of the liquid sensor. The first aliquot acts as a buffer between the liquid initially present in the sensor tubing and the other aliquots that will be tested. Thus data from this first aliquot should be ignored. The background particle count is equal to the mean of the particle counts of the last three aliquots at the >=0.5 micrometer particle size.
h) Remove the sampling beaker from the ABS and pour the remaining test water into the flask. The volume of the liquid now in the flask is equal to 1000 mL less 200 mL (4 aliquots) less four times the additional amount extracted by the ABS for each aliquot (see 8.a).

8.3 Testing the Specimen

a) Under the laminar flow, remove a fabric specimen from the plastic bag with the long tweezers. The test specimen should not be the top or bottom specimen in a sample stack. Carefully place the specimen in the flask. The specimen should be

gently positioned so that it is entirely wet. Seal the flask opening with rinsed aluminum foil.

b) Carefully position the flask in the biaxial shaker and ensure that it is firmly secure. Activate the biaxial shaker and shake the specimen for five minutes.
c) Remove the flask from the biaxial shaker and place it under the laminar flow near the ABS. Remove aluminum foil from the flask. With the long tweezers remove the specimen and allow it to drip into the flask for 10 s. Pour at least 250 mL of the sample liquid into the 300 mL sampling beaker.
d) Position the sampling beaker into the ABS and sample four aliquots. Data from the first aliquot is ignored. The last three aliquots are used to find the mean particle counts for each specimen.
e) The above procedure should be repeated for the testing of multiple specimens.

9. Calculation

The following formula is used to calculate the relative number of particles of any given size generated by a particular fabric specimen:

No. of particles/sq.cm - $\frac{(P)\ (VT)}{(VA)\ (A)}$

Where:

P = particle count for specimen
VT = Volume of ultrapure water used in flask to test specimen (mL)
VA = Volume of aliquot (MI)
A = Area of specimen (sq.cm.)

This equation adjusts the particle count for a specific particle size according to fabric specimen area, aliquot size, and volume of ultrapure water used.

10. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Number of specimens tested
g) For computer processed data, identify the software used and the version
h) Deviation from the standard test procedure, if any
i) When calculated, the standard deviation or the coefficient of variation
j) Whether or not samples were conditioned prior to testing and, if so, for how long
k) Anything unusual noted during the testing
l) For a specific particle size range (such as >=0.5 micrometers), calculate the mean of the three particle counts found in (8.3.d). From this value, subtract the average background particle count obtained in (8.2.f).
m) Each particle sample can be characterized by averaging results of at least five specimens.

11. Precision

The precision for this method is yet to be determined.

STANDARD TEST: WSP 160.3.R4 (09)

Standard Test Method for Measuring Fibrous Debris From Nonwoven Fabrics

The number in parentheses indicates the year of the last revision

1. Scope

This method is a technique for quantifying fibrous debris released and generated from nonwoven materials. Just as with particles, [1,2] there is no **unique** answer for the quantity of fibrous debris that can be generated from such materials: the outcome depends on the kind and amount of energy administered. Obviously, a multiplicity of reasonable conditions exist under which nonwovens can be made to generate fibrous debris, as well as a multiplicity of conditions under which this debris can be collected and enumerated. In this method, an arbitrary but not unreasonable set of conditions is used. The terms "fibrous debris", "fibers", and "fibrous entities" are used interchangeably throughout.

The method rests on the hypothesis that a quantity of **readily releasable** fibrous debris (F_o [fibrous entities/m^2]) is already present on the nonwoven, and that this debris is, by definition, easily removed there from merely by wetting the nonwoven with water and gently sluicing away the debris for subsequent enumeration. Thus, in the determination of F_o, a specimen of known dimensions is placed flat in a tray and gently sluiced with water. The resulting suspension is filtered through a membrane filter, and the fibrous debris counted using optical microscopy. Dividing the number of fibrous entities by the area of the sample tested gives F_o.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

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1 C.F. Mattina and S.J. Paley, "Assessing Wiping Materials for their Potential to Contribute Particles to Clean Environments: A Novel Approach, **"Particles in Gases and Liquids 2: Detection, Characterization and Control,** K.L. Mittal, Editor, 117-128, Plenum Publishing Corporation, New York (1990).

2 C.F. Mattina and S.J. Paley, "Assessing Wiping Materials for their Potential to Contribute Particles to Clean Environments: Constructing the Stress-Strain Curves."
Journal of the IES, 34 (5) 21-218 (1991).

3 C.F. Mattina and J.M. Oathout, "Assessing Wiping Materials for their Propensity to Generate Particles: Biaxial Shaking Versus the Construction of Characteristic Curves", **Proceedings**, 40th Annual Meeting of the Institute of Environmental Sciences, Chicago, Illinois, 1-6 May 1994, 30 (1994).

4 "Evaluating Wiping Materials Used In Cleanrooms and Other Controlled Environments," IES-RP-CC004.2, Institute of Environmental Sciences, 940 East Northwest Highway, Mount Prospect, Illinois 60056, 1992.

Reference number
WSP 160.3.R4 (12) A

Current edition approved WSP 160.3.R4 (12)
Originally published as WSP 160.3.in 2002
Last approved as WSP 160.3 in 2009

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document:

2.1 ISO test methods

a) ISO 5725 -1 Accuracy (trueness and precision) of Measurement Methods and Results – Part 1: General Principles and Definitions

b) ISO 5725 -2 Accuracy (trueness and precision) of Measurement Methods and Results – Part 2: Basic Method for the Determination of the Repeatability and Reproducibility of a Standard Measurement Method

c) ISO 139-2005 Textiles — Standard atmospheres for conditioning and testing

d) ISO 2859-1:1999 Sampling procedures for inspection by attributes

e) ISO 3951-1:2005 Sampling procedures for inspection by variables

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Principle

Generated fibrous debris

F_g [fibrous entities/m^2] is material which was either not initially present on the nonwoven or else was held very tightly within the matrix of the specimen. In this test method F_g is determined using a methodology in which the specimen is placed in a jar containing a liquid and shaken on a shaker. However, since the results depend upon the volume of water used in the shaking, [3] that volume is chosen so that it is related to an inherent property of the nonwoven - namely, its sorptive capacity[4] - rather than employing an arbitrary single volume for all nonwovens.

The choice of three minutes for the shaking is arbitrary: longer or shorter times of agitation usually influence the generation of fibrous debris. Thus, after the F_o of a specimen has been determined as described above, the same ply (now devoid of readily releasable fibrous debris) is placed in a jar and shaken for three minutes along with a volume of water equal to twenty times the sorptive capacity of the ply being tested. Collection, enumeration and calculation of the fibrous debris are as described above for F_o.

The total quantity of fibrous debris, therefore, given by:

$F=F_o + F_g$

Where:

F_o [fibrous entities/m^2] is the number of readily releasable fibrous entities per unit area,

F_g [fibrous entities/m^2] is the number of generated fibrous entities per unit area.

F [fibrous entities/m^2] is the total number of fibrous entities, both releasable and generated per unit area.

4. Apparatus

4.1 Balance

Capable of determining mass of specimens to three significant figures.

4.2 Poly (ethylene)

Photographic tray or equivalent (6 cm x 30cm x 50 cm)

4.3 Beaker

2-L, with 100 mL scale gradations

4.4 Poly (ethylene) jar

4L; height 25 cm; diameter: 15 cm

4.5 Shaker

Model RX-86 having a frequency of 280 cycles/s with amplitudes, respectively, of 17 mm and 8mm, in the major and minor axes of the plane of oscillation.

4.6 Graduated cylinders

10 mL 25mL and 500mL

4.7 Apparatus for filtering suspensions of particles

For subsequent enumeration (Millipore kit xx71 047-11 is acceptable)

4.8 Membrane filters

Black 47 mm diameter, 0.8 μm pore size, 3.0 mm grid squares, 100 squares per filtered membrane area.

4.9 Microscope

Capable of resolving and sizing entities in range of interest (american optical stereo zoom 7 is acceptable).

4.10 Distilled water

5. Conditioning

Conditioning is not necessary for this procedure

6. Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 2 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

6.1 Laboratory sample

From each roll or portion of material taken from the lot sample, cut at least one laboratory sample the full width of the fabric and 1 m in the machine direction. This is done after removing the first outside wrap or discarding the first 1 m length. For nonwoven fabric components of fabricated systems use the entire system.

6.2 Test specimens

The specimens to be tested should be of a size and shape so as to fit comfortably in the polyethylene tray. Convenient are squares measuring 230 x 230 mm.
Folded items should be unfolded prior to testing.

7. Procedure

7.1 Measuring the sorptive capacity of the nonwoven being tested

a) Determine to three significant figures, the mass and dimensions of a single ply of the nonwoven. Fill the tray with a few hundred millimeters of water.

b) Place the ply in the tray. Allow ample time (and/or use physical persuasion) so that the specimen sorbs as much water as possible. After sorption is complete, grasp two adjacent corners of the ply and remove it from the tray. Hold the ply at an angle to the horizontal, allowing the excess liquid to drain into the tray. The angle should be steep enough to facilitate dripping but not so steep that pleating of the ply occurs. The specimen should not be stretched or otherwise dimensionally deformed while it is draining. After sixty seconds, determine the mass of the wetted nonwoven to three significant figures.

c) Repeat step 7.1.a twice again with the same ply and average the three measurements of the mass of the wetted specimen.

d) Calculate the intrinsic sorptive capacity of the nonwoven as follows:

$A_i = (m_w - m_d)/(m_d \times d_o)(2)$

A_i (intrinsic sorptive capacity) is the volume of liquid sorbed per unit mass of nonwoven (mL/g),
m_w is the mass [g] of the ply wetted with the liquid
m_d is the mass [g] of the dry ply, and
d_o is the density of water [0.997 b/mL] at 25°C.

e) Calculate the extrinsic sorptive capacity of the nonwoven as follows:

$A_e = (m_w - m_d)/(d_o \times l_w \times w_w)$ (3)

where:
A_e (extrinsic sorptive capacity) is the volume of liquid sorbed per unit mass of nonwoven (mL/m^2),
l_w is the length [m]of the ply, and
w_w is the width [m] of the ply.
Equations (2) and (3) are related, such that:
$A_e = A_i \times bw$
where:
bw is the basis weight [g/m^2] of the ply.

f) The procedure should be repeated on at least one more ply. Once the sorptive capacity of a nonwoven is known, however, it is not necessary that it be predetermined each time a nonwoven of the same kind is tested for fibrous debris.

7.2 Determining F_o, readily releasable fibrous debris

a) Place a single ply flat in the plastic tray.

b) Add approximately 500 mL of water to the tray; the volume used is not critical nor need it be known precisely at this point. By lifting the ends of the tray, allow the water to wet the nonwoven and gently sluice across its surface. Avoid delivering extraneous mechanical stress to the nonwoven. Decant the liquid into the 2 L beaker.

c) Repeat step 7.2.b twice again with further additions of 500 mL of water. Record the total volume of water in the beaker to the nearest 50 mL. Steps 7.2.b and 7.2.c require no more than 90 seconds to complete.

d) Stir the suspension gently with a stirring rod, then aliquot it immediately using a graduated cylinder capable of reading the volume of aliquotted to three significant figures.

NOTE 3 Unless a nonwoven is exceptionally low in fibrous debris, it will always be necessary to aliquot the suspension of particles for subsequent enumeration by optical microscopy. Since the proper volume cannot be known **a priori**, sometimes more than one aliquot must be taken so as to deposit on the membrane filter a quantity of fibrous debris large enough to give sufficient statistical certainty, but not so large (fewer, say, than 25 entities per grid square) that the obstruction of some fibrous entities by others takes place. Generally, the aliquotted volume will lie between 10 mL and 200 mL. It is sometimes helpful to examine the membrane filter with a hand lens immediately after the filtration of the aliquot in order to determine whether the volume aliquotted might possibly have been either too small or too large; in either of which cases a second aliquot can be taken immediately using a fresh membrane.

e) Using the filtration apparatus, filter the aliquotted suspension through the membrane filter. Allow the membrane to dry in air.

f) Using a microscope with a calibrated eyepiece reticule, count the fibrous debris on the membrane at an appropriate level of magnification and calculate F_o.

NOTE 4 The optical conditions chosen depend on the size of the entities that are of interest to the user: for fibrous debris 50 μm and larger, 40-fold magnification is adequate. The entire membrane need not be counted if individual squares appear to be representative of the entire membrane as well as sufficiently populated that counting a relatively small number of them results in the enumeration of a minimum of , say, 100 entities.

g) Sample calculation dimensions of ply 0.230 x 0.230 m total volume of water used: 1650 mL
aliquotted volume:
18.5 mL
fibrous entities (50 μm and larger) counted on seven grid squares: 17, 12, 14, 15, 11, 18, 14
F_o = (17+12+14+15+11+18+14) (100/7) x (1650mL/18.5mL/(0.230 x 0.230m) = 2.4 x 10^6 fibrous entities/m^2

NOTE 5 In this calculation, the average number of particles per grid square, (17+12+14+15+11+18+14) / 7, is multiplied by the total number of grid squares on the filtered area of the membrane, 100, corrected for the aliquotting, 1650 mL/18.5 mL, and divided by the area of the ply, 0.230 x 0.230 m.

7.3 Determining F_g, generated fibrous debris:

a) Place the same ply that was tested for F_o into the 4 L jar.

b) Using a graduated cylinder, add a volume of water to the jar equal to twenty times the nonwoven's extrinsic sorptive capacity times the area of the ply. Shake the jar containing the ply for three minutes.

c) Swirl the suspension gently, then aliquot it immediately using a graduated cylinder capable of reading the volume aliquotted to three significant figures.

d) Using the filtration apparatus, filter the aliquotted suspension of fibrous debris through the membrane filter. Allow the membrane to dry in air.

e) Using a stereoscopic microscope with a calibrated eyepiece at an appropriated level of magnification and calculate F_g.

f) Sample calculation:
Dimensions of the ply 0.230 x 0.230 m
sorptive capacity, A_e , of the nonwoven
250 mL/m^2
total volume of water used in shaking:
250 mL/m^2 x 0.230 m 0.230 m x 20 = 265 mL aliquotted volume
10.1 mL
fibrous entities (50 μm and larger) counted on six grid squares:
22, 18, 27, 19, 21, 24
F_g = (22+18+27+19+21+24)(100/6) x (265 mL/10.4 mL/(0.230m x 0.230 m)
= 1.1 x 10^6 fibrous entities/m^2

NOTE 6 In this calculation, the average number of particles per grid square, (22+18+27+19+21+24)/6, is multiplied by the total number of grid squares on the filtered area of the membrane, 100, corrected for the aliquotting, 265 mL/10.4 mL, and divided by the area of the ply, 0.230 m x 0.230 m.

And since:

$F = F_o + F_g$

$= 2.4 \times 10^6 + 1.1 \times 10^6$

$= 3.5 \times 10^6$ fibrous entities/m^2

7.4 It is sometimes desirable to determine simultaneously the sum of F_o and F_g

Rather than measuring each as a discrete quantity and adding them together, in which case the following procedure may be used.

a) Place a single ply of the nonwoven being tested into the 4 L jar and follow the procedure described in 8.3.b through 8.3.e.

b) Calculate F, the sum of the readily releasable and generated particles.

8. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Laboratory testing conditions
e) Number of specimens tested
f) For computer processed data, identify the software used and the version
g) Deviation from the standard test procedure, if any
h) When calculated, the standard deviation or the coefficient of variation
i) Anything unusual noted during the testing

9. Precision

The precision of this test was established

By selecting a single nonwoven fabric, which was believed to be of extremely uniform manufacture, and testing ten plies of this material for F_o and F_g using the procedure described above. The results are given in Table 1. Applying standard statistical methods to these data gives means and standard deviations as follows:

$F_o = (0.44 \pm 0.07) \times 10^6$ fibrous entities/m^2

$F_g = (0.83 \pm 0.13) \times 10^6$ fibrous entities/m^2

$F = F_o + F_g$

$= 1.27 \pm 0.17) \times 10^6$ fibrous entities/m^2

Fibrous debris[a] released and generated from a single nonwoven fabric

Ply	F_o	F_g	$(F_o + F_g)$
	[No. x 10^{-6}]/m^2	[No. x 10^{-6}]/m^2	[No. x 10^{-6}]/m^2
1	0.49	0.96	1.45
2	0.55	1.01	1.56
3	0.50	0.83	1.33
4	0.37	0.83	1.20
5	0.36	0.98	1.34
6	0.40	0.72	1.12
7	0.51	0.85	1.36
8	0.38	0.64	1.02
9	0.40	0.69	1.09
10	0.46	0.76	1.22
Mean	**0.44**	**0.83**	**1.27**
Std Deviation	**0.07 (16%)**	**0.13 (16%)**	**0.17 (13%)**

Table 1

STANDARD TEST: WSP 160.4.R3 (12)

Standard Test Method for Determining Fibrous Debris From Hydrophobic Nonwoven Fabrics

The number in parentheses indicates the year of the last revision

1. Scope

This test method covers the quantifying of fibrous debris released and generated from nonwoven fabrics with water repellency.

This test method applies to all nonwoven fabrics with repellant character, such as might be used for medical gowns and drapes, etc., or protective apparel.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document:

2.1 ISO test methods

a) ISO 139-2005 Textiles — Standard atmospheres for conditioning and testing
b) ISO 2859-1:1999 Sampling procedures for inspection by attributes
c) ISO 3951-1:2005 Sampling procedures for inspection by variables

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Sorption - in nonwoven fabrics

A process in which liquid molecules are taken up either by absorption or adsorption, or both

Reference number
WSP 160.4.R3 (12) A

Current edition approved _WSP 160.3.R3 (12)
Originally published as WSP 160.4.in 2002
Last approved as WSP 160.4 in 2005

3.2 Extrinsic sorptive capacity - in nonwoven fabrics
The sorptive capacity of a fabric to a specified liquid on a per-unit-area basis under specified conditions.

While extrinsic sorptive capacity is expressed in terms of volume per unit area, intrinsic capacity has been used to describe capacity in terms of volume per unit mass. By way of example, if a fabric exhibited an intrinsic capacity of 5 mL/g, a one-gram mass of that fabric would hold 5 mL whether it was part of a 50 g/m^2 or a 200 g/m^2 fabric. The extrinsic sorptive capacity would, however, be four (4) times higher for the 200 g/m^2 fabric than for the lighter weight material.

3.3 Sorptive capacity - in nonwoven fabrics
The maximum amount of liquid absorbed and adsorbed under specified conditions.

3.4 Fibrous debris - in nonwoven fabrics
Fibrous material released from a fabric during actions such as wear in operating theaters, hazardous cleaning operations, etc., under specified conditions.

4. Principle

This test method rests on the hypothesis that a quantity of readily releasable fibrous debris (F_o [fibrous entities/m^2]) is already present on the nonwoven fabric, and that this debris is, by definition, easily removed there from merely by wetting the nonwoven fabric with surfactant solution and gently sluicing away the debris for subsequent enumeration. Generated fibrous debris (F_g [fibrous entities/m^2]) is material which was either not initially present on the nonwoven fabric or else was held very tightly within the matrix of the specimen.

Just as with particles[3,4] there is no unique answer for the quantity of fibrous debris that can be generated from such materials: the outcome depends on the kind and amount of energy administered. Obviously, a multiplicity of reasonable conditions exist under which nonwovens can be made to generate fibrous debris, as well as a multiplicity of conditions under which this debris can be collected and enumerated. In this test method, an arbitrary but not unreasonable set of conditions are used. Because the results depend upon the volume of liquid used in the shaking[5], a volume is chosen so that it is related to an inherent property of the nonwoven namely its sorptive capacity[6] rather than employing an arbitrary single volume for all nonwovens. The terms "fibrous debris," "fibers," and "fibrous entities" are used interchangeably throughout this test method.
This test method is useful to select hydrophobic fabrics which release or generate a minimum of fibrous debris during use. It can also be used to research water-repellant fabrics for improved resistance to fibrous debris release and for production control.

Releasable fibrous debris (F_o) A specimen of known dimensions is placed flat in a tray and gently sluiced with water containing a surfactant to wet the fabric. The resulting suspension is filtered through a membrane filter, and the releasable fibrous debris is counted using optical microscopy.

Generated fibrous debris (F_G) After the releasable fibrous debris (F_o) of a specimen has been determined, the same specimen (now devoid of readily releasable fibrous debris) is placed in a jar and shaken for three minutes along with a volume of surfactant solution equal to twenty times the sorptive capacity of the ply being tested. The resulting suspension is filtered through a membrane filter, and the generated fibrous debris is counted using optical microscopy.

Simultaneously determined releasable fibrous debris and generated fibrous debris (F) Releasable and generated fibrous debris are determined by either of two procedures: (1) releasable fibrous debris and generated fibrous debris are determined separately and the results added together, or (2) the procedure described for determining generated fibrous debris only is used and the releasable fibrous debris and generated fibrous debris are determined simultaneously.

Size of debris counted Debris is counted above a certain chosen minimum size. This minimum size may be selected by the user. However, a minimum size of 50 μm is recommended as that size is about the minimum typically seen by the unaided eye.

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[3]C.F. Mattina and S.J. Paley, "Assessing Wiping Materials for their Potential to Contribute Particles to Clean Environments: A Novel Approach," Particles in Gases and Liquids 2: Detection, Characterization and Control, K.L. Mittal, Editor, 117-128, *Plenum Publishing Corporation*, New York (1990)

[4]C.F. Mattina and S.J. Paley, "Assessing Wiping Materials for their Potential to Contribute Particles to Clean Environments: Constructing the Stress-Strain Curves." *Journal of the IES*, 34(5), 21-28 (1991).

[5]C.F. Mattina and J.M. Oathout, "Assessing Wiping Materials for their Propensity to Generate Particles: Biaxial Shaking Versus the Construction of Characteristic Curves," *Proceedings, 40th Annual Meeting of the Institute of Environmental Sciences*, Chicago, Illinois, 106 May 1994, 20 (1994).

[6]"Evaluating Wiping Materials Used in Cleanrooms and Other Controlled Environments," IES-RP-CC004.2, *Institute of Environmental Sciences*, 940 East Northwest Highway, Mount Prospect, Illinois 60056, 1992.

5. Apparatus

5.1 Balance
Top loading, with a sensitivity of at least 0.01 g.

5.2 Photographic tray
Or equivalent, 300 x 500 x 60 mm (12 x 20 x 2.4 in).

5.3 Beaker
2-L, (2-qt) capacity with 100 mL scale gradations.

5.4 Jar
Poly(ethylene), or equivalent, 4-L (1-gal) capacity; height: 25 cm (10 in.); diameter: 15 cm (6 in.).

5.5 Shaker
Having a frequency near 280 cycles/sec with amplitudes, respectively, of 17 mm and 8 mm, in the major and minor axes of the plane of oscillation, such as Tyler Model RX-86, or equivalent.

5.6 Graduated cylinders
10 mL, 25 mL and 500 mL.

5.7 Filtration apparatus
For filtering suspensions of particles for subsequent enumeration, such as Millipore kit XX71 047-11, or equivalent

5.8 Membrane filters
Black, 47.0-mm diameter, 0.8-μm pore size, 3.0-mm grid squares, 100 squares per filtered membrane area.

5.9 Microscope
Capable of resolving and sizing entities in range of interest, such as american optical stereo zoom 7, or equivalent.

5.10 Water
At least distilled grade.

5.11 Surfactant, Zonyl® FSO
Available from DuPont

5.12 Fluorinated surfactant solution
0.1% Zonyl® FSO in water, Items 5.10 and 5.11. (Use of alternate surfactant discussed in Note 4, following 9.2.1.)

5.13 Measuring rule
Metal, graduated in 1 mm (0.05 in.).

5.14 Die cutter
Or equivalent, for 229 x 229 ± 1 mm (9.00 x 9.00 ± 0.05 in) specimens

5.15 Utility knife.

5.16 Stirring rod.

5.17 Hand lens
Such as linen, pick, or magnifying glass having about 8X magnification.

6. Conditioning

No conditioning is required unless otherwise specified in a material specification or contract order. The test shall be carried out at room temperature, 23° ± 1C.

7. Sampling

7.1 Lot Size
A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

7.2 Sampling
If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (*Sampling procedures for inspection by attributes)* or ISO 3951-1:2005 (*Sampling procedures for inspection by variables)* can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 2 Handle specimens with care and guard against contamination, abrasion or disturbing fibers that could contribute to an error in the fibrous debris count.

NOTE 3 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

7.3 Laboratory sample

From each roll or portion of material taken from the lot sample, cut at least one laboratory sample the full width of the fabric and 1 m in the machine direction. This is done after removing the first outside wrap or discarding the first 1 m length. For nonwoven fabric components of fabricated systems use the entire system.

7.4 Test specimens

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material.

a) Care in handling should be observed so that specimens do not contact any contaminants such as soap, salt, oil etc.
b) Specimens should be cut 300 x 300 mm
c) Unless otherwise specified, cut 3 specimens, evenly spaced across the available width of each sample.

8. Preparation of Test Apparatus and Calibration

a) Verify that the balance is within calibration.
b) Verify that graduated cylinders, beakers and microscopes are within calibration.

9. Procedure

9.1 Specimen dimensions

Measure and record the length (L) and width (W) of the specimen to the nearest 1 mm (0.05 in.)

9.2 Extrinsic sorptive capacity

Extrinsic sorptive capacity of the fabric to be tested must be known for the surfactant solution to determine generated fibrous debris. Establish as directed in 9.2.1 or 9.2.2, as applicable.

9.2.1 Prepare required

Surfactant solution by dissolving 1.0 g of Zonyl® FSO in 1000 mL distilled water, with stirring. Use this solution to determine extrinsic capacity and fibrous debris, as directed.

NOTE 4 Surfactants other than Zonyl® FSO may be found to be satisfactory for some fabrics. It is, however, necessary for the fabric to wet-out to overcome such hydrogen bonds as may exist in some fabrics, especially those containing cellulose. If an alternate surfactant is chosen, the identification and method exception should be noted in section 11.2.4. Some fabrics may also require a higher than 0.1% concentration of surfactant when using Zonyl® FSO or alternative. If an alternate concentration is chosen, the method exception should be noted in clause 11.2.4.

9.2.2 If the extrinsic sorptive capacity

Of a particular nonwoven is known for the surfactant solution, it is not necessary that extrinsic sorptive capacity be determined. Use known values to meet the requirements of 9.4.b.

9.2.3 If extrinsic sorptive capacity

Is not known, determine it using the surfactant solution as directed in test methods IST 10.2, or as directed in Annex A1 and use to meet the requirements 9.4.b.

9.3 Releasable Fibrous Debris (F_O)

Determine releasable fibrous debris as follows:

a) Place a single ply test specimen flat in the center of the plastic tray.
b) Add approximately 500 mL of surfactant solution to the tray so the specimen is completely covered.
   The precise volume used is not critical and need not be known at this stage of the test.
c) Allow ample time (and/or use physical persuasion) so that the specimen sorbs as much liquid as possible, usually when no air bubbles are observed on the surface of the liquid.
d) After the specimen has sorbed the solution to its capacity, grasp the ends of the tray, lift it and, alternating the tray ends in a smooth up-and-down motion, gently sluice the solution across the specimen surface for 30 $\pm$ 3 s. Avoid delivering extraneous mechanical stress to the test specimen.
e) Decant the solution into the 2-L (2-qt) beaker and reserve.
f) Using fresh surfactant solution, repeat step 9.2.2 through 9.2.3 two additional times.
g) Measure and record the total volume (V_{OTB}) of solution in the beaker to the nearest 50 mL.
h) Stir the suspension with a stirring rod, then aliquot it immediately using a graduated cylinder capable of reading the volume aliquotted to three significant figures. Record the aliquotted volume as (V_{OA}). (See Notes 3 and 4.)

i) Using the filtration apparatus, filter the aliquotted suspension through the membrane filter.

NOTE 5 Unless a nonwoven fabric is exceptionally low in fibrous debris, it will always be necessary to aliquot the suspension of fibrous debris for subsequent enumeration by optical microscopy. Because the proper volume cannot be known, *a priori*, sometimes more than one aliquot must be taken so as to deposit on the membrane filter a quantity of fibrous debris large enough to give sufficient statistical certainty, but not so large (higher than 25 entities per grid square) that the obscuration of some fibrous entities by others takes place. Fibrous debris of 5 to 25 entities for each grid is recommended. Generally, the aliquotted volume will be between 10 mL and 200 mL.

NOTE 6 It is sometimes helpful to examine the membrane filter with a hand lens immediately after the filtration of the aliquot in order to determine whether the volume aliquotted might possibly have been either too small or too large to provide the recommended number of fibrous entities per grid. In either case, the first aliquot can be replaced by a second aliquot using a different volume of aliquotted solution taken immediately and using a fresh membrane. For some fabrics, the aliquotted volume may have an unusually high count of fibrous debris that makes counting difficult. When this occurs, dilute the aliquotted volume by a factor of 2 or more with water as needed to obtain counts less than 25 for each grid.

j) Air-dry the membrane filter in the test room atmosphere, shielded from dirt, lint or other air-borne particles.
k) Using a microscope with a calibrated eyepiece reticle, count and record the releasable fibrous debris (C_{O1}+$C_{O2}C_{ON}$) on each grid of the filter membrane measured, and the number of grids measured (N_O), using an appropriate level of magnification. (See Note 6)
l) The fibrous debris present on all the membrane grid squares need not be counted if individual membrane grid squares counted appear to be representative of the grids throughout the entire membrane, as well as sufficiently populated, such that counting a relatively small number (N_O) of grid squares results in the enumeration of a minimum of 100 fibrous entities. In any event, when making grid square counts, the minimum number of grid squares counted must be 10 and the minimum total count of fibrous debris must be 100 entities.

NOTE 7 The optical conditions chosen depend on the size of the entities that are of interest to the user; for fibrous debris 50 μm and larger, 40X magnification is usually adequate, for smaller fibrous, higher magnification may be required to provide clear images.

9.4 Generated fibrous debris (F_G)

Determine generated fibrous debris as follows:

a) Place the same ply that was tested for F_o (9.3) into the 4-L (1-gal) jar.
b) Using a graduated cylinder, add a volume of surfactant solution (V_{GTJ}) to the jar equal to at least twenty times the test specimen's extrinsic sorptive capacity (mL/m^2) multiplied by the area (m^2) of the test specimen. In any event, the total volume must be at least 250 mL.
c) Using the shaker, shake the jar containing the ply for three minutes. Swirl the suspension gently, then aliquot it immediately using a graduated cylinder capable of reading the volume aliquotted to three significant figures. Record the aliquotted volume as (V_{GA}). (See Notes 4 and 5.)
d) Using the filtration apparatus, filter the aliquotted suspension of fibrous debris through the membrane filter.

e) Air-dry the membrane filter in the test room atmosphere, shielded from dirt, lint or other air-borne particles.

f) Using a microscope with a calibrated eyepiece reticle, count and record the generated fibrous debris ($C_{G1}+C_{G2}C_N$) for each grid of the filter membrane measured, and the number of grids measured (N_G) using an appropriate level of magnification. (See Note 7.)
The fibrous debris present on all the membrane grid squares need not be counted if individual membrane grid squares counted appear to be representative of the grids throughout the entire membrane, as well as sufficiently populated, such that counting a relatively small number (N_G) of grid squares results in the enumeration of a minimum of 100 fibrous entities. In any event, when making grid square counts, the minimum number of grid squares counted must be 10 and the minimum total count of fibrous debris must be 100 entities.

9.5 Simultaneous releasable and generated fibrous debris (F)

It is sometimes specified to determine the sum of the releasable fibrous debris (F_o) and generated fibrous debris (F_g) simultaneously, rather than measuring each as a discrete quantity and adding them together. When specified, determine releasable and generated fibrous debris simultaneously as follows:

Place a single ply of the nonwoven fabric being tested into the 4-L jar and follow the procedure described in 9.4.b through 9.4.e. Determine the total volume of surfactant solution in the jar (V_{FTJ}) and the aliquotted volume (V_{FA}). Record the fibrous debris count as ($C_{F1}+C_{F2}C_{FN}$) for each grid counted, and number of grids counted as (N_F)

9.6 Continue as directed in 10.2 through 10.5

Until three specimens have been tested for each: releasable fibrous debris and generated fibrous debris, if determined separately; and releasable and generated fibrous debris if determined simultaneously, for each laboratory sampling unit.

10. Calculations

10.1 Releasable fibrous debris (F_o)

Calculate the releasable fibrous debris for individual specimens using Eq 1. (See Note 6.) Before using equation 1, convert millimeters (mm) to meters (m) by dividing millimeters (mm) by 1000, and convert inches (in.) to meters (m) by multiplying inches (in.) by 0.0254, as applicable.

$$F_O = \{\Sigma(C_{O1}+C_{O2}+C_{On}) \times (100/N_O)\} \times \{(V_{OTB} / V_{OA}) / (L \times W)\} \quad (1)$$

Where:

F_O = Releasable fibrous debris, fibrous entities/m^2.
$(C_{O1}+C_{O2}+C_{On})$ = Count of fibrous debris for individual grids (from 9.3.k)
N_O = Number of grids counted (from 9.3.L)
V_{OTB} = Total volume of surfactant solution used from the beaker, mL (from 9.3.g)
V_{OA} = Volume of aliquoted surfactant solution, mL (from 9.3.h)
L = Length of specimen, m (from 9.1)
W = Width of specimen, m (from 9.1)

NOTE 8 In equations 1, 2 and 3, the average number of fibrous debris per grid square counted is multiplied by the total number of grid squares on the filtered area of the membrane, usually 100, corrected for the ratio of the total volume used divided by the volume aliqotted, divided by the area of the test specimen. If the membrane filter is other than specified and the total number of grids is different in the filtering area, that number must be substituted for 100 in the equations.

10.2 Generated fibrous debris (F_G)

Calculate the generated fibrous debris for individual specimens using Eq 2. (See Note 8.) Before using equation 2, convert millimeters (mm) to meters (m) by dividing millimeters (mm) by 1000, and convert inches (in.) to meters (m) by multiplying inches (in.) by 0.0254, as applicable.

$$F_G = \{\Sigma(C_{G1}+C_{G2}+C_{Gn}) \times (100/N_G)\} \times \{(V_{GTJ} / V_{GA}) / (L \times W)\} \quad (2)$$

Where:

F_G = Generated debris, fibrous entities/m^2.
$(C_{G1}+C_{G2}+C_{Gn})$ = Count of fibrous debris for individual grids (from 9.4.f)
N_G = Number of grids counted (from 10.4.f)
V_{GTJ} = Total volume of surfactant solution used from the jar, mL (from 9.4.b)
V_{GA} = Volume of aliquoted surfactant solution, mL (from 9.4.c)
L = Length of specimen, m (from 9.1)
W = Width of specimen, m (from 9.1)

NOTE 9 It is sometimes of interest to determine simultaneously the sum of F_o and F_g (rather than measuring each as a discrete quantity and adding them together), in which case equation 3 may be used.

10.3 Simultaneously determined releasable and generated fibrous debris (F)

Calculate the simultaneously determined releasable and generated fibrous debris for individual specimens using Eq 3 (See Notes 8 and 9.) Before using equation 3, convert millimeters (mm) to meters (m) by dividing millimeters (mm) by 1000 and converting inches (in.) to meters (m) by multiplying inches (in.) by 0.0254, as applicable.

$$F = \{\Sigma(C_{F1}+C_{F2}+C_{Fn}) \times (100/N_F)\} \times \{(V_{FTJ} / V_{FA}) / (L \times W)\} \quad (3)$$

Where:

F = Releasable and generated fibrous debris, fibrous entities/m^2.
$(C_{F1}+C_{F2}+C_{Fn})$= count of fibrous debris for individual grids (from 9.5)
N_F = Number of grids counted (from 10.5)
V_{FTJ} = Total volume of surfactant solution used from the jar, mL (from 9.5)
V_{FA} = Volume of aliquoted surfactant solution, mL (from 9.5)
L = Length of specimen, m (from 9.1)
W = Width of specimen, m (from 9.1)

10.4 Calculate the average

Releasable fibrous debris and generated fibrous debris for the laboratory sampling unit and for the lot to three significant figures, as applicable.
For convenience, the results can be divided by 1,000,000 to express fibrous debris in millions/m^2 (M/m^2).

11. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Laboratory testing conditions
e) Number of specimens tested
f) For computer processed data, identify the software used and the version
g) Deviation from the standard test procedure, if any
h) When calculated, the standard deviation or the coefficient of variation
i) Anything unusual noted during the testing
j) Releasable fibrous debris, if determined separately.
k) Generated fibrous debris, if determined separately.
l) Releasable and generated fibrous debris, if determined simultaneously.
m) Use of alternate surfactant or concentration, if used, as allowed in clause 9.2.1.

12. Precision and Bias

The precision for this method is yet to be determined.

ANNEX A
(Mandatory Information)

A1. Alternate Procedure for Determining Extrinsic Sorptive Capacity of a Fabric When Unknown.

A1.1 Alternately, extrinsic sorptive capacity to meet the requirements of 9.4.b can be determined as follows.

A1.1.1 Prepare two additional specimens as directed in clause 7.

A1.1.2 Measure and record the length (L) and width (W) of one specimen to the nearest 1 mm (0.05 in.)

A1.1.3 Place the specimen on the balance, then measure and record the mass (m_d) to the nearest 0.01 g.

A1.1.4 Pour several hundred millimeters of surfactant solution into the tray, such that the liquid is deep enough to provide coverage of the specimen.

A1.1.5 Place the specimen into the solution. Allow ample time (and/or use physical persuasion) so that the specimen sorbs as much liquid as possible, usually when no air bubbles are observed on the surface of the liquid.

A1.1.6 After sorption is complete, grasp two adjacent corners of the specimen and remove it from the liquid. Hold the ply at an angle to the horizontal, allowing the excess liquid to drip from the lowest corner into the tray for 60 $\pm$ 2s.

A1.1.6.1 The angle should be steep enough to facilitate dripping but not so steep that pleating of the ply occurs. Do not stretch or otherwise dimensionally deformed the specimen while it is dripping.

A1.1.7 Place the wet specimen on the balance and determine the mass to the nearest 0.01 g, record as (m_{w1}).

A1.1.8 Repeat A.1.4 through A.1.7 two additional times on the same specimen. Record as (m_{w2}) and (m_{w3}) respectively).

A1.1.9 Repeat the A1.1.2 through A1.1.8 using the second specimen.

A1.2.1 Calculate the average length (L_A) and width (W_A) of the two specimens. (from A1.1.2)

A1.3.1 Calculate the average dry mass (M_D) of the two specimens. (from A1.1.3)

A1.4.1 Calculate the average wet mass (M_w) for individual specimens using Eq 4.

$$M_w = (m_{w1} + m_{w2} + m_{w3})/3 \quad (4)$$

Where:

M_w = average wet mass of individual specimens, g

$m_{w1} + m_{w2} + m_{w3}$ = individual wet mass measurements, individual specimens, g (from A1.1.7 and A1.1.8)

A1.4.2 Calculate the average wet mass (M_W) of the two specimens. (from A1.4.1)

A1.5.1 Calculate the average extrinsic sorptive capacity, for individual specimen to three significant figures using Eq 5, as applicable.

A1.5.1.1 Before using equation 5, convert millimeters (mm) to meters (m) by dividing millimeters (mm) by 1000; and convert inches (in.) to meters (m) by multiplying inches (in.) by 0.0254, as applicable.

$$A_e = (M_W - M_D)/(D \times L_A \times W_A) \quad (5)$$

Where:

A_e = extrinsic sorptive capacity, mL/m^2

D = density of surfactant solution at 25^oC, (0.997 g/mL)

L_A = average length of specimen, m (from A1.2.1)

W_A = average width of specimen, m (from A1.2.1)

M_W = average wet mass of the test specimen, g (from A1.4.2)

M_D = average dry mass of the test specimen, g (from A1.3.1)

STANDARD TEST: WSP 300.0.R4 (12)

Standard Test Method for Nonwovens Bacterial Filtration Efficiency

The number in parentheses indicates the year of the last revision

1. Scope

This test method describes the evaluation of Bacterial Filtration Efficiency of nonwoven filter media designed for use as surgical face masks.

The method is an in vitro test and therefore in principle will determine the performance of the face mask filter material itself and not the efficiency of a finished mask. It must be recognized that face mask design characteristics have a bearing on ultimate in-use performance.

SI values are regarded as the official standard system of measurement for this standard test method.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document:

2.1 ISO test methods

a) IS1 5725 -1 Accuracy (trueness and precision) of measurement methods and results – Part 1: General principles and definitions

b) ISO 5725 -2 Accuracy (trueness and precision) of measurement methods and results – Part 2: Basic method for the determination of the repeatability and reproducibility of a standard measurement method

c) ISO 139-2005 Textiles — Standard atmospheres for conditioning and testing

d) ISO 2859-1:1999 Sampling procedures for inspection by attributes

e) ISO 3951-1:2005 Sampling procedures for inspection by variables

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

2.3 Military Specifications

Mask surgical – Disposable Mil-M-36954C (June 12, 1975)

Reference number
WSP 300.0.R4 (12) A

Current edition approved WSP 300.0.R4 (12)
Last approved as WSP 300.0 in 2009
Originally published as WSP 300.0 in 2002

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Bacterial Filtration Efficiency (BFE)

The filtration efficiency of a filter medium is dependent upon the size of the challenge particles, the flow rate of the air stream passing through the filter, and the surface properties of the particles (e.g. either moist or dry).

Essentially the method of determining (BFE) of a surgical face mask comprises the five following stages:

a) **Aerosol generation**
   A system which delivers a constant controlled amount of aerosolized bacteria of a known and precisely controlled average particle size and particle size range.
b) **Aerosol chamber**
   The nebulizer may be contained in this chamber or be separate and the chamber may have the facility to vent in additional filtered air.
c) **Filter housing**
   Sited at the exit of the aerosol chamber and in which is placed the filter medium to be tested.
d) **Bacterial collection device**
   This assays the number of viable droplets or particles in the aerosol which challenge the test medium with no specimen in place and which pass through the test medium with the specimen in place.
e) **Vacuum pump and flow meter**
   A post filter vacuum created by the vacuum pump induces airflow at a controlled rate.

Providing the method utilized is reproducible with little variability and incorporates all the above stages it is acceptable.

4. Principle

Annex 1 describes a commonly used protocol and is cited to give guidance for the interpretation of the principles of the test procedure

Prospective users of this protocol are advised of the limitations of the method as detailed in clause A 1 in so far as the method is applicable to the filter medium itself and not the finished article.

5. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) The particle size range of the challenge aerosol

f) The bacteria challenge employed
g) The airflow rate at which the test was conducted
h) Efficiencies quoted should be the average of at least five individual readings obtained with adequate controls
i) Laboratory testing conditions; Barometric pressure, Temperature, Relative humidity
j) Number of specimens tested
k) For computer processed data, identify the software used and the version
l) Deviation from the standard test procedure, if any
m) Anything unusual noted during the testing
n) Where an average BFE is given the number of tests performed should be indicated.
o) Calculation of efficiency:

$$BFE\% = \frac{(ColoniesWithoutFilter - ColoniesWithFilter)}{(ColoniesWithoutFilter)} \quad x \quad 100\%$$

ANNEX A
(informative)

Bacterial Filtration Efficiency

This annex describes a commonly used protocol and is cited merely to assist the prospective test laboratory to interpret the principles embodied in WSP 300.0 (09)

A 1. Principle

The following method is used for determining the bacterial filtration efficiency of surgical face mask material and other filter materials. The method was developed by Dr Paul S. Nicholes of the University of Utah.
N.B It should be noted that the method assesses the filtration efficiency of a material and not the efficiency of face mask per se.

A 2. References

a) Military specification - MIL-M-36954C, 1975, p. 21
b) Andersen 2000 Inc. “Instructions and Care of the Andersen Viable Sampler”. 5.1.71
c) Andersen 2000 Inc. Catalog

A 3. Apparatus (see figures 2 and 3)

a) Glass cloud chamber - custom made.
b) Andersen air sampler
c) Andersen air sampler - adapted for plastic plates
d) Flow meter
e) Air pressure source
f) Pressure gauge
g) Filter apparatus
h) Condenser
i) Incubator
j) Agar sterilizer
k) Autoclave
l) Colony counter
m) Syringe pump
n) Automatic petri plate filler
o) Chicago nebulizer
p) Vacuum pump
q) Spectrophotometer

A 4. Material and Reagents

a) Tryptic soy agar - Gibco
b) Difco bacto-peptone
c) Distilled water
d) Nutrient broth
e) Sodium chloride (reagent grade)

This methodology can also be modified to accommodate other sources of nebulized bacteriological challenges e.g. The Collison nebulizer can accommodate other particle

size challenges. In all references to performance the choice of nebulizer and particle size distribution of the challenge medium should be quoted.

NOTE 2 SAFETY WARNING

All normal safety precautions essential for safe handling of potentially hazardous organisms and essential for a properly run microbiological laboratory should be enforced.

Routine checks should be made on the test apparatus to ensure good seals and connections are maintained and that there are no leaks. It will be noted that the Andersen sampler assembly is provided with a back-up filter holder which will accommodate a high efficiency filter medium such as a glass fiber filter which has a high collection efficiency for sub-micron particles.

Additionally, a high efficiency bacterial filter covers the pressure equalizing part in the aerosol chamber to protect the environment from aerosolized bacteria.

A 5. Procedure

A 5.1 Preparation of media and reagents

a) **Tryptic soy agar plates**
Tryptic soy agar is mixed with distilled water at a concentration of 40 grams per liter and autoclaved at 121°C for 20-30 minutes. 27 ml ± 1 ml are dispensed per glass Andersen plate.

b) **Nutrient broth**
8 grams of powdered nutrient broth is dissolved per liter of distilled water. 30 ml volumes are dispensed into 125 ml flasks and autoclaved at 121°C per 30 minutes. The broth is kept at 10°C ± 1°C until it is used.

c) **Peptone dilution medium**
15 grams of Difco-peptone and 9 grams of sodium chloride (Reagent Grade) in 1 liter of distilled water. 75-100 ml volumes are dispensed into 125 ml flasks. The flasks are autoclaved at 121°C for 30 minutes and stored at room temperature.

d) **Tryptic soy agar slants**
The agar is prepared as in 1 above and 6 ml are placed in a 10 ml test tube and autoclaved at 121°C for 20 minutes. The tubes are placed on a slant and allowed to solidify.

A 5.2 Preparation of test culture

This methodology cites the use of Staphylococcus aureus as the challenge organism, however alternative organisms such as Staphylococcus epidermidis which may be potentially less hazardous may be employed.

a) **New slants**
New slants are inoculated with isolated colonies from previously run culture plates of Staphylococcus aureus UT 15. The slant cultures are incubated at 37°C ± 1°C for 24-48 hours with the screw caps loosened. At the end of the incubation period the caps are tightened and the slant cultures are stored at room temperature. Slant cultures may be used until a loss in viability is noted. New slants are prepared every two weeks. Slants can be identified by a number which corresponds to month and day of inoculation, for example, if the slant is started on August 6th, the identifying number is 806.

b) **Test broth**
Staphylococcus aureus UT 15 is aseptically transferred from a mature slant to 30 ml of nutrient broth using a sterile inoculating loop. The broth is agitated for about 30 seconds and then incubated for 24 hours without agitation. The culture is again agitated for about 30 seconds just prior to use.

c) **Culture dilution**
The culture is diluted to an appropriate concentration with peptone to deliver a total count of 2200 ± 500 viable particles on the control plates when the aerosol is collected in the Andersen sampler.

A 5.2.1 The dilution procedure is as follows:

a) **The spectrophotometer**
(B & L Spectronic 20) is set at 625 nm and zeroed at 0 % transmittance

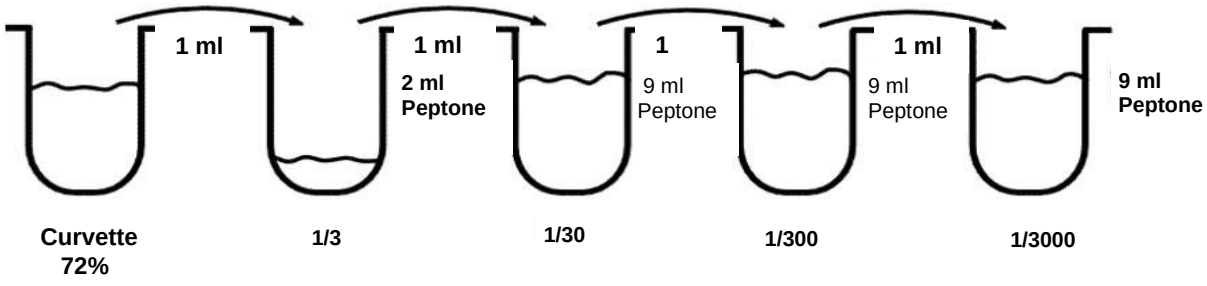
b) **Peptone dilution medium**
Peptone dilution medium is added to a clean sterile cuvette. The cuvette is then placed in the spectophometer which is then adjusted to read 100 % transmittance.

c) **The cuvette is then emptied and allowed to drain**
The undiluted culture is then added to the cuvette. The culture turbidity is measured on the spectrophotometer and recorded in percent transmittance, T.

d) **Peptone dilution medium is added**
Peptone dilution medium is added to the culture until the turbidity measures 72 % T. With each addition of peptone the culture is swirled with a vortex mixer.

e) **The 72 % T culture must then be diluted**
The 72 % T culture must then be diluted to yield 2200 ± 500 viable particles per 0,2 ml test broth aerosolized. A serial dilution is used. For example, if a 1/3000 dilution factor is required the dilution procedure would be as follows in figure 1:

Figure A 1
Only clean, sterile glassware is used with culture handling



A 5.3 Apparatus operation

a) **Once the test culture has been prepared**
Once the test culture has been prepared it is drawn into a sterile 5 cc Hamilton gas tight syringe. The syringe is then connected to the Chicago syringe pump.

b) **The tryptic soy agar plates**
The tryptic soy agar plates are then placed into the Andersen sampler. All fittings and hoses are inspected to insure that all connections are made properly.

c) **The syringe pump**
The syringe pump is then used to prime the nebulizer. The timer activating the syringe pump is shut off when the test solutions come within approximately 6 mm of the capillary tube tip.

d) **The apparatus is now ready to operate**
Using the first set of plates as a waste set, the flows are set and the apparatus is used as follows
The vacuum to the Andersen sampler is turned on and adjusted to pull 28. lpm airflow. The flow is measured by a Gilmont flow meter which has been calibrated by a dry gas meter.

The air to the nebulizer is turned on and the pressure is adjusted to 15 psi.

The timer activating the syringe pump is set for one minute. After 1 minute has elapsed, the syringe pump is switched off. After 1 minute 45 seconds total elapsed time, the air to the nebulizer is switched off. After 2 minutes total elapsed time, the vacuum from the Andersen sampler is switched off.

The Andersen plates are then removed from the sampler and replaced with fresh plates. After the waste set of plates a control is run without any test material in place.

Filter samples are then run using a fresh set of plates for each sample.

It is suggested that one control run be made for every 6 samples tested.

The average control value used for each batch of 6 test samples is the average of the two control runs prior to and subsequent to those six tests.

A 5.4 Incubation, counting and calculations

a) **Incubate**
The inoculated plates are then inverted and incubated at 35-37°C for 24-48 hours.

b) **After incubation**
The colonies are counted using an automatic colony counter. All colonies are counted on plates 1 and 2. On plates 3-6 only those colonies deposited in line (deposit areas) with the air stream holes are counted. These numbers are then converted using the positive hole conversion table supplied by Andersen. Ref: Andersen A.A. (1958). New Sampler for the collection, sizing and enumeration of viable airborne particles. Journal of bacteriology 76 471-484.

This table converts the numbers of holes filled with viable particles to the probable number of actual particles in the aerosol. This table takes into account the probability that as the number of holes filled with viable particles increases, then the chances of a second or third viable particle also entering the same hole also increases.

c) **The counts**
The counts are totaled and the filtration efficiencies are calculated as follows:

$$BEF\,\% = \frac{(ControlAverage - IndividualMaskData)}{(ControlAverage)} \quad X \quad 100\%$$

A 5.5 Particle size of challenge aerosol
Average droplet or particle size is calculated based on the distribution of particle collection in the Andersen sampler and using a weighted average calculation. Andersen particle fractionating samplers are also available with eight multi-orifice impactor stages which separate the particles into 8 fractions from 11 microns and above down to 0,4 micron diameter.

Typical particle size distribution (microns)

Stage	0	1	2	3	4	5	6	7
Stage 6	-	>7	4.4 - 7	3.3 – 4.7	2.1 – 3.3	1.1 – 2.1	0.65 – 1.1	-
Stage 8	>11	7-11	4.7 - 7	3.3 – 4.7	2.1 – 3.3	1.1 – 2.1	0.65 – 1.1	0.48 - 0.65

Figure A 2
Schematic diagram of a six-stage Andersen sampler

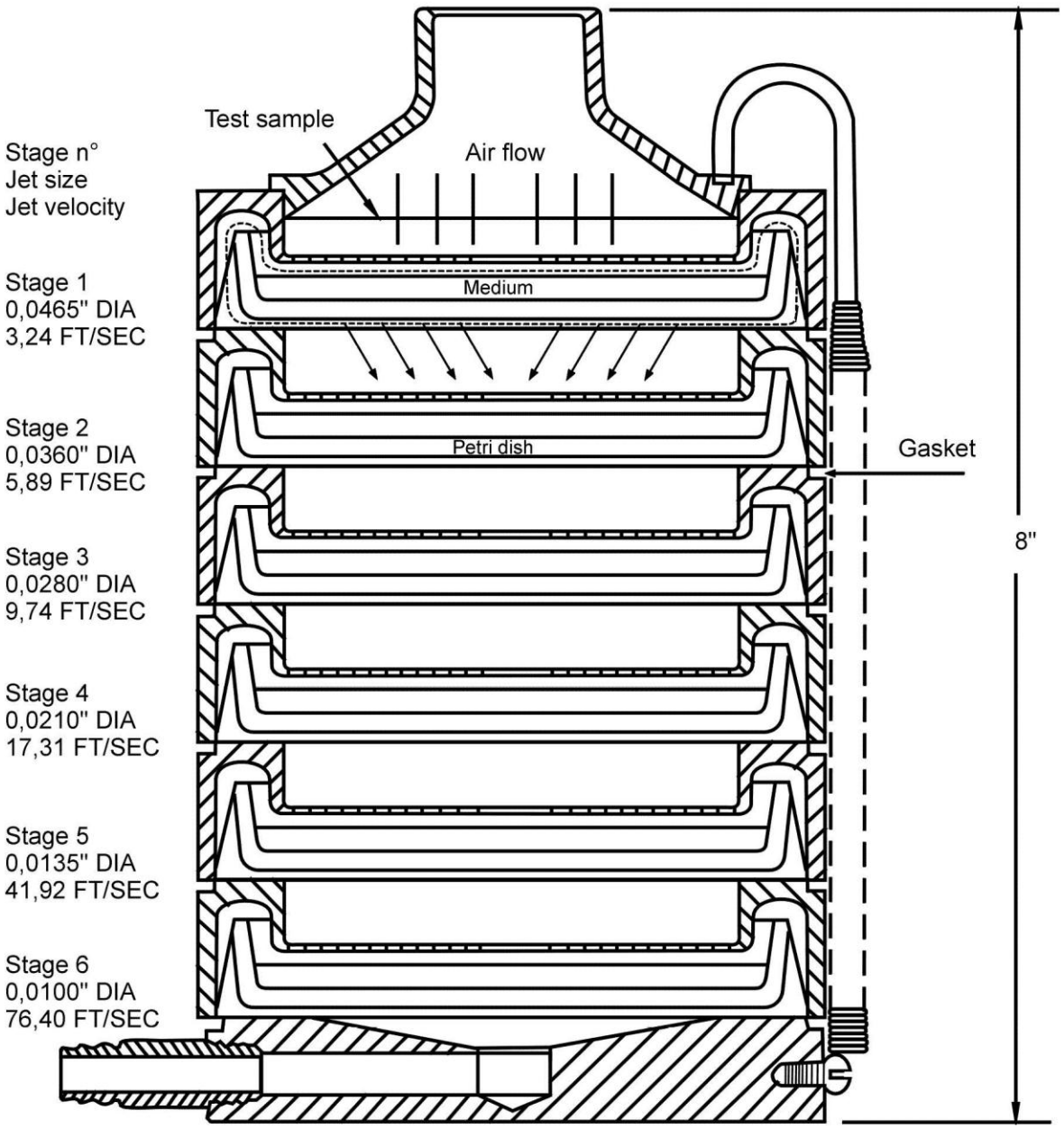
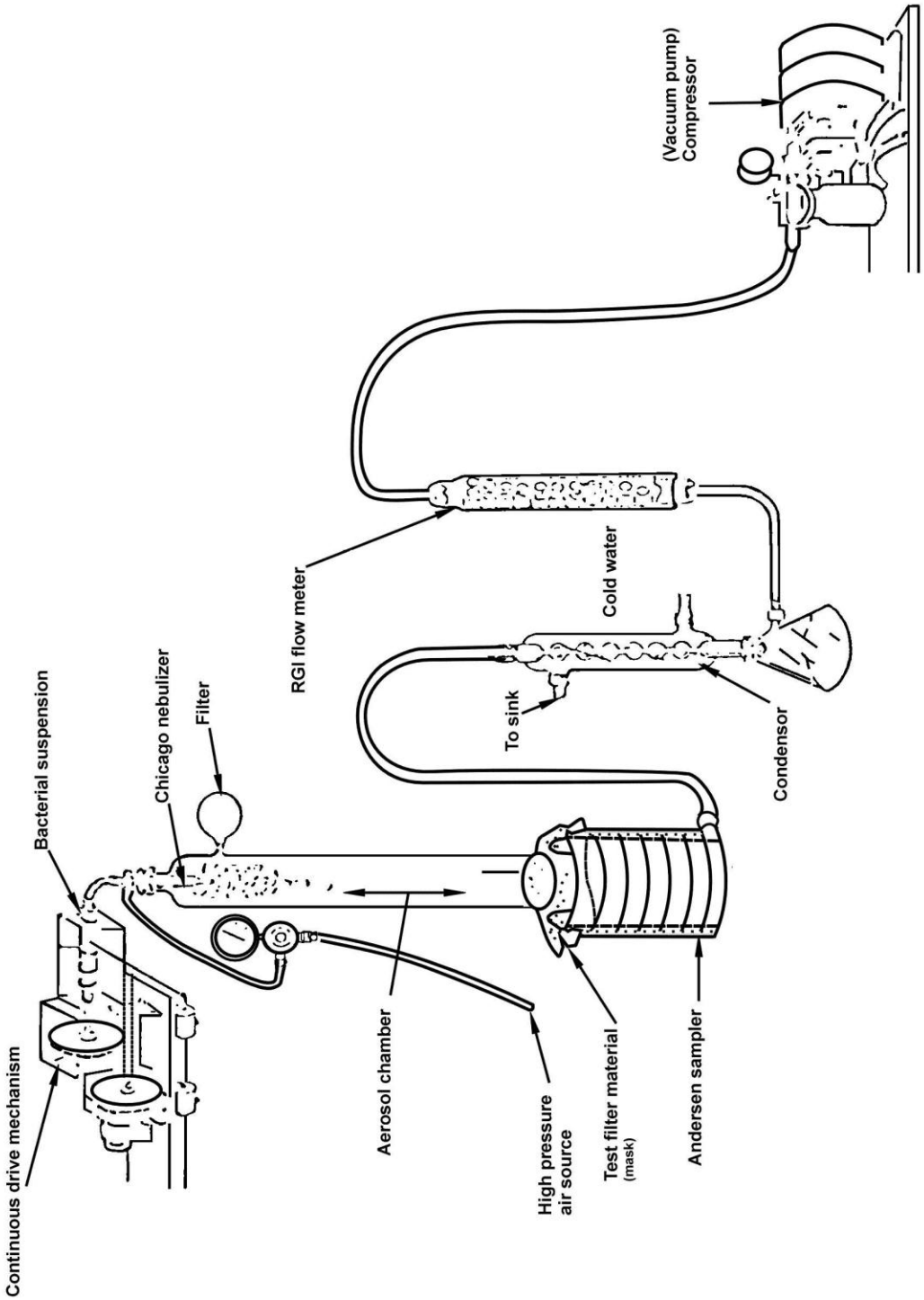


Figure A 3
Bacterial filtration efficiency



A 5.6 Additional data reporting

All of the following data is also recorded at the time of the test:

a) Room temperature
b) Relative humidity
c) Barometric pressure
d) Culture turbidity
e) Dilution factor
f) Slant number

STANDARD TEST: WSP 301.0.R4 (12)

Standard Test Method for Dry Bacterial Penetration

The number in parentheses indicates the year of the last revision

Foreword

There are numerous examples of situations where bacteria may migrate through a barrier material in the dry state carried by organic or inorganic particles. The dry penetration of bacteria carrying skin scales through an operating gown or a clean air suit is one example. Penetration through a packaging material during storage is another.

The WSP describes a test method, with the associated equipment, that may be used to determine a material's resistance to penetration of bacteria on particles in the size range most typical for human skin scales.

1. Scope

This test method provides a means for assessing the resistance to penetration of bacteria carrying particles through nonwovens.

NOTE 1 Due to its complexity, this WSP cannot be considered as a useful method for routine quality control, but may suite the needs when a material shall be assessed for compliance with the requirements of current regulations such as 93/42/EEC.

SI values are regarded as the official standard system of measurement for this standard test method.

NOTE 2 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.1 ISO test methods

a) ISO 139-2005 Textiles — Standard atmospheres for conditioning and testing
b) ISO 2859-1:1999 Sampling procedures for inspection by attributes
c) ISO 3951-1:2005 Sampling procedures for inspection by variables

Reference number
WSP 301.0.R4 (12) A

Current edition approved WSP 301.0.R4 (12)
Originally published as WSP 301.0 in 2002
Last approved as WSP 301.0 in 2009

d) prEN 13795-3: 2001 Surgical drapes, gowns and clean air suits, used as medical devices for patients, clinical staff and equipment – Part 3: Test Method for Dry Bacterial Penetration Through barrier Materials

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Principle

The test is carried out on test specimen with each fixed in a container. In each container except one a portion of talc contaminated with Bacillus subtillis endospores is poured on the test specimen. One container is left uncontaminated as a control. A sedimentation plate is inserted at the base of each container at a short distance below the test piece.

The apparatus supporting the containers is then brought into vibration by a pneumatic ball vibrator. The talc that penetrates the specimen is captured on the sedimentation plate. The sedimentation plates are removed and incubated.

The number of colonies produced is counted.

4. Material and Reagents

4.1 Method to infect talc with spores

4.1.1 Materials needed

a) 50 g of talc (95% < 15µ), e.g. Finntalc M15 from Omya Benelux S.A., Plage Eug. Keym 43 B 27, B-1170 Brussels, Tel: +32-2-674.23.11, Fax: +32-2672.92.68.
b) Purified spores of Bacillus subtilis ATCC 9372 in concentration of ≥ 10^9/ ml of ethyl alcohol commercially available, e.g. Simicon GmbH, Schuhmacherring 12, D-81737 Munchen, Fax: +49-89-67.33.66.22
c) TGE agar plates

4.1.2 Procedure

a) Prepare 50 g sterile talcum powder and sterilize at 160°C with dry heat for 2 hours plus 1 hour for heating in a suitable container.
b) Open the ampoule with 5 ml of the ethanolic spore solution.
c) Spread the spore solution in 50 steps (50 x 100 µl) over the talcum powder.
d) After every step, shake the closed vessel with a vortex vibrator.
e) Put the opened vessel in a desiccator with silica gel and dry it at room temperature over 2-3 days.
f) Weigh the vessel before and after drying to assure a complete drying.
g) Estimate the bioburden expressed as cfu/g (3 fold, each two fold times repeated) of the spore talcum mixture on TGE agar after incubation overnight at 35°C.
h) The final concentration should be 10^4 or 10^8 cfu/g talc. It is necessary to ensure that the spores are homogeneously distributed in the talc.

5. Apparatus

5.1 General layout (Figure 1)

a) A 10 mm marble plate, 40 cm x 40 cm, underneath which 4 rubber stoppers are mounted at the corners.
b) A pneumatic ball vibrator, e.g. K13, made by ERKALAITE OY, Helsinki, Finland. The vibrator shall be able to generate 20.8 KVPM with a force of 650 N.
c) The vibrator is attached, by means of screws, to the upper surface of the marble plate along one of its sides.
d) Suitable compressed air flow meter to measure 158 l/min ± 1%. The flow of the compressed air governs the vibration frequency.
e) Six (6) stainless steel test containers.
f) A stainless steel plate with 6 retaining holes of suitable dimensions to fit the containers. The stainless steel plate is held to the marble plate by means of clips.
g) Stopwatch.

5.2. Test containers (Figure 2)

a) A suitable stainless steel container with a lid. The lid has a central aperture through which a metal plunger may be inserted to reach 10 mm underneath the lid to ensure that the test material is slack when inserted.
b) Each container has a sedimentation plate insertion slot near the base.
c) To ensure good contact between the containers and the marble plate by means of the retainer plate, each container is equipped with a rubber ring resting on the flanged base.
d) The rim of the container is chamfered to prevent damage to the test specimen when inserted.
e) A supply of 9 cm diameter Petri dishes containing a suitable agar medium, e.g. TGE agar.

6. Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in WSP 5.0. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 3 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

7. Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 4 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

7.1 Laboratory sample

From each roll or portion of material taken from the lot sample, cut at least one laboratory sample the full width of the fabric and 1 m in the machine direction. This is done after removing the first outside wrap or discarding the first 1 m length. For nonwoven fabric components of fabricated systems use the entire system.

7.2 Test specimens

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material.

a) Care in handling should be observed so that specimens do not contact any contaminants such as soap, salt, oil etc.
b) Specimens should be cut 200 x 200 mm
c) Unless otherwise specified, cut 12 specimens, evenly spaced across the available width of each sample.

8. Procedure

8.1 Place all 12 test specimen in sterilizing bags
And sterilize by the method given by the manufacturer.

8.2 Put containers
In sterilizing bags and sterilize.

8.3 Fix the bases of the containers
Onto the marble plate by means of the retainer plate and secure with the clips.

8.4 Aseptically remove the specimen
From the bags and place over the mouths of the test containers.

8.5 With the plungers distended downwards
The lids are affixed to the containers thus fixing the specimen with controlled slackness.

8.6 Remove the plungers.

8.7 Pour a 0.5 g portion of the contaminated talc
Through the plunger orifice onto each of 5 of the test specimen, leaving the 6th one uncontaminated as a control.

8.8 Seal the orifices with cling film.

8.9 Put a small plastic bag over each container

8.10 Insert a lidless sedimentation plate
Through the slot at the base of each container

8.11 Close the slots with adhesive tape

8.12 Run the vibrator
At 158 l/min for 5 and/or 30 minutes.

8.13 Remove plastic bags and adhesive tape

8.14 Insert the lids
Of the sedimentation plates through the slots.

8.15 Remove the sedimentation plates
And incubate at 35°C for 24 hours.

8.16 Count the number of colonies produced.
The control plate (6th) should read 0.
If not, the test should be aborted as there is extraneous contamination.

8.17 For each material
repeat points 8.1 through 8.16.

8.18 Calculate the geometric mean for the 10 valid results.

9. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Number of specimens tested
g) For computer processed data, identify the software used and the version
h) Deviation from the standard test procedure, if any
i) When calculated, the standard deviation or the coefficient of variation
j) Whether or not samples were conditioned prior to testing and, if so, for how long
k) Anything unusual noted during the testing
l) Details of the contaminant used
m) Geometeric mean

10. Precision

The precision for this method is yet to be determined.

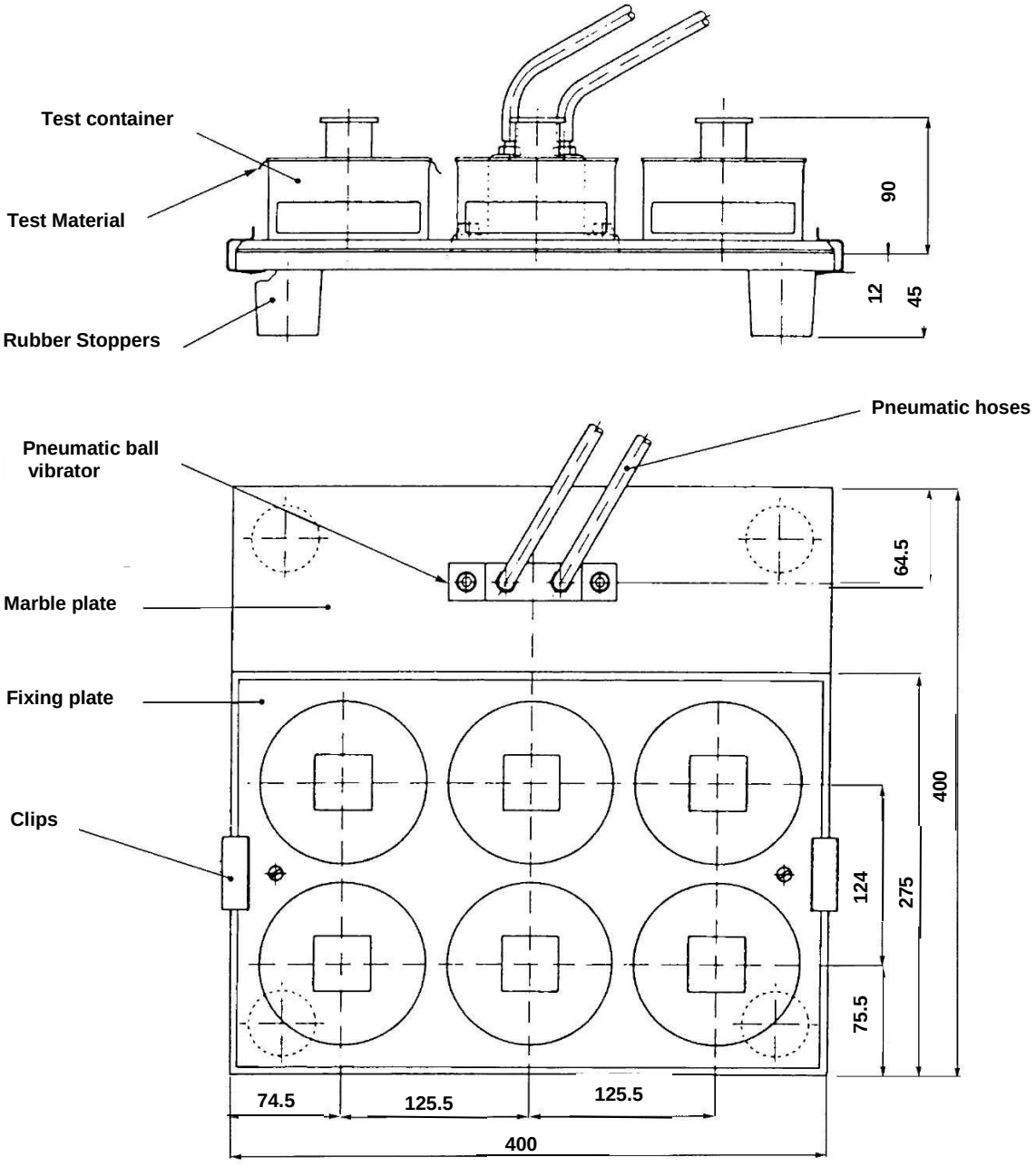


Figure 1
General Layout

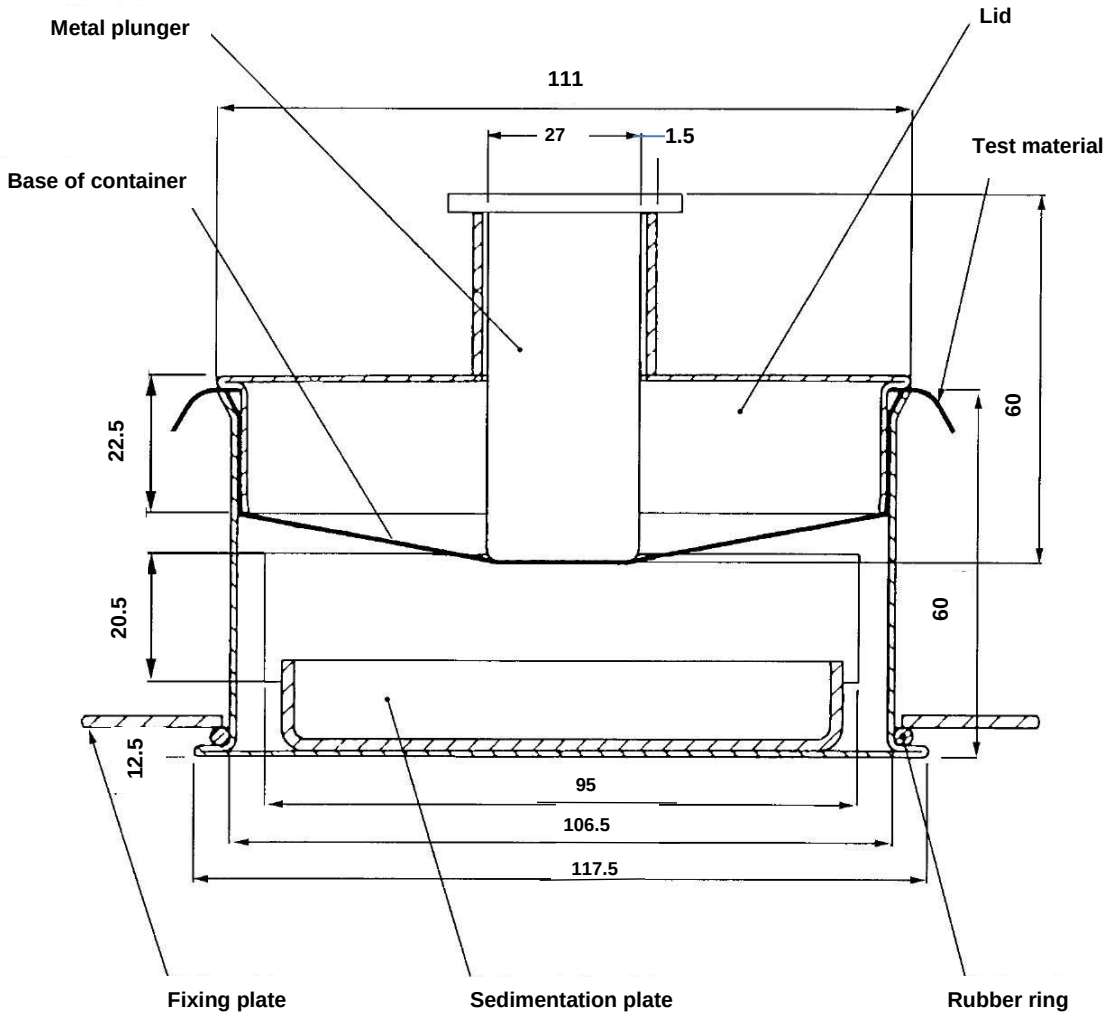


Figure 2
Test Container

STANDARD TEST: WSP 302.0.R4 (12)

Standard Test Method for Nonwoven Wet Bacterial Penetration

The number in parentheses indicates the year of the last revision

Foreword

There are numerous examples of situations where bacteria carried by a liquid may migrate through a barrier nonwoven in the wet state. The wet penetration of skin flora through a surgical patient drape could be one example.

European Medical Device regulations specifically put the responsibility to avoid device related infections on the manufacturer. In order to demonstrate compliance with this requirement and to describe a product to the user, there is a need to use harmonized and recognized test methods.

1. Scope

This WSP test method describes test methods, with the associated equipment, that may be used to determine a nonwoven's resistance to penetration of bacteria in a liquid.

SI values are regarded as the official standard system of measurement for this standard test method.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document:

2.1 ISO test methods

a) ISO 554:1976 Standard Conditioning
b) ISO 186:1985 Nonwoven Sampling
c) prEN 13795-4:2001 Surgical drapes, gowns and clean air suits, used as medical devices for patients, clinical staff and equipment – Part 4:Test Method for Resistance to Wet Bacterial battier Penetration

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

Reference number
WSP 302.0.R4 (12) A

Current edition approved WSP 302.0.R4 (12)
Originally published as WSP 302.0 in 2002
Last approved as WSP 302.0 in 2009

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Agar plate
Petri dish containing sterile agar nutrient medium (see Annex B)

3.2 Carrier material
Material used to prepare the donor.

3.3 Covering material
Material used for covering the patient, equipment and certain surfaces, i.e. surgical drapes, to prevent the skin bacteria from the patient and/or bacteria from other non-sterile surfaces from reaching the operation wound (prEN 13795-1).

3.4 Donor
Material that has been contaminated with a known number of viable cells of a defined strain of Staphylococcus aureus.

3.5 Finger
Part on apparatus for testing resistance to wet bacterial penetration, used to bring donor and covering materials into contact with the surface of an agar plate at one spot.

3.6 Petri dish
Receptacle used to prepare agar plates.

3.7 Test specimen
A prepared specimen of covering material for which the resistance to bacterial penetration is going to be determined.

4. Principle

A test piece is put on a lidless agar plate on a rotating disk. On top of the test piece, a piece of donor material and a piece of 10 µ HD polyethylene film of corresponding size are placed and fixed using a double steel ring. An abrasion resistant finger is place on top of the donor material to exert a specified force on the donor and test specimen to bring them into contact with the agar. The finger is applied to the material by a pivoted lever moved by an excenter cam in such a way that it moves over the entire surface of the plate within 15 minutes. The assemblage of materials is stretched by the weight of the steel ring so that only a small area of the test piece is brought into contact with the agar surface at a time. Due to the combined effect of rubbing and liquid migration bacteria may spread from the donor material through the test piece down to the agar surface.

After 15 minutes of testing, the agar plate is replaced and the test repeated. Within five periods of 15 minutes each, tests are performed with the same pair of donor material and test piece. In that way the test allows for an estimation of the penetration over time.

Finally the remaining bacterial contamination on the primary side of the test piece is sampled using the same technique.

The agar plates are incubated to visualise the bacterial colonies, which are then enumerated.

The results are processed in accumulated form to characterize the barrier capability of the material.

5. Material and Reagents

a) Apparatus, shown in Annex A, figure A.1.
b) Sets of 6 agar plates, 14 cm diameter, filled with nutrient agar, Annex B.
c) Five pieces, 25 x 25 cm, of carrier material to produce donors.
d) Five pieces, 25 x 25 cm, of 10 µ HD polyethylene film.
e) Staphylococcus aureus suspension.
f) Five test specimens, 25 x 25 cm.
g) Reference barrier material.

NOTE 2 The equipment in clause (5 a) can be purchased from e.g. Shütt Labortechnik, Rudolf-Wissel-Straße 1, D-37079 Göttingen, Germany.

6. Apparatus

6.1 The apparatus (Annex A) has an electrically driven

Timer controlled turntable which holds an agar plate, 14 cm diameter. A horizontal lever with a vertical finger is fitted to a pivot allowing sideways movements of the finger from the center to the periphery of the rotating (60 rpm) agar plate and back. A weight of 250 g can be slid along the lever of the finger to adjust the force to be exerted by the finger on the materials. The lever is guided by an excenter cam rotating 5, 60 times per minute. The finger with a semi-spherical, polished end, radius 11 mm, is removable and shall be disinfected between tests.

The force, 3 N exerted by the finger on the materials is measured by e.g. a dynamometer attached to the lever or by a balance placed on the turntable.

The material under test shall only be in contact with the agar at one point at a certain time. It shall also only be in contact with that point one time during the 15 minute run. To ensure that the finger moves over the entire surface it shall be regularly monitored using the technique below. The resulting documentation is a quality record and shall be retained.

Prepare an assemblage, using the steel rings (see Annex A) consisting of one sheet of white paper, one sheet of carbon paper and one sheet of HD polyethylene film. Put a bottom part of a 14 cm Petri dish upside down on the rotating disk and the assemblage over it as described in 7.1. Apply the finger to the materials and run the apparatus for 15 minutes. Extract the white paper and ensure that the finger has left an even contact pattern over the whole surface of the plate.

6.2 Sets of 6 agar plates

The sets of 6 Petri dishes, 14 cm diameter, are filled with nutrient agar, see Annex B, to 3.0 ± 0.2 mm from the rim. The agar plates shall be prepared the same day as the test is performed or e.g. stored over water so that the weight loss is ≤ 0.2 % when used. Le the plates dry for 20 minutes without lid in a clean bench. Visible fluid (condensate) on the agar surface shall not be present. The height of Petri dishes is not industrially standardized so different suppliers' dishes may have different height. Therefore the weight or volume of agar that gives the above distance must be determined. Volumetric or gravimetric methods shall then be used when pouring the agar into the dishes. To monitor the distance agar to rim, e.g. put a razor blade on the center of the agar surface and a steel ruler standing on the dish rim across the dish. Then determine the distance between the ruler and the blade using wire gauges or a dial indicator. This distance shall be determined for each batch of plates and be noted in the test report.

6.3 Carrier material

The carrier material shall be wettable polyurethane polymer film of 30 µ thickness carried on paper.

Cut pieces of the carrier 25 x 25 cm. Put each piece between sheets of cardboard, and then in a sterilizer bag.

Sterilize by steam.

6.4 Staph aureus suspension

Staph. aureus strain, ATCC 29213, is cultured 18 to 24 h at 36°C ± 1°C on tryptic soy agar. From this, 2 – 3 colonies are suspended in 3 ml tryptic soy broth, see Annex B, and cultured 18 to 24 h at 36°C ± 1°C. The broth is diluted with peptone water, see Annex B, in 1:10 steps to yield a dilution to 105 cfu/ml. A viable count from 1:10 step dilutions is performed on the final suspension.

6.5 Contamination of carrier material

Open a sterilizer bag and extract the polyurethane film. Remove the paper carrier and place the carrier material on a clean tray, if appropriate, wettable side up. For case of handling fix the polyurethane film to the tray using adhesive tape in the corners. An area corresponding to the lid of the agar plate is marked on the carrier material. 1.0 ml of the Staph aureus suspension is evenly distributed over this area of the carrier material with a pipette. The donor is then dried in 56°C for 20 min. If necessary the Staph aureus suspension is further spread on the polymer film during the drying using a disinfected glass spreader.

The donor shall be used the same day as it is prepared.

6.6 Test specimen

Depending on the intended use of the test results, a suitable pretreatment of the test specimen shall be determined.

Five specimens 25 cm x 25 cm or with a diameter of 25 cm shall be randomly cut from the covering material to be tested.

Prior to testing, the test pieces are packed and sterilized, using the same packaging and sterilizing methods as those recommended by the manufacturer for the final product.

7. Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 3 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

8. Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 3 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

8.1 Laboratory sample

From each roll or portion of material taken from the lot sample, cut at least one laboratory sample the full width of the fabric and 1 m in the machine direction. This is done after removing the first outside wrap or discarding the first 1 m length. For nonwoven fabric components of fabricated systems use the entire system.

8.2 Test specimens

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material.

a) Care in handling should be observed so that specimens do not contact any contaminants such as soap, salt, oil etc.
b) Specimens should be cut 25 x 25 cm
c) Unless otherwise specified, cut 5 specimens, evenly spaced across the available width of each sample.

9. Procedure

Adjust the weight on the lever so that the force from the finger on the agar plate is 3N.
Place agar plate nº 1 on the turntable.

9.1 Application of materials

To standardize the material stretch, use the following technique. Use a circular weight consisting of an outer and an inner ring together weighing 800 ± 1 g (see Annex A, figures A.2 and A.3).

Put the inner ring and a cylindrical body approx. 9 cm in diameter and 4 cm in height in its center onto a horizontal sterile working surface. Use suitable means such as double sided adhesive tape on the outside of the ring to increase friction. Put a test material on the ring and the donor and a piece of HD polyethylene on top of it. Now push the outer ring down firmly so that the materials are securely held between the two rings.

9.2 Performance of the test

The assemblage can now be lifted with the materials slightly slack and placed on the first agar plate with the steel ring hanging freely outside the rotating disk. Apply the finger to the donor material in such a way that the test specimen comes into contact with the agar surface just beneath the finger. Start running the test as described with a finger pressure of 3N and for 15 minutes.

Remove the steel ring with the donor-test piece combination immediately when the 15 minute period has elapsed.

Remove plate nº 1 from the rotating disk and put the lid on it. Put plate nº 2 on the rotating disk and out the ring with the materials on it.

Repeat the above 4 times using the same material assemblage.

Finally, remove the donor, turn the test piece upside down, cover with the HD polyethylene film and run the sixth plate for 15 minutes.

If liquid has accumulated on the agar surface, dry the plate(s) in a clean bench and incubate the agar plates (1 through 6) with their lids on in a thermostat at 36ºC ± 1ºC for 48h.

Count the colonies of S. aureus on each plate.

Run the remaining 4 test pieces in the same way as described. Use a freshly prepared donor with each test piece.

9.3 Calculation of results

Calculate the expected plate for penetration (EPP) using the following technique:

X1, X2, X3, X4 and X5 are the numbers of colonies on the five plates from one of five runs of a covering material.

Z is the plate count from the inverted test specimen.

$T = Z + X1 + X2 + X3 + X4 + X5$

$CUM1 = X1/T$

$CUM2 = X2 + X1/T$

$CUM3 = X3 + X2 + X1/T$

$CUM4 = X4 + X3 + X2 + X1/T$

$CUM5 = X5 + X4 + X3 + X2 + X1/T$

$EPP = 6 – (CUM1 + CUM2 + CUM3 + CUM4 + CUM5)$

10. Test Repot

In addition to the precise test results, the report shall include the following information:

a) Reference to this test method.
b) Reference to calibrations according 6.1.
c) Test conditions, i.e. temperature and humidity.
d) Distance from agar surface to rim of Petri dish.
e) Identification of covering material.
f) Pretreatment of the test piece if any.
g) Statement that the donor material corresponds with 6.6.
h) Colony count results from the six test plates of each of the 5 test specimens.
i) Viable counts of the S. aureus suspensions used.
j) Calculated EPP characteristic, mean and standard deviation over the five test specimens.

11. Calibration with Reference Material

The test method may be calibrated using the reference material in combination with the test method described in this European Standard.

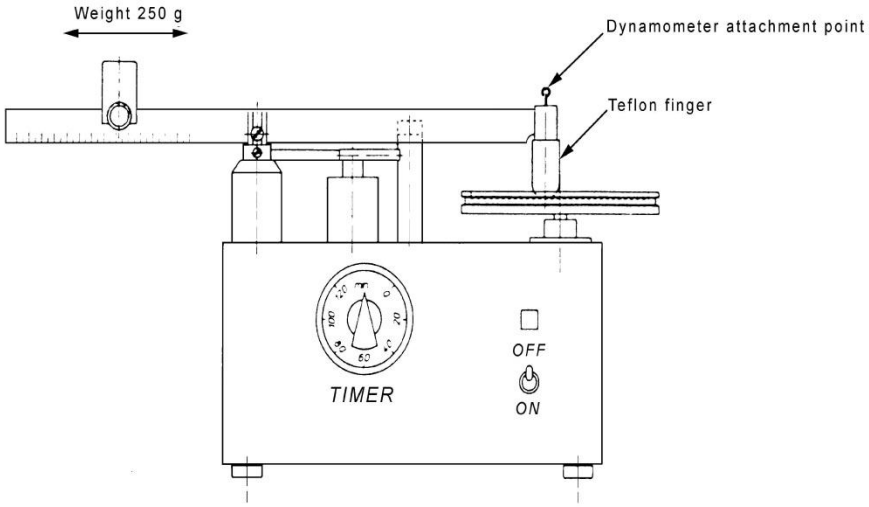
The reference material should be packed in a sterilizer bag that complies with EN 868-1 and sterilized with steam at 120°C.

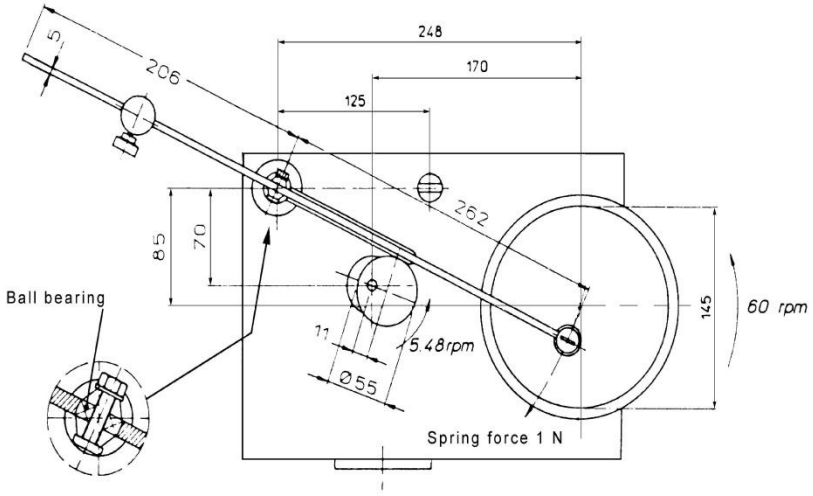
The EPP characteristic of the reference material should typically be in the range 3.5 – 4.0.

12. Precision

The precision for this method is yet to be determined.

ANNEX A
(normative)
Apparatus for testing resistance to wet microbial penetration





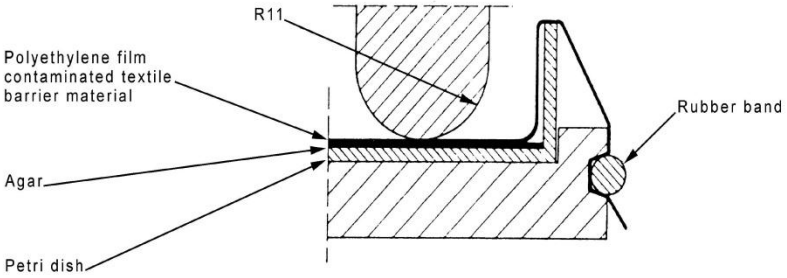


Figure A 1 (top) Apparatus (top view)

Figure A 2 (middle) Apparatus (front view)

Figure A 3 (bottom) Inner ring

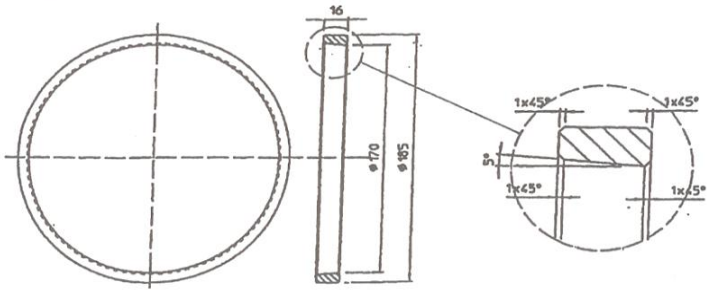


Figure A 4
Outer Ring

ANNEX B
(normative)

Nutrient media

B.1 Tryptic soy agar

Tryptone	15 g
Papaic digest of soybean meal	5 g
Sodium chloride	5 g
Agar	17 g
Dest. Water	1000 ml

B.2 Tryptic soy broth

Tryptone	17 g
Papaic digest of soybean meal	3 g
Dextrose	2,5 g
Sodium chloride	5 g
Dipotassium phosphate	2,5 g
Dest. Water	1000 ml

B.3 Peptone water

Peptone	10 g
Sodium chloride	5 g
Dest. Water	1000 ml

STANDARD TEST: WSP 310.1.R4 (12)

Standard Test Method for Free and Hydrolysed Formaldehyde in Nonwovens (Water Extraction Method)

Method I

The number in parentheses indicates the year of the last revision

Introduction

The methods I, II and III (respectively WSP 310.1.R4 (12), 311.1.R4 (12) and 312.0.R4 (12) describe test methods for the evaluation of the formaldehyde content in nonwovens and precursor fibers under various conditions. Method IV (WSP 313.1.R4 (12)) describes a method for the release of formaldehyde during the processing of nonwovens.

◊ **Method I determines**
the amount of free formaldehyde and formaldehyde extracted partly through hydrolysis by means of a water extraction method.
This method is suitable for determination of contents above 20 mg/kg. It is based on the CEN/ISO standard: Textiles - Determination of formaldehyde - Part 1: Free and hydrolyzed formaldehyde.
The testing conditions (40ºC, 4 hours) simulate the extended wearing conditions (consumer stage).

◊ **Method II determines**
the aggregate amount of free formaldehyde and the formaldehyde extracted partly through hydrolysis at stressed extraction conditions (e.g. in industrial applications like automotive industry).
The testing conditions (80°C, 1 hour) simulate conditions encountered in some industrial applications.
This method can also be used to accelerate the release of formaldehyde through hydrolysis by increasing the temperature. It is not recommended for medical / hygiene / wipes applications which is suited to Method 1

◊ **Method III determines**
the free formaldehyde using HPLC to overcome the interferences form colored or formaldehyde related species which can limit the usability of methods I and II.
The conditions for extraction are specified in methods I and II.

◊ **Method IV determines**
the formaldehyde released by aqueous systems under defined drying conditions.
The aqueous systems tested are formaldehyde-containing or formaldehyde-cleaving systems that could be used in the bonding or finishing process of nonwovens.

Reference number
WSP 310.1.R4 (12) A

Current edition approved WSP 310.1.R4 (12)
Originally published as ERT 310.1 in 1999
Last approved as WSP 310.1 in 2009

Note: The AATCC 112 method [(1)] has been adopted as EN ISO 14184-2 standard: Textiles Determination of formaldehyde - Part 2: Released formaldehyde (vapor absorption method).
This absorption method measures the propensity of a resin treated sample to liberate formaldehyde under prolonged hot humid conditions simulating garment processing or storage (garment makers stage). (1) AATCC Technical Manual. American Association of Textile Chemists and Colorists. Method 112 -1990.

1. Scope

This test method determines the amount of free formaldehyde and formaldehyde extracted partly through hydrolysis by means of a water extraction method. The method can be applied to the testing of nonwovens and precursor fibers. The method is suitable for determination of contents above 20 mg/kg.

NOTE 1 Information on the accuracy of the method is given in annex A

SI values are regarded as the official standard system of measurement for this standard test method.

NOTE 2 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document:

2.1 ISO test methods

a) ISO 5725-1 Accuracy (trueness and precision) of Measurement Methods and Results – Part 1: General Principles and Definitions

b) ISO 572 -2 Accuracy (trueness and precision) of Measurement Methods and Results – Part 2: Basic Method for the Determination of the Repeatability and Reproducibility of a Standard Measurement Method

c) ISO 554: 1976 Standard Conditioning

d) ISO 186: 1985 Nonwoven Sampling

e) EN ISO 14184-1 Textiles - Determination of formaldehyde - Part 1: Free and hydrolyzed formaldehyde (water extraction method)

2.2 WSP test methods

a) WSP 1.0 – 05 Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

b) WSP 3.0 – 05 Guidelines for Standard Atmospheres for Conditioning and/or Testing

c) WSP 5.0 – 05 Nonwoven Sampling

3. Principle

Formaldehyde is extracted from a nonwoven with water at 40°C. The amount of formaldehyde is then determined by colorimetry.

NOTE 3 **SAFETY WARNING**

This WSP calls for the use of substances and / or procedures that may be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage. It has been assumed in the drafting of this WSP that the execution of its provisions is entrusted to appropriately qualified and experienced people.

4. Material and Reagents

4.1 Distilled water
Or grade 3 water complying with ISO 3696

4.2 Acetylacetone reagent (Nash reagent)
In a 1000 ml volumetric flask, dissolve 150 g of ammonium acetate (analytical reagent grade) in about 800 ml of water (5.1), add 3 ml of glacial acetic acid and 2 ml of acetylacetone. Make up to the mark with water (5.1) and mix. Store in a brown bottle.

The reagent darkens in color slightly on standing over the first 12 h. For this reason the reagent should be held 12 h before use. The reagent is usable over a considerable period of time, at least 6 weeks.

However, since the sensitivity may change slightly over a long period of time, it is good practice to run a calibration curve weekly to correct for slight changes in the standard curve.

4.3 Formaldehyde solution
At approximately 37 % (w/v or w/w)

NOTE 4 Standardization according to annex B

4.4 Ethanolic solution of dimedone
Prepare by dissolving 1 g of dimedone (dimethyl-dihydro-resorcinol or 5.5-dimethyl-cyclohexanedione) in ethanol and by diluting the solution with ethanol to make 100 ml. Prepare immediately before use.

5. Apparatus

5.1 Stoppered volumetric flasks
50 ml, 250 ml, 500 ml and 1000 ml.

5.2 Flask
250 ml with stopper

5.3 Pipettes
1 ml, 5 ml, 10 ml and 25 ml volumetric and 5 ml graduated. Note: An automatic pipette system of the same accuracy as manual pipettes may be used.

5.4 Burettes
10 ml and 50 ml

5.5 Water bath
Operating at a temperature of 40 ± 2ºC

5.6 Filters
Made from heat resistant glass having a pore size between 40 and 100 µm (pore symbol P 100 in accordance with ISO 4793)

5.7 Photoelectric colorimeter or spectrophotometer
Wavelength, 412 nm

5.8 Test tubes
Colorimeter tubes or spectrometer tubes.

5.9 Balance
Accurate to 0.2 mg.

6. Preparation of Standard Solution and Calibration

6.1 Preparation
Prepare an approximately 1500 mg/ml stock solution of formaldehyde by diluting 3.8 ml of formaldehyde solution (5.3) to one liter with water (5.1). Determine the concentration of formaldehyde in the stock solution by a standard method (see annex B).
Record the accurate concentration of this standardized stock solution. This stock solution will keep for at least four weeks and is used to prepare standard dilutions.

6.2 Dilution
The equivalent concentrations of the formaldehyde in the test specimen, based on the mass of 1 g of the test specimen and 100ml of water, will be 100 times the accurate concentrations of the standard solutions.

6.2.1 Preparation of the standard solution (S2)
Dilute 10 ml of titrated standard solution (containing 1.5 mg/ml of formaldehyde), prepared in 6.1, with water (4.1) to 200 ml in a volumetric flask. This solution (S2) contains 75 mg/l of formaldehyde.

6.2.2 Preparation of the calibration solutions

Prepare calibration solutions from the standard solution (S2), by diluting with water (4.1) in 500 ml volumetric flasks, using a minimum of five solutions from the following:

1 ml S2 to 500 ml, containing 0.15 µg CH2O / ml = 15 mg/kg CH2O on the fabric
2 ml S2 to 500 ml, containing 0.30 µg CH2O / ml = 30 mg/kg CH2O on the fabric
5 ml S2 to 500 ml, containing 0.75 µg CH2O / ml = 75 mg/kg CH2O on the fabric
10 ml S2 to 500 ml, containing 1.50 µg CH2O / ml = 150 mg/kg CH2O on the fabric
15 ml S2 to 500 ml, containing 2.25 µg CH2O / ml = 225 mg/kg CH2O on the fabric
20 ml S2 to 500 ml, containing 3.00 µg CH2O / ml = 300 mg/kg CH2O on the fabric
30 ml S2 to 500 ml, containing 4.50 µg CH2O / ml = 450 mg/kg CH2O on the fabric
40 ml S2 to 500 ml, containing 6.00 µg CH2O / ml = 600 mg/kg CH2O on the fabric

NOTE 5 This double dilution is necessary to have the same formaldehyde concentrations in the calibration solutions as in the test solutions of the fabrics.

6.3 Calibration curve

Use 5 ml aliquots of each of the standard solutions prepared in 6.2 and the procedure described in 8 to prepare a calibration graph in which mg/ml formaldehyde are plotted against absorbance.

7. Preparation of Sample Solution and Condition of the Sample

a) Do not condition the sample because the predrying and humidity in connection with the conditioning may cause changes in the formaldehyde content of the sample.
b) Prior to test store the sample in a container.
c) Cut two test specimens for parallel determinations.
d) Cut each test specimen into small pieces, and weigh approximately 1 g of the pieces to an accuracy of 10 mg. The test for each specimen should preferably be run in duplicate.
e) If the formaldehyde content is low, increase the test specimen weight to 2.5 g in order to achieve a sufficient accuracy.
f) For each test specimen, put the weighed pieces into a 250 ml flask with stopper and add accurately 100 ml of water (clause 4.1). Stopper tightly and place in a water bath at 40 ± 2°C for 60 ± 5 minutes. Shake the flask at least every 5 min. Then filter the solution into another flask through a filter.

NOTE 6 If agreed between the interested parties, use a conditioned parallel specimen to calculate a correction coefficient to be used in correcting the mass of the test specimen to be used for the test. (This should be reported in 10).

8. Procedure

8.1 Put 5 ml of the test specimen solution into a tube (clause 5.8)

And 5 ml of the standard formaldehyde solutions into further tubes (clause 5.8), add 5 ml of acetylacetone reagent (clause 4.2) into each tube and shake them.

8.2 Keep the test tubes first in a water bath

At 40 ± 2°C for 30 ± 5 min and then at ambient temperature for 30 ± 5 min. Taking the solution of 5 ml of acetylacetone reagent in 5 ml of water having been treated in the same way as the blank reagent and using a spectrophotometer, measure the absorbances in a 10 mm or longer absorption cell at a wavelength of 412 nm against water (clause 4.1).

8.3 If the absorbance of the test specimen solution
Is out of the range of the calibration curve, prepare another calibration curve or the test specimen solution may be diluted. The dilution factor shall be taken into account to calculate the results.

8.4 To account for the effect of any impurities
Or discoloration in the test specimen solution, put 5 ml of the sample solution in a separate test tube add 5 ml of water (clause 4.1) instead of acetylacetone and treat in the same way as above. Determine the absorbance of this solution ASB, in the same way as above, using water (clause 4.1) as the control.

8.5 Make at least 2 parallel tests

8.6 If there is a doubt that the absorbance
May not be due to formaldehyde but for example to an extracted coloring agent or other substances, carry out a confirmation test, with dimedone or directly by HPLC (Method III).

NOTE 7 Dimedone reacts with formaldehyde, and thus no color reaction resulting from formaldehyde will be observed.

8.7 For dimedone confirmation
Put 5 ml of the sample solution in a test tube (diluted where necessary), add 1 ml of ethanol solution of dimedone and shake. Warm the solution in a water bath at 40 ± 2°C for 10 ± 1 min, then add 5 ml of acetylacetone reagent, shake and continue to warm the solution in a water bath at 40 ± 2°C for 30 ± 5 min. Leave the solution still at room temperature for 30 ± 5 min. Determine the absorbance of the solution using a control solution prepared in the same way as above, but with water (clause 4.1) instead of the sample solution. The absorbance from formaldehyde at 412 nm disappears.

9. Calculation and Expression of the Results

For each test specimen, calculate the corrected absorbance of the test specimen (A) as follows:

$$A = A_{TS} - A_{RB} - A_{SB}$$

Where

A_{TS} = measured absorbance of the test specimen
A_{RB} = measured absorbance of the blank reagent
A_{SB} = measured absorbance of blank specimen (only in case of discoloration or other contamination)

Determine the concentration of formaldehyde C on the calibration curve using the value of the corrected absorbance. Calculate the amount of formaldehyde extracted for each test specimen using the following equation:

$$F = C \frac{100}{m}$$

Where

F is the formaldehyde content of the test specimen, in mg/g (or mg/kg)
C is the concentration of formaldehyde in mg/ml as read from the calibration curve
m is the mass of the test specimen, in g.

9.1 Express the amount of extracted formaldehyde as mg/kg to the nearest mg/kg. Calculate the arithmetic mean of the two values. If the result is less than 20 mg/kg report as not detectable.

10. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) The mass of the test specimen and, if required, the correction coefficient for the mass
e) The range of the calibration graph
f) The amount of formaldehyde extracted from the sample, in mg/kg
g) For computer processed data, identify the software used and the version
h) Deviation from the standard test procedure, if any
i) When calculated, the standard deviation or the coefficient of variation
j) Anything unusual noted during the testing

11. Precision

The precision for this method is yet to be determined.

ANNEX A

(Normative)

Standardization of Formaldehyde Stock Solution

A.1 General

The stock solution containing approximately 1500 mg/ml of formaldehyde shall be accurately standardized in order to prepare a precise calibration curve for use in colorimetric analysis.

A.2 Principle

An aliquot of the stock solution is reacted with an excess of sodium sulphite followed by a back titration with acid solution in the presence of thymolphthalein as indicator.

A.3 Apparatus

a) Volumetric pipette, 10 ml.
b) Volumetric pipette, 50 ml.
c) Burette, 50 ml.
d) Erlenmeyer flask, 150 ml.

A.4 Reagents

a) Sodium sulphite, c Na_2SO_3 = 1 mol/l; made by dissolving 126 g of anhydrous Na_2SO_3 per liter of water (5.1).
b) Thymolphthalein, 10 g/l in ethanol.
c) Sulphuric acid, c H_2SO_4 = 0.01 mol/l.

NOTE A 1 This reagent may be purchased in a standardized form or should be standardized using a standard sodium hydroxide solution.

A.5 Procedure

Pipette 50 ml of sodium sulphite (clause A 4.a) into the Erlenmeyer flask (clause 3.d). Add a few drops of thymolphthalein indicator (4.2). Add a few drops of sulphuric acid (clause A 4.c), if necessary until the blue color disappears.

Pipette 10 ml of the stock formaldehyde solution into the flask (the blue color will reappear). Titrate the solution with sulphuric acid (4.3) until the blue color is discharged. Record the volume of sulphuric acid solution used.

NOTE A 2 The volume of sulphuric acid should be approximately 25 ml.

NOTE A 3 A calibrated pH meter may be used in place of thymolphthalein indicator, in which case the end point is reached at pH = 9.5

Carry out the procedure in duplicate.

A.6 Calculations

1 ml of 0.01 mole/l sulphuric acid is equivalent to 0.6 mg of formaldehyde.
Calculate the formaldehyde concentration (µg/ml) in the stock solution from the following equation:

$$\text{Formaldehyde } (\mu g/ml) = \frac{\text{Volume of sulphuric acid used (in mL)}}{\text{Volume of sample used (in mL)}} \times 0.6 \cdot 1000$$

Calculate the average of the results and use the concentration determined above in preparing the calibration curve for the colorimetric analysis.

ANNEX B

(Informative)

Information on the Accuracy of the Method

This method is based on the Finnish standard SFS 4996

The accuracy of the test SFS 4996 was found to depend on the formaldehyde content of the sample and to be as follows for uniform samples

Formaldehyde Content	Approximate Accuracy
Mg/kg	%
1000	0.5
100	2.5
20	15
10	80

Factors due to the method result in the fact that contents below 20 mg/kg cannot be shown to be caused by formaldehyde.

NOTE B 1 that the WSP 310 uses a different calibration curve to that used for the above mentioned results.

STANDARD TEST: WSP 311.1.R4 (12)

Standard Test Method for Free and Hydrolysed Formaldehyde Extracted at Stressed Extraction Conditions in Nonwovens Method II

Draft U1

The number in parentheses indicates the year of the last revision

Introduction

The methods I, II and III (respectively WSP 310.1.R4 (12), 311.1.R4 (12) and 312.0.R4 (12)) describe test methods for the evaluation of the formaldehyde content in nonwovens and precursor fibers under various conditions. Method IV (WSP 313.1.R4 (12)) describes a method for the release of formaldehyde during the processing of nonwovens.

◊ **Method I determines**

The amount of free formaldehyde and formaldehyde extracted partly through hydrolysis by means of a water extraction method.
This method is suitable for determination of contents above 20 mg/kg. It is based on the CEN/ISO standard: Textiles - Determination of formaldehyde - Part 1: Free and hydrolyzed formaldehyde.
The test conditions (40ºC) simulate the normal wearing conditions (consumer stage).

◊ **Method II determines**

The aggregate amount of free formaldehyde and the formaldehyde extracted partly through hydrolysis at stressed extraction conditions.
The testing conditions (80°C) simulate conditions encountered in some industrial applications.
This method can also be used to accelerate the release of formaldehyde through hydrolysis by increasing the temperature. This simulates the behavior of the sample over an extended period of time.

◊ **Method III determines**

The free formaldehyde using HPLC to overcome the interferences from colored or formaldehyde-related species which can limit the usability of Methods I and II.
The conditions for extraction are specified in methods I and II.

◊ **Method IV determines**

The formaldehyde released by aqueous systems under defined drying conditions.
The aqueous systems tested are formaldehyde-containing or formaldehyde-cleaving systems that could be used in the bonding or finishing process of nonwovens.

Reference number
WSP 311.1.R4 (12) A

Current edition approved WSP 311.1.R4 (12)
Originally published as ERT 211.1 in 1999
Last approved as WSP 311.1 in 2009

Note: The AATCC 112 method [(1)] has been adopted as EN ISO 14184-2 standard: Textiles Determination of formaldehyde - Part 2: Released formaldehyde (vapor absorption method).
This absorption method measures the propensity of a resin treated sample to liberate formaldehyde under prolonged hot humid conditions simulating garment processing or storage (garment makers stage).
(1) AATCC Technical Manual. American Association of Textile Chemists and Colorists. Method 112 -1990.

1. Scope

This test method is for determining the aggregate amount of free formaldehyde and of formaldehyde extracted partly through hydrolysis at stressed extraction conditions. The method can be applied to the testing of nonwovens and precursor fibers.

2 NORMATIVE REFERENCE

WSP 310 1: Free and hydrolysed formaldehyde in nonwovens.

2.1 ISO test methods

a) ISO 5725-1 Accuracy (trueness and precision) of Measurement Methods and Results – Part 1: General Principles and Definitions
b) ISO 572 -2 Accuracy (trueness and precision) of Measurement Methods and Results – Part 2: Basic Method for the Determination of the Repeatability and Reproducibility of a Standard Measurement Method
c) ISO 554: 1976 Standard Conditioning
d) ISO 186: 1985 Nonwoven Sampling
e) EN ISO 14184-1 Textiles - Determination of formaldehyde - Part 1: Free and hydrolyzed formaldehyde (water extraction method)

2.2 WSP test methods

a) WSP 1.0 – 05 Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods
b) WSP 3.0 – 05 Guidelines for Standard Atmospheres for Conditioning and/or Testing
c) WSP 5.0 – 05 Nonwoven Sampling

3 PRINCIPLE

Colorimetric determination of the amount of formaldehyde extracted from a nonwoven or precursor fibres in a water bath at 80ºC.

This method is similar to the method I: WSP310.1.R4 (12), except that all references to 40ºC in method I should be read 80ºC in method II.

STANDARD TEST: WSP 312.0.R4 (12)

Standard Test Method for Determination of Free Formaldehyde in Nonwovens by Liquid Chromatography Method III

The number in parentheses indicates the year of the last revision

Introduction

The methods I, II and III (respectively WSP 310.1.R4 (12), 311.1.R4 (12) and 312.0.R4 (12)) describe test methods for the evaluation of the formaldehyde content in nonwovens and precursor fibers under various conditions. Method IV (WSP 313.1.R4 (12)) describes a method for the release of formaldehyde during the processing of nonwovens.

◊ **Method I determines**
The amount of free formaldehyde and formaldehyde extracted partly through hydrolysis by means of a water extraction method.
This method is suitable for determination of contents above 20 mg/kg. It is based on the CEN/ISO standard: Textiles - Determination of formaldehyde - Part 1: Free and hydrolyzed formaldehyde.
The testing conditions (40ºC, 1 hour) simulate the normal wearing conditions (consumer stage). The testing conditions (40ºC, 4 hours) simulate the extended wearing conditions (consumer stage).

◊ **Method II determines**
The aggregate amount of free formaldehyde and the formaldehyde extracted partly through hydrolysis at stressed extraction conditions (e.g. in industrial applications like automotive industry).
The testing conditions (80°C, 1 hour) simulate conditions encountered in some industrial applications.
This method can also be used to accelerate the release of formaldehyde through hydrolysis by increasing the temperature. It is not recommended for medical / hygiene / wipes applications which is suited to Method 1

◊ **Method III determines**
The free formaldehyde using HPLC to overcome the interferences from colored or formaldehyde-related species which can limit the usability of Methods I and II.
The conditions for extraction are specified in methods I and II.

◊ **Method IV determines**
The formaldehyde released by aqueous systems under defined drying conditions.
The aqueous systems tested are formaldehyde-containing or formaldehyde-cleaving systems that could be used in the bonding or finishing process of nonwovens.

Reference number
WSP 312.0.R4 (12) A

Current edition approved WSP 312.0.R4 (12)
Originally published as ERT 212.1 in 1996
Last approved as WSP 312.0 in 2009

Note: The AATCC 112 method [(1)] has been adopted as EN ISO 14184-2 standard: Textiles Determination of formaldehyde - Part 2: Released formaldehyde (vapor absorption method).
This absorption method measures the propensity of a resin treated sample to liberate formaldehyde under prolonged hot humid conditions simulating garment processing or storage (garment makers stage).
(1) AATCC Technical Manual. American Association of Textile Chemists and Colorists. Method 112 -1990.

1. Scope

This test method is for the determination of free formaldehyde extracted partly through hydrolysis. The method can be applied to the testing of nonwovens and precursor fibers.

The determination uses HPLC to overcome the interferences from colored or formaldehyde-related species which can limit the usability of methods I and II.
The conditions for extraction are specified in methods I and II.

SI values are regarded as the official standard system of measurement for this standard test method.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document:

2.1 ISO test methods

a) ISO 5725-1 Accuracy (trueness and precision) of Measurement Methods and Results – Part 1: General Principles and Definitions
b) ISO 572 -2 Accuracy (trueness and precision) of Measurement Methods and Results – Part 2: Basic Method for the Determination of the Repeatability and Reproducibility of a Standard Measurement Method
c) ISO 554: 1976 Standard Conditioning
d) ISO 186: 1985 Nonwoven Sampling
e) EN ISO 14184-1 Textiles - Determination of formaldehyde - Part 1: Free and hydrolyzed formaldehyde (water extraction method)

2.2 WSP test methods

a) WSP 310.1.R4 (12) recommended test method I: Free and hydrolysed formaldehyde in nonwovens.
b) WSP 311.1.R4 (12) recommended test method II: Free and hydrolysed formaldehyde extracted at stressed extraction conditions.

3. Principle

An aqueous extract from a nonwoven or precursor fibers in a water bath at 40°C or 80°C is chromatographed on a reversed-phase ODS column using an aqueous mobile phase and a photometric detector at 412 nm. Formaldehyde is separated from the other species in the matrix on a chromatographic column.

a) The detection system includes a post-column reactor (PCR) which produces a lutidine derivative when formaldehyde reacts with the 2,4-pentanedione reagent (Nash reagent).
b) Optional it is possible to complex the formaldehyde with the Nash reagent before running the HPLC (pre-column reaction). In this case it is not necessary to use a PCR.

The concentration of free formaldehyde in the aqueous extracts is determined using peak areas from the standard and sample chromatograms (calibration by external standard). This method is specific for formaldehyde.

NOTE 2 **SAFETY WARNING**

This method calls for the use of substances and/or procedures that may be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage. It has been assumed in the drafting of this method that the executing of its provisions is entrusted to appropriately qualified and experienced people.

4. Comments on the Method

4.1 Significance and use

With the need to calculate free formaldehyde levels in above aqueous extracts, it is necessary to make the determination without upsetting any equilibria that might generate or deplete formaldehyde. This method provides a means for determining ppm levels of free formaldehyde in these extracts without upsetting any equilibria. The established working range of this method is 0.5 mg/kg to 15 mg/kg formaldehyde in the aqueous extract. Aqueous extracts can be diluted to meet the working range.

4.2 Interferences

This method is very selective for formaldehyde and potential interferences are either chromatographically separated from formaldehyde or do not react with the Nash reagent. The following species were identified as possible interferences for the method: acetaldehyde, acetone, benzaldehyde, formamide, formic acid, glyoxylic acid and propionaldehyde. These species, when chromatographed using this method, did not interfere with the formaldehyde peak at the 1000 ppm level.

4.3 Because nonwovens and precursor fibers vary in composition

The method run time may need to be extended to allow for late eluting compounds. Compounds which remain on the column after an analysis may interfere with the formaldehyde peak in subsequent runs.

5 Apparatus

5.1 Liquid chromatograph

Any liquid chromatographic instrument having an injection valve, a 412 nm UV-VIS-detector, and an isocratic solvent delivery system may be used. The solvent delivery system must deliver a mobile phase flow of at least 0.6 ml/min up to 1.0 ml/min (might depend on the system PCR or pre-column reaction).
The UV-VIS-detector may incorporate either a tungsten lamp or a deuterium lamp with a second order visible filter that filters out light below 400 nm.
Other liquid chromatography equipment can be used, as long as they provide a similar or better accuracy compared to the test equipment described herein.

5.1.1 Post-column reactor (optional)

Any post-column reactor that can deliver a reagent flow at 0.5 ml/min contains a knitted reaction coil that can be heated to 95°C and contains a static mixing tee (Figure 1).

5.1.2 Pre-column reaction

No special apparatus is needed (Figure 2).

5.2 Chromatographic column (according to test equipment under 5.1)

The column should be 250 x 4.6 mm internal diameter packed with reversed-phase pH stable C-18, 5 micron particles.

5.3 Chromatographic guard column (optional)

The column should be 10 x 4.6 mm internal diameter packed with reversed-phase pH stable C-18, 5 micron particles. The use of a guard column is optional depending on the sample matrix.

6. Configuration of Liquid Chromatograph

An in-line check valve is placed between the pump and the injector. The guard and analytical columns are connected to the injector. The outlet of the analytical column is connected to the mixing tee as described below.

6.1 Configuration of (optional) Post Column Reactor (PCR)

The post-column reagent passes through a pulse-dampener and an in-line check valve prior to the mixing tee. The outlet of the analytical column is connected to one side of mixing tee. The reaction coil is connected to the outlet of the mixing tee. Stainless steel tubing with 0.25 mm internal diameter is used to make the connections. Tubing lengths should be kept to a minimum. The mixing tee and reaction coil are placed inside a 95°C oven. A 40 cm length of 0.25 mm internal diameter stainless steel tubing is connected to the outlet of the reaction coil and is placed in a ambient temperature stirred water bath. (This configuration acts as a heat exchanger.) The exit of the stainless steel tubing is connected to the UV-VIS-detector. Figure 1 shows a schematic of the system.

6.2 Procedure for (optional) pre-column reaction

Mix in a fresh test tube 2 ml of sample serum and 2 ml of Nash reagent. Place the closed test tube in an oven for 30 min at 40 °C. remove from the oven and allow the mixture to cool down to room temperature for at least 2 hours before measuring with the HPLC.

7. Reagents and Materials

7.1 Purity of reagents

Reagent grade chemicals shall be used with this method. Unless otherwise indicated, it is intended that all reagents shall conform to the specification of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

7.2 Water

Unless otherwise indicated, references to water shall be understood to mean reagent water minimally conforming to Type II of Specification D1193, or distilled deionized water. HPLC grade water from chromatography suppliers is also acceptable.

7.3 Acetic acid, glacial (CH_3CO_2H)

7.4 Ammonium acetate ($CH_3CO_2NH_4$)

7.5 Acetyl acetone (2,4-pentanedione) 99% ($CH_3COCH_2COCH_3$)

7.6 Methanol (CH_3OH)

7.7 Formaldehyde solution of known content

Determined by titration, approx. 36-37 g/100g

7.8 Preparation of Nash reagent

62.5 g ammonium acetate is transferred into a 1 l amber volumetric flask that contains a stir bar. 600 ml water is added and mixed on a stir plate until the ammonium acetate is completely dissolved. After addition of 7.5 ml glacial acetic acid and 5 ml acetyl acetone (2,4-pentanedione) the contents of the flask are diluted to volume with water and mixed thoroughly (45 min of mixing is suggested) until the acetyl acetone is dissolved completely. The shelf life of this solution is one week at room temperature, four weeks protected from light in a refrigerator. For each measurement take only a small part which is needed

2,4-pentanedione is light sensitive and should be protected from light during use.

The post-column reagent is transferred to the post-column reactor reservoir, where it should be replaced weekly if stored at room temperature. The reservoir should be protected from light. The post-column reagent has to be degassed with a helium sparge.

NOTE 3 The Nash reagent in this method has a concentration that is different from the concentration specified in methods I and II.

8. Operating Condition For Analysis

Adjust the liquid chromatograph in accordance with the manufacturers directions and the following parameters. Allow the instrument to equilibrate until a stable base line is obtained on the data system.

Tab. 1: Operating conditions with a PCR

Column temperature	Ambient
Mobile phase	Water (or 6.3 mM Na_2HPO_3)
Flow rate	0.6 ml/min
Injection volume	20µl
PCR temperature	95°C
PCR flow rate	0.3-0.5 ml/min
Detector	UV/VIS, 412 nm

Tab. 2: Operating conditions with pre-column reaction

Column temperature	30°C
Mobile phase	Water : Methanol, 40:60 – to 60:40 (+ 0,5 % acetic acid)
Flow rate	1.0 ml/min
Injection volume	10 µl
Detector	UV/VIS, 412 nm

Determine whether the system is working properly by injecting an equivalent volume of a 10 ppm formaldehyde standard solution. A typical chromatogram of a 10 ppm formaldehyde standard obtained under the conditions outlined is shown in figure. 3.

The peak asymmetry (as at 10% peak height) value for formaldehyde should be within the range of 0.8 and 1.7. A typical retention time for formaldehyde is 6 minutes. For HPLC as described under 5.3 .

The run time for the analysis is 10 min. The run time may have to be extended to 20 - 30 minutes if late eluting compounds interfere with the formaldehyde peak.

9. Calibration and Standardization

Approximately 100 - 200 mg reagent grade formaldehyde (nominally 37%) is weighed to the nearest 0.1 mg into a 100 ml flask. This solution is diluted to volume with water. This stock solution of formaldehyde is used for preparing standard solutions ranging from 0.05 to 15 ppm of formaldehyde in water for calibration.
The range of concentrations of the calibrating solutions has to cover the expected concentration of the test samples.

The stock solution should be stored in a refrigerator when not in use.
The stock solution should be analyzed by titration before preparing new standard solutions. Fresh standard solutions should be prepared for each calibration of the HPLC.
Calibration of the HPLC should be done every time the mobile phase is replaced.
Calculate the calibration factor (CF) according to the following equation:

$$CF = \frac{As}{Cs} \quad [\mu V \times sec \times ml/mg]$$

where:

A_S = area of formaldehyde peak of standard solution [μV x sec]
C_S = concentration of formaldehyde standard solution [mg/ml]

10. Calculation

Calculate the concentration of formaldehyde in the sample by using the above formula (method of external standard):

$$M_T = \frac{A_T}{C_F \times C_T} \times 10^6$$

where:

MT = amount of formaldehyde in test sample [mg / kg]
AT = area of formaldehyde in test sample [mV x sec]
CT = concentration of test sample in the injected solution [mg/ml].

11. Report

The test report shall include the following information

a) Test method used
b) Description of the sample tested
c) Conditions of extraction
d) Amount of formaldehyde extracted
e) Result from the blank test
f) Any deviation from the standard procedure

NOTE 4 The apparatus and operating parameters may be varied to suit specific circumstances (e.g. another column diameter - 4 or 5 mm - can be used but the flow rate specified in clause 9 has to be adapted accordingly). It must be ascertained that any such variations do not have an adverse effect on the results obtained (validation). Any deviation from the standard method must be recorded and mentioned in the report.

NOTE 5 In well validated conditions, pre-column derivatization can be used. This should be mentioned in the report.

Figure 1
Configuration of liquid chromatograph with a post-column reactor

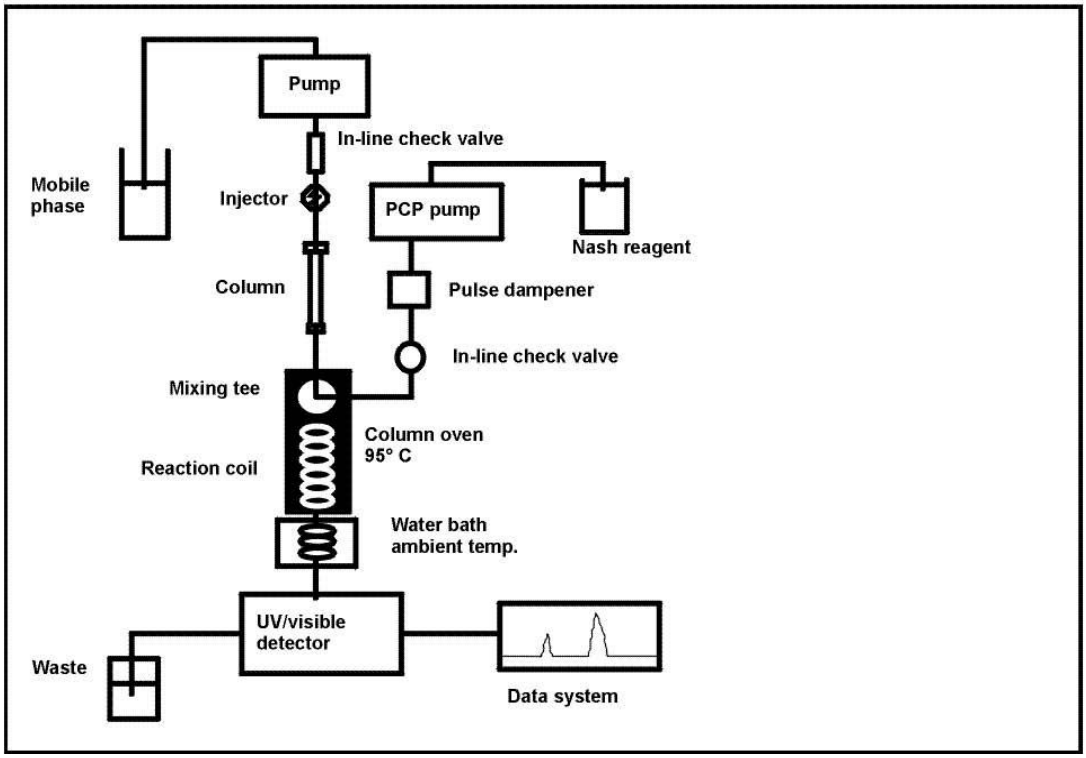


Figure 2
Configuration of liquid chromatograph with a pre-column reaction

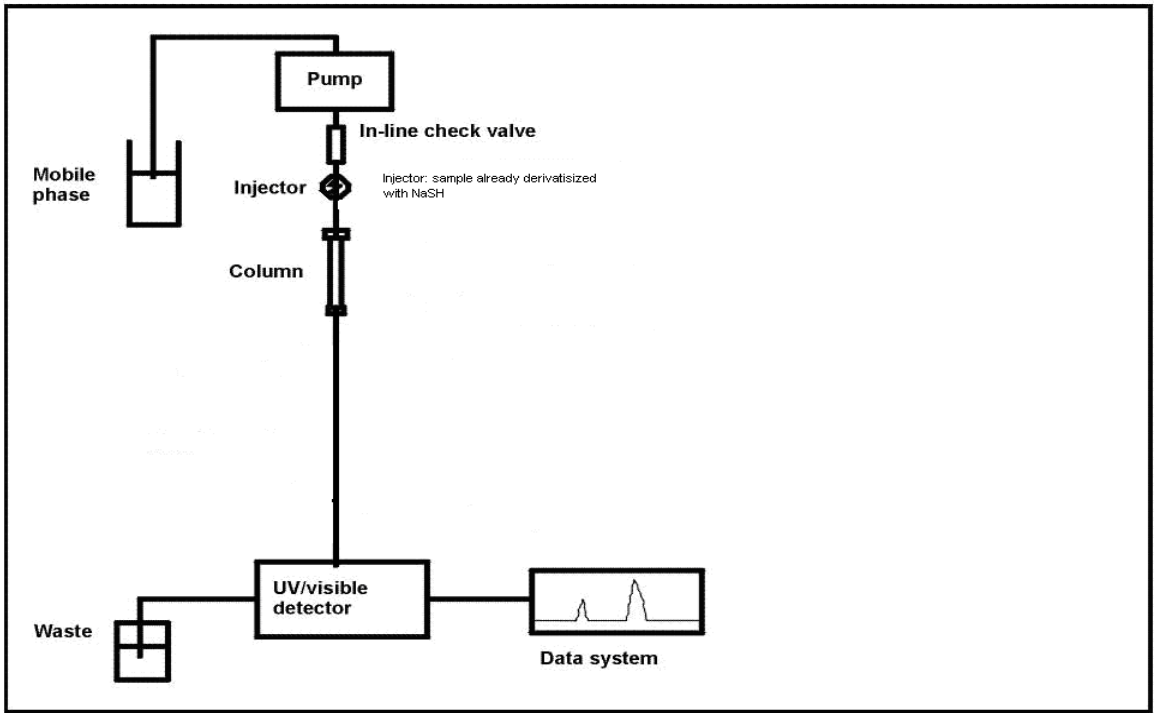
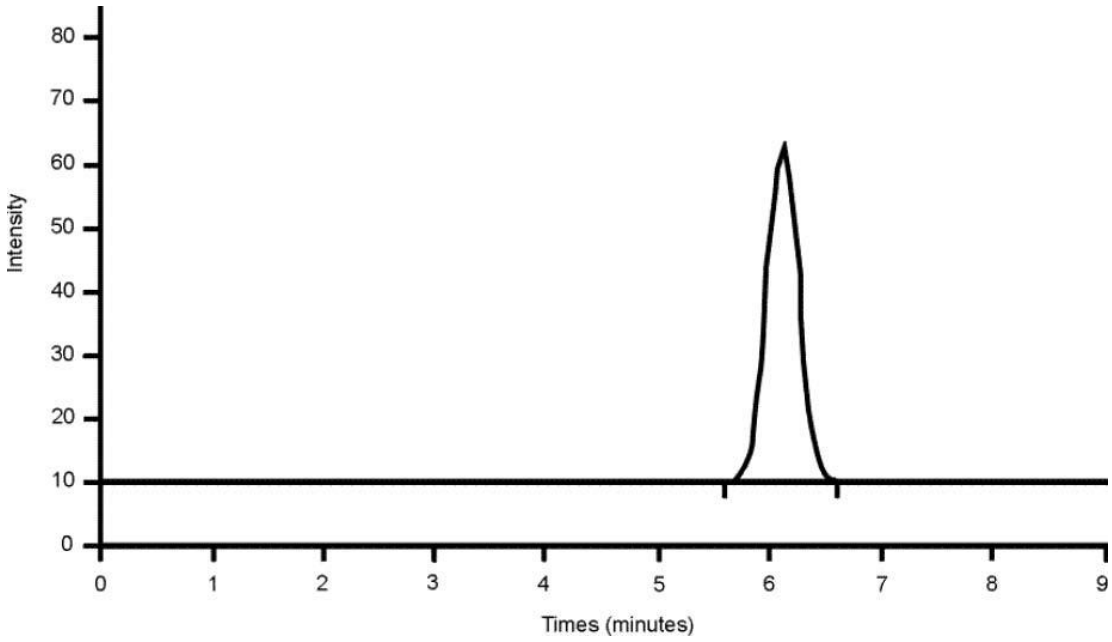


Figure 3
Lutidine derivative of formaldehyde peak obtained through HPLC



STANDARD TEST: WSP 313.1.R4 (12)

Standard Test Method for the Determination of Released Formaldehyde in the Processing of Aqueous Systems Method IV

The number in parentheses indicates the year of the last revision

Introduction

The methods I, II and III (respectively WSP 310.1.R4 (12), 311.1.R4 (12) and 312.0.R4 (12)) describe test methods for the evaluation of the formaldehyde content in nonwovens and precursor fibers under various conditions. Method IV (WSP 313.1.R4 (12)) describes a method for the release of formaldehyde during the processing of nonwovens.

◊ **Method I determines**

The amount of free formaldehyde and formaldehyde extracted partly through hydrolysis by means of a water extraction method.
This method is suitable for determination of contents above 20 mg/kg. It is based on the CEN/ISO standard: Textiles - Determination of formaldehyde - Part 1: Free and hydrolyzed formaldehyde.
The testing conditions (40ºC, 1 hour) simulate the normal wearing conditions (consumer stage). The testing conditions (40ºC, 4 hours) simulate the extended wearing conditions (consumer stage).

◊ **Method II determines**

The aggregate amount of free formaldehyde and the formaldehyde extracted partly through hydrolysis at stressed extraction conditions (e.g. in industrial applications like automotive industry).
The testing conditions (80°C, 1 hour) simulate conditions encountered in some industrial applications.
This method can also be used to accelerate the release of formaldehyde through hydrolysis by increasing the temperature. It is not recommended for medical / hygiene / wipes applications which is suited to Method 1

◊ **Method III determines**

The free formaldehyde using HPLC to overcome the interferences from colored or formaldehyde-related species which can limit the usability of Methods I and II.
The conditions for extraction are specified in methods I and II.

◊ **Method IV determines**

The formaldehyde released by aqueous systems under defined drying conditions.
The aqueous systems tested are formaldehyde-containing or formaldehyde-cleaving systems that could be used in the bonding or finishing process of nonwovens.

Reference number
WSP 313.1.R4 (12) A

Current edition approved WSP 313.1.R4 (12)
Originally published as ERT 213.1 in 1999
Last approved as WSP 313.1 in 2009

Note: The AATCC 112 method [(1)] has been adopted as EN ISO 14184-2 standard: Textiles Determination of formaldehyde - Part 2: Released formaldehyde (vapor absorption method).
This absorption method measures the propensity of a resin treated sample to liberate formaldehyde under prolonged hot humid conditions simulating garment processing or storage (garment makers stage).
(1) AATCC Technical Manual. American Association of Textile Chemists and Colorists. Method 112 -1990.

1. Scope

This test method simulates the release of formaldehyde during processing of aqueous systems in the textile and nonwovens industry. The formaldehyde releasing system is dried on an inert substrate, and the quantity of released formaldehyde is determined.

The method offers the following possibilities:

a) Estimation of the quantity of formaldehyde released under defined conditions
b) Simulation of worst-case scenario by making the drying conditions more severe
c) Comparative assessment of formaldehyde-cleaving systems

SI values are regarded as the official standard system of measurement for this standard test method.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative Reference

The following referenced document is indispensable for the application of this document:

The method was developed and checked by the working group “Auxiliaries for Industrial Textiles” of the German TEGEWA association and was published in Melliand Textilberichte 7-8/1996, p. 481.

3. Principle

The formaldehyde-containing or formaldehyde-cleaving systems, e.g. aqueous emulsion polymerisates or solutions of urea/ formaldehyde or melamine/ formaldehyde resins are dried on an inert substrate (quartz sand) under defined drying conditions (time, temperature, air throughflow). The formaldehyde released is then quantitatively collected and the quantity determined using the established acetylacetone method.

4. Apparatus (Figure 1)

Apparatus for simulating conditions of film formation and crosslinking of dispersions as close as possible to actual working conditions consisting of

a) Magnetic hotplate stirrer with a temperature sensor connector for thermostatic control
b) Height-adjustable laboratory jack BOY, plate size e.g. 180 mm x 210 mm
c) Crystallizing basin, Duran glass (D = 190 mm, H = 90 mm, contents about 2 liters)
d) silicone oil for heating baths up to 250°C, e.g. Merck quality
e) Teflon-coated magnetic stirrer bars, about 40 mm in length
f) Erlenmeyer flask, 100 ml with flat bottom and NS-29 attachment for passing the carrier gas through. The outlet must be fitted with a ball and socket joint
g) Three-way stopcock with ball and socket joints, bore 4 mm
h) Temperature measuring device, e.g. contact thermometer reading up to 200°C
i) Flowmeter for adjusting the flow of the carrier gas, e.g. rotameter
j) Infrared lamp; the STM double-tube lamp (400 Watt/250 mm length) and holder supplied by Heraeus is recommended, mounted e.g. on a U-shaped aluminium bar (made in the laboratory), which is provided with a round bar, so that the lamp mounted in this manner can be fixed to a stand. The double-tube lamp must form a front with the open side of the U of the bar. The opening (distance between the two arms) of the U is about 60 mm for example
k) 2 washbottles, about 100 ml with ball and socket joints
l) Stands and various clamps.

Other apparatus: stop clock, graduated flasks (10 ml, 250 ml), transfer pipettes (5 ml), bulb pipettes (100 µl, 200 µl), water bath with thermostat, lead rings for weighting the 10 ml graduated flask, analytical balance (d = 0.1 mg), cuvettes (path length 1 cm), spectrophotometer (e.g. Varian DMS 80).

5. Material and Reagents

5.1 Calibration substance

Formaldehyde solution, p.a., about 37% e.g. from Merck (content determined iodometrically as the mean of three measurements).

5.2 Reagents

Acetylacetone, p.a., ammonium acetate, p.a., glacial acetic acid, p.a., carrier gas air (or N_2), fully demineralized water, sea sand, heated to red, p.a. (Merck: particle size about 0.1 – 0.3 mm).

5.3 Solutions

Acetylacetone reagent solution: 15 g of ammonium acetate, 0.3 ml of glacial acetic acid and 0.2 ml of acetylacetone are placed in a 100 ml graduated flask and the flask is filled to the mark with fully demineralized water. The solution should be freshly made up each day as required.

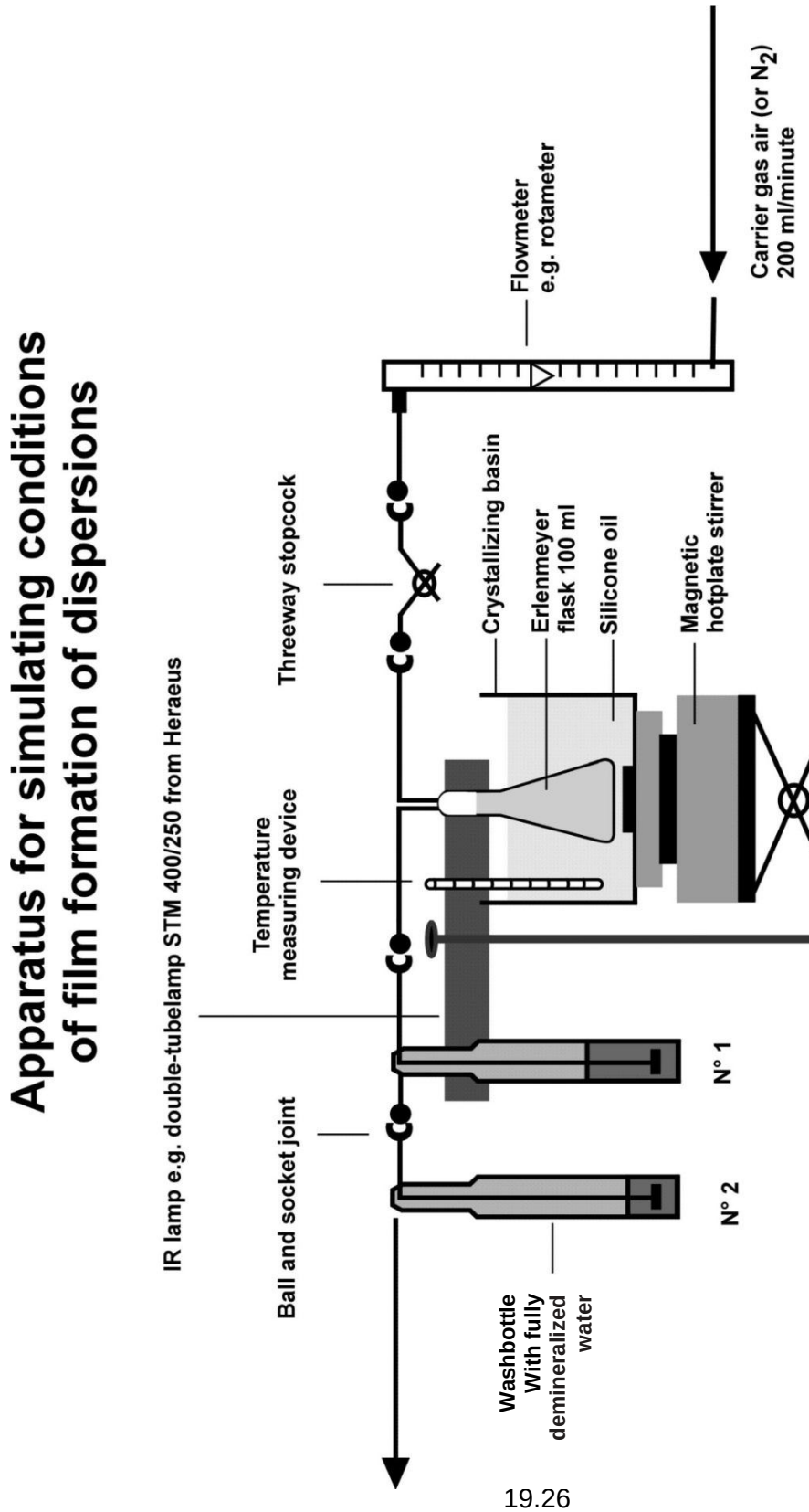

Apparatus for simulating conditions of film formation of dispersions
IR lamp e.g. double-tubelamp STM 400/250 from Heraeus
Ball and socket joint
Temperature measuring device
Threeway stopcock
Flowmeter e.g. rotameter
Carrier gas air (or N_2) 200 ml/minute
Crystallizing basin
Erlenmeyer flask 100 ml
Silicone oil
Magnetic hotplate stirrer
Laboratory jack BOY
N° 1
N° 2
Washbottle With fully demineralized water

Figure 1

6. Procedure

6.1 Sample preparation, formaldehyde cleaving, color reaction

Firstly, the apparatus is prepared for simulating as closely as possible the practical conditions encountered in film formation of dispersions. The first washbottle is filled with 50 ml of fully demineralized water and the second with 25 ml of fully demineralized water. The jack with the magnetic stirrer and silicone oil bath is placed in the lowered position. The silicone oil bath is heated up to 160°C. Once the specified temperature has been attained, the flow rate of the carrier gas (air or nitrogen) is set to 200 ml/min. The three-way stopcock is set so that the carrier gas is not yet flushed through the washbottles. 3g of sea sand are now placed in the Erlenmeyer flask in such a manner that the whole of the flat bottom of the flask is covered. The pH of the dispersion, if not known, is measured and recorded. 1g ± 50 mg of the dispersion is then weighed on the analytical balance and added to the Erlenmeyer flask using a bulb pipette in such a way that the dispersion is distributed as uniformly as possible over the sea sand. If the dispersion is very viscous, it should be diluted beforehand to a lower content of solid using fully demineralized water. It should be noted here that it is difficult to dilute viscous dispersions by pipetting. Consequently, it is easier to perform dilution by weighing, e.g. a 60% dispersion may be diluted to a 40% solid content by weighing 33.33 g of dispersion into 50 ml graduated flask and then filling to the mark with fully demineralized water. The subsequent procedure is as described above.

The dilution step must be taken into consideration in the final calculation of the formaldehyde content. The filled Erlenmeyer flask is allowed to stand for two minutes. During this time, the dry Erlenmeyer attachment is prewarmed with the infrared lamp, and is then placed on the Erlenmeyer flask after two minutes (caution, the attachment is hot!). The Erlenmeyer flask and attachment are then connected to the apparatus. The three-way stopcock between the Erlenmeyer flask and the flowmeter is turned so that both washbottles are flushed for 30 sec.; the flow rate (200 ml/min) may need to be adjusted subsequently. While the washbottles are being flushed through, the path from the Erlenmeyer flask attachment to the first washbottle is warmed with the IR lamp (distance to the apparatus approx. 5 cm). When flushing is complete, the jack with the magnetic stirrer and silicone oil bath is rapidly raised (caution: hot silicone oil) so that the Erlenmeyer flask dips about 1 cm below the NS-29 ground joint in the hot silicone oil (160°C). The stop clock is started at the same time as the Erlenmeyer flask is immersed in the oil. After precisely 5 minutes, the carrier gas flow is stopped by turning the three-way stopcock, and the silicone oil bath on the jack is again lowered.
The solutions containing formaldehyde in the washbottles are then rinsed into a 250 ml graduated flask using fully demineralized water. It is essential to rinse the Erlenmeyer flask attachment and all connectors with fully demineralized water and to pour the washings into the graduated flask, since even small condensation residues, which are not visible to the naked eye, may bind considerable quantities of formaldehyde. This may result in large experimental errors! Only then should the 250 ml graduated flask be filled to the mark with fully demineralized water.

5 ml of the solution containing formaldehyde are removed from the 250 ml graduated flask using a transfer pipette, and placed in a 10 ml graduated flask, 5 ml of

acetylacetone reagent solution are pipetted into the 10 ml graduated flask. The graduated flask is sealed, the solutions are mixed thoroughly and heated for 30 minutes at 40°C in the water bath (use the lead rings). The graduated flask is allowed to cool to about 20°C, and the color of the sample solution is then measured.

NOTE 2 Diluted dispersions tend to produce foam under thermal stress. Consequently, it is recommended that dilution should be performed only for very viscous dispersions. As a general rule, foaming should be avoided, therefore wherever possible the original dispersion should be used.

6.2 Measurement procedure

The extinction of the sample solution is measured in a 1 cm cuvette using the spectrophotometer against the reagent blank value at 412 nm.

6.3 Assessment

$$\%\quad formaldehyde = \frac{Ext.\,a\;V}{E\;\;10}$$

Ext. = extinction of the sample at 412 nm
V = dilution factor (50 for a 5 mL sample diluted to 250 mL)
E = quantity of dispersion (g) weighed
A = slope of calibration lines

6.4 Calculation of the calibration function

The calibration line is plotted from five measured values and is checked annually. The calibration line should be re-plotted if the spectrophotometer used for measurement is replaced.

6.5 Preparation of the formaldehyde stock solution

2 ml of formaldehyde solution (calibration substance) is pipetted into a 1 litre graduated flask filled with 200 ml of fully demineralized water, and the flask is filled to the mark with fully demineralized water. The formaldehyde content of this stock solution is determined iodometrically (mean of two to three determinations).

6.6 Preparation of the formaldehyde standard solutions

A serial dilution is prepared from the stock solution. Aliquots of 1.00 ml, 2.00 ml, 2.50 ml, 3.00 ml and 5.00 ml of the stock solution are pipetted into a 500 ml graduated flask, and the flasks are filled to the mark with fully demineralized water.

6.7 Plotting the calibration lines

Aliquots of 5 ml of the formaldehyde standard solutions and 5 ml of acetylacetone reagent solution are pipetted into a 10 ml graduated flask, treated further as described under 6.1, and then the extinction at 412 nm is measured in a 1 cm cuvette against a reagent blank value. A regression line is plotted from the 5 pairs of measured values as follows:

mg formaldehyde (absolute)= a Ext.+ b

As an example, the following regression line was obtained:

mg formaldehyde=0.0369 Ext. + 0.0002

The intersect on the ordinate, 0.0002, may be ignored.

7. Report

The test report shall include the following information

a) Test method used
b) Description of the sample tested
c) Amount of formaldehyde released
d) Any deviation from the standard procedure

STANDARD TEST: WSP 350.1.R3 (12)

Standard Test Method for Menstrual Tampons Absorbency – Syngina Method

The number in parentheses indicates the year of the last revision

1. Scope

This test method specifies a test procedure for the in-vitro measurement of absorbency of menstrual tampons by the Syngina method. It is a quality control test that is used in production sites for determining conformance to internal manufacturing specifications and for ensuring compliance to the EDANA Code of Practice for Tampon Labeling that has been agreed upon with the European Commission. It is important to note that this laboratory test is not intended to be used for predicting absorbency in-vivo.

The protocol has been used by the tampon industry globally for more than 30 years and it is favored by some regulatory authorities. It is applicable for products with an absorbency of up to 25 grams. The coefficient of repeatability has been estimated for an absorbency of around 10.5 grams to be less than 5%.

This test method provides the values in both SI units and inch-pound units. Inch-pound units are the customary units used in the United States and these values will be in parentheses in the body of this method. The International System of Units (SI units) are the customary metric units used in most of the rest of the world.

SI values are regarded as the official standard system of measurement for this standard test method.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following standards contain provisions which, through reference in this text, constitute provisions of this standard method. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However parties to agreements based on this standard method are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. For undated references, the latest edition of the standard referred to applies.

2.1 ISO test methods

a) ISO 5725 -1 Accuracy (trueness and precision) of measurement methods and results – Part 1: General principles and definitions

Reference number
WSP 350.1.R3 (12) A

Current edition approved 2012
Originally published as ERT 350.0 in 2002
Last approved as WSP 350.1 in 2005

b) ISO 5725 -2 Accuracy (trueness and precision) of measurement methods and results – Part 2: Basic method for the determination of the repeatability and reproducibility of a standard measurement method

2.2 ASTM test methods

a) ASTM D 3492-83, Standard Specification for Rubber Contraceptives (Condoms)
b) ASTM D 3492-97, Standard Specification for Rubber Contraceptives (Male condoms)

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Syngina
The term is derived from “synthetic vagina”.

3.2 Menstrual tampon/ tampon
A device to be inserted into the vagina to absorb menses

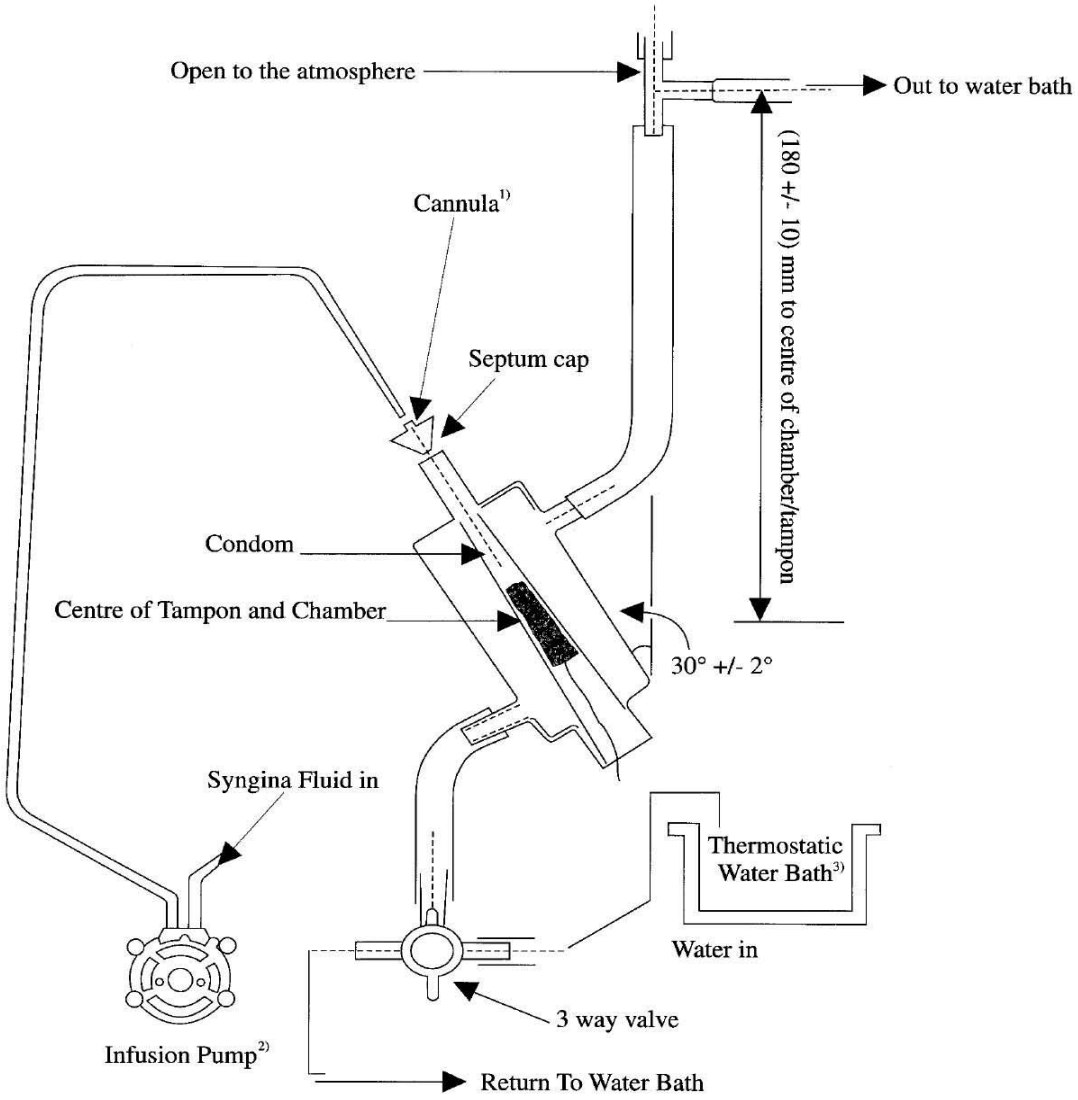
4. Principle

The principle is to simulate the vaginal environment in the laboratory by applying standard pressure to a tampon inside a flexible membrane (a certain type of condom) and then introducing defined amounts of fluid until the tampon leaks. The tampon weight is taken before and after the test to calculate the weight of fluid absorbed.

5. Material and Reagents

Syngina fluid
The formulation and preparation are given below:

a) Distilled or de-ionized water.
b) Sodium chloride (analytical reagent grade).
c) Color agent: acid fuchsin, Fisher F97 Certified Biological Stain, Color Index N° 42685; Fisher Scientific Company or Fruchterot dye, E 144 or Ponceau Cochenillerot E 124 or FD&C Red #40.
d) Sodium chloride solution: Dissolve 10 grams sodium chloride in 1 liter distilled or de-ionized water.
e) Syngina fluid: Dissolve 0.5 gram color agent in 1 liter sodium chloride solution.
f) Syngina fluid should be regularly replaced to avoid microbiological contamination.
g) Syngina fluid should be stored and used at room temperature.



[1)] min 100 mm long; (1,5 +/- 0,15) mm I.D.

[2)] see 5.2.2

[3)] see 5.2.3

Figure 1
Syngina Apparatus

6. Apparatus

6.1 Standard laboratory equipment

6.2 Syngina apparatus

The syngina apparatus set-up is illustrated in Figure 1. This is designed to provide constant hydrostatic pressure of 180 ± 10 mm.

a) Syngina chamber, details of which are provided in Figure 2.
b) Infusion pump, set up to deliver 50 ± 2 ml/hour.
c) Thermostatic bath, with external circuit, set up to 27 ± 1°C.

6.3 Straight unlubricated condoms

Having a tensile strength between 17 MPa and 30 MPa measured in accordance with ASTM D 3492-83 and ASTM D 3492-97 (Appendix X1).

NOTE 2 For condom installation and replacement: see Annex A (Normative)

7. Preparation of test specimens

7.1 The test specimen (tampon)

Shall be removed from its wrapping and applicator, if applicable.

7.2 The test specimen (tampon)

Shall be unwrapped immediately before testing.

7.3 The number of specimens per test, and sampling instructions

Must be defined for each specific application.

8. Procedure

8.1 Weigh the specimen (tampon)

To be tested (including withdrawal cord) to the nearest 0.01 gram, and record the weight.

8.2 With the syngina chamber empty

Place the tampon within the condom so that the center of the tampon is at the center of the chamber and the withdrawal cord is positioned toward the bottom of the chamber (see Figure 1).

8.3 Insert the infusion needle (cannula)

Through the optional septum cap so that it contacts the top end of the tampon.

8.4 Fill the outer part of the chamber with water

And adjust the flow such that water trickles over the head and back to the water bath. The liquid must not rise into the atmospheric vent.

8.5 Examine the position of the tampon

And, if necessary, drain, re-center and repeat steps 8.3 and 8.4.

8.6 Pump the syngina fluid into the chamber

8.7 The “end point”

Is defined by the first drop of liquid that exits the apparatus. Terminate the test by stopping the fluid flow.

NOTE 3 The test shall be discarded if fluid is detected in the folds of the condom before the tampon is saturated.

8.8 Drain the water from the chamber

Remove the tampon and weigh it immediately to the nearest 0.01 gram, and record the wet weight.

8.9 After the tampon has been weighed

Carefully remove any residual fluid (using a non-fiber shedding absorbent laboratory wipe) from the inside of each condom in preparation for the next test.

NOTE 4 If the test stand comprises more than one chamber, use tampons with the same absorbency, for parallel testing.

9. Calculation and Expression of Results

9.1 Calculate the absorbency of each specimen tampon as follows:

$A = B - C$ where: A = Absorbency of tampon in grams

B = Weight in grams of saturated tampon

C = Weight of dry tampon in grams

And express the results to the first decimal.

9.2 Calculate the average absorbency of the total number of test specimens.

ANNEX A

(normative)

Condom Installation and Replacement

A 1 Open and unravel a condom.

A 2 Mark the condom at 20 mm and 160 mm length from the open end (see Figure 3).

A 3 Insert the condom through the chamber with the aid of a rod so that the 160 mm mark rests on the edge of the smaller opening of the chamber (see Figure 2).

A 4 Cut the tip of the condom and secure with a rubber band, such that the 160 mm mark remains on the edge of the small opening of the chamber.

A 5 Draw the condom through the large chamber opening so that the 20 mm mark rests on the opening's edge (see Figure 2) and secure with a rubber band.

A 6 Replace condoms (a) if they leak, (b) after every tenth test or (c) daily – whichever applies first.

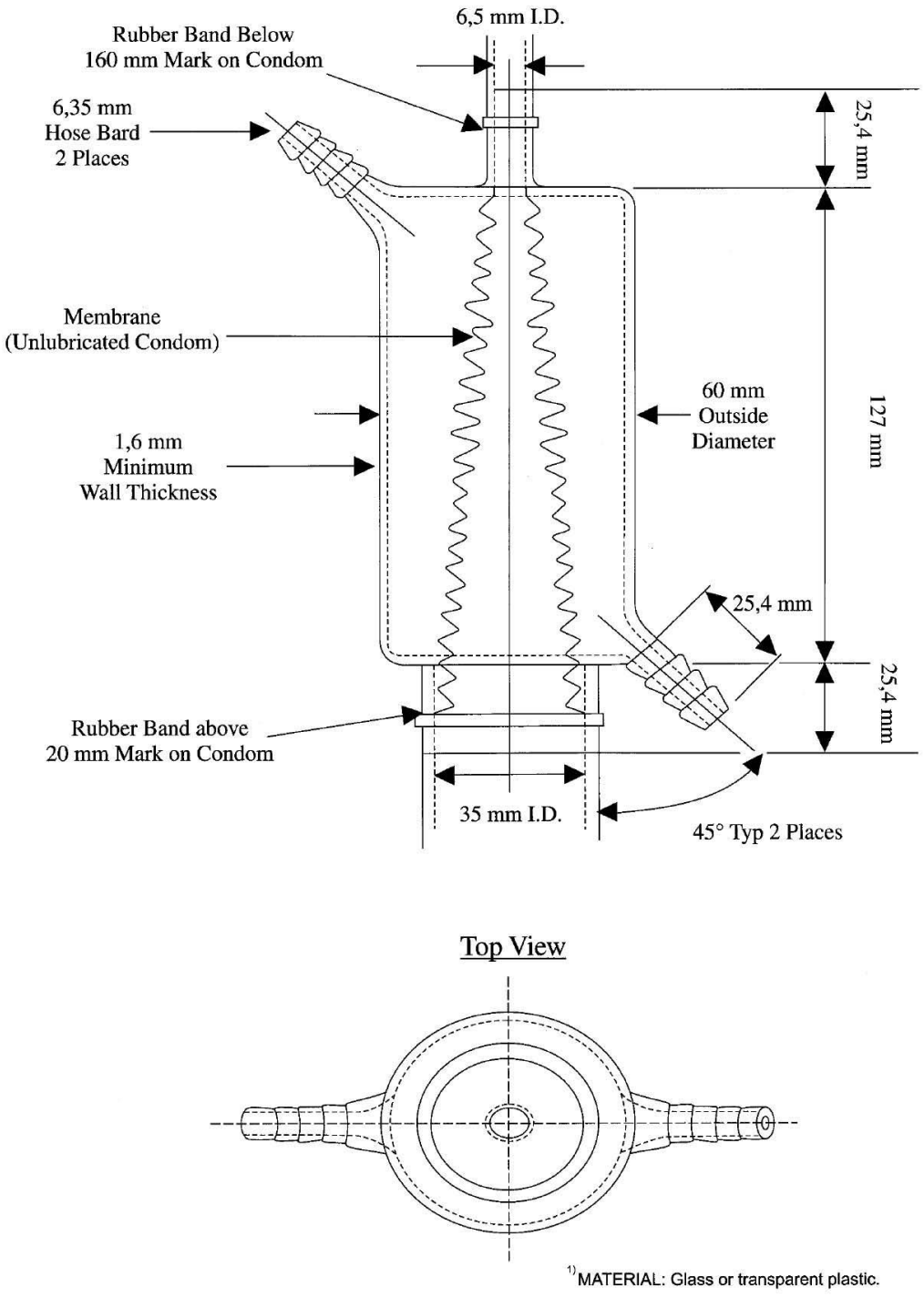


Figure 2
Syngina chamber

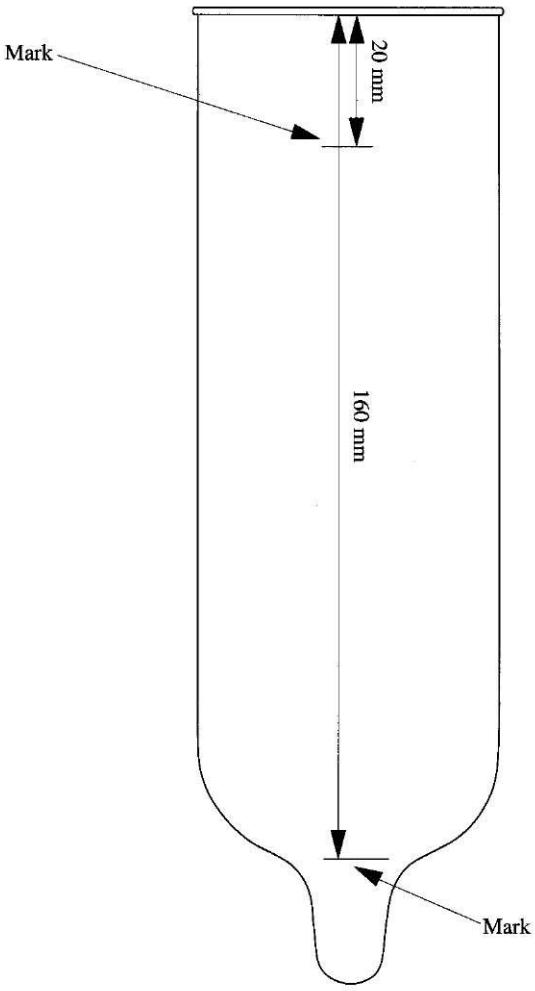


Figure 1
Condom marking

STANDARD TEST: WSP 351.0.R4 (12)

Standard Test Method for Determination of Ethanol- Extractable Organotin l Species in Absorbent Hygiene Products and Materials

The number in parentheses indicates the year of the last revision

1. Scope

This test method is for identifying and quantifying organotin cation species of the types $R_nSnCl_{(4-n)}$ extracted from in absorbent hygiene products and corresponding raw materials (e.g. nonwovens, elastics, films, adhesives,...). The butyl and octyl species are of most common interest where:

R =	and	n =
butyl		1 to 3
octyl		1 to 2

Other organotin species would be detected as well, if present, for example propyltins, tetrabutyltin, triphenyltin, and heptyltins. The quantification limit for product extracts is 2 ug of organotin species per kg of substrate.

SI values are regarded as the official standard system of measurement for this standard test method.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document:

2.1 EDANA test methods

a) ERT 360.0 – 02 Absorbent Hygiene Products – Organotin l

2.2 DIN test methods

DIN-38407-13, Entwurf 1999-10, determination of selected organotin compounds in water, waste water and sludge by gas chromatography.

Reference number
WSP 351.0.R4 (12) A

Current edition approved WSP 351.0.R4 (12)
Originally published as ERT 360.0 in 2002
Last approved as WSP 351.0 in 2009

3. Principle

A representative test portion of a product or raw material is extracted with a dilute solution of sodium diethyldithiocarbamate in ethanol, after adding internal standard reference substances.

Subsequently, after addition of buffer to an aliquot of the extract, the organotin cation species are alkylated with sodium tetraethylborate, extracted, cleaned-up by adsorption chromatography and analysed by gaschromatography with mass spectrometric detection, or atomic emission detection.

NOTE 2 **SAFETY WARNING**

This procedure requires the handling of organotin components that are classified as very toxic by inhalation, in contact with skin and if swallowed. They are readily absorbed through skin. To avoid contact, wear protective clothing and use gloves. In case of skin- or eye- contact, flush with copious amounts of water. For specifics consult the Sigma-Aldrich material safety datasheet.

4 Reagents and Solutions

NOTE 3 Reagent quality, Use reagents that yield “none detect” blank readings for organotins. Analytical grade reagents suffice. Verify absence of organotins by running a blank analysis (6.2.3).

4.1 Nitric acid, HNO_3, 65%, analytical reagent grade

4.2 Glacial acetic acid, CH_3COOH, analytical reagent grade

4.3 Sodium acetate CH_3COONa, analytical reagent grade

4.4 Dichloromethane CH2Cl2, analytical reagent grade

4.5 Organotin standards

a) Monobutyl tin trichloride MBTCl, $C_4H_9SnCl_3$, purity 95 % minimum
b) Dibutyl tin dichloride DBTCl, $C_8H_{18}SnCl_2$, 95 % minimum
c) Tributyl tin chloride TBTCl, $C_{12}H_{27}SnCl$, 95 % minimum
d) Tetrabutyl tin TTBT, $C_{16}H_{36}Sn$, 95 % minimum
e) Monooctyl tin trichloride MOTCl, $C_8H_{17}SnCl_3$, 95 % minimum
f) Dioctyl tin dichloride DOTCl, $C_{16}H_{34}SnCl_2$, 95 % minimum
g) Monoheptyl tin trichloride MHTCl, $C_7H_{15}SnCl_3$, 95 % minimum
h) Diheptyl tin dichloride DHTCl, $C_{14}H_{30}SnCl_2$, 95 % minimum
i) Tripropyl tin chloride TPTCl, $C_9H_{21}SnCl$, 95 % minimum
j) Tetrapropyl tin TTPT, $C_{12}H_{28}Sn$, 95 % minimum

4.6 Ethanol, C2H6O, 96 %, analytical reagent grade

4.7 Sodium diethyldithiocarbamate trihydrate, C5H10NS2Na.3H2O, analytical reagent grade

4.8 Sodiumtetraethylborate, analytical reagent grade

4.9 Hexane, analytical reagent grade

4.10 Sodium sulphate, Na_2SO_4, anhydrous, analytical reagent grade

4.11 Acetone, analytical reagent grade.

4.12 Extraction solvent:
Weigh 2.00 g of sodiumdiethyldithiocarbamate trihydrate (4.7) in a 1000 ml volumetric flask (5.2). Dissolve and bring to volume with ethanol.
Renew at least once every 2 weeks.

4.13 Acetate buffer solution
Weigh about 82.0 g of sodium acetate (4.3) in a 1 liter volumetric flask (5.2) and dissolve in 500 ml of deionized water. Add enough glacial acetic acid (4.2) to bring the pH value at 4.5. Then bring to volume with deionized water and mix. Renew at least once every 2 weeks.

4.14 Multi component standard solution in ethanol, stock solution A
For the preparation of a stock solution containing about 1 mg/ml of each organotin cation, weigh approximately the amount of organotin substances that are specified in table 1 for solution A, into one 100 ml volumetric flask (5.1).

Record the exact weight W_y, of each organotin component y, to an accuracy of 0.0001 g. Dissolve and bring to volume with ethanol (4.6), and homogenise (solution A).

Protect from direct light, e.g. by wrapping with aluminium foil.

Renew monthly.

4.15 Internal standard solution in ethanol, stock solution B
Weigh, to an accuracy of 0.0001 g, approximately 122 mg of diheptyl tin chloride, 149 mg of monoheptyl tin trichloride, 114 mg of tripropyl tin chloride and 100 mg of tetrapropyl tin into one 100 ml volumetric flask (5.1). Record the exact weight W_z of each component z, in mg.

Dissolve and bring to volume with ethanol (4.6) and homogenise the solution (solution B). Protect from direct light, e.g. by wrapping with aluminium foil. Renew monthly.

4.16 Internal standard working solution (solution B1)
Pipette 100 µl of stock solution B (4.15) in a 100 ml volumetric flask (5.1), bring to volume with ethanol (4.6) and homogenise the solution (Solution B1). Protect from direct light, e.g. by wrapping with aluminium foil. Prepare fresh weekly.

Calculate the exact concentration of each cation z in solution B1 according to:

ng/ml of cation z = W_z x weighing factor z x 10

Where: W_z = weight of organotin component z, in mg (4.15)
For weighing factor z: see table 1

Typically this concentration is about 1000 ng/ml.

Required amounts of organotin components, and their weighing factors, for 100 mg of organotin cations

Substance	Weighing factor*	Weighed portion mg	Solution
Monobutyl tin trichloride	0.623	160.5	A
Dibutyl tin dichloride	0.767	130.4	A
Tributyl tin chloride	0.891	112.2	A
Tetrabutyl tin	1.000	100.0	A
Monooctyl tin trichloride	0.686	145.9	A
Dioctyl tin dichloride	0.830	120.5	A
Monoheptyl tin trichloride	0.672	148.8	B
Diheptyl tin dichloride	0.817	122.4	B
Tripropyl tin chloride	0.875	114.3	B
Tetrapropyl tin	1,000	100.0	B

* Weighing factor = molar mass (organotin cation)/molar mass (organotin chloride)

Table 1

4.17 Multi component standard working solutions

For preparation of the standard working solutions, pipette 1 ml of the stock solution A (4.14) into a 100 ml volumetric flask (5.1), bring to volume with ethanol (4.6), and homogenise the solution (solution A1).

Pipette 1 ml of solution A1 into a 100 ml volumetric flask (5.1), bring to volume with ethanol (4.6) and homogenize (solution A2).

Renew weekly and protect from direct light, e.g. by wrapping with aluminium foil.

Calculate the actual concentration of each organotin cation y in solution A2 in ng/ml by:

ng/ml of cation y = W_y x weighing factor y

Where: W_y = weight of organotin component y, in mg (4.14)
For weighing factor y: see table 1

Typically this concentration is about 100 ng/ml.

4.18 Derivatisation agent (20% in ethanol)

Weigh 2,0 g of sodium tetraethylborate (4.8) into a vial (5.7), and add with a pipette 10 ml of ethanol (4.6). Swirl to mix.

Prepare freshly.

This is an agressive reagent and gets warm when prepared. Use adequate protection (gloves, fume hood). Remove spills immediately with plenty of water.

4.19 Silica gel cartridges

Solid phase extraction cartridges, loaded with 1 g of silicagel, particle size 45 um, specific surface of 500 m^2/g. With liquid reservoir, capable of holding 10 ml of liquid.

4.20 Eluant

Pipette 5 ml of acetone (4.11) in a 100 ml volumetric flask (5.2). Bring to volume with hexane (4.9), and mix.

5. Apparatus

NOTE 3 Care must be exercised to avoid contamination. Therefore flasks, equipment and anything making contact with test samples and extracts thereof, must preferably be dedicated. Cleaning of equipment in dishwashers must be avoided. Instead, rinsing with extraction solvent (4.12) and ethanol (4.6) is preferred.

NOTE 4 To minimise recovery losses by adsorption, the use of polypropylene recipients instead of glass is preferred, until after the derivatisation step. In the case of positive blank values (> 0.2 ng/ml of single organotin species) that are due to contamination of equipment, this must be cleaned.

NOTE 5 Clean by soaking for several hours with extraction solvent (4.12). Then rinse with ethanol (4.6).Persistent contamination from glass equipment can be eliminated as follows:

NOTE 6 Fill a 5 l glass beaker about 3 cm deep with concentrated nitric acid. Place the vessel to be cleansed with the opening downwards in the glass beaker. Heat the nitric acid for 6 hours on a heating plate very slowly, but do not let it boil. After cooling, rinse with water giving no blind reading. Finally rinse with acetone (4.11) and dry in an air-drier.

Then verify blank values and recovery.

5.1 Volumetric flasks, polypropylene, 100 ml

5.2 Volumetric flasks, glass, 10 ml, 100 ml, 1000 ml

5.3 Pipettes, with disposable tips, 10 µl, 20µl, 50µl, 100 µl, 200 µl, 500 µl, 1 ml, 5 ml, 20 ml, fixed volume or adjustable volume, inaccuracy < 2.0 %

5.4 Microlitre syringes, 10 µl, 500 µl

5.5 Ultrasonic bath, capable of holding 250 ml Erlenmeyer flasks and 60 ml vials (5.7). Bath temperature should not increase by more than 10 °C during 1 hour of operation.

5.6 Erlenmeyer flasks, polypropylene, 250 ml, with polypropylene stopper.

5.7 Vials, cylindrical, polypropylene, 60 ml, about 25 mm diameter, Teflon lined screw cap

5.8 Liquid dispenser, 50 ml, 200 ml, accurate to within 1 ml

5.9 Pasteur pipette, glass

5.10 Solid phase extraction vacuum manifold. With vacuum regulator, capable of eluting silica gel Solid Phase Extraction cartridges (4.19), as specified by the supplier.

5.11 Vials, glass, 10 -15 ml, for collecting Solid Phase Extraction eluent in a vacuum manifold (5.10)

5.12 Magnetic stirrer, capable of 1200 revolutions/minute.

5.13 Magnetic stirring rod, polytetrafluoroethene coated, 30 mm x 4.5 mm

5.14 Vortex mixer, compatible with polypropylene vials (5.7)

5.15 Vials, glass, conical, 1.5 ml, septum sealable, compatible with GC autosampler (5.16). As no graduated vials are available, make a mark approximately at the 100 µl level e.g. after adding 100 µl of hexane.

5.16 Gas chromatograph, equipped with:

a) Multi-step temperature gradient elution up to 350 °C
b) Capability for operating 0.32 mm capillary columns up to 100 kPa inlet pressure
c) Helium carrier gas
d) Split less injection
e) Atomic emission, or mass spectrometric (EI mode) detection
f) Data system for recording chromatograms, peak integration, internal standard calibration and recording of mass spectra
g) Auto sampler (preferred)

5.17 Capillary gas chromatography column, 25 m x 0.32 mm. Non-polar stationary phase, e.g. CP-SIL 8 CB, OV 1, HP-1, or equivalent, film thickness of about 0.25 um. Capable of providing baseline resolution of all organotin species in the working standard and test samples.

5.18 Analytical balance, capable of 200 g, accurate to $\pm$ 0.0001 g.

5.19 pH indicator paper, accurate to 0.3 pH units.

6. Procedure

Make sure equipment and tools are clean and organotin free. Run a blank analysis (6.2.3) to verify.

If necessary, clean tools (e.g. scissors) by removing visible residues with a suitable solvent (e.g use successively hexane, dichloromethane). Then, wipe repeatedly with filter paper, wetted with ethanol (4.6), rinse with ethanol (4.6) and dry at the air.

After cleaning, contact with plastic surfaces (e.g. PVC, rubber gloves), other than test materials and clean laboratory equipment, must be avoided, as these can contain organotin components.

6.1 Calibration solutions

6.1.1 Pipette respectively 10 µl, 20 µl, 50 µl, 100 µl, 200 µl and 500 µl of stock solution A2 (4.17) into separate 60 ml vials (5.7). Add 20 ml of ethanol (4.6), 10 ml of acetate buffer (4.13) and 10 ml of deionized water.

a) To each vial add, with a micropipette, 100 µl of internal standard working solution B1 (4.16), stir on a vortex mixer (5.14), and derivatise as specified from step 6.3.4. to 6.4.6.

b) These solutions are for instrument calibration. Label these from CS1 (10 µl aliquot) thru CS6 (500 µl aliquot) respectively.

6.1.2 Calculate the amount m_{yj} of each organotin cation y in each calibration solution j by:

$$m_{yj} = \frac{\text{ng/ml of cation y (4.17) x } V_j}{1000}$$

Where V_j = pipetted aliquot, in µl, of stock solution A2, for calibration solution j (6.1.1)

Calculate the amount m_{zj} of each organotin cation z for each of the calibration solutions j by:

$$m_{zj} = \frac{\text{ng/ml of cation z (4.16) x 100}}{1000}$$

6.2 Sample preparation

Products must be prepared for use, prior to sampling. I.e. release tapes, and papers, and applicators must be removed if present.

6.2.1 Hygiene products

6.2.1.1 Baby diapers

a) Cut the product in half, along the longitudinal axis. One half is for analysis, where the other half is kept as a retained sample.
b) For the analysis, remove the absorbent core material (cellulose pulp and superabsorbent polymer) from the product. Scraping of adhering matter from the top and bottom layers may be necessary, however a small amount of residue is tolerable.
c) The remaining product chassis is cut into smaller specimens and transferred to a tared 250 ml Erlenmeyer flask (5.6). If analysis of the core material is desired, collect the core material in a separate tared 250 ml Erlenmeyer flask.
d) Determine and record the weight of each test portion to an accuracy of ± 0.01 gram. For a diaper chassis this is about 8 ± 2 gram and for the core about 13 ± 4 gram.
e) Add with a dispenser (5.8) 200 ml of extraction solvent (4.12) to each of the Erlenmeyer flasks. If necessary, press the solid materials down with a polypropylene rod, to make sure they are fully wetted.
f) Close the flask with a polypropylene stopper and protect from direct light, e.g. by wrapping with aluminum foil.

6.2.1.2 Feminine hygiene products

6.2.1.2.1 For **thick** (i.e. with cellulose pulp core) feminine hygiene products, remove the absorbent core material (cellulose pulp and superabsorbent polymer) from the product. Scraping of adhering matter from the top and bottom layers may be necessary, however a small amount of residue is tolerable. Remove the release paper from the panty-fastening adhesive (if present). Place the test portion in a tared 250 ml Erlenmeyer flask (5.6). If necessary cut the test portion into smaller pieces.

a) Take as many product samples as necessary to obtain about 8 ± 2 grams of material.
b) If analysis of the core material is desired, collect the core material in a separate tared 250 ml Erlenmeyer flask.
c) Determine and record the exact sample weights to an accuracy of ± 0.01 gram. Continue from step 6.2.1.2.4 onwards.

6.2.1.2.2 For **thin or ultra- products** (i.e. with superabsorbent core), remove the release paper from the panty-fastening adhesive (if present). Cut the product in specimens and transfer to a tared 250 ml Erlenmeyer flask (5.6)

a) Take as many product samples as necessary to obtain about 8 ± 2 grams of material.
b) Determine and record the exact sample weight to an accuracy of ± 0.01 gram and continue from step 6.2.1.2.4 onwards.

6.2.1.2.3 For **tampons** cut slices of about 1 cm, and take as many as required for a total weight of 8 ± 2 grams. Include the cord. Transfer to a tared 250 ml Erlenmeyer flask (5.6). Determine and record the exact sample weight to an accuracy of ± 0.01 gram.

6.2.1.2.4 Add with a dispenser (5.8) 200 ml of extraction solvent (4.12). If necessary, press the product down with a polypropylene rod, to make sure it is fully submerged.

Cover the flask with a polypropylene stopper, and protect from direct light, e.g. by wrapping with aluminum foil.

6.2.1.3 Incontinence products

6.2.1.3.1 Light incontinence products

a) Remove the absorbent core material (cellulose pulp and superabsorbent polymer) from the product. Scraping of adhering matter from the top and bottom layers may be necessary, however a small amount of residue is tolerable. Remove the release paper from the panty-fastening adhesive (if present).
b) Cut the separated product chassis into smaller specimens and transfer to a tared 250 ml Erlenmeyer flask. Take as much product sample as necessary to obtain about 8 ± 2 grams of material.
c) If analysis is desired on absorbent core material, take at random about 1 gram samples until a total of about 20 grams has been obtained. Transfer this to another tared 250 ml Erlenmeyer flask (5.6).
d) Determine and record the exact sample weights to an accuracy of ± 0.01 gram and carry-on from step 6.2.1.3.3 onwards.

6.2.1.3.2 Heavy Incontinence products

a) Cut the product in half, along the longitudinal axis. One half is for analysis, where the other half is kept as a retained sample.
b) For the analysis, isolate the chassis part by removing the absorbent core material (cellulose pulp and super-absorbent polymer) from the product. Scraping of adhering matter from the top and bottom layers may be necessary, however a small amount of residue is tolerable.
c) About 5 to 10 grams of the separated product chassis is required. If the weight of the prepared chassis is above the specified range, take proportional samples from each of the key parts (elastics, tapes, backsheet, topsheet, waistband etc.) to have a total of about 8 grams.
d) Cut the selected fraction(s) in smaller specimens and transfer these to a tared 250 ml Erlenmeyer flask (5.6).

e) If analysis is desired on absorbent core material, sample at random about 20 grams of core material. Transfer to a tared 250 ml Erlenmeyer flask (5.6).
f) Determine and record the exact weight of the test material(s) to an accuracy of ± 0.01 gram.

6.2.1.3.3 Add with a dispenser (5.8) 200 ml of extraction solvent (4.12) to each of the Erlenmeyer flasks. If necessary press the solid materials down with a polypropylene rod, to make sure they are fully wetted.

6.2.1.3.4 Close the flasks with a polypropylene stopper and wrap with aluminum foil to protect from direct light.

6.2.2 Materials (e.g. nonwovens, adhesives and components thereof, elastics,…)

a) Cut a representative portion of about 2.0 grams of material, and transfer into a tared 60 ml screw-cap vial (5.7).
b) Record the exact weight to an accuracy of ± 0.001 gram.
c) For adhesives and components of adhesive formulations, dissolve in 10 ml, of hexane or dichloromethane (4.4). Warm gently if necessary to dissolve, then allow to cool.
d) Add with a dispenser 50 ml of extraction solvent (4.12). Cover the flask, with a Teflon lined screw cap and wrap with aluminum foil to protect from direct light.

6.2.3 Blanks

Before and after each batch of test samples, blank determinations must be carried out, i.e. by running the entire analysis procedure from step 6.2.1 onwards without test sample.

6.3 Extraction and derivatisation

NOTE 7 Perform steps 6.3.4 thru 6.4.6 under a fume hood. The reaction of organotin cations with tetraethylborate, in presence of diethylditiocarbamate, leads to malodorous by-products.

6.3.1 Place the flasks and vials with test samples and blank (6.2.1.1, 6.2.1.2.4, 6.2.1.3.4, 6.2.2, 6.2.3) in an ultrasonic bath (5.5) for 1 hour. Temperature must not increase by more than 10 °C. Let stand at ambient temperature for minimum 22 hours, and again place in an ultrasonic bath for one hour.

6.3.2 From each supernatant, pipette a 20 ml aliquot in a 60 ml screw cap vial (5.6). For adhesive samples, let settle and make sure that the 20 ml aliquot is taken from the clear supernatant. Add, with a pipette, 100 µl of the internal standard working solution B1 (4.16).

6.3.3 Add 10 ml of acetate buffer (4.13), and 10 ml of deionized water, cap, and stir briefly with a vortex mixer (5.14), such that the phases are well mixed. Check the pH with indicator paper (5.19), and, if necessary, add dropwise glacial acetic acid (4.2) to adjust the pH until between 4.2 and 4.5.

6.3.4 Add, with a syringe (5.4), 500 µl of derivatisation agent (4.18) and 3 ml of hexane (4.9). **For elastics**, use 1 ml of derivatisation agent, instead of 500 µl.

Cap, and stir vigorously (vortex mixer) for about 1 minute, such that the phases are thoroughly mixed.

Allow to react for at least 20 minutes, with occasional shaking. Then mix vigorously (vortex mixer) again for 1 minute.

6.3.5 Stop stirring, and allow the phases to separate.

If an emulsion forms during extraction, after settling, the entire emulsion layer is separated off with a Pasteur pipette and the organic phase is separated by appropriate measures (e.g. strong agitation, freezing-out, the addition of Na2SO4, the addition of Ca2+ or Mg2+ ions, centrifugation).

6.4 Clean-up

6.4.1 Mount a silica gel cartridge (4.19) on a Solid Phase Extraction manifold (5.10). Add about 3.0 g of anhydrous sodium sulphate (4.10) on the top of the silica gel layer, and run 5 ml of hexane (4.9) through the cartridge. Do not allow the cartridge to run dry. Discard the hexane rinse.

The cartridge is then ready for use.

6.4.2 With a Pasteur pipette, collect as much as possible of the hexane phase of the derivatised sample solution (6.3.5), and run this through the prepared silicagel cartridge (6.4.1), collecting the eluate in a 10 ml vial (5.11).

6.4.3 After collecting the hexane layer, add another portion of 2 ml hexane (4.9) on top of the aqueous phase (6.3.5). Cap and mix (vortex) for a few seconds. After separation, collect the hexane layer with a Pasteur pipette, and run this through the silica cartridge combining the eluate with the previous one.

6.4.4 Rinse the cartridge with two successive portions of 2 ml of eluant (4.20), combining all of the eluates (6.4.2, 6.4.3, 6.4.4).

6.4.5 Concentrate the combined eluates by gentle evaporation at room temperature, e.g. under a stream of air or nitrogen, to about 1.5 ml.

6.4.6 Transfer the concentrated solution into a conical vial (5.15), and concentrate by gentle evaporation under an air stream, down to 100 µl. Then seal with a septum.

This solution is ready for analysis by GC-MS or GC-AED.

6.5 Measurements

6.5.1 Chromatography conditions

a) Injection: splitless, temperature 300 °C
b) Injection volume 1 ul
c) Temperature gradient:
d) 60 °C (hold 1 min) — 5 °C /min → 240 °C — 10 °C /min → 290 °C
e) If appropriate, adjust conditions to achieve baseline resolution for the organotin components, similar to the chromatograms, in Annex B.

6.5.2 Detector conditions

Component detection after chromatography, can be done either by Mass Spectroscopy or Atomic Emission Spectroscopy.

6.5.2.1 Mass spectrometry detection

a) Transfer line: 280°C
b) Electron ionization energy: 70 eV

Use selected ion monitoring (quadrupole mass detector). Select relevant m/e values considering that the isotope cluster of organotin components is formed from 10 natural tin isotopes:

Mass numbers and abundance of the natural tin isotopes

Mass number in amu	Abundance in %	Relative abundance in %
112	0.95	2.88
114	0.66	1.97
115	0.34	1.03
116 *	14.24	43.19
117	7.57	22.96
118 *	24.01	72.82
119	8.58	26.02
120 *	32.97	100.00
122	4.71	14.29
124	5.98	18.14

Table 2

For analysis by GC/MS, collect for each of the analytes the Selective Ion Monitoring (SIM) signal for all three of the m/e (table 3) that correspond with the most abundant tin isotopes (see * in table 2)

Characteristic masses for identification and evaluation

Substance	Most intense m/e	cation
Monobutyltriethyltin	235 / 233 / 231	Sn(Et)2Bu+
Dibutyldiethyltin	263 / 261 / 259	Sn(Bu)2Et+
Tributylmonoethyltin	291 / 289 / 287	Sn(Bu)3+
Tetrabutyltin	291 / 289 / 287	Sn(Bu)3+
Monooctyltriethyltin	291 / 289 / 287	Sn(C8H17)(Et)2+
Dioctyldiethyltin	375 / 373 / 371	Sn(C8H17)2(Et)+
Monoheptyltriethyltin	277 / 275 / 273	Sn(C7H15)Et2+
Diheptyldiethyltin	347 / 345 / 343	Sn(C7H15)2Et+
Tripropylethyltin	249 / 247 / 245	Sn(Pr)3+
Tetrapropyltin	249 / 247 / 245	Sn(Pr)3+

Table 3

6.5.2.2 Atomic emission spectrometry detection

a) Transfer line 280°C
b) Cavity temperature 280°C
c) Helium scavenger gas flow rate 240 ml/min (measured at the "cavity vent")
d) Wavelength 270,651 nm or 303,419 nm

6.5.3 Adjust chromatography conditions to have a similar chromatogram as in Annex B, with baseline separation for all of the organotin components within about 35 minutes.

The peaks of the derivatised organotin components must have an asymmetry factor of > 90 % at 10 % peakheight. Otherwise the chromatography column needs to be replaced.

When injecting 1 µl of the derivatised calibration solution CS1 (6.1), peak height to noise (peak to peak) ratio for dibutyltin must be better than 25.

6.5.4 Calibration and analysis of test samples

6.5.4.1 Inject 1 µl of the derivatised (6.4.6) calibration solution corresponding with CS 6, and record the retention times and peak areas.

6.5.4.2 Repeat step 6.5.4.1 and verify whether retention times match within 0,05 min. with previous values. Peak areas must match within 5 %. In case this condition is not met, trouble-shoot the gas chromatograph and detection system.

6.5.4.3 Inject calibration solutions and test samples in the following sequence:

a) hexane
b) reagent blank extract
c) derivatised calibration solutions CS1 thru CS6, in increasing order of concentration
d) hexane
e) sample extracts, up to 6
f) blank
g) calibration solution CS3

After each sixth injection of sample extracts, inject extracts of the blank solution and of one of the calibration solutions (re-calibration) for controlling system performance.
If the value found for the blank solution does not agree with the blank value that was originally found, or if the relative response factors for calibration solution CS3 do not fit within 10 % of the original calibration, the last series of measurements must be repeated. If necessary, eliminate the source of the blank response, and re-calibrate until the condition is met.

7 Data Interpretation

The interpretation of the acquired data consists of several parts:

a) Establishing the correct identity of the analyte peaks
b) Verification of derivatisation completeness, and recovery
c) Calibration
d) Quantification of analytes in test samples

7.1 Requirements for identification

The analyte identity is confirmed as two conditions are met simultaneously:

a) The retention times of an analyte in the chromatograms for calibration solutions and test samples agree within $\pm$ 0.05 min, or relative retention times agree within $\pm$ 0.2%.
b) At the correct retention time, the analyte gives a response from a selective detector, i.e. Atomic Emission Detector (AED) or Selective Ion Monitoring MS.

As the AED is selective for tin, interference by other components is unlikely. For MS the m/e selected for SIM must not be interfered significantly by other substances.

7.2 Selecting fragment m/e for selective ion monitoring by MS.

From the m/e values listed in table 3, for each organotin cation those m/e must be identified that are sufficiently selective, i.e. do not suffer from interference by foreign substances.

To achieve this, the SIM peak areas (A_{m1}, $A_{m2,}$ and A_{m3}) for a component of interest, corresponding with the three selected m/e (m_1, m_2 and m_2) from table 3, are determined from the chromatograms for 1 the calibration solutions and 2 the test samples.

For each analyte, the ratios of the SIM peak areas are determined:

$R_1 = A_{m1} / A_{m2}$

$R_2 = A_{m2} / A_{m3}$

$R_3 = A_{m3} / A_{m1}$

Calculate the peak area ratios for calibration solutions (R_{1c}, $R_{2c,}$ R_{3c}) and compare with the correspondingly established ratios (R_{1e}, R_{2e}, R_{3e}) from the chromatograms of the sample extracts. This needs to be done for each type of test matrix.

The identity of a component in the sample is confirmed if for one or more of the ratios R_i the following condition is met:

$$(1.00 - 0.3) < \frac{R_{ic}}{R_{ie}} < (1.00 + 0.3)$$

Any of the two peak areas that corresponds to an R_i that meets this requirement can be used for quantitation. From these, select the peak area for the ion that gives the strongest response.

7.3 Recovery and completeness of derivatisation

The ratio of peak areas for tetrapropyltin versus mono-, di- heptyltin and- tri-propyltin is an indicator for recovery and completeness of derivatisation.

Determine the corresponding peak areas (A_{tetra}, A_{mono}, A_{di}, A_{tri}) for both the calibration solutions (c) and test samples (e).

Calculate the ratios:

$$R1 = \frac{A_{mono}}{A_{tetra}} \qquad R2 = \frac{A_{di}}{A_{tetra}} \qquad R3 = \frac{A_{tri}}{A_{tetra}}$$

For each R_{ie} and R_{ic} , verify that $R_{ie} / R_{ic} > 0.80$ If this condition is met, recovery and derivatisation are considered adequate.

If not, repeat the extraction and derivatisation and trouble-shoot the system. For some matrix types, an increased amount of reagent (i.e. 1 ml instead of 500 µl) will be required in step 6.3.4.

7.4 Calibration

7.4.1 Full calibration upon start-up

The procedure is calibrated with two internal standards. Di-heptyltin is the internal standard for the determination of mono- and di-octyltin. Tri-propyltin is the internal standard for mono-, di-, and tri-butyl tin.

For establishing a calibration, the extracts from six calibration solutions from across the calibration range (see 4.17) are measured.

For each substance y, the relative response factor is calculated according to:

$$R_{ylj} = \frac{A_{yj} \cdot m_{lj}}{A_{lj} \cdot m_{yj}}$$

where for each solution CS_j (see 4.17) :

R_{ylj} is the relative response factor of the substance y referring to the internal standard I
A_{lj} is the peak area of the internal standard I
m_{yj} is the weight of the standard substance y, in ng, in the calibration solution (6.1.3)
A_{yj} is the peak area of the substance y
m_{lj} is the weight of the internal standard I, in ng, in the calibration solution (6.1.3)
The overall relative response factor for each component y is obtained by finding the mean value across all the calibration solutions j:

$$R_{yl} = \frac{1}{6} \cdot \sum_{j=1}^{6} R_{ylj}$$

where:

R_{yl} is the mean relative response factor of the substance y versus internal standard I across all standard solutions j;

R_{ylj} is the relative response factor of the substance y versus the internal reference I, for calibration solution j;

The standard deviation of the relative response is calculated according to:

$$SR_{yl} = \sqrt{\frac{\sum (R_{yl} - R_{ylj})^2}{j-1}}$$

where:

SR_{yl} is the standard deviation of the relative response factor for substance y versus internal standard I across all working standard solutions j;

R_{yl} is the mean relative response factor of the substance y versus the internal standard I across all working standard solutions j;

R_{ylj} is the relative response of substance y versus the internal standard I, for working standard solution j;

j index for working standard solutions

and from this the relative standard deviation RSD

$$RSD = \frac{SR_{yI}}{R_{yI}} \cdot 100$$

where:

RSD is the % relative standard deviation of the relative response factors for standard substance y versus the internal standard I, across all working std. solutions j.

SR_{yI} is the standard deviation of the relative response factor of the internal standard substance y versus the internal standard I in calibration across all masses j.

R_{yI} is the mean relative response factor of the standard y versus internal reference standard I, across all calibration masses j.

The relative standard deviation should not be more than 5 %.

7.4.2 Once the R_{yI} has been determined (7.4.1), and the RSD shown to be within limits, ongoingly, a three point calibration suffices. This procedure has a linear calibration curve through the origin, over the concentration range of interest.

In that case, calculate the R_{yIj} after injecting calibration solutions CS2, CS4 and CS6. Verify that it does not differ by more than 10 % from the previously established Ry_I value. If the deviation is more than 10 %, then perform the 6 point calibration as in 7.4.1.

7.5 Quantitative evaluation of chromatograms from test samples

The peak areas A for the organotin components i, and for the internal standard I are obtained from the chromatograms by integration.

Calculate the mass of component y extracted from a test sample by:

$$m_y = \frac{A_y \times m_I \times V_s}{A_I \times R_{yI} \times 20}$$

where:

m_y = mass of organotin cation y, in ng

m_I = mass of the internal standard in ng. This is the mass in 100 µl of solution B1 (4.16).

A_y = peak area of component y

A_I = peak area of the internal standard

R_{yI} = Relative response factor of organotin component y versus internal standard I

V_s = Volume of extraction solvent, in ml
For products, this is 200 ml
For materials, other than adhesives, this is 50 ml

For adhesives, this is 60 ml

The concentration C_y of organotin cation y in the extracted product sample is:

$$C_y = \frac{m_y}{W} \text{ ug/kg}$$

where:
W = sample weight in grams

8. Reporting

The result is stated in micrograms of organotin cations per kilogram of product with at the most two significant figures.

Any result below 2 micrograms per kilogram must be reported as “non detectable”.

The report must relate to this procedure and shall include the following information:

a) Identity of the test sample (name, source, production code, sampling date).
b) Details about pre-treatment of the sample and its processing.
c) Complete details on the procedure (e.g. GC conditions).
d) Any deviation from this standard procedure and details of all circumstances which might possibly have influenced the results.

ANNEX A
(Normative)

ORGANOTIN ANALYSIS SAMPLING INSTRUCTIONS

A.1 Preparation

All equipment and surfaces that come in contact with the test material must be clean and organotin free.

To achieve this, use metal tools, and metal-, ceramic-, or glass-, working surfaces, that have been cleaned thoroughly. Clean by wetting and wiping repetitively with ethanol, and a clean paper tissue, made from white non-recycled paper.

During or after the sampling, do not allow any of the test substance to be in contact with other synthetic polymers than from its original package. Specifically avoid contact with PVC, poly-urethane, poly-olefin, rubber, silicone, adhesive tape etc. Where necessary use white, and non-recycled, paper for covering and wrapping.

A.2 Sampling

A 2.1 For films, nonwovens, etc,

Remove the protective wrapping, if present. Cut a portion of about 10 grams minimum of material, from the end of a representative product roll. Sample, across the whole width of the material.

Wrap with white, non-recycled, paper or tissue and put in a sealed paper envelope for shipment.

Repeat this for a second portion.

A.2.2 For adhesives

Remove the packaging material, if present. Cut a portion of about 10 grams minimum from a side or corner of the adhesive block, including the outside film, and wrap in a clean white paper.

Repeat this for a second portion.

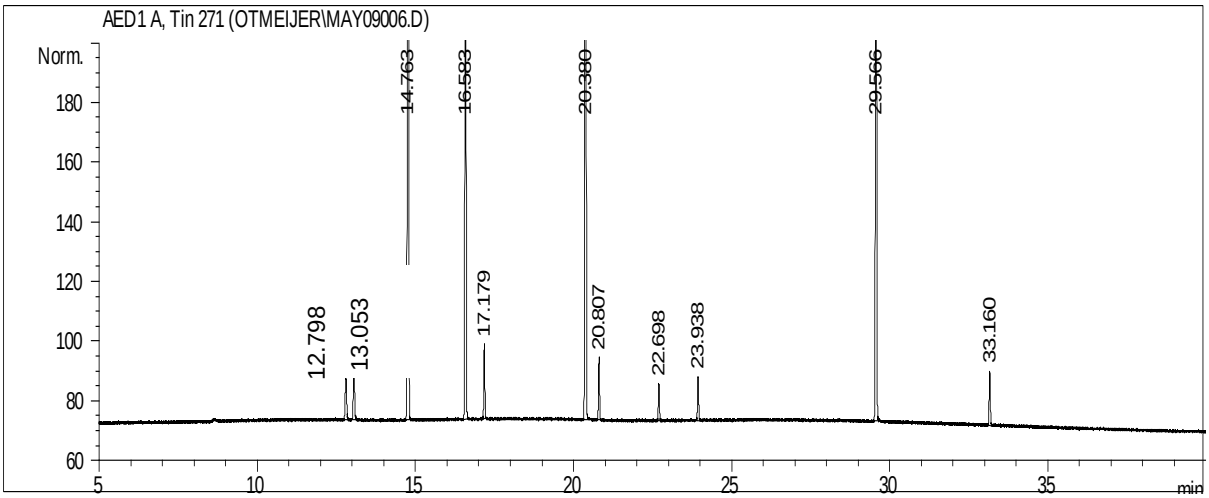
A.3 Labeling

For each portion, provide the unique material identification (originator, material name, production code, lot nr, sampling date, plant, line).

Send one portion for analysis and keep the other as a retained sample.

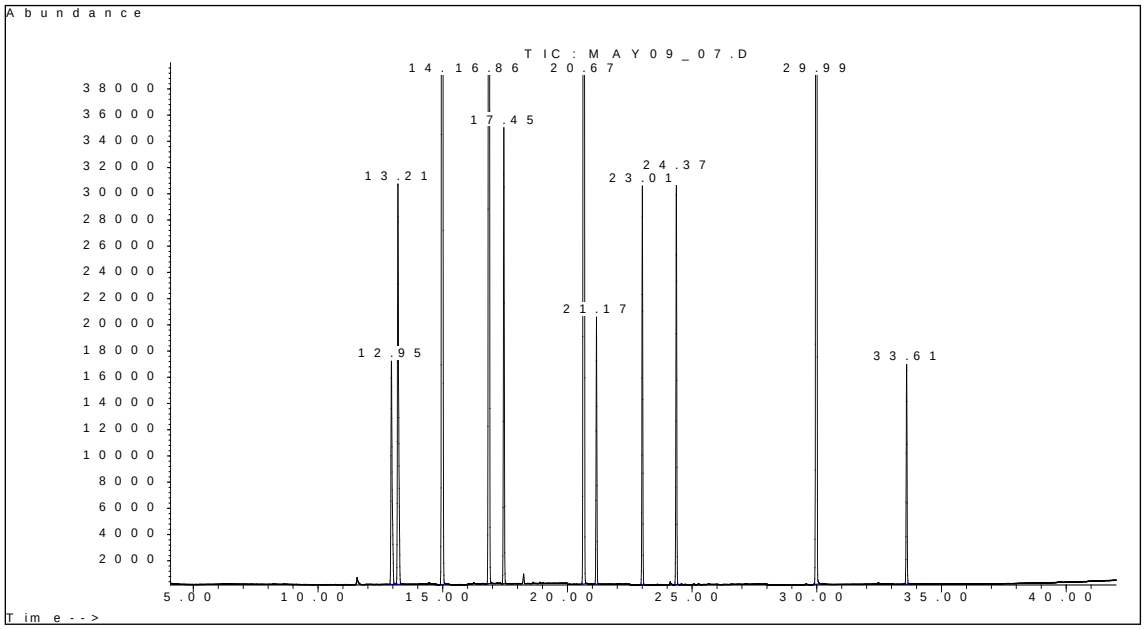
ANNEX B
(Informative)

CHROMATOGRAM 1
CALIBRATION SOLUTION 5, AED DETECTION



Retention time (min)	Component
13.053	MBT
14.763	TPT
16.583	TETRPT
17.179	DBT
20.380	MHT
20.807	TBT
22.698	MOT
23.938	TETRBT
20.566	DHT
33.160	DOT

CHROMATOGRAM 2
CALIBRATION SOLUTION 5, GC-MS DETECTION

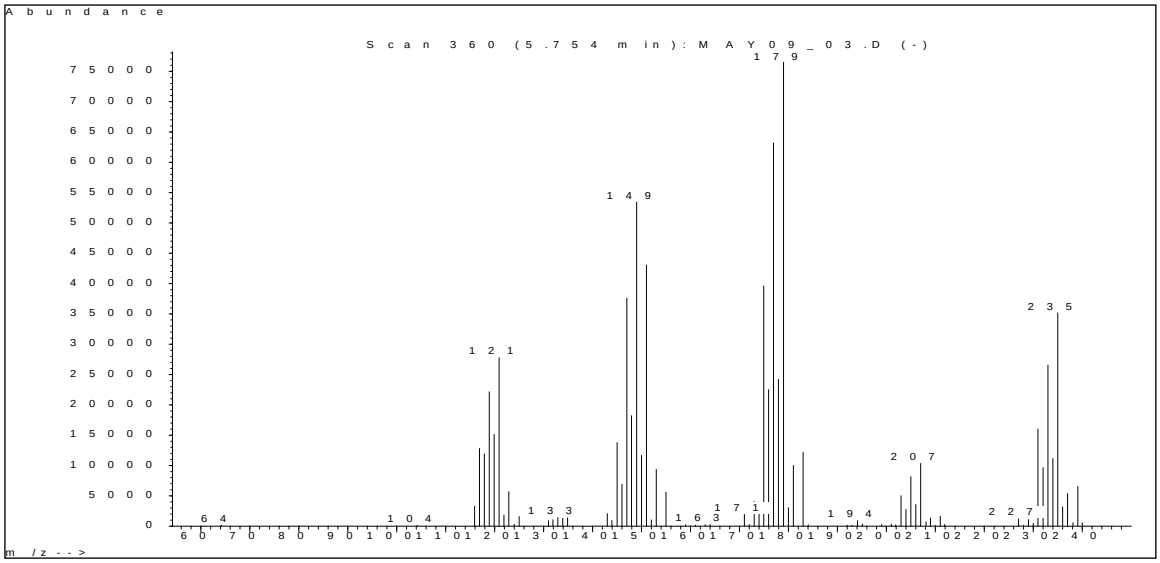


Retention time (min)	Component
13.210	MBT
14.980	TPT
16.860	TETRPT
17.450	DBT
20.670	MHT
21.170	TBT
23.010	MOT
24.370	TETRBT
29.990	DHT
33.610	DOT

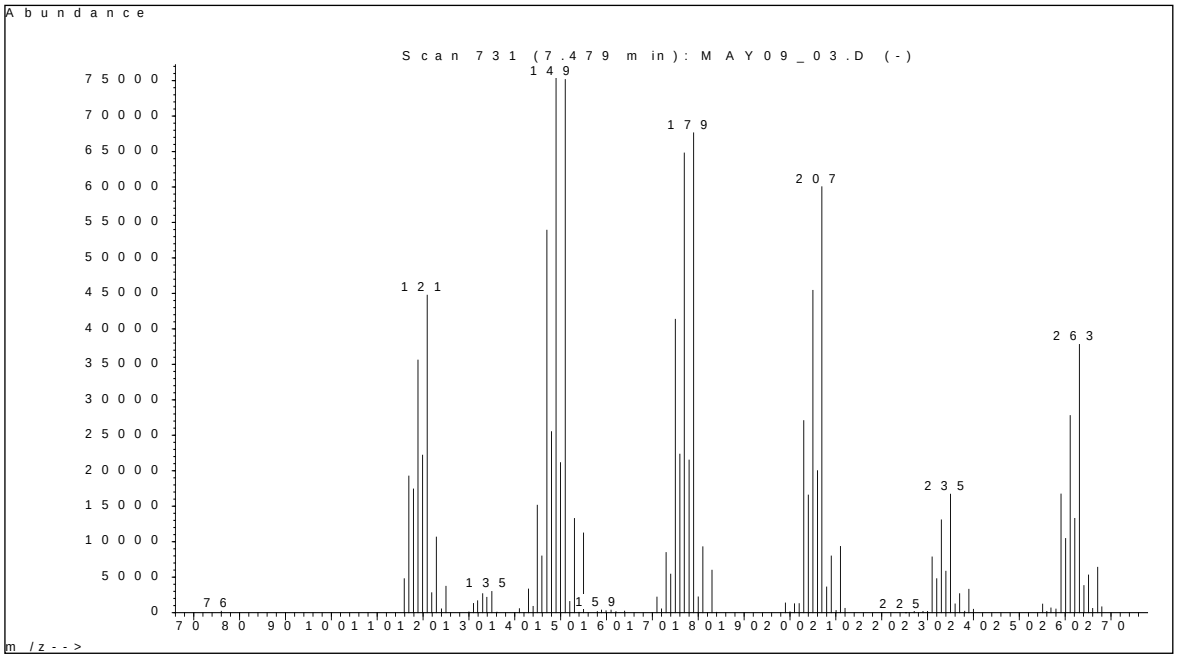
ANNEX C
(Informative)

MS SPECTRA

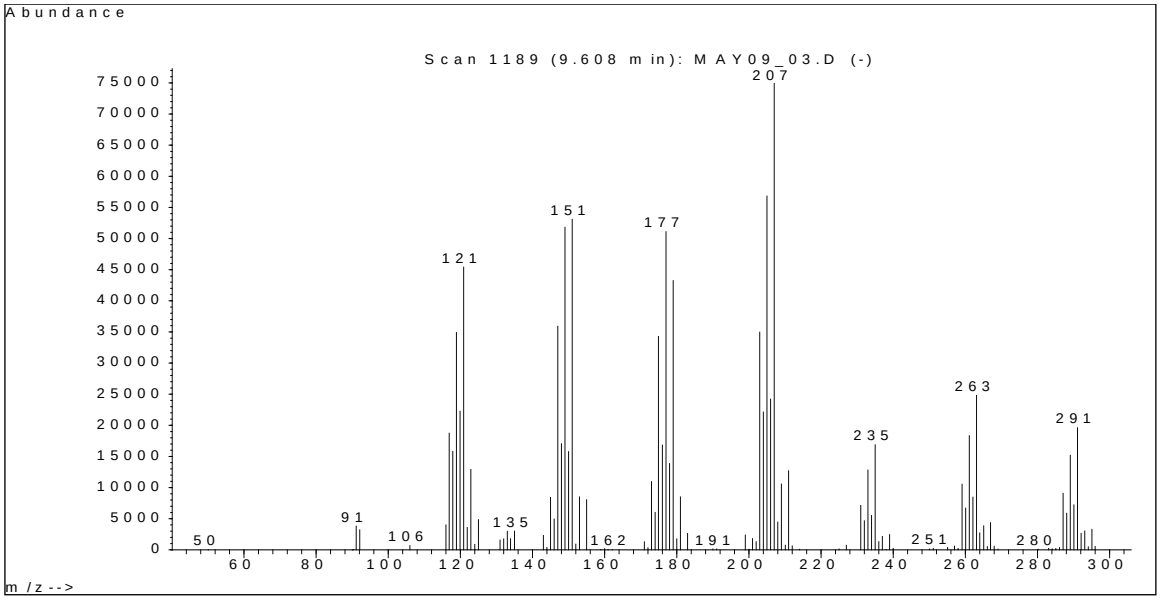
Monobutyl triethyltin



Dibutyl diethyltin



Tributyl ethyltin



ANNEX D
(Informative)

STATISTICS

For product extracts, the quantification limit is 2 ug of organotin species/kg of product, and for added standard amounts of 20ug/kg, the recovery for the individual organotin species is between 92 and 110 %, with relative standard deviations below 6 %.

Interlaboratory ring testing summary

D.1 Nonwoven with standard addition

	MBT	DBT	TBT
No. of participating laboratories	8	8	8
No. of non-eliminated laboratories	8	7	8
No. of single values of the non-eliminated laboratories	24	21	24
Std. amount added, ug/kg	21	20	32
Average (µg/kg)	20.7	1.9	14.1
Standard deviation of repeatability, s_r	2.9	1.1	3.0
Coefficient of repeatability, CV_r	14	58	21
Repeatability limit, r (2,8 x s_r)	8.1	3.1	8.4
Standard deviation of reproducibility, s_R	8.5	1.6	8.8
Coefficient of reproducibility, CV_R	41	84	62
Reproducibility limit, R (2,8 x s_R)	24	4.5	25

D.2 Adhesive

***** Not available, as too many reported data points are below the quantification limit

	MBT	DBT	TBT
No. of participating laboratories	7	7	7
No. of non-eliminated laboratories	7	7	7
No. of single values of the non-eliminated laboratories	21	21	21
Average (µg/kg)	14.4	9.3	<2.0
Standard deviation of repeatability, s_r	3.1	1.8	*
Coefficient of repeatability, CV_r	22	19	*
Repeatability limit, r (2,8 x s_r)	8.7	5.0	*
Standard deviation of reproducibility, s_R	10.6	7.6	*
Coefficient of reproducibility, CV_R	74	82	*
Reproducibility limit, R (2,8 x s_R)	30	21	*

D.3 Rubber Elastic

***** Not available, as too many reported data points are below the quantification limit

	MBT	DBT	TBT
No. of participating laboratories	7	7	7
No. of non-eliminated laboratories	6	6	6
No. of single values of the non-eliminated laboratories	18	18	18
Average (µg/kg)	34.6	8.9	<2.0
Standard deviation of repeatability, s_r	6.4	3.5	*
Coefficient of repeatability, CV_r	18	39	*
Repeatability limit, r (2,8 x s_r)	17.9	9.8	*
Standard deviation of reproducibility, s_R	27.7	4.9	*
Coefficient of reproducibility, CV_R	80	55	*
Reproducibility limit, R (2,8 x s_R)	78	13.7	*

STANDARD TEST: WSP 353.0.R2 (12)

The Standard Method for the Determination of Acetone Extractable Finish on Nonwoven

The number in parentheses indicates the year of the last revision

1. Scope

The purpose of the test method is to determine the amount of finish extracted from nonwovens with acetone. The amount of finish directly influences nonwoven performance and processing properties such as: repeated strike through time, run-off, wetback and bonding.

This test method is intended for quality control and is designed for comparison of amount of finish for different nonwoven coverstocks and treatments. It does not simulate in-use conditions for finished products.

The SI values are regarded as the official standard system of measurement for this standard test method.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative reference

The following referenced documents are indispensable for the application of this document.

2.1 ISO test methods

a) ISO 5725 -1 Accuracy (trueness and precision) of Measurement Methods and Results – Part 1: General Principles and Definitions

b) ISO 5725 -2 Accuracy (trueness and precision) of Measurement Methods and Results – Part 2: Basic Method for the Determination of the Repeatability and Reproducibility of a Standard Measurement Method

c) ISO 139 (05) Standard Conditioning

d) ISO 2859-1:1999 Sampling procedures for inspection by attributes

e) ISO 3951-1:2005 Sampling procedures for inspection by variables

2.2 WSP test methods

a) WSP 001.0:R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

Reference number
WSP 353.0.R2 (12) A

Current edition approved _WSP 353.0.R2 (12)
Last approved as WSP 353.0 in 2008
Originally published as WSP 353.2 in 2008

3. Principle

The finish is extracted by running acetone through a coverstock specimen that is held in a metal tube.
The effluent is collected in a tray, mounted on a temperature-controlled hot-plate. After evaporation of the solvent is complete the extracted amount of finish is determined gravimetrically.

4. Materials and Reagents

a) Acetone, analytical reagent grade.
b) Aluminum collection tray, about 5 cm diameter, 1 cm deep, and a flat rim, or equivalent, compatible with the extraction apparatus as specified in clause 5.

5. Apparatus

The extraction unit consists of several components that are mounted together on a suitable laboratory support (figure 1):

5.1 Extraction tube

Which is constructed of stainless steel, for details, see figure 2.

5.2 Plunger

Which has a 1 kg loading weight to generate the pressure on the test specimen.

5.3 Heated collection tray

Which consists of:

a) A heated support ring
b) An aluminium collection tray
c) And a retaining ring.

NOTE 2 The aluminium tray should be clamped at the rim to have metal-to-metal contact with the heater. In the center of the tray there must be an air gap to the heater, or equivalent, capable of collecting the column effluent, and evaporating the solvent without loss of surfactant.

NOTE 3 Information concerning suitable apparatus can be obtained from EDANA, 157 Avenue Eugène Plasky, B-1030 Brussels, Belgium, Tel: +32 2 734 93 10, Fax: +32 2 733 35 18, e-mail:info@edana.org.

6. Conditioning

For conditioned testing

Condition the nonwoven test specimens for 24 hrs at 23 ºC and 50 % relative humidity. For roll goods take test specimens from the role before conditioning. Use the same conditions for conditioning and testing. When using different test conditions, it must be mentioned in the report. ISO 139 (05) specifies tolerances..

NOTE 4 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing nonwovens for a reasonable period of time before the specimens are tested; i.e., 4 hours.

7. Sampling

7.1 Lot Size

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

7.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (*Sampling procedures for inspection by attributes)* or ISO 3951-1:2005 (*Sampling procedures for inspection by variables)* can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

8. Procedure

8.1 Set up the apparatus as indicated in figure 1

The extraction tube should be attached to a support, and the plunger must move freely in the vertical direction.

a) During the test, the plunger presses down into the tube. The weight is placed on top of the plunger.
b) Before starting a series of tests, the hot-plate is allowed to warm-up to a suitable temperature (set by the power regulator). The correct temperature has been obtained when the solvent evaporates from the dish almost as quickly as fresh solution filters through to replace it. This prevents flooding of the tray and losing finish to the retaining ring.
c) The temperature is too high when the solvent evaporates violently as the drops of solution hit the hot tray.

NOTE 5 In the following steps, do not touch the aluminium tray with bare fingers; use pincers or a forceps for manipulating the material to avoid contamination.

8.2 Pre-weigh

An unused clean aluminium tray to an accuracy of 0.0001 g. Record the accurate weight (e_1). The pre-weighed aluminum tray is placed on the support under the extraction tube. Make sure there is thermal contact with the heater.

8.3 Cut a test specimen

From the conditioned portion of the test material. This specimen should weigh (2 ± 0.1) g, and weigh to an accuracy of 0.001 g.

8.4 Feed the weighed test portion evenly into the extraction tube with the help of a forcep and the plunger.

The packing should be such that during the extraction, 10 ml of acetone takes 5 to 10 minutes to percolate through the test portion. If necessary, adjust the size of the pieces and the tightness of packing to meet this requirement.

8.5 Fit into position on the apparatus

The plunger and the 1kg weight, as indicated in figure 1.

8.6 Place a small amount (about 1 ml) of solvent

On the tray before starting the extraction. This helps to avoid sputtering and excessive heating during the extraction.

8.7 Pour 10 ml of acetone

Into the cup at the top of the tube. The acetone runs along the plunger, through the test portion, and the effluent drips into the collection tray.

8.8 Add another 10 ml portion of acetone

Into the cup at the top of the tube after the first 10 ml of solvent ceases to flow from the tube, this additional acetone is also collected in the tray.

8.9 Repeat step 8.7

8.10 Hand press the plunger with the weight
This will remove any excess solvent from the specimen. When the solvent has completely evaporated, continue to heat the tray for a further 10 seconds before removing it.

8.11 Then re-weigh the tray
After it was allow to cool until a constant weight is reach. Record the weight to the accuracy of 0.0001 g. Record the exact weight (e_2). The amount of extractable finish is then calculated from the weight difference of the tray before and after extraction.

8.12 Where a blank is available
A blank can be a nonwoven without applied finish, run a blank determination by carrying out steps 8.3 thru 8.10 on the blank material. Determine 6 blank replicates in total.

NOTE 6 Alternatively, previously determined blank values from similar nonwoven may be used.

9. Calculation

The amount of extractable substance (% extractable) should be expressed as a percentage.

$$\% \text{ Extractable} = \frac{100 \times (e_2 - e_1)}{W} \qquad (9.1)$$

Where:

W (g) is the weight of the nonwoven test specimen before extraction
e_1 (g) is the weight of the receiving tray (8.3)
e_2 (g) is the weight of the receiving tray with the extracted finish (8.12)

If blank determinations were carried out (8.13), calculate the average value for the blank.

Calculate the % acetone extractable finish (% AEF) by:

$$\% \text{ AEF} = \% \text{ extractable} - \% \text{ average blank} \qquad (9.2)$$

Where:

% extractable = mass % extracted from the test materials as calculated by 9.1

% average blank = average of 6 replicate determinations of the mass % extracted from the blank material, as calculated by 9.1, or the previously determined blank value.

10. Report

In addition to the test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Type of finish
e) Individual amount of extractable finish (AEF), in percent, to an accuracy of 2 decimal places
f) Whether or not the % extractable finish has been corrected for a blank value, and if so, the blank value that was used
g) Make and model of testing equipment
h) Laboratory testing conditions
i) Number of specimens tested and note CD and MD if significant
j) Software used and version
k) Deviation from the standard test procedure, if any.
l) When calculated, the standard deviation or the coefficient of variation
m) Whether or not samples were conditioned prior to testing and, if so, for how long.
n) Anything unusual noted during the testing.
o) When photos are used as the standard, attach copies

11. Remarks

Maintenance

The reproducibility of this test depends on avoiding cross-contamination and the cleanliness of the extraction equipment. In order to avoid contamination from the inner part of the apparatus, clean it carefully after every test or see the maintenance instructions from the manufacturer.

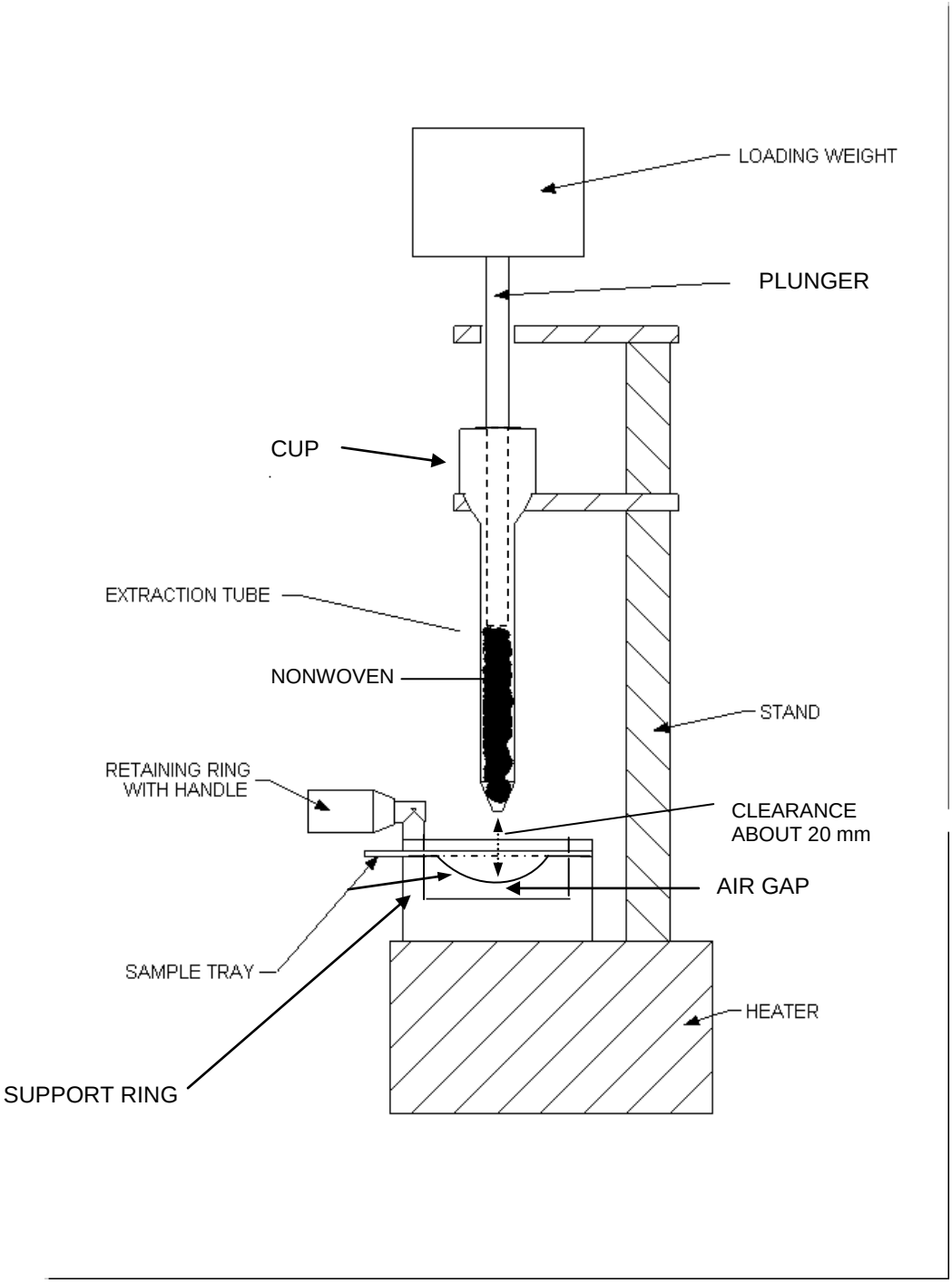


Figure 1: Extraction apparatus

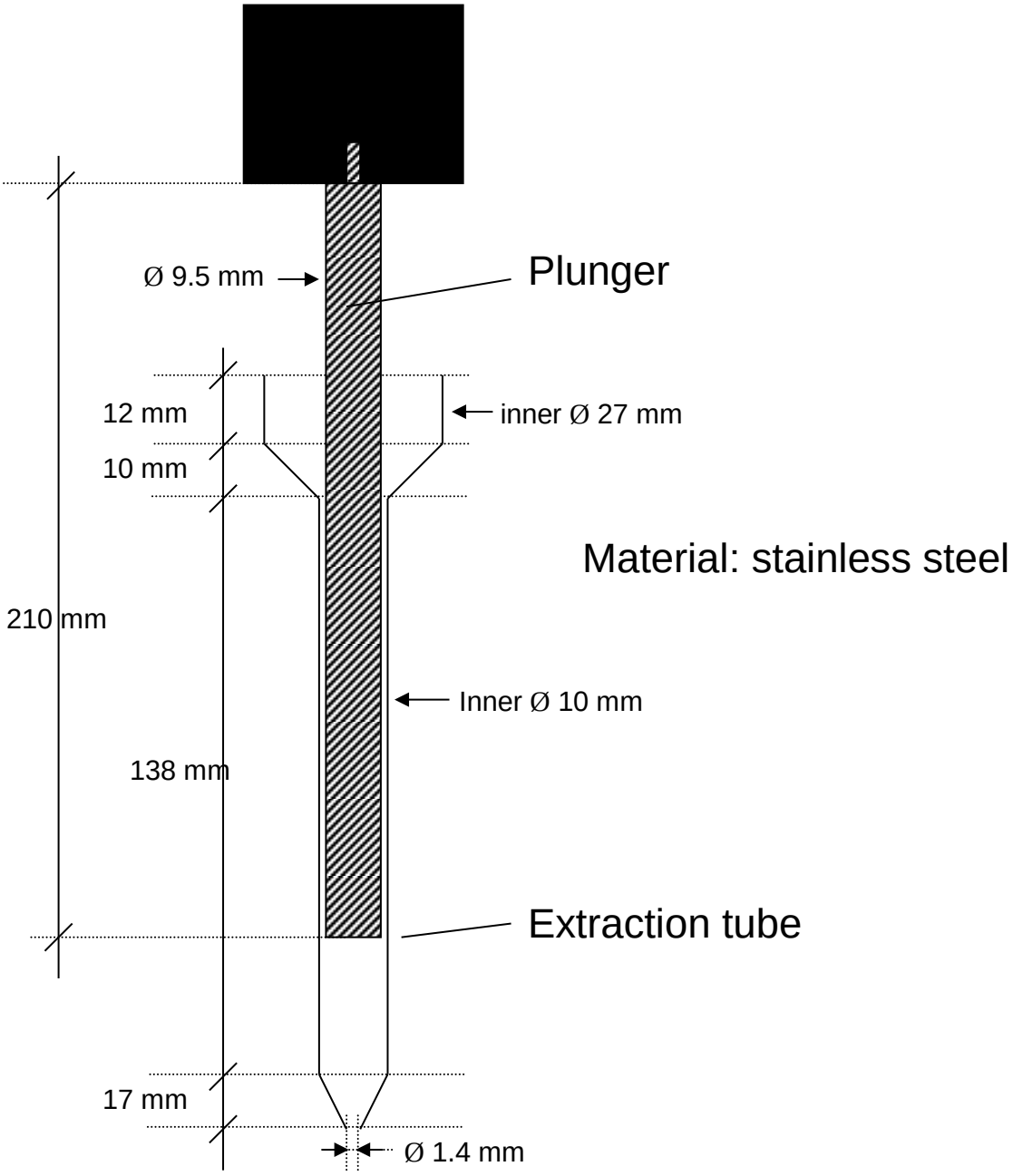


Figure 2: Details of the extraction tube

ANNEX A

(informative)

Statistical Results of Interlaboratory Tests

Figures for the repeatability$_{(r)}$ and reproducibility$_{(R)}$ of this method are the result of collaborative studies carried out in 2003 by EDANA. The evaluation of the interlaboratory test was carried out in accordance with ISO 5725-2 and results are as follows:

	Nonwoven A	Nonwoven B	Nonwoven C
No. of participating laboratories	6	6	6
No. of non-eliminated laboratories	6	6	6
No. of single values of non-eliminated labs	60	60	60
Average (% extractable finish)	0.42	0.54	0.39
Standard deviation of repeatability, s_r	0.029	0.021	0.020
Coefficient of repeatability, CV_r	6.9 %	3.9 %	5.2 %
Repeatability limit, r (2.8 x s_r)	0.080	0.059	0.056
Standard deviation of reproducibility, s_R	0.035	0.028	0.032
Coefficient of reproducibility, CV_R	8.3 %	5.3 %	8.2 %
Reproducibility limit, R (2.8 x s_R)	0.097	0.080	0.088

STANDARD TEST: WSP 354.0.R2 (12)

Standard Test Method: Absorption before Leakage Using an Adult Mannequin

The number in parentheses indicates the year of the last revision

1. Scope

This test method originated from EDANA and covers the evaluation of the performance of incontinence products for moderate and severe incontinence. It has been validated for all sizes briefs and pads (XS, S, M, L and XL) and Absorption Before Leakage (ABL) values from 300 g to 1100 g.

NOTE 1 This test has been designed for the evaluation of the performance of incontinence products for non-ambulatory adults in residential settings and nursing homes.

NOTE 2 This test is not applicable to incontinence products for light incontinence and other situations, than described above.

The SI values are regarded as the official standard system for measurement for this standard test method.

NOTE 3 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative Reference

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document applies.

2.1 ISO test methods

a) ISO 139:2005 Standard atmospheres for conditioning and testing

b) ISO 16021:2000 Urine absorbing aids – Basic principles for evaluation of single-use adult-incontinence-absorbing aids from the perspective of users and caregivers

c) ISO 9949-3:1993 Urine absorbing aids – Vocabulary

d) ISO 3696:1987 Water for analytical laboratory use; Specification and test methods

2.2 DIN test methods

a) DIN EN ISO 3386-1:1998 Polymeric materials, cellular flexible. Determination of stress-strain characteristics in compression. Part 1: Low density materials

b) DIN 53505: 2000: Testing of rubbers and elastomers –Shore A and Shore D hardness

Reference number
WSP 354.0.R2 (12) A

Current edition approved WSP 354.0.R2 (12)
Originally EDANA published this method as WSP 354.0 in 2009
Last approved as WSP 354.0 in 2010

2.3 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods.

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply.

3.1 Absorption before leakage

Mass of test fluid the product can absorb under specific conditions before it leaks.

3.2 Leakage

The moment in time when test fluid is observed to flow from the absorbency pad.

3.3 Mannequin

A mannequin, moulded in appropriate synthetic material, representing the lower part of the body. It represents a female body, but a male adapter is provided. It is designed to deliver saline solution from a reservoir.

3.4 Repeatability $_r$

As determined by the test method is the variability found between the test results of randomly selected homogenous specimens, tested at one laboratory, using one technician, one instrument, and one set of environmental conditions which were found on one given day.

3.5 Reproducibility $_R$

As determined by this test method is the variability found between the test results of randomly selected homogenous specimens, which were tested at different laboratories, using more than one technician at each laboratory, and tested over a two day period using standard laboratory environmental conditions which were found at each laboratory.

4. Principle

The product to be tested is applied to a mannequin and repetitive insults of test fluid occur until leakage is observed. The mass of test fluid the product can absorb before it leaks is measured by the weight difference between the saturated and the dry product.

5. Apparatus

5.1 Mounting frame

The mounting frame is made from stainless steel. An example of an appropriate mounting frame can be seen in drawing A 3.1. Other frames must fulfil the testing conditions. Close access to the mannequin from all sides is recommended.

5.2 Mannequin

The dimensions of the recommended mannequin for this test can be seen in figures 1-2.
The mannequin and the male adapter surface consist of a high-tensile silicone rubber with the following mechanical characteristics:

a) hardness Shore A (DIN 53505): 21 ± 3
b) relative density at 25°C (g/cm³) : 1.20 ± 0.1
c) when test fluid (see 5.7) is applied on the cleaned, dry silicone surface of the mannequin droplets show contact angle of 45-60°.

The test fluid delivery tube should be made of silicone with a 3 mm inner diameter and 5 mm outer diameter.

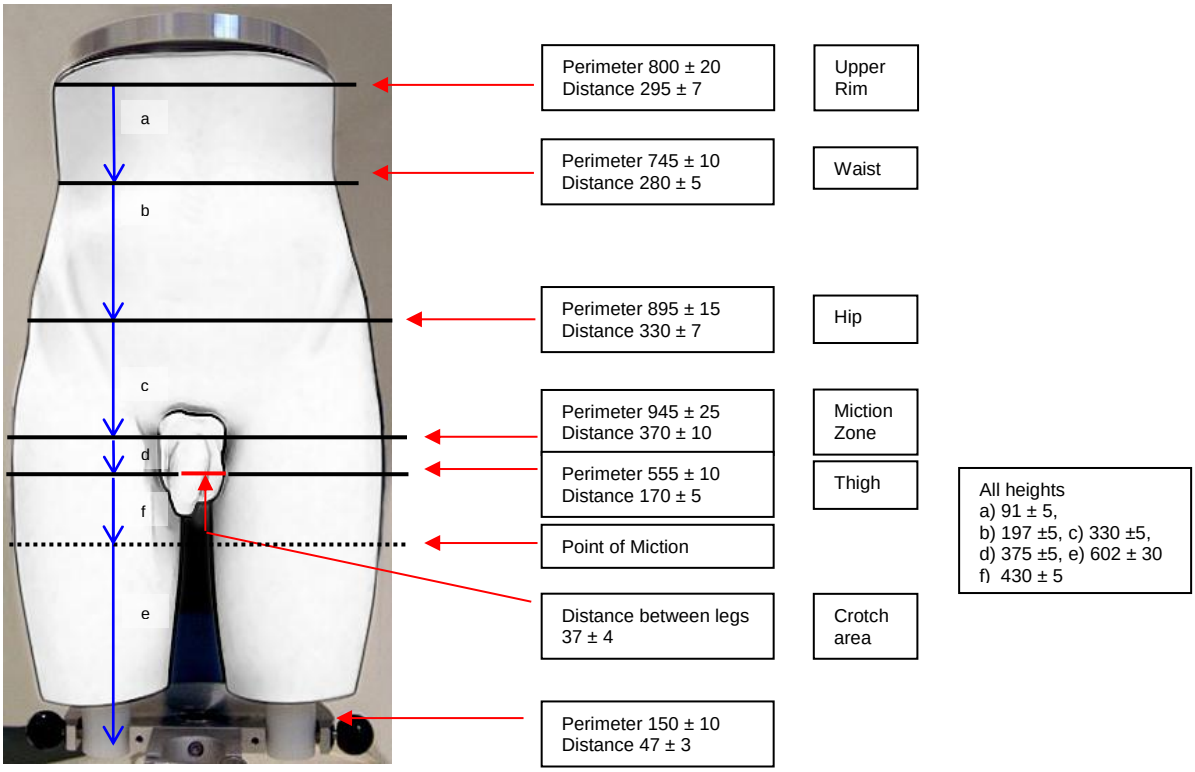


Figure 1: Dimensions [mm] mannequin size 2 – front view

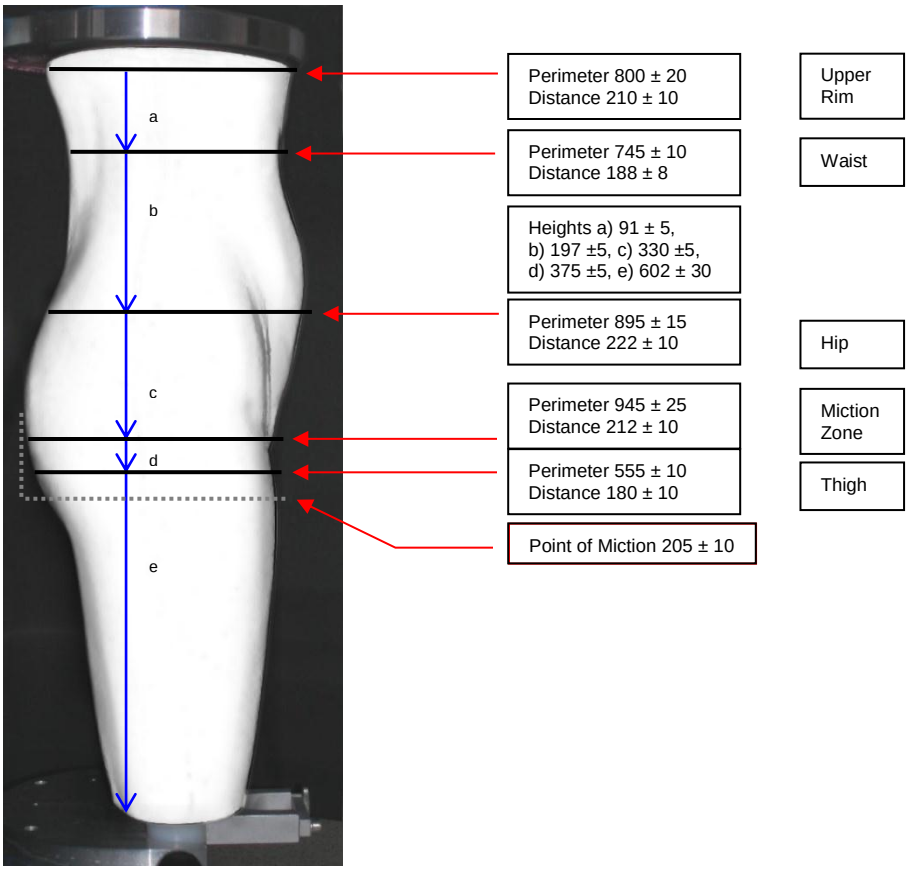


Figure 2: Dimensions [mm] mannequin – side view

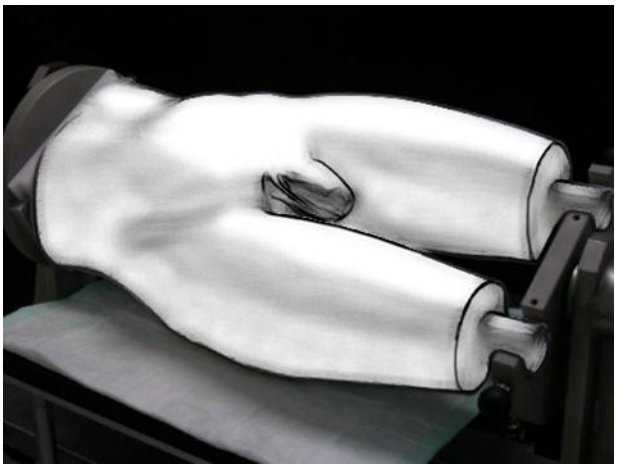


Figure 3: Inclined position of mannequin with male adapter

The mannequin is equipped with a male adapter slightly inclined to one side. During the testing the mannequin is turned along its centre-line with an angle of 30° towards the side of the inclined adapter (see figure 3). The dimensions of the male adapter are described in figures 4-5.

There are two different sizes for male adapters:

a) The standard size male adapter is applicable to all pads.
b) For briefs the standard size male adapter is from size medium onwards.
c) The small male adapter is applicable to briefs in sizes small and less, i.e. waist size below 90 cm.

The dimensions of the standard male adapter are described in figures 4-5.
The dimensions of the small male adapter are described in figures 6-7.

Courtray Consulting-Labservice, Douai, France, should be approached directly for any matter related to the mannequin and its accessories (male adapters).

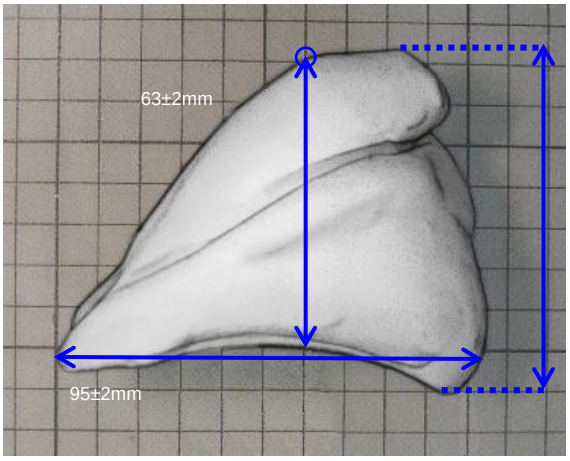


Figure 4: Male Adapter side view
(1 square = 1 cm²)
for briefs sizes M, L, XL and all pads

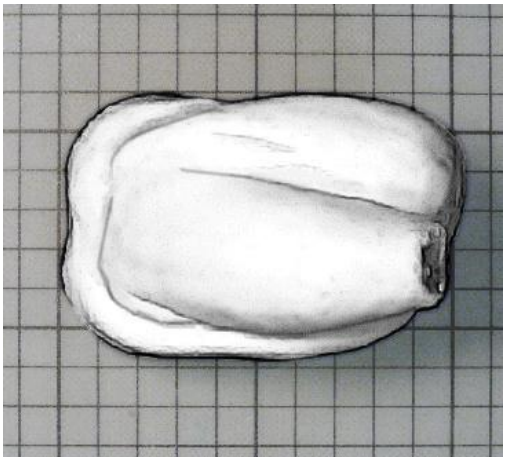


Figure 5: Male adapter front view

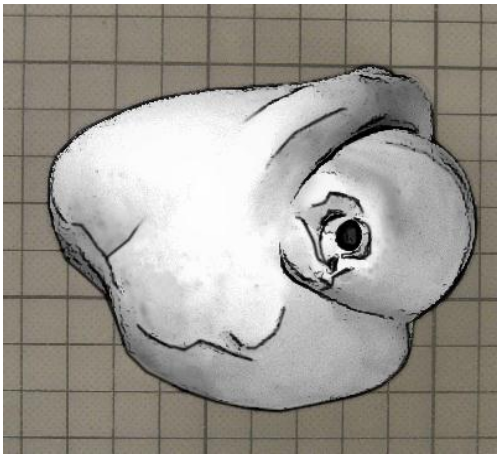


Figure 6: Male adapter bottom side view (1 square = 1 cm²)

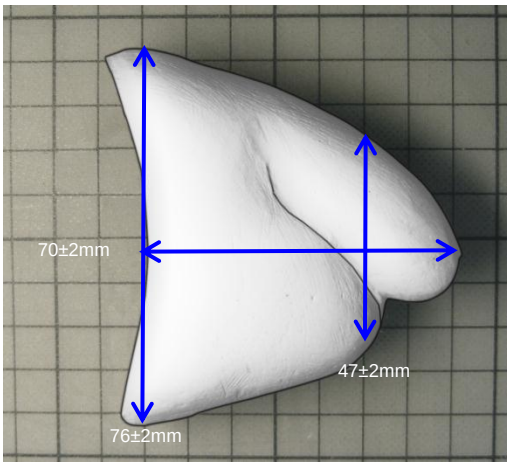


Figure 7: Small male adapter side view
(1 square = 1 cm²)
for briefs sizes XS, S

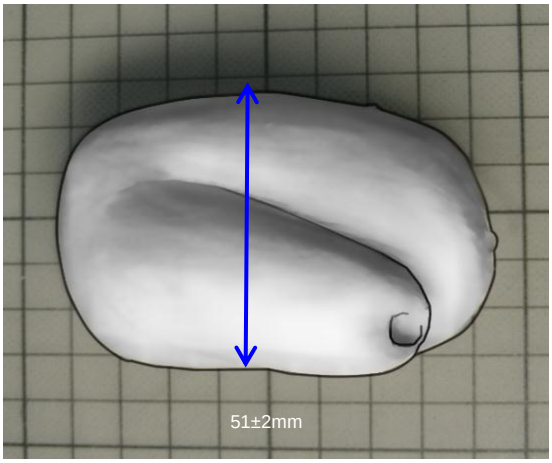


Figure 8: Small male adapter front view

5.3 Mattress

Sponge rubber as rectangular pad;

a) dimensions (length x width x height). : 530 x 425 x 25 mm
b) density: 0.55 ± 0.05 g/cm³,
c) hardness Shore A (DIN 53505): 15 ± 5;
d) bulge resistance 40% (DIN EN ISO 3386): 185 ± 8 kPA

5.4 Wedge

Wedge-shaped foam cushion with waterproof protection cover;

a) dimensions(length x width x height): 405 x 300 x 180/0 mm;
b) density: 0.40 ± 0.05 g/cm³;
c) hardness according to Shore A (DIN 53505): 15 ± 5;
d) bulge resistance 40% (DIN EN ISO 3386): 6.5 ± 0.5 kPA

5.5 Balance

Capable of determining mass up to 2000 g to an accuracy of ±1g.

5.6 Stopwatch

With precision to the second.

5.7 Test Liquid

0.9 ± 0.01% sodium chloride solution in demineralized water (grade 2 acc. to ISO 3696) stained with fuchsin acid red (5 ±1mg/l).

6. Conditioning

Condition the sample in an opened bag for at least 12 hours at 23°C and 50% relative humidity; test conditions are to be mentioned in the report (see ISO 139) for tolerances and choice of conditions.

7. Positioning of the test product on the mannequin

Always follow the product manufacturer's instructions given to apply the product to the human body as shown on the package or leaflet.

General recommendations for applying an incontinence product on the mannequin are given below.

7.1 Pads

The product is gently folded in the longitudinal direction forming a pouch; the absorbency pad may not be damaged thereby mechanically.
Refer to the manufacturer's instructions how to apply the product. Usually the putting on position is determined by the leg cut out so that the insult point lies approximately in the middle of the leg cut out.
If the product possesses cuffs, it is to be made certain the cuffs come to rise when putting on correctly and they properly lie in the groin. Correct position is achieved when the upstanding cuffs surround the male adapter properly (see figure 9). In doing so do not pull the cuffs. The position is controlled from the ventral and back side.
The leg elastics are folded outwardly in the crotch region so that the backside faces outwards (see figure 10).
The product is spread flatly on front and backside to ensure close, snug fit. In the area of the wetness indicator no recessing may be recognizable.
The product is fixed afterwards with a net pant of suitable size

7.2 Briefs

The product is gently folded in the longitudinal direction forming a pouch; the absorbency pad may not be damaged thereby mechanically.
Refer to the manufacturer's instructions how to apply the product. Usually the putting on position is determined by the leg cut out so that the insult point lies approximately in the middle of the leg cut out.
If the product possesses cuffs, it is to be made certain the cuffs come to rise when putting on correctly and they properly lie in the groin. Correct position is achieved when the upstanding cuffs surround the male adapter properly (see figure 9). In doing so do not pull the cuffs. The position is controlled from the ventral and back side.
The leg elastics are folded outwardly in the crotch region so that the backside faces outwards (see figure 10).
Unfold the ears of the product and put on smoothly.
The product is spread flatly on front and backside to ensure close, snug fit. In the area of the wetness indicator no recessing may be recognizable.
The product is fixed now with the help of the tapes. First the lower tapes are fixed tightly and aligned to each other as shown in figure 13.
Then pull the ear slightly diagonally into direction of absorbency pad in order to correctly apply the waist and back region. A faultless fit, free of creases shall be achieved.
Finally fix the upper tapes as is shown in figure 13.

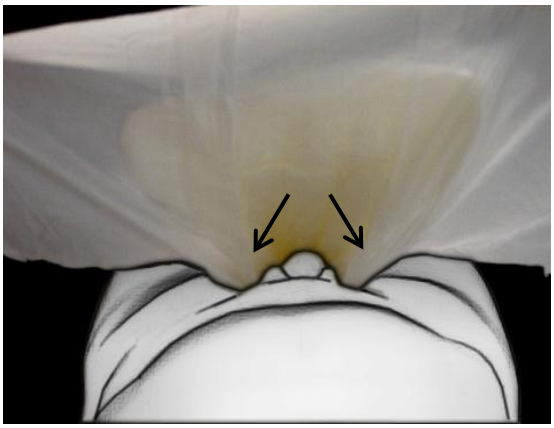


Figure 9: Upstanding position of cuffs in the crotch area

Figure 10: Outwardly applied leg elastics in the crotch area

NOTE 4: If ear length of extra small and small size briefs do not enable closure of front to back region by own tapes the product can be fixed by additional adhesive stripes (see figure 11)

NOTE 5: Take care not to apply small briefs too tight to the body – avoid direct contact between small adapter outflow and product surface. The liquid flow needs a pouch in the crotch area to be properly absorbed (figure 12)

NOTE 6: Large and extra large briefs are applied with overlapping ears

Figure 11: Fixation of small size brief product with additional adhesive stripe

Figure 12: Product pouch in the crotch area

Figure 13: Example for fixation of tapes with briefs size M

8. Flow Profile

Time [sec]	Flow [ml/min]	Volume [ml]
0	0	0,00
2	100	3,33
4	200	6,67
6	500	16,67
8	1000	33,33
10	1200	40,00
12	500	16,67
14	400	13,33
16	250	8,33
18	350	11,67
20	100	3,33
22	80	2,67
24	60	2,00
26	40	1,33
28	40	1,33
30	40	1,33
Total		162

Table 1: Flow data; for tolerances see clause 10

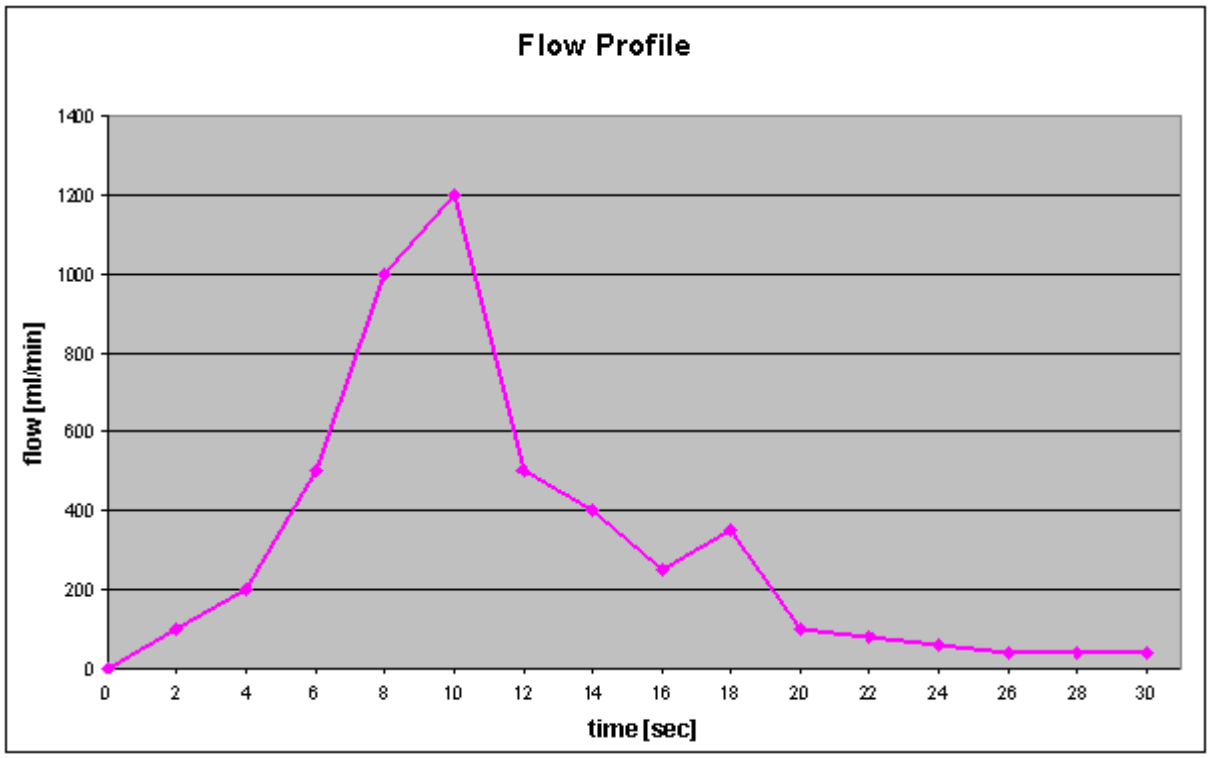


Figure 14: Flow profile

9. Detection of leakage

The test is performed until leakage occurs, i.e. test fluid leaves the absorbent core. Leakage may show up as test fluid is visibly wetting the non absorbent part of the product, puddles of test fluid forming within the non absorbent part of the product or test fluid even running out of the product (see figures 15-17) or any other type of leakage according to the definition.
Each product construction has its critical points of leakage and must be observed accordingly.

Figure 15: Leakage: Test Fluid wetting the non absorbent part of the product.

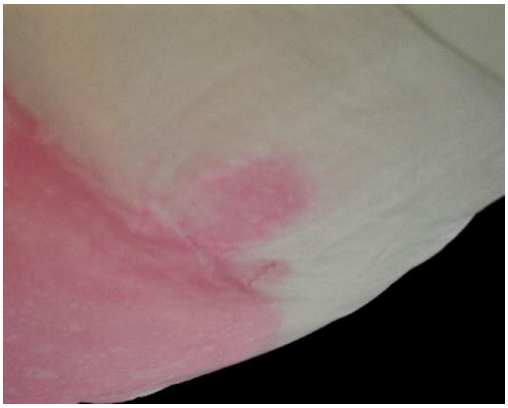


Figure 16: Leakage: Puddle of Test Fluid

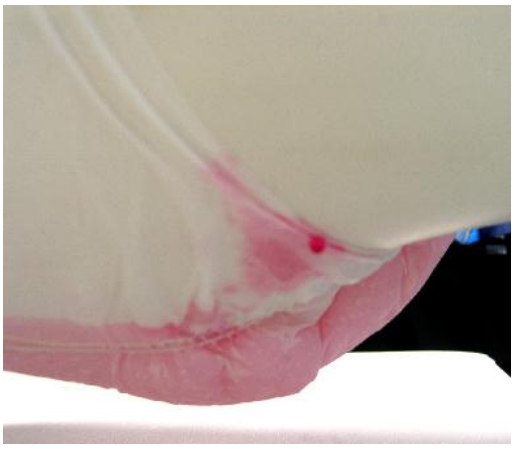


Figure 17: Leakage: Test Fluid dripping out of the product

10. Procedure

Absorption Before Leakage (ABL)

1. Take the sample out of the conditioned bag; weigh the product; P_{dry}
2. Apply the product on the mannequin according to manufacturer's instructions and pay attention to the critical points mentioned in chapter 7.
3. The mannequin is brought into the standard position acc. to chapter 5.2.
4. Place an under pad between the mannequin and the mattress for better indication of leakage
5. Place the wedge cushion from left side under the mannequin. Position is correct when the sharp front edge of the wedge is 4 ± 1 cm right of the longitudinal center line of the mannequin (see figures 18-19).
6. Subsequently the supporting plate with mattress, underpad and wedge is pressed pneumatically on the mannequin with a force of 162 ± 15 N
7. Use the standard flow profile: 162 ± 2 ml in 30 ±1 sec (see clause 8)
8. Perform a single pre-test to determine the approximate range of ABL for this product. This value is not part of the calculation. Note the number of insults needed until leakage.
9. The first insult is injected with the adjusted time/volume profile. After 5 min retention time check for leakage. Leakage must be observable from outside through the backsheet.
10. During this 5 min retention time do not lower the table or lose the product to check for leakage. When arriving close to the leakage range as determined by pre-testing, the table can be lowered after the 5 min retention time to check for leakage. It is recommended to lower the table one insult before reaching the total number of doses as determined by pre-test. Make sure not to open or move the product for checking. Lowering and re-lifting the table must be done within max. 30 sec.
11. If no leakage is detected, proceed with the next insult. Repeat insults until leakage occurs. If leakage occurs directly after an insult, wait again for 5 min before removing the product.
12. Lower the supporting plate and remove the wedge, then carefully remove the product from front to back. Remove excessive test fluid.

13. Subsequently, weigh the wet product; Pwet

Absorption Before Leakage ABL = P_{wet} - P_{dry} [g]

Indicate average, minimum, maximum values and standard deviation, rounded to the nearest 10 g. Perform at least 6 replicates.

11. Report

In addition to the precise test results, the report shall include the following information:

a) Reference to the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Number of specimen tested
g) Software used and version
h) Deviation from the standard test procedure, if any
i) Average absorption before leakage rounded to the nearest 10 g, minimum, maximum and its standard deviation
j) Whether or not samples were conditioned prior to testing and, if so, for how long
k) Anything unusual noted during the testing
l) Identification of the liquid and include the conductivity and surface measurement method used
m) Noncommittal recommendations to facilitate the testing procedure
n) Detection of leakage: Use a mirror to inspect the under parts of the product
o) Detection of leakage: On the outside of the product mark the contour of the absorbent core with a dark marker pen. Test fluid leaving the absorbent core is easily detected when crossing this line (see figure 20).
p) Application of product: To reduce the friction of the skin like surface of the mannequin use a lubricating powder. A small amount of e.g. talcum powder might be brushed on surface areas on legs and crotch area.

Figure 20: Brief product with marked absorbent core line

ANNEX A

(informative)

Statistical results of interlaboratory tests

A.1 Briefs size M, Pads

Figures for the repeatability$_{(r)}$ and reproducibility$_{(R)}$ of this method are the result of collaborative studies carried out in (2010) by (EDANA). Six laboratories of incontinence product manufacturers participated in a lab round robin of the Absorption Before Leakage (ABL) test method. Twelve neutralized samples which were also used in a correlated in-use study, were tested in all participating labs (six briefs size M and six pads).
Each lab repeated six individual samples for each product. Statistical methods for evaluation were a robust estimation of the mean and of the standard deviation according to DIN 38 402 part A45.

Table A 1 shows the cumulated results for six briefs size medium and six pads. The evaluation obtained a common coefficient of variation of 7.3 %.

Product		Dim.	ABL
Pad Z	Mean	g	737
	SD	g	35
	CV	%	4,8%
Pad W	Mean	g	328
	SD	g	27
	CV	%	8,3%
Pad R	Mean	g	739
	SD	g	33
	CV	%	4,5%
Pad S	Mean	g	526
	SD	g	47
	CV	%	9,0%
Pad X	Mean	g	496
	SD	g	73
	CV	%	14,6%
Pad T	Mean	g	427
	SD	g	29
	CV	%	6,7%
Brief Z	Mean	g	840
	SD	g	66
	CV	%	7,8%
Brief W	Mean	g	614
	SD	g	49
	CV	%	8,0%
Brief Q	Mean	g	800
	SD	g	41
	CV	%	5,1%
Brief U	Mean	g	720
	SD	g	46
	CV	%	6,4%
Brief X	Mean	g	557
	SD	g	37
	CV	%	6,7%
Brief T	Mean	g	814
	SD	g	45
	CV	%	5,5%
	CSD	g	46
	CCV	%	7,3%

Table A 1: Evaluation of the Test Method by Lab Round Robin

Mean = robust estimation of the mean
SD = robust standard deviation of the mean
CV = coefficient of variation as percentage of the mean
CSD = common standard deviation within products
CCV = common coefficient of variation
Dim = dimension

A.2 Briefs size XS, S, L and XL

Six laboratories of incontinence product manufacturers participated in a lab round robin to determine the ABL of briefs sizes extra small (XS), small (S), large (L) and extra large (XL). Each lab repeated six individual samples for each product Statistical methods for evaluation were a robust estimation of the mean and of the standard deviation according to DIN 38 402 part A 45.

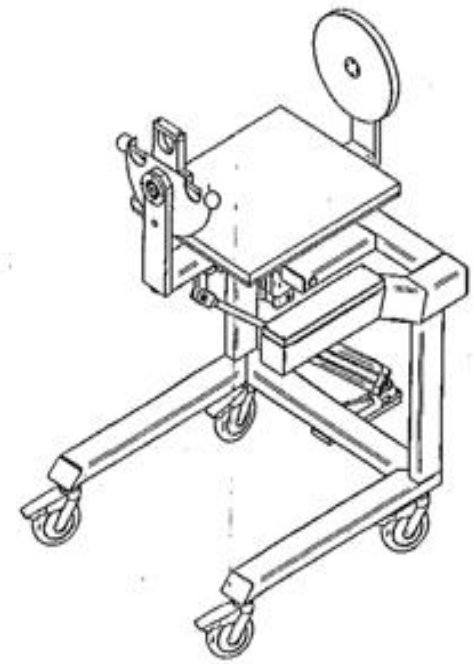
Table A 2 shows the cumulated results for eleven briefs with two briefs size XS, two briefs size S, five briefs size L and two briefs size XL. The evaluation obtained a common coefficient of variation of 7.0 %.

Product		*Dim.*	**ABL**
Brief 1 - XS	Mean	*g*	461
	SD	*g*	19
	CV	*%*	4,1%
Brief 2 - XS	Mean	*g*	352
	SD	*g*	37
	CV	*%*	10,6%
Brief 3 - S	Mean	*g*	628
	SD	*g*	22
	CV	*%*	3,6%
Brief 4 - S	Mean	*g*	508
	SD	*g*	65
	CV	*%*	12,8%
Brief 5 - L	Mean	*g*	618
	SD	*g*	43
	CV	*%*	7,0%
Brief 6 - L	Mean	*g*	635
	SD	*g*	17
	CV	*%*	2,7%
Brief 7 - L	Mean	*g*	643
	SD	*g*	23
	CV	*%*	3,6%
Brief 8 - L	Mean	*g*	689
	SD	*g*	66
	CV	*%*	9,5%
Brief 9 - L	Mean	*g*	1038
	SD	*g*	68
	CV	*%*	6,5%
Brief 10 - XL	Mean	*g*	801
	SD	*g*	40
	CV	*%*	5,0%
Brief 11 - XL	Mean	*g*	328
	SD	*g*	10
	CV	*%*	2,9%
	CSD	*g*	42
	CCV	*%*	7,0%

Table 3: Evaluation of the ABL Round Robin on mannequin with small male adapter

Mean = robust estimation of the mean
SD = standard deviation of the mean
CV = coefficient of variation as percentage of the mean
CSD = common standard deviation within products
CCV = common coefficient of variation
Dim. = dimension

Attachment A 3



Drawing A 3.1: Mounting Frame; CAD drawing

USEFUL METHOD: WSP 400.0.R2 (12)

Surface Linting of Nonwovens

The number in parentheses indicates the year of the last revision

1. Scope

This test method measures particle loss from the surface of nonwovens, i.e. it evaluates the weight of particles, mainly fibers, likely to become detached from the surface of the nonwoven under conditions of use.

SI values are regarded as the official standard system of measurement for this standard test method.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are used in the application of this document:

2.1 ISO test methods

a) ISO 139: Textiles — Standard atmospheres for conditioning and testing
b) ISO 2859-1:1999 Sampling procedures for inspection by attributes
c) ISO 3951-1:2005 Sampling procedures for inspection by variables

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

This is based on methods already used as internal methods by industry and which have been adapted by the Technical Committee of EDANA.

3. Principle

A roller covered with a specified adhesive tape passes ten times over the nonwoven sample. Samples are weighed before and after the roller treatment, the difference in weight thus giving a quantitative measurement of particles collected by the adhesive rolls. Measurements were taken on the two sides of the nonwoven and in both directions MD and CD.

Reference number
WSP 400.0.R2 (12) UM

Current edition approved WSP 400.0.R2 (12)
Originally published as WSP 400.0 in 2005
Last approved as WSP 400.0.R2 in 2005

4. Apparatus

4.1 Roller (Plexiglass® cylinder)

a) Outside diameter = 70 mm
b) Width = 60 mm
c) Weight = 390 g
(including axle but not adhesive)
d) Speed = 240 cm/min

4.2 Adhesive tape (double surface type)

a) Reference = 3M 400 adhesive
b) Width = 50 mm

4.3 Balance

Capable of determining mass to an accuracy of 0.0001 g

5. Conditioning

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 2 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested, i.e. 4 hours.

6. Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (*Sampling procedures for inspection by attributes)* or ISO 3951-1:2005 (*Sampling procedures for inspection by variables)* can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 to 1200	35

NOTE 3 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

6.1 Laboratory sample

From each roll or portion of material taken from the lot sample, cut at least one laboratory sample the full width of the fabric and 1 m in the machine direction. This is done after removing the first outside wrap or discarding the first 1 m length. For nonwoven fabric components of fabricated systems use the entire system.

6.2 Test specimens

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material.

a) Care in handling should be observed so that specimens do not contact any contaminants such as soap, salt, oil etc., which might facilitate or hinder water penetration.
b) Specimens should be cut 50 x 400 mm.
c) The area tested (5 cm x 15 cm = 75 cm^2) is delinted by two adhesive silicon papers put on the sample as shown on the diagram. The purpose is to avoid extending fibers when the roller changes direction.

7. Procedure

Procedure	Worked Example
7.1 Cut 10 samples in each direction (MD and CD) to a size of 50 x 400 mm and note side A and side B on the sample. For each direction, 5 samples will be tested on side A and 5 others on side B.	
7.2 Put the adhesive silicon paper on the side to be tested according to the diagram.	
7.3 Weigh the samples to an accuracy of 0,0001 g. (This is weight m1).	
7.4 Open the clamps of the apparatus.	
7.5 Place the first test piece (side A, MD) over the platform without distortion and without pre-tensioning.	
7.6 Clamp it into position.	
7.7 Cut a length of 220 mm, from the adhesive tape roll (width 50 mm) and stick it to the roller.	
7.8 Put the roller on the runner.	
7.9 Run the test (roller passes over sample 5 times to and fro).	Side A, MD m_1 (g) / m_2 (g) / $Lint_{A\ MD}$ (g/m^2) 1.9712 / 1.9706 / 0.08 2.0534 / 2.0529 / 0.07 2.6822 / 2,6817 / 0.07 2.9623 / 2.9616 / 0.09 2.6473 / 2.6468 / 0.07
7.10 Release clamp and weigh the sample to an accuracy of 0.0001 g. (This is weight m_2)	
7.11 The amount of surface lint is calculated as follows : Lint = $(m_1 - m_2)$ X 133 g/m^2	
7.12 Repeat with the other 4 remaining samples (Side A, MD)	Average: $Lint_{A,MD}$ = 0.08 g/m^2 Average: $Lint_{A,CD}$ = 0.12 g/m^2
7.13 Average the 5 values for side A, MD = $Lint_{A,MD}$ (g/m^2)	Surface linting side A:
7.14 Repeat with side A, CD and side B, MD and CD	$Lint_A = \frac{0.08 + 0.12}{2} = 0.10\ g/m^2$
7.15 Calculations and results (in g/m^2): a) Average measured for surface linting	Side B Average: $Lint_{B,MD}$ = 0.06 g/m^2 Average: $Lint_{B,CD}$ = 0.09 g/m^2

side A: $Lint_A = \frac{Lint_{A,MD} + Lint_{A,CD}}{2}$ b) Average measured for surface linting side B: $Lint_B = \frac{Lint_{B,MD} + Lint_{B,CD}}{2}$	Surface linting side B: $Lint_B = \frac{0.06 + 0.09}{2} = 0.08\ g/m^2$
c) Total amount of surface linting for the sample Total lint = $Lint_A + Lint_B$	Total surface linting: Total lint = 0.18 g/m^2

8. Report

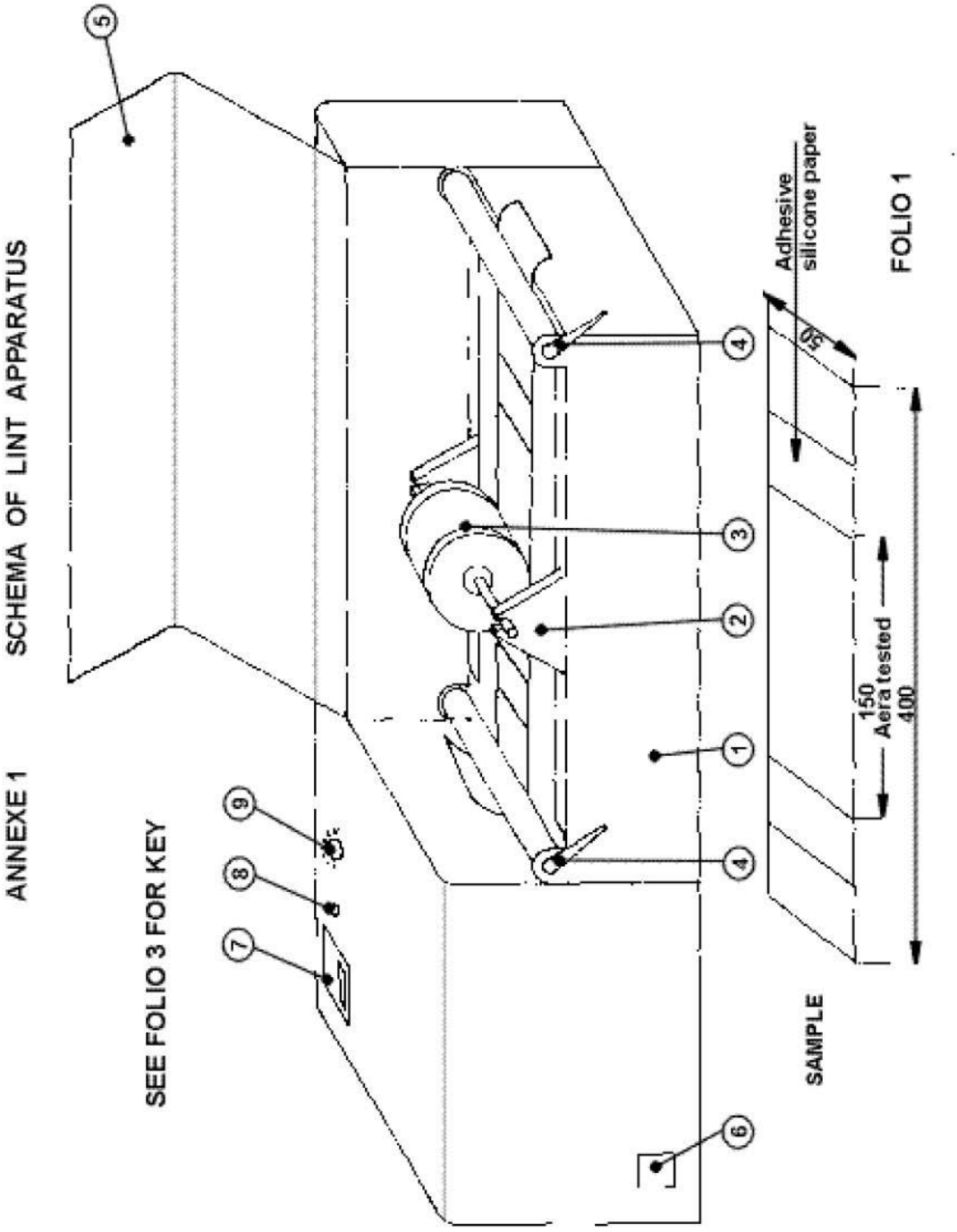
In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Number of specimens tested and note CD and/or MD if significant
g) For computer processed data, identify the software used and the version
h) Deviation from the standard test procedure, if any
i) When calculated, the standard deviation or the coefficient of variation
j) Whether or not samples were conditioned prior to testing and, if so, for how long
k) Anything unusual noted during the testing
l) Average surface linting on each side of sample in g/m^2
m) Total amount of surface linting in g/m^2

9. Precision

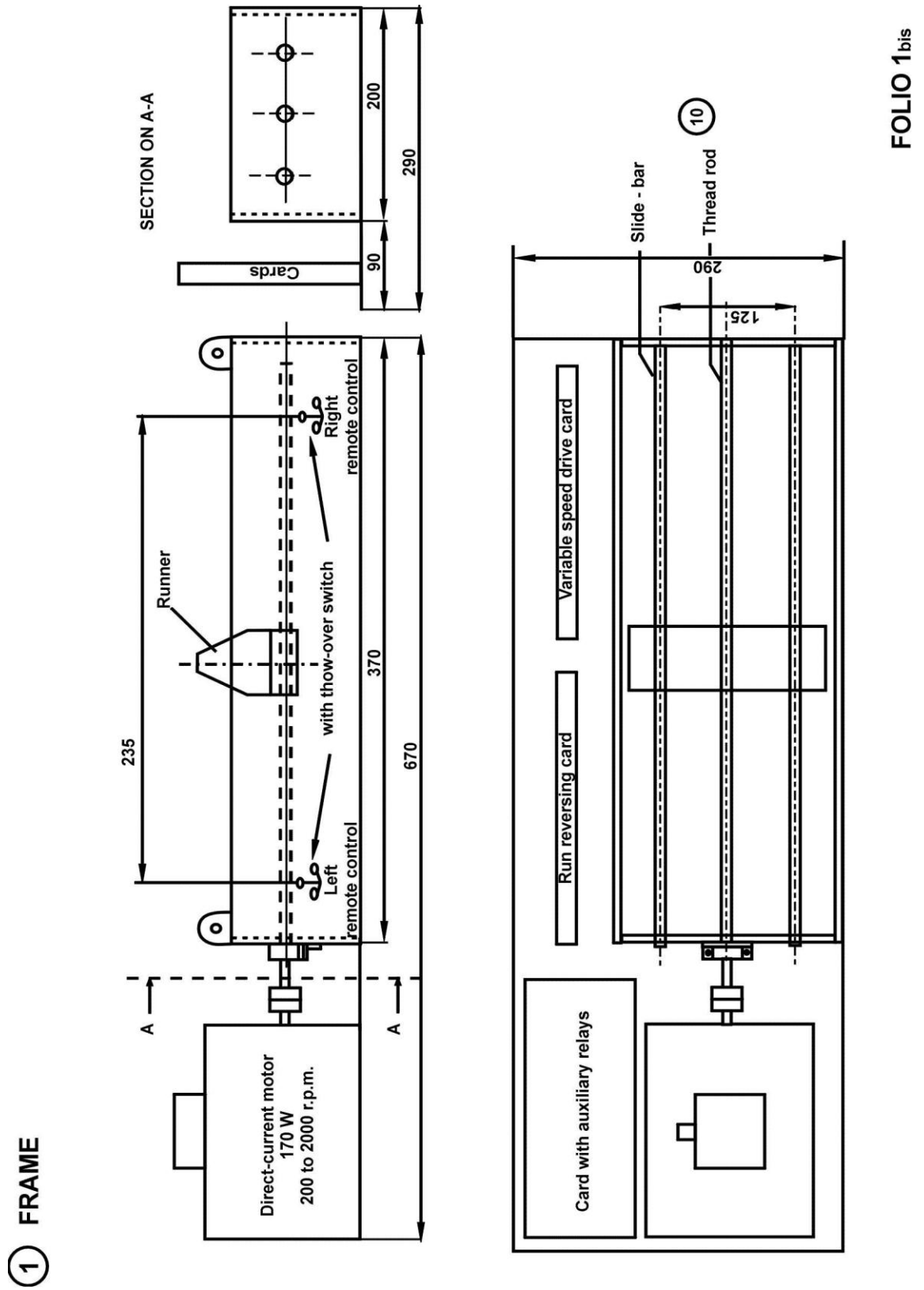
The precision for this method is yet to be determined.

ANNEXE 1 SCHEMA OF LINT APPARATUS

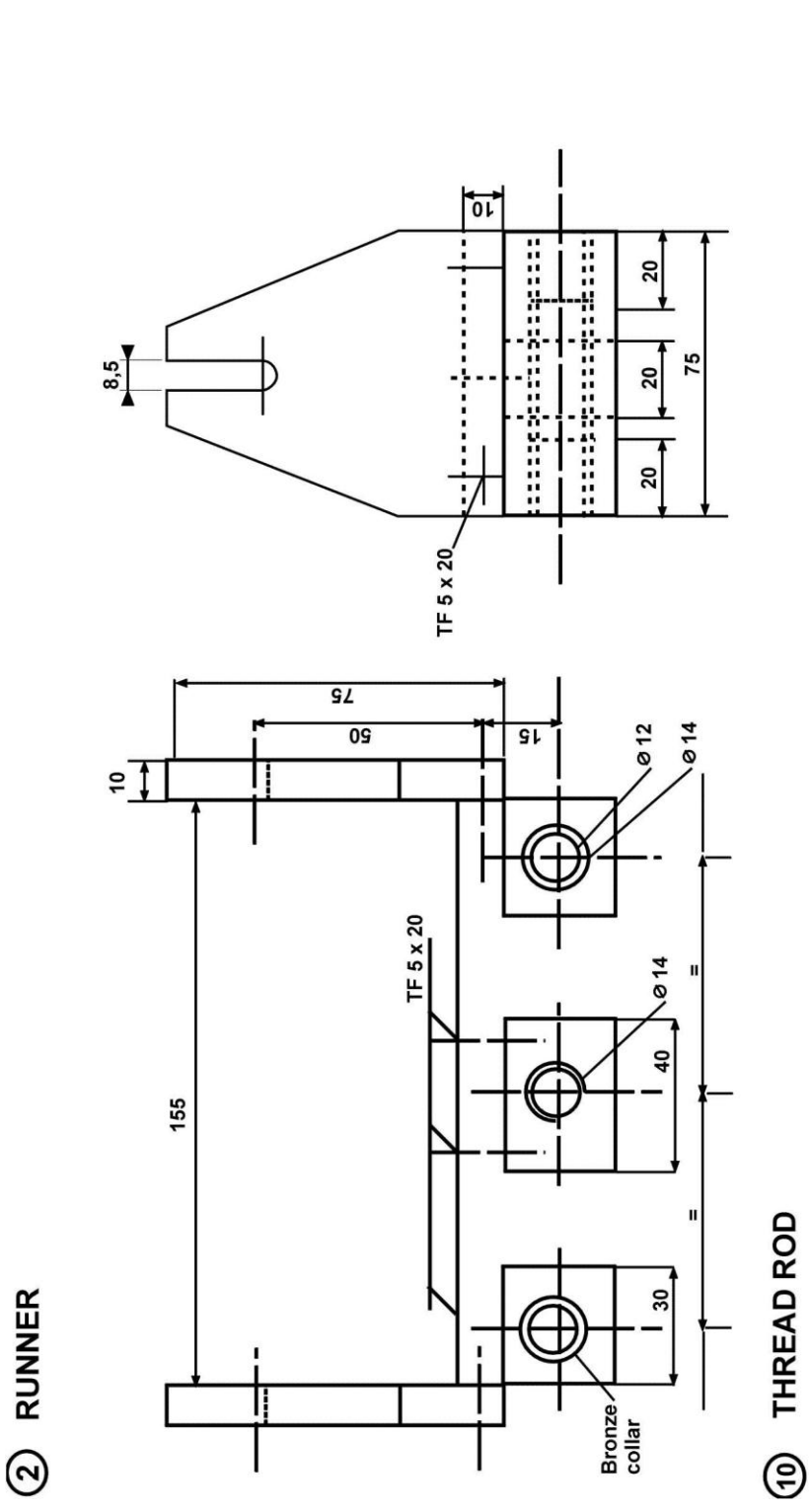


FOLIO 1bis

① FRAME



FOLIO 2



② RUNNER

⑩ THREAD ROD

FOLIO 3

NAMES OF PARTS

REFERENCE	DIAGRAM	DESCRIPTION	MATERIAL
1	Folio 1bis	FRAME	SOFT STEEL
2	Folio 2	RUNNER	ALUMINIUM
3	Folio 3	ROLLER	PLEXIGLASS
4	Folio 1	TIGHTENING ECCENTRIC	SOFT STEEL
5	Folio 1	PROTECTION	PLEXIGLASS
6	Folio 1	MAIN SWITCH	"
7	Folio 1	COUNTER	"
8	Folio 1	PUSH-BUTTON (cycle starting)	"
9	Folio 1	VARIABLE SPEED DRIVE	"
10	Folio 2	THREAD ROD M 14	STAINLESS STEEL

③ ROLLER

Total weight 390 g

USEFUL METHOD: WSP 401.0.R3 (12)

Test Method for Composites Lamination Strength

The number in parentheses indicates the year of the last revision

1. Scope

This WSP useful test method gives guidelines for measuring the force necessary to separate from each other two components of laminated products composed of two or more components.

This method is based on procedures already in use as internal methods by the industry, which have been adapted by an ad-hoc committee at EDANA. Although it can be used to measure lamination strength on laminates obtained by any process, this method has been statistically validated for hot-melt laminates as well as for extrusion coated laminates. It has not been validated for any other lamination process, and is therefore referred to as a "useful test method" rather than as a "standard test method".

Separation force for a specified width, on a specified length of material, is determined by applying a force longitudinally at a specified constant rate of extension.

SI values are regarded as the official standard system of measurement for this standard test method.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative reference

The following referenced documents are for the application of this document:

2.1 ISO test methods

a) ISO 139: Textiles — Standard atmospheres for conditioning and testing
b) ISO 2859-1:1999 Sampling procedures for inspection by attributes
c) ISO 3951-1:2005 Sampling procedures for inspection by variables

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

Reference number
WSP 401.0.R3 (12) UM

Current edition approved WSP 401.0.R3 (12)
Originally published as WSP 401.0 in 2005
Last approved as WSP 401.0.R2 in 2009

3. Terminology

For the purpose of this document, the following terms and definitions apply:

3.1 Laminate
The term “laminate” refer to composites made of at least two layers, bonded together by any of several possible means.

3.2 Hot-melt laminates
Hot melt laminates refer to laminates in which one layer of hot melt adhesive assures the bonding of two juxtaposed layers.

3.3 Extrusion coated laminates
Extrusion coated laminates refer to laminates in which a plastic film has been extruded on a nonwoven substrate.

4. Principle

Two juxtaposed layers of the composite are clamped in the jaws of a dynamometer after initial manual delamination. Delamination is then performed at constant speed.

The recorded force is essentially variable over the sample length, and has the typical configuration as represented in figure 1, where B and C represent the points were the measuring respectively starts and finishes.

OB= 25 mm
BC= 100 mm

The lamination strength is calculated as the average separation force measured on a 100 mm displacement.

5. Apparatus

5.1 Hydraulic press and cutting die,
Where the cutting die is 25 mm wide and at least 200 mm long. This is the preferred set up, as the test pieces must be cut out cleanly. A Laboratory paper cutter or a template and scalpel are, however, also acceptable. Scissors are not, as they tend to distort the sample.

5.2 Tensile testing machine (dynamometer)
With constant rate of extension and jaws at least 50 mm wide (capable of holding the test piece securely across their full width without damage) and fitted with a system for recording force - displacement curves.

6. Conditioning

It is recommended to wait four weeks after production to measure lamination strength of laminates. This recommendation applies in particular to hot-melt laminates, as research has proven the influence of time on the performance of hot-melt adhesives.

For conditioned testing:
Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25 % of the mass of the specimen.

NOTE 2 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing nonwovens for a reasonable period of time before the specimens are tested, i.e. 4 hours.

7. Sampling

7.1 Lot Size
A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

7.2 Sampling
If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (*Sampling procedures for inspection by attributes)* or ISO 3951-1:2005 (*Sampling procedures for inspection by variables)* can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE.3 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

7.3 Laboratory samples

From each roll or piece of fabric selected from the lot sample, cut at least one laboratory sample the full width of the fabric and at least 300 mm from each outside edge.

8. Procedure

8.1 Cut out 5 test pieces

In the machine direction only, according to the latest edition of ERT 130. They must be cut out cleanly, (25 ± 0.5) mm wide, and more than 200 mm long so that a displacement of more than 125 mm can be obtained between the jaws of the dynamometer.

8.2 Initiate sample delamination

(i.e. separation of laminated compound components) in the traveling direction of the material (figure 2) by any suitable physical or chemical means. For example, hot melt laminates will effectively be separated with the help of a solvent; extrusion coated components can be separated by rubbing.

8.3 Proceed with initial separation

Until the delaminated portion of the sample is long enough to fit easily between the jaws of the dynamometer

8.4 Place the test piece between the jaws of the tensile machine

These being (50 ± 1) mm apart. Place the piece so that one of the initially separated component is securely clamped in one jaw, the other component being clamped in the opposite jaw. The test piece should be as straight as possible without applying pretension.

8.5 Apply a constant rate of extension

Of 300mm/min and record the force – displacement curve, which will generally appear similar to figure 1.

8.6 Discard the results
From any test piece where breakage of any kind occurs

8.7 Establish the scale
Of the force - displacement curve.

8.8 Disregard the initial part of the curve on 25 mm.

8.9 Consider a displacement of 100 mm.

9. Calculation

Calculate the average separation force by adding all maximum and minimum peaks obtained on 100 mm displacement, and dividing the sum by the number of reported values.

10. Report

The test report shall include the following information:

a) Complete identification of all materials tested and method of sampling
b) Average separation force, in N, to the nearest 0.1 N and standard deviation.
c) Any deviation from the standard procedure.
d) Reference the test method used
e) Name and address of testing institution
f) Laboratory testing conditions
g Number of specimens tested
h) For computer processed data, identify the software used and the version
i) Deviation from the standard test procedure, if any

11. Drawings

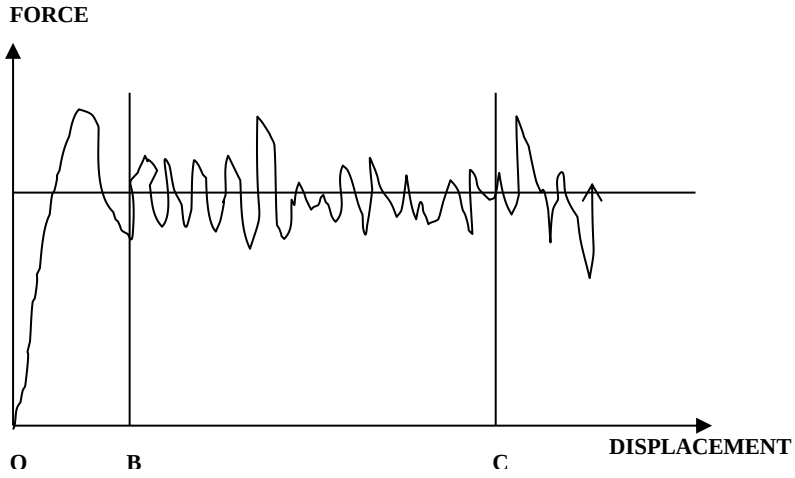


Figure 1

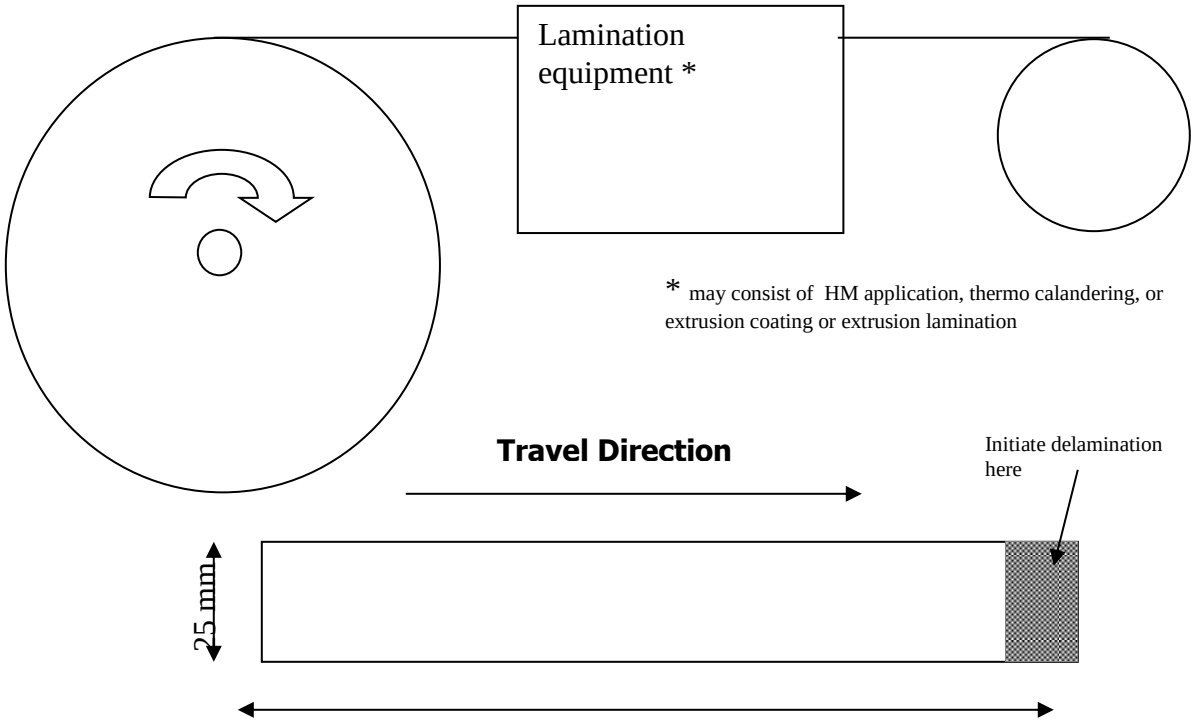


Figure 2

USEFUL METHOD: WSP 402.0.R2 (12)

Test Method for Cup Crush

The number in parentheses indicates the year of the last revision

1. Scope

This test method measures the simultaneous, multi-directional deformation of a material. This test method is used to determine the softness of a material less than 1 mm thick by using peak load and energy to quantify softness. This method is designed to compare relative softness of a given type of fabric made under different processing conditions. It is not usable for comparing the softness of fabrics made using different manufacturing processes. For example, one cannot compare fabrics made via spunbonding versus carded, needlepunched, spunlace, etc.

This test method is applicable to woven and nonwoven materials where analysis of the softness of the material is desired. The material must have sufficient structural integrity to be formed into the cup shape and then be able to maintain that shape until it is tested. The forming cup is designed for specimens less than 1 mm thick.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are for the application of this document

2.1 ISO test methods

a) ISO 5725 - Accuracy (trueness and precision) of Measurement Methods and Results – Part 1: General Principles and Definitions

b) ISO 5725-2 Accuracy (trueness and precision) of Measurement Methods and Results – Part 2: Basic Method for the Determination of the Repeatability and Reproducibility of a Standard Measurement Method

c) ISO 139 (05) Standard Conditioning

d) ISO 3951-5 (06) Sequential sampling plans indexed by acceptance quality limit (AQL) for the inspection by variables (known standard deviation)

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods Standard Test Methods

Reference number
WSP 402.0.R2 (12) UM

Current edition approved WSP 402.0.R2 (12)
Originally published as WSP 400.0 in 2008
Last approved as WSP 400.0.R2 in 2012

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

Constant-rate-of-extension (CRE) tensile testing machine
A testing machine in which the rate of increase of specimen length is uniform with time.

4. Principle

A 225-mm square specimen is formed into a cup shape and mounted in a tensile testing machine. A 44.5 mm diameter hemispherical-shaped plunger descends into the cup-shape deforming the shape.

The specimen is shaped inside a forming cup. The forming cup and the specimen are then placed on a testing plate which is mounted on a tensile tester. A foot descends into the cup "crushing" the specimen. The results are a manifestation of the softness of the material. The softer the material, the lower the peak force and energy values.

5 Apparatus

5.1 Tensile Testing Machine, of the constant-rate-of-extension (CRE)

Conforming to WSP 110.4.R3 with respect to force indication, working range, capacity, and elongation indicator, and designed for operation at a speed of 405 ± 5 mm/min

Discussion-The tensile testing machine must be capable of maintaining the speed of 405 ± 5 mm/min. while in a compression mode.

5.2 Load Cell

Compression or bi-directional load cell, 5 kg or smaller, is recommended. Choose a load cell such that the peak force values fall within 10 to 90 % of full scale for the CRE-type testing machine.

5.3 Foot

A 91 X 13 mm metal plunger with an attached 44.5 mm diameter hemisphere at one end.

5.4 Forming cup and stand

Consisting of an inner stand that nests within an outer cup

5.5 Retaining ring

Magnetic ring designed to retain the specimen in a cup shape

6. Sampling

6.1 Lot Size

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

6.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (*Sampling procedures for inspection by attributes)* or ISO 3951-1:2005 (*Sampling procedures for inspection by variables)* can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established.

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE.2 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

6.2 Laboratory sample

From each roll or portion of material taken from the lot sample, cut at least one laboratory sample the full width of the fabric and 1m in the machine direction.

NOTE 3 Results obtained on small hand samples can only be considered as representative of that sample and cannot be assumed to be representative of the material portion from which the hand sample or swatch was taken.

6.3 Test specimens

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test material

a) Cut each specimen 225 by 225 ± 1 mm
b) From each laboratory sample, test a minimum of five specimens from the warp (machine) direction.

7. Conditioning

7.1 For conditioned testing*:*

Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139 (05).

NOTE 4 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested.

8. Preparation of Test Apparatus and Calibration

8.1 Prepare the machine

According to the manufacturer's instructions and using the conditions given in 10.2 and 10.3.

8.2 Set the distance

Between the bottom of the plunger and the top of the testing plate at the start of the test at 75 ± 1 mm

8.3 Set the crosshead

For a compression rate of 405 mm/min. and a travel distance of 65 mm.

9. Preparation of Test Apparatus and Calibration

Prepare the machine according to the manufacturer's instructions and using the conditions given in 9.a and 9.b.

a) Set the distance between the bottom of the plunger and the top of the testing plate at the start of the test at 75 ± 1 mm
b) Set the crosshead for a compression rate of 405 mm/min. and a travel distance of 65 mm.

10. Procedure

10.1 Place the steel ring over the forming stand.

10.2 Center the specimen, test side up, over the forming stand.

10.3 Slowly slide the forming cup over the forming stand
Until the material is pinched between the forming cup and the steel ring.

10.4 Slowly and carefully lift up the forming cup
Check that the specimen kept the formed shape and is pinched between the ring and the cup.

10.5 Place the forming cup on top of the testing plate on the tensile tester
The forming cup will fit snugly onto a ridge on the testing plate.

10.6 Start the crosshead

10.7 When the test has ended and the crosshead has returned
Remove the forming cup from the testing plate and remove the specimen from the forming cup.

11. Calculation

Calculate the peak force between 15 and 60 mm of crosshead travel.

Calculate the energy between 15 and 60 mm of crosshead travel.

12. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) The average peak force for specimens,
g) The average energy of acceptable specimens,
h) Number of specimens tested
i) For computer processed data, identify the software used and the version
j) Deviation from the standard test procedure, if any
k) When calculated, the standard deviation or the coefficient of variation
l) Whether or not samples were conditioned prior to testing and, if so, for how long
m) Anything unusual noted during the testing

13. Precision

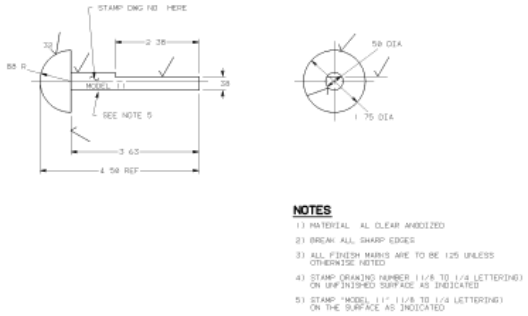
Three materials were tested on one day in one laboratory by five different testers. Table A contains the estimates for the repeatability (Sr) and reproducibility (SR) values. Values for Sr and SR were obtained from ANOVA tables produced using the EXCEL spreadsheet. The material types were:

Sample 1: Perforated Roll Tissue #04460 Scott Standard Bathroom Tissue (embossed)
Sample 2: Kimberly-Clark Hi-Count Roll Towels #39107
Sample 3: 1.4 osy SMS

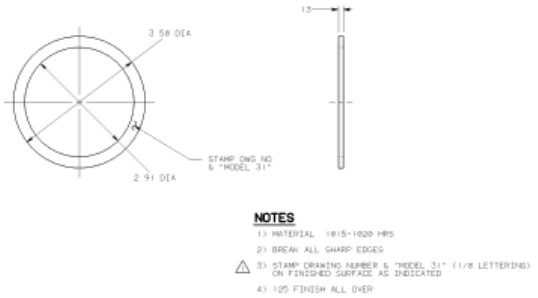
TABLE A

Cup Crush Peak Load Repeatability and Reproducibility				
Sample	Average	S(x-bar)	Sr	SR
1	34.39	2.02	3.26	3.55
2	91.02	7.32	10.65	12.01
3	208.70	7.60	30.82	30.82

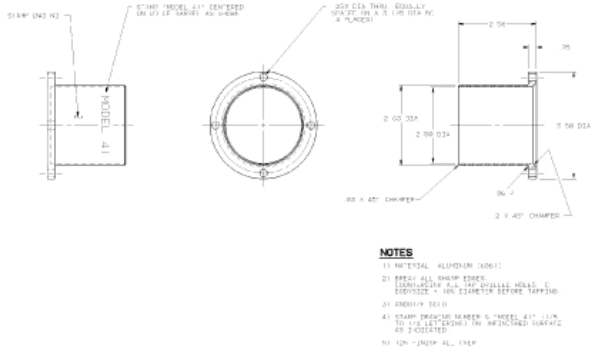
ANNEX A
A.1 Illustrations of Testing Components



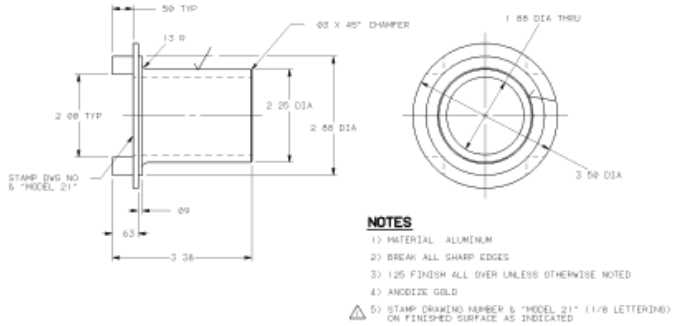
Foot Detail



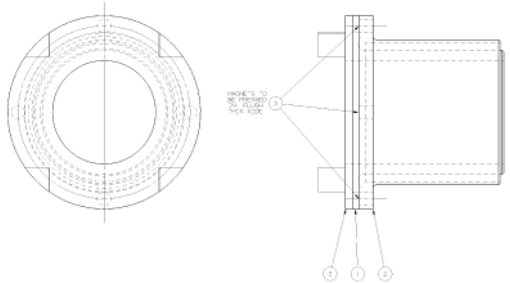
#5332B Clamp Ring



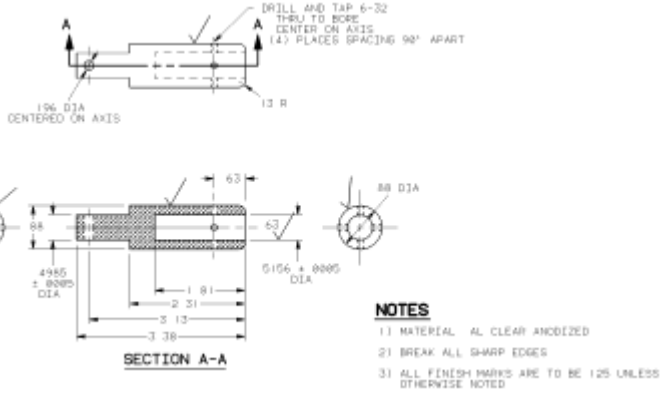
#5335C Forming Cup



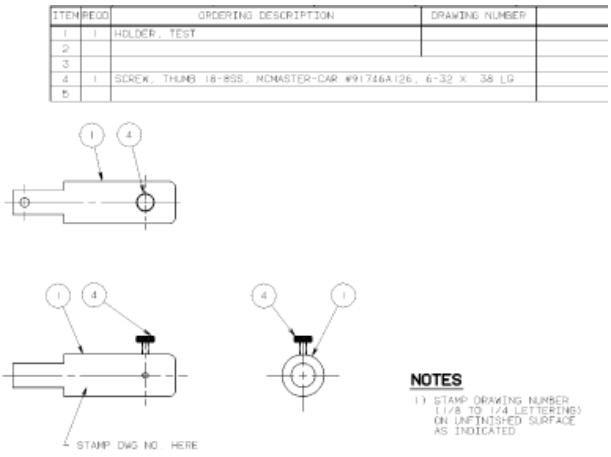
#5343B Forming Stand



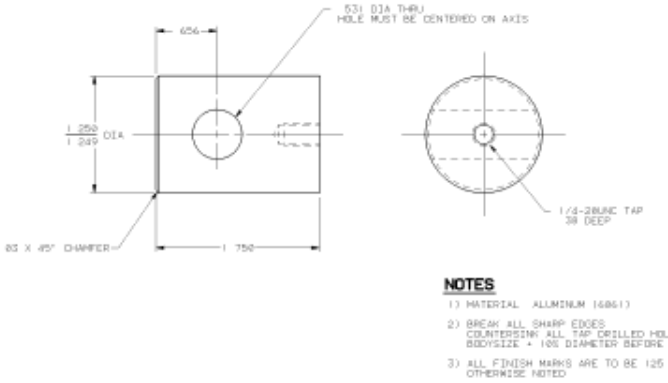
#5334C Forming Cup Assembly



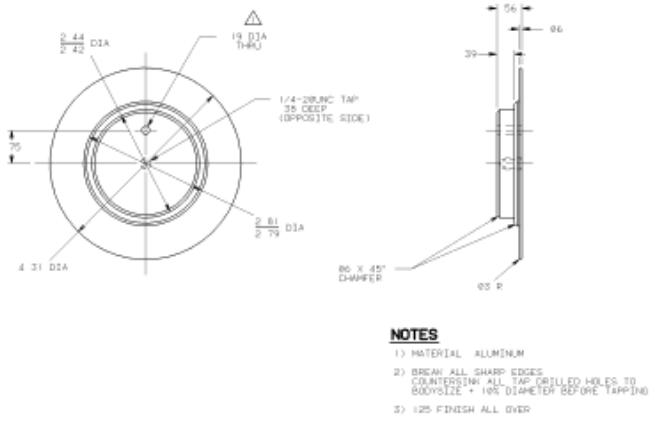
#5755B Test Holder



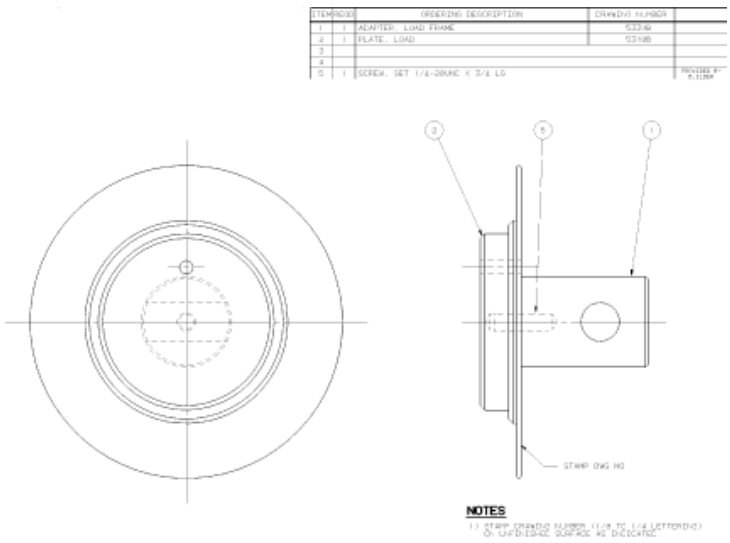
5433 Test Holder Assembly



#5339B Load Frame Adapter



#5340B Testing Plate



#5336C Testing Plate Assembly

Useful Method: WSP 403.0.R2 (12)

Test Method for Testing High Loft and Needled Batting For Flame Resistance and Thermal Transfer Properties

The number in parentheses indicates the year of the last revision

1. Scope

This test method may be used to determine the theoretical thermal damage that could occur to a flammable material in contact with the thermal barrier material when exposed to a specific level of heat over a specified period of time.

This test may be used to determine how well a barrier fabric performs with respect to its relationship to other materials within a composite build of materials.

Observations of testing in accordance with California Technical Bulletin 603 have shown that flame resistant fabrics tested in accordance with this procedure have created a protective barrier protecting such volatile materials as polyurethane foam and other flammable components in mattresses. It is therefore proposed that the method of testing described in this procedure can provide an accurate indicator of the effectiveness of a highloft nonwoven thermal barrier. When used in conjunction with normal quality inspections, this method can provide a reliable record of lot control for nonwoven Flame Retardant barrier products.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SPECIAL SAFETY INSTRUCTIONS

This instruction covers the testing of Fire Retardant, (FR) fiber batting using a high temperature Meker type open flame burner. This procedure should not be used to test any non flame resistant cotton, untreated shoddy or polyester fiber batting. This procedure should be conducted in an area which is protected from fiber dust and normal plant activities; preferably in a specially constructed all metal burn cabinet with adequate ventilation.

NOTE 2 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are for the application of this document:

Reference number
WSP 403.0.R2 (12) UM

Current edition approved WSP 403.0.R2 (12)
Originally published as WSP 403.0 in 2010

2.1 ISO test methods

a) ISO 5725-1 Accuracy (trueness and precision) of Measurement Methods and Results – Part 1: General Principles and Definitions

b) ISO 5725-2 Accuracy (trueness and precision) of Measurement Methods and Results – Part 2: Basic Method for the Determination of the Repeatability and Reproducibility of a Standard Measurement Method

c) ISO 139 (05) Standard Conditioning

d) ISO 3951-1:2005 Sampling procedures for inspection by variables

e) ISO 2859-1:1999 Sampling procedures for inspection by attributes

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Fiber batting

A treated or untreated fiber blend which has been garneted or carded into a unified fiber batt, is to be used in Home Furnishings, Protective Clothing, Construction, or any other Industrial or Commercial applications for the purpose of fire abatement.

3.2 Ignition source

For the purpose of this instruction, is a controlled open flame, generated by a "High Temperature" Meker type Burner. The burner used for this test can be found in the Cole-Parmer catalog, model number U-36130-XX.

NOTE 3 SAFETY

All testing shall be conducted under a ventilation hood with suction fans capable of evacuating the test area of any smoke or fumes. In addition to a ventilation hood, it is suggested that particulate masks capable of blocking smoke from the burning test sample be available for use.

4. Principle

The principle of Thermal Transfer Properties, (TTP) involves measuring the effectiveness of a flame retardant barrier in three critical areas:

a) The ability to reduce thermal conduction, (thermal transfer) through test specimen,

b) The ability to block an open flame and

c) The ability to withstand a prolonged or timed insult without collapse or accelerated degradation. In applications such as bedding or furniture, it is important to protect volatile filler materials such as polyurethane foams, or mixed battings from an open flame and intense heat flux. The TTP test introduces a vertical flame to the material being tested, which is placed in a horizontal position on a base plate at a set distance from the flame source. Thermocouples are attached to measure the flame temperature, and to measure the temperature through the specimen at the side opposite the flame. This difference in thermal intensity or this ability to mitigate thermal conductivity is referred to as the Thermal Transfer Property of the test

material. Open flames and heated gasses are not hindered as they pass through the test specimen which will indicate a materials ability to block an open flame over a specified period of time. If a material is unable to withstand the insult of an open flame, the test fixture will allow that material to degrade or burn through as it would in field applications.

5. Material and Reagents

Fire retardant Insulator pad
A densified needled pad manufactured from fibrous textile clippings containing a majority of cellulosic or cotton fiber which has been treated with an external flame retardant sufficient to prevent penetration from an open flame source within the time specified in this procedure.

6. Apparatus

6.1 Digital thermometer/data logger

Type J/K Dual Input, capable of recording temperatures in excess of 1093 C°, (2000° F) using type K, Chromel and Alumel thermocouples. One thermocouple will be in contact with the ignition source, the second thermocouple will measure the temperature increase on the backside of the test sample.

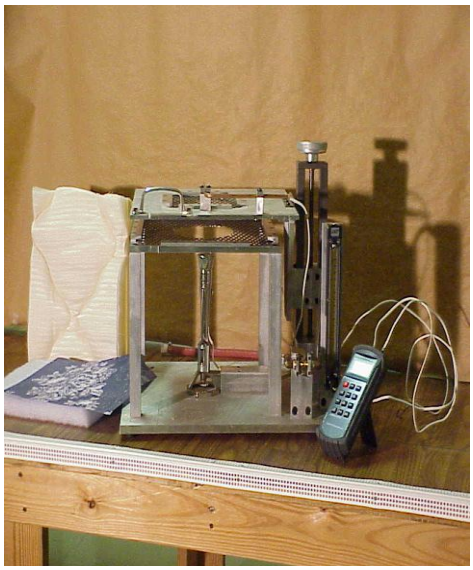


Figure 1 TTP Test Fixture

Figure 2 Gas source must secured outside the hood testing area

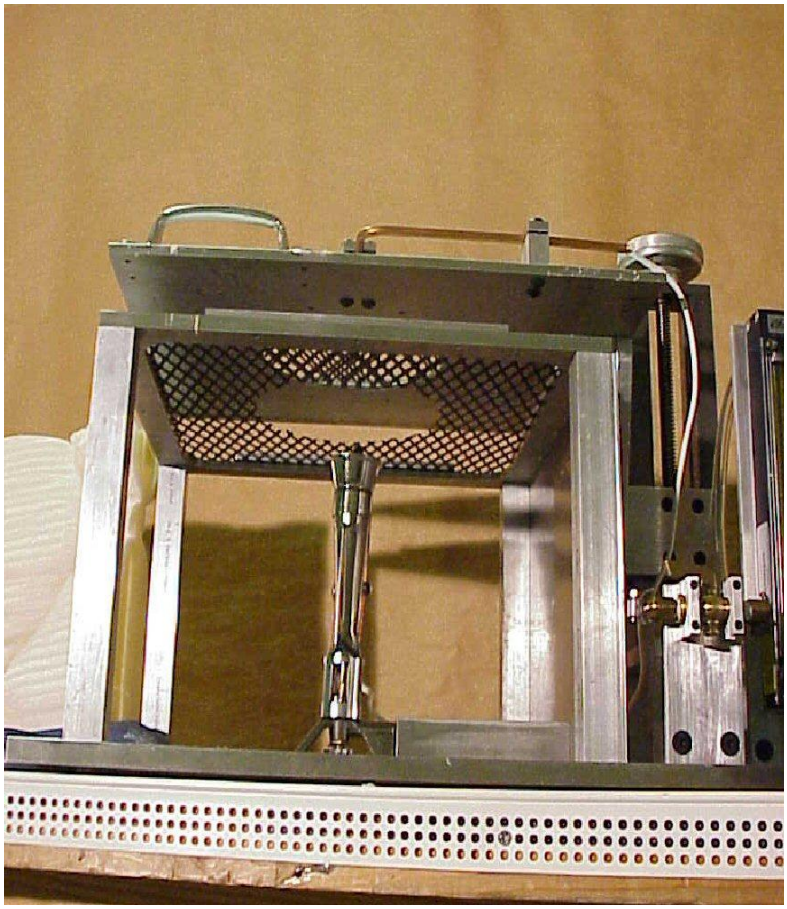


Figure 3 Bottom View of Tester

6.2 Ventilation hood
Has a suction fan capable of evacuating the test area.

6.3 Copper calorimeter
A device used to calibrate the heat flux of the burner in terms of calories per seconds squared. Copper calorimeter and instructions for calibrating heat flux can be obtained from AKS Technology Inc.

7. Sampling

7.1 Lot Size
A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

7.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (*Sampling procedures for inspection by attributes)* or ISO 3951-1:2005 (*Sampling procedures for inspection by variables)* can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 4 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

7.3 Sample preparation

Obtain a minimum of three cut samples from the production line for testing purposes. Cut specimens shall be taken from a strip sample, 300 to 400 mm wide cut across the width of the production line or finished roll. As a minimum, the samples shall be taken from the middle of the floor apron, and from each side of the floor apron. The technician shall prepare 300 to 300 mm specimens pads by trimming excess material from the sample strip.

7.4 Test specimen preparation

Once the specimens have been trimmed to size, weigh each sample and record that weight. Record the thickness of the product in accordance with WSP 120.1. The combination of specimen weight and thickness will provide a baseline density for the product being tested. Measurement of weight and thickness after exposure to the flame can be achieved by taking a 4" diameter plug from the middle of the burn area, and taking weight and thickness measurement of the plug section. Using the weight and thickness of the plug section, post burn density can be established and compared to the baseline density of the product.

a) Care in handling should be observed so that specimens do not contact any contaminants such as soap, salt, oil etc., which might facilitate or hinder test results
b) Specimens should be cut 300 to 300 mm

NOTE 5 SAFETY

Prior to conducting this procedure, the test technician shall insure that all equipment is in proper working condition. The technician shall also insure that all thermocouple leads are properly positioned and that there is no danger of flash-over from collected dust or fiber lint.

8. Preparation, Calibration, and Verification of Apparatus

8.1 Verification

Once verified that the weight and thickness of the specimens fall within specified limits, prepare the samples and the test stand for the burn test. Should the samples not meet the requirements for weight and thickness, stop the test until proper samples are received. Turn on the gas by using the opening the valve to the regulator on the propane bottle.

Adjust the regulator to 9.1 kilograms, PSIG on the output valve.

8.2 Calibration

It is recommended that calibration of the TTP burner and flow rates be performed at least twice yearly. To calibrate the flame to the California TB603 test unit, ignite the Meker burner and adjust the flow meter so that the floating ball falls between 35 and 40 on the scale. This correlates to about 600 ml/min. At this rate the blue flame should extend no further than 3 mm, (⅛ in) beyond the orifice of the burner. Once the gas flow is set, turn off the gas and proceed to the next step.

To calibrate the flame so that it corresponds with the California TB 603 ignition source, take the following steps: Carefully remove the top thermocouple from its holding fixtures on the top platen of the tester, set it to the side. Next, remove the screen from the top platen by removing the holding screws and dog plates which hold it secure and set these aside.

a) Connect the calorimeter leads to the T1 terminal of the data logger, and place it over the burner so that the copper slug is facing the burner.
b) Insure that the gas pressure is between 35 and 40 kPa on the flowmeter.
c) With the copper calorimeter in place on the top plate of the tester, adjust the height of the top platen so that it is 50 ± 1.6 mm, from the top of the burner.

d) With the data logger in the memory mode taking a reading every 3 seconds, ignite the burner and time the calibration period for 30 seconds.
e) At the end of the 30 second period, shut down the flame and remove the calorimeter from the test stand. Download the data from the data logger onto a spreadsheet program.
f) Subtract the 20 second reading from the initial reading to determine the temperature increase. The Heat Flux Index should be between 1.1 and 1.2 calories per square centimeter per second. This heat flux correlates with the burners used to conduct flammability testing in accordance with California Technical Bulletin 603. Repeat this for a total of three readings, and compare readings for consistency.

9. Procedure

9.1 Remove the calorimeter

Once the flame has been calibrated, remove the calorimeter from the test plate and reconnect the top thermocouple. Adjust the thermocouple so that the tip is extended beyond the grating by about 3 mm. Reconnect the terminal to the T1 position on the data logger.

9.2 Insure placement of probe

Check the type K, ceramic tipped probe, (Cole-Parmer catalog no. 08467-64) in the holding fixture adjacent to the Meker burner. Insure that the lead of the probe is connected to thermometer at the T2 terminal. Insure that the probe is placed between 6 to 13 mm from the top of the burner and that it extends approximately 3 to 6 mm, into the flame.

9.3 Placement of specimen

Next, place a specimen of the material that is to be tested in the fixture and lower the top plate onto the sample. Insure that the probe will contact the surface of the sample by checking for fiber as it is gently raised up. Raise or lower the top temperature probe by adjusting the set screw on the main column. If this is the very first test of the shift, remove the sample from the test unit and proceed to the next steps.

9.4 Verification the probes

Press the red ON/OFF button on the digital thermometer and insure that you are getting a reading from both probes, and that the probes are connected to the correct terminals. To verify that the probes are correctly connected, lift the top plate, open the cock valve to the gas and ignite the burner.

9.5 Check readings

The T1 set of numbers should remain close to room temperature, while the T2 set of numbers should read the flame temperature. Insure both probes are set to “K” input on the digital thermometer. A “J” reading on the thermocouples will produce false readings. Normal flame temperature at the T2 thermocouple should read between 700 and 800^{o} C, (1300 and 1500^{o} F)

9.6 Check gas flow
Once the gas flow, the flame configuration and the temperature probes are within their specified limits, turn off the gas valve and proceed to test the specimens for Thermal Transfer Properties.

9.7 Placement of the kraft paper
Place a piece of brown kraft paper on the base plate of the burn stand, and place the specimen on top of the kraft paper. For bi-lofted specimens or specimens with a sacrificial layer, place the specimen with the white polyester, or sacrificial layer to the flame, against the kraft paper.

NOTE 6 The kraft paper is optional, it does not affect the outcome of the test, but it does help to keep the sample flat in the fixture, and prevent the batting from bulging through the 6 inch diameter opening of the bottom plate.

9.8 With the specimen in place
Once the specimen is in place, lower the top plate over the specimen and verify that the probe is making contact with the specimen.

9.9 Ignition of the burner
Press the “MEM” button on the digital thermometer and about 3 to 5 seconds after that, open the cock valve to the gas and ignite the burner. This will give the data logger a couple of neutral readings before capturing the burn data.

9.10 End of the test period
Conduct the burn for a total of 90 seconds minimum at the end of the test period, turn off the gas, press the “MEM” button to stop the data logger and raise the top plate out of the way to remove the specimen.

NOTE 7 SAFETY

The technician should be wearing leather or heat resistant gloves when removing the top plate and the sample from the test fixture. Also a wet cloth should be on hand, in case the burner over heats causing a flash-back situation. With the gas turned off, the technician may cool the burner tube by wrapping a wet cloth around it, be careful to avoid steam burns

9.11 Repeat
Steps 9.1 through 9.10 for each of the samples specified in the inspection plan. When all samples have been tested, enter the information collected into the appropriate database or spreadsheet program.

10. Calculation/ Interpretation of the Results

10.1 Download
The burn data from the data logger onto a spreadsheet program and order the data so that there is contiguous 90 second record of the sample that was tested from ignition to extinguish.

10.2 Reporting units

Heat transfer may be reported as temperature units, (C^o or F^o) or energy units, (cal/cm^2-sec.).

$$\frac{TemperatureRiseC^o}{Time} \text{ x .135 = cal/cm}^2\text{-sec}$$

$$\frac{TemperatureRiseF^o}{Time} \text{ x .075 = cal/cm}^2\text{-sec}$$

Report any physical response the material had to the flame *i.e.* break open, melting, dripping, shrinking … etc.

The comparison of the flame temperature, (T2) to the barrier temperature, (T1) is used to determine the heat passing through the barrier material.

11. Report

See examples in Annex A

Report that the heat transfer through the nonwoven materials used as a thermal barrier

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and include weight and thickness as supporting characteristics also include method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) For computer processed data, identify the software used and the version
f) Deviation from the standard test procedure, if any
g) Anything unusual noted during the testing
h) When photos are used as the standard, attach copies

12. Precision

The precision for this method is yet to be determined.

Annex A
Sample Data
Sample 7, Fire Retardant Batting, 93gsm

Product: Fire Retardant Batting, 93 gsm

Time	Sample 1		Sample 2		Sample 3		Sample 4		Sample 5		Sample 6		Average	
	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2
0:00:03	71.0	202.2	86.5	770.7	97.2	754.2	91.9	939.7	89.8	747.4	91.2	479.8	86	628
0:00:06	71.0	636.6	87.2	1102.5	97.0	947.7	96.0	1179.4	89.7	949.5	91.3	973.6	89	933
0:00:09	73.2	1005.7	94.5	1210.7	102.8	1181.1	124.1	1296.8	90.6	1194.0	99.7	1212.7	97	1145
0:00:12	93.5	1207.2	132.4	1329.6	128.8	1270.8	141.4	1368.1	108.5	1321.8	132.3	1326.3	118	1289
0:00:15	119.8	1311.1	144.8	1389.3	144.6	1323.4	145.5	1392.8	129.8	1384.7	146.9	1398.4	136	1358
0:00:18	133.7	1373.0	149.6	1433.5	149.8	1362.7	149.3	1421.0	139.6	1414.4	151.6	1441.9	145	1401
0:00:21	139.6	1409.3	152.8	1461.4	151.5	1388.5	151.1	1439.5	143.4	1437.5	153.9	1469.1	148	1430
0:00:24	142.7	1429.2	158.5	1477.9	152.4	1400.7	155.5	1463.4	145.9	1456.3	156.2	1479.4	152	1449
0:00:27	144.7	1447.6	166.6	1482.6	153.9	1401.1	163.0	1471.5	146.6	1458.7	164.0	1495.4	156	1459
0:00:30	146.0	1452.9	176.1	1493.4	156.6	1406.9	176.1	1488.5	148.2	1469.2	177.0	1503.3	163	1468
0:00:33	150.3	1456.2	187.8	1503.4	159.7	1415.3	189.3	1490.7	151.7	1482.7	190.8	1519.8	171	1477
0:00:36	154.3	1462.9	197.3	1512.6	165.5	1418.1	196.2	1496.5	156.8	1490.7	197.4	1517.7	177	1483
0:00:39	159.0	1468.1	208.4	1514.9	172.6	1422.6	207.0	1496.9	159.8	1497.8	209.7	1516.8	185	1485
0:00:42	164.4	1475.6	217.4	1515.5	180.9	1428.8	216.8	1498.5	167.0	1503.4	221.4	1525.6	193	1490
0:00:45	171.4	1477.9	224.4	1513.6	189.5	1430.8	224.7	1505.3	175.9	1502.9	231.3	1532.2	201	1493
0:00:48	180.6	1480.7	230.0	1525.0	196.8	1433.1	231.0	1510.8	184.0	1498.3	238.8	1533.4	209	1497
0:00:51	190.7	1495.5	234.6	1529.4	202.9	1439.0	236.1	1519.4	191.4	1502.7	244.7	1534.6	216	1502
0:00:54	200.4	1507.4	238.5	1524.4	207.2	1446.1	241.0	1519.9	194.9	1502.9	247.2	1530.6	221	1504
0:00:57	207.1	1512.7	241.8	1520.0	209.1	1449.0	242.7	1525.9	202.1	1508.0	252.3	1537.9	226	1508
0:01:00	214.8	1511.9	243.3	1524.8	211.7	1456.7	245.7	1531.6	207.2	1511.7	255.4	1537.0	229	1511
0:01:03	221.5	1512.1	246.4	1525.3	214.2	1465.8	248.5	1529.8	211.0	1513.9	258.2	1545.9	233	1514
0:01:06	226.8	1513.6	248.4	1534.9	216.3	1473.8	251.1	1530.9	214.5	1524.2	260.4	1542.3	236	1519
0:01:09	231.4	1518.2	249.8	1538.9	218.5	1469.4	253.6	1531.6	217.5	1528.0	262.6	1541.6	239	1522
0:01:12	235.5	1522.0	251.1	1546.1	220.2	1471.0	255.7	1525.2	219.9	1526.5	263.5	1539.3	241	1521
0:01:15	238.8	1519.1	252.8	1542.8	220.9	1474.9	257.5	1525.4	220.9	1529.6	264.9	1540.8	243	1521
0:01:18	241.6	1518.4	254.3	1541.3	220.9	1475.6	259.1	1522.8	223.2	1529.3	266.4	1544.9	244	1522
0:01:21	243.0	1519.6	255.7	1540.2	222.1	1469.5	260.3	1521.4	225.0	1534.2	267.9	1547.1	245	1523
0:01:24	245.7	1520.0	257.3	1545.4	223.5	1469.6	261.5	1526.3	226.6	1538.0	268.6	1543.4	247	1524
0:01:27	247.7	1516.9	258.6	1552.9	225.4	1468.1	262.5	1531.9	227.5	1540.8	269.9	1548.5	248	1527
0:01:30	249.7	1525.0	260.1	1550.9	225.7	1470.2	263.7	1538.0	228.9	1539.6	271.2	1549.3	250	1528

Caliometer Calibration

Purpose: To test flame source prior to TTP testing

Conducted by: KC Thompson

Date: 05/01/06

Regulator setting = 20 lb

Flowmeter setting = variable, see below

Heat Flux Range = 1.0 - 1.2 calories/sq cm/sec

Note: Caliometer set 2 inches from Meeker Burner

Test #1

Flow = 35

	Time	T1	T2	Calories/ squ cm / sec
	0:00:00	247.6	1264.0	
	0:00:03	324.5	1371.8	
	0:00:06	386.2	1418.3	0 sec - 30 sec
	0:00:09	445.2	1442.5	
Measure	0:00:12	465.1	1450.1	1.02
	0:00:15	529.4	1462.4	
	0:00:18	581.8	1473.7	
	0:00:21	631.0	1480.2	
	0:00:24	677.4	1492.8	
	0:00:27	701.2	1490.0	
End	0:00:30	749.4	1495.0	
Average		521.7	1440.1	

Test #2

Flow = 35

	Time	T1	T2	Calories/ squ cm / sec
	0:00:00	204.5	1124.4	
	0:00:03	269.3	1281.7	
	0:00:06	333.7	1368.9	0 sec - 30 sec
	0:00:09	395.7	1417.7	
	0:00:12	455.5	1445.2	1.04
	0:00:15	513.6	1459.0	
	0:00:18	542.8	1462.8	
	0:00:21	595.1	1464.3	
	0:00:24	645.9	1478.0	
	0:00:27	703.1	1478.8	
	0:00:30	747.5	1476.1	
Average		491.5	1405.2	

Test #3

Flow = 35

	Time	T1	T2	Calories/ squ cm / sec
	0:00:00	241.2	1183.7	
	0:00:03	306.9	1287.0	0 sec - 30 sec
	0:00:06	341.8	1330.9	
	0:00:09	418.3	1390.4	1.19
	0:00:12	478.6	1417.7	
	0:00:15	535.2	1430.3	
	0:00:18	563.6	1446.8	
	0:00:21	614.0	1470.1	
	0:00:24	662.1	1485.9	
	0:00:27	707.4	1482.1	
	0:00:30	750.7	1481.8	
Average		511	1401	

Average 3 tests

	Time	Caliometer	Thermocouple	Calories/ squ cm / sec
	0:00:00	231.1	1190.7	
	0:00:03	300.2	1313.5	0 sec - 30 sec
	0:00:06	353.9	1372.7	
	0:00:09	419.7	1416.9	1.18
	0:00:12	466.4	1437.7	
	0:00:15	526.1	1450.6	
	0:00:18	562.7	1461.1	
	0:00:21	613.4	1471.5	
	0:00:24	661.8	1485.6	
	0:00:27	703.9	1483.6	
	0:00:30	749.2	1484.3	
Average		508.0	1415.3	

Correlation between Weight, Thickness and Density

Thermal Transfer Properties
Product: Fire Retardant Batting, 93 gsm

Sample No.	Pre- Burn Weight oz. per sq.ft.	Pre-Burn Thickness	Pad Density oz/cu.ft.	Post Burn Biscut Weight	Biscuit wt. Ounces per sq.ft.	Biscut Thickness	Biscuit Density oz/cu.ft.	Percent Change in Density	Peak Burn Temp.
1	0.83	0.73	13.66	0.05	0.15	0.46	3.96	71%	267
2	1.08	0.70	18.62	0.07	0.19	0.43	5.31	71%	227
3	1.16	1.16	11.99	0.06	0.17	0.46	4.40	63%	136
4	0.72	0.25	35.24	0.04	0.11	0.13	10.05	72%	377
5	0.50	0.23	26.15	0.03	0.08	0.09	10.66	59%	384
6	1.05	0.69	18.35	0.06	0.16	0.32	8.81	41%	243
7	1.15	1.05	13.07	0.05	0.15	0.38	8.78	33%	250

Figure A1
Weigh Samples

Weigh each sample and record that weight

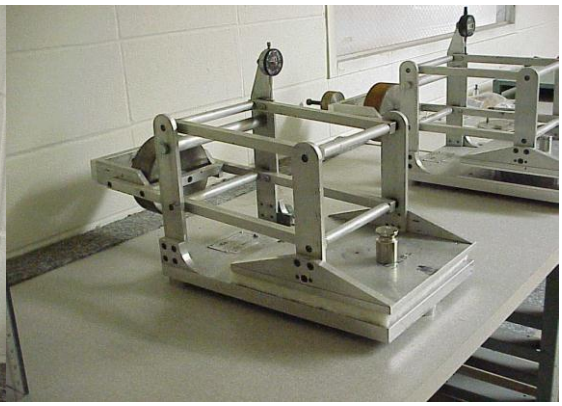


Figure A2
Measure Thickness

Record the thickness of the product in accordance with WSP 120.1. The combination of specimen weight and thickness will provide a baseline density for the product being tested.

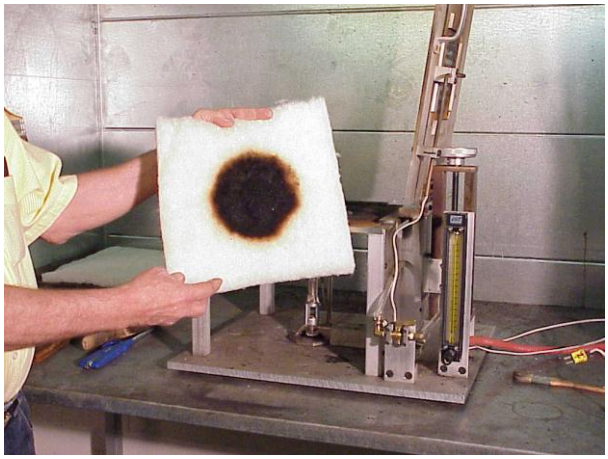
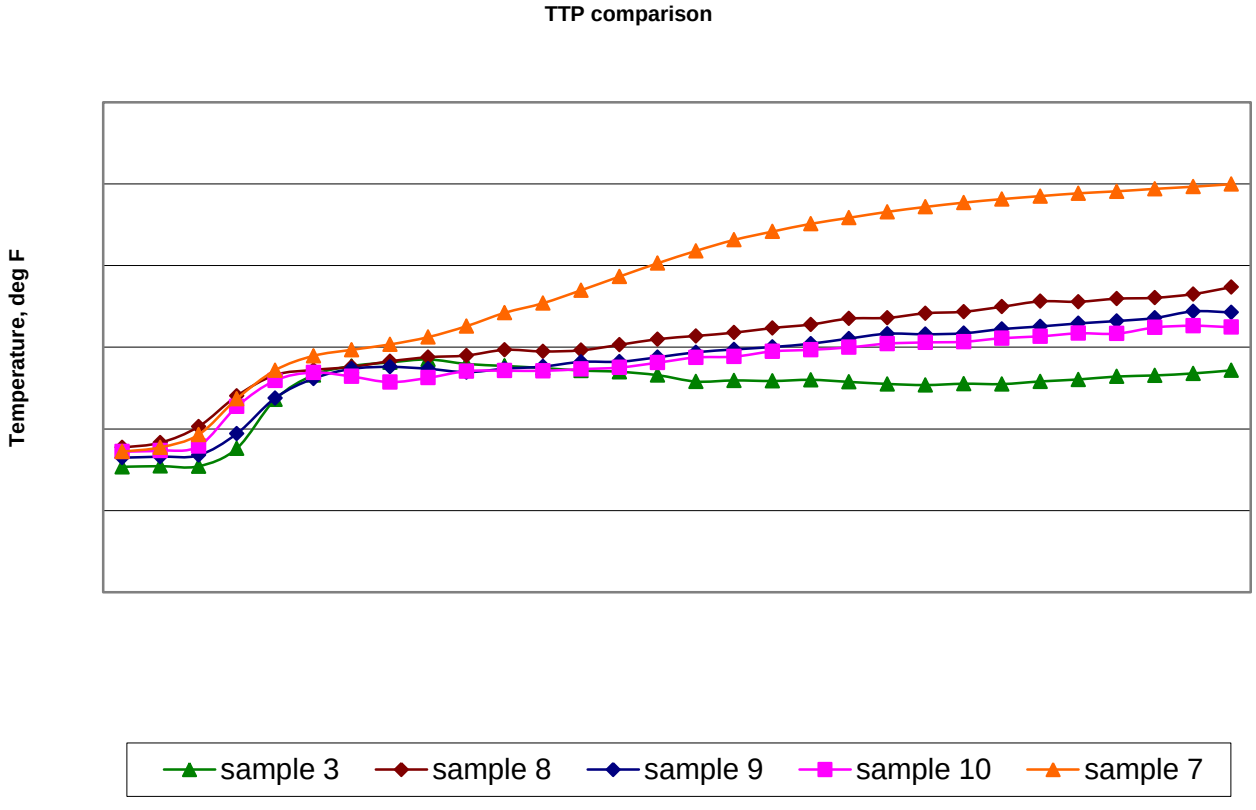


Figure A3
End of Test Period

Conduct burn for a total of 90 seconds, or terminate the test if there is a burn through. Record the time for the burn through.



USEFUL METHOD: WSP 404.0.R1 (12)

Test Method for the Homogenization of Absorbent Hygiene Products Using a Laboratory Cutting Mill

The number in parentheses indicates the year of the last revision

1. Scope

This test method describes a procedure for the homogenization of absorbent hygiene products to a particle size smaller than 2 mm, for the purpose of producing homogeneous samples of a suitable size to be used for subsequent chemical analysis. The applicability of the homogenized material for the proposed subsequent analysis has to be verified. An annex proposes a way to assess the homogeneity of the mill discharge.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative reference

The following referenced documents are indispensable for the application of this document.

2.1 ISO test methods

ISO 13528 Statistical methods for use in proficiency testing by interlaboratory comparisons, first Edition 20050901

3. Terminology

For the purpose of this document, the following terms and definitions apply:

3.1 Aliquot

The exact portion of a larger volume of liquid to be used for testing.

3.2 Absorbent hygiene product (AHP)

For the purpose of this method, all disposable products designed to absorb body fluids, such as baby diapers, feminine hygiene products or adult incontinence management devices.

3.3 Homogeneity / homogenous sample

Absorbent hygiene products consist of an assembly of different components, such as plastic films, wood pulp, superabsorbent powders and adhesives and many other components, some of which present in minute amounts, if compared to others which make the bulk of the products. Homogeneity means that the proportion of each component originally present in the AHP to be submitted to milling is maintained and can be found in each aliquot of the ground sample.

Reference number
WSP 404.0.R1 (12) UM

Current edition approved 404.0.R1 (12)
Originally published as WSP 404.0.R1 in 2012
Last approved as New Method

4. Principle

A number of integral samples of absorbent hygiene products are ground in a cutting mill with an 8 mm bottom sieve. The operation is then repeated using a 2 mm bottom sieve. Homogeneity has to be statistically checked for any milling machine as per Annex A.

5. Materials

5.1 Sieves
Fitting bottom sieves (perforation: 8mm and 2mm)

5.2 Air pistol to supply pressurized air

5.3 Scissors

5.4 Disposable wipes and ethanol (70%) for cleaning

5.5 **0.1 mm thick black plastic** foil

Here are some definitions for foil
1**.** A thin, flexible leaf or sheet of metal: aluminum foil.
2**.** A thin layer of polished metal placed under a displayed gem to lend it brilliance.
3**.** The reflective metal coating on the back of a glass mirror.

6. Apparatus

6.1 Balance

6.2 Cutting Mill
High performance cutting mill,
SM 2000 / 695 rpm (Retsch) or equivalent (For additional information on this apparatus contact EDANA.)

7. Conditioning

No conditioning of samples or equipment is required.

8. Sampling

Take randomly six absorbent hygiene products from one production code out of the package.

9. Procedure

9.1 Pretreatment
Cut the six samples into smaller portions in order to fit in the funnel of the cutting mill.

9.2 Milling sequence

Grind all parts of the six samples as described in 9.3. Dispose of ground sample 1, as this is used to avoid any cross contamination from previously cut AHP's.

9.3 Grinding procedure

Successively grind all cut parts of the AHP with the 8 mm bottom sieve and collect them in one container. Typical grinding time for one mill load is 2-3 min. Then, grind the collected material with the 2 mm bottom sieve for another 2-3 min. to get the final homogenate.

9.4 Cleaning of the cutting mill

After every AHP lot, the cutting mill has to be cleaned thoroughly. For that purpose, the cutting mill is precleaned with compressed air and carefully wiped with a disposable wipe moistened with ethanol (70%).

ANNEX A
(informative)

Assessment of the suitability of a cutting mill to generate homogenous material

The purpose of this assessment is to check the suitability of a milling machine to generate homogeneous material, in the sense of the definition of homogeneity given under point 3.3. This assessment should be made according to a laboratory equipment calibration plan as part of a quality assurance system.

A.1 Procedure

Place a piece of piece of 0.1 mm thick black plastic foil on an AHP as shown in figure 3 below.

Proceed as described under 9.1 to 9.4 to grind an AHP together with the piece of 0.1 mm thick black plastic foil.

Figure A 1: Diaper with black plastic foil

Figure A 2: Precut with a pair of scissors

Figure A 3: Prepared samples for milling

Figure A 4: Homogenate after grinding using a 8 mm sieve

Figure A 5: Homogenate after grinding using a 2mm sieve

Count accurately the number of black particles in each ground sample. Six to ten aliquots are needed to ensure statistical significance of the results..

A2. Calculation of Results

Using the Grubbs test, examine for outliers the population of single values of every homogenate subsample.

If there are no outliers detected, a variance analysis has to be carried out. The variances s_2^2 (s_2 = standard deviation of the black particles for all samples) and s_1^2 (s_1 = standard deviation of the black particles for the subsamples) are compared with the F test.

In a first step it examine whether the analytical standard deviation under repeatable conditions (s_{an}) is comparable with the expected standard deviation. Otherwise the valuation of the inhomogeneity doesn't make sense. The standard deviation s_{an} is calculated according formula 1

$$S_{an} = \sqrt{\frac{\sum(\Delta x_1)^2}{2 \cdot n}} \quad (1)$$

Because the reproducibility standard deviation is not yet known, the target standard deviation (s_{target}) can be helpful. The target standard deviation is an empirical value from previous measurements. Step 1 can be fulfilled if

$$S_{an} < 0.5 \cdot S_{target} \quad (2)$$

In a second step is has to be examined whether a statically significant heterogeneity exists between the samples. Therefore a test value has to be calculated according formula 3

$$F = \frac{s_2^2}{s_{an}^2} = 4 \cdot \frac{\sum_{n-1}^{(\Delta x_2)^2}}{\sum_{n}^{(\Delta x_1)^2}} \quad (3)$$

When the zero hypothesis $F = {s_2}^2 / {s_{an}}^2 < F_{tab\ (P;\ f1;\ f2)}$ met, then there is no significant difference between the standard deviation of the mean of all samples and the standard deviation of one sample. This means there is no significant difference of black particles distribution among the samples.

In a third step, examine the value the standard deviation of the mean s_2 would assume if the analytical error was insignificant. This theoretical standard deviation is called the heterogeneous standard deviation $s_{heterogen}$ and it is calculated according formula 4

$$S_{heterogen} = \sqrt{\frac{\sum(\Delta x_2)^2}{n-1} - 0.25 \cdot \frac{\sum(\Delta x_1)^2}{n}} \quad (4)$$

If the term under the root becomes negative, the heterogeneous standard deviation is to be assumed zero.

The heterogeneous standard deviation is zero if the samples are homogeneous. If the heterogeneous standard deviation doesn't exceed the 0.3 times of the target standard deviation it can be assumed that the heterogenous standard deviation has no influence on the reproducibility standard deviation.

The following table contains an example summary of possible results and the appropriate interpretations

Step 1 $S_{an} < 0.5 \cdot S_{target}$	Step 2 $F < F_{tab}$	Step 3 $S_{heterogen} < 0.3 \cdot S_{target}$	Interpretation
no	-	-	generally no sample homogeneity test possible
yes	no	no	significant sample inhomogeneity and to high heterogeneity standard deviation. Samples not homogenous
yes	no	yes	significant sample inhomogeneity, but acceptable heterogeneity standard deviation
yes	yes	no	no significant sample inhomogeneity, but inacceptable heterogeneity standard deviation
yes	yes	yes	no significant sample inhomogeneity and acceptable heterogeneity standard deviation

Table A1: Interpretation of results

ANNEX B
Example of assessment of the suitability of a cutting mill to generate homogenous material

Homogeneity test with Retsch Cutting Mill

Date:	23.08.2011
Sample Material	Diapers
Sample ID	20091106
Analyt	Particles

Subsample #	# of Black articles Replicate 1	# of Black articles Replicate 2
1	672	**585**
2	572	**578**
3	585	**585**
4	597	**591**
5	587	**566**
6	570	**579**
7	607	**598**
8	563	**584**
9	615	**569**
10	567	**586**

Mean	**588**
RSD_R origin	Horwitz
RSD_R %	17.3
S_{target}	101.9
n	10-
$S_{an} = S_1$	23.62
$S_{heterogen}$	4.92
F	1.09
F_{tab}	8.02
f_1	2
f_2	9
$S_{an} < 0.5 \cdot S_{target}$	Yes
F<Ftab	Yes
$S_{heterogen} < 0.3 * S_{target}$	Yes
Results	

no significant sample inhomogeneity and acceptable heterogeneity standard deviation

USEFUL METHOD: WSP 405.0.R1 (12)

Standard Test Method for Superabsorbent Materials — Polyacrylate Superabsorbent Powders — Determining the Content of Respirable Particles

The number in parentheses indicates the year of the last revision

1. Scope

This test method determines the content of respirable particles in polyacrylate (PA) superabsorbent powders.

This test method determines the content of respirable particles in polyacrylate (PA) superabsorbent powders.

NOTE 1 Commercial Polyacrylate superabsorbent powders consist of particles averaging 400-800 µm in diameter, which are much larger than the maximum size for respirable particles of approximately 10 µm. Due to the production process, very low amounts of respirable particles may be present in commercial superabsorbent powders.

The SI values are regarded as the official standard system of measurement for this standard test method.

NOTE 2 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are for the application of this document

2.1 ISO test methods

a) ISO 17190-11:2001 Urine-absorbing aids for incontinence – Test methods for characterizing polymer-based absorbent materials – Part 11: Determination of content of respirable particles.

b) ISO 3696 Water for analytical laboratory use – Specification and test methods

c) ISO 5725 -1 Accuracy (trueness and precision) of Measurement Methods and Results – Part 1: General Principles and Definitions

d) ISO 5725 -2 Accuracy (trueness and precision) of Measurement Methods and Results – Part 2: Basic Method for the Determination of the Repeatability and Reproducibility of a Standard Measurement Method

e) ISO 139-2005 Textiles — Standard atmospheres for conditioning and testing

f) ISO 2859-1:1999 Sampling procedures for inspection by attributes

g) ISO 3951-1:2005 Sampling procedures for inspection by variables

h) ISO 8213 Chemical products for industrial use – Sampling techniques – solid chemical products in the form of particles varying from powders to coarse lumps

Reference number
WSP 405.0.R1 (12) UM

Current edition approved WSP 405.0.R1 (12)
Originally EDANA published this method as WSP 280.2 in 2010
Last approved as WSP 280.2 in 2009
A change in reference numbers WSP 280.0 to WSP 405.0.R1 UM

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply

3.1 Repeatability $_{(r)}$

As determined by the test method is the variability found between the test results of randomly selected homogenous specimens, tested at one laboratory, using one technician, one instrument, and one set of environmental conditions which were found on one given day

3.2 Reproducibility $_{(R)}$

As determined by this test method is the variability found between the test results of randomly selected homogenous specimens, which were tested at different laboratories, using more than one technician at each laboratory, and tested over a two day period using standard laboratory environmental conditions which were found at each laboratory.

3.3 Respirable particle

Particle having a size smaller than 10 µm

4. Principle

The particle size fraction <106 µm of the superabsorbent powders is separated from the bulk by sieving the bulk with a set of sieves with 500 µm, 250 µm and 106 µm pore size. The fraction of respirable particles (<10 µm) is determined by analyzing the fraction of particle sizes < 106 µm by a laser-light scattering particle-size analyzer using light diffraction. A wet dispersion in dry petroleum ether of the particle size fraction < 106 µm is used for the determination of respirable particles.

5. Reagents and Materials

Use only reagents of recognized analytical grade, unless otherwise specified.
Petroleum ether, — dried, with a boiling range from 60 °C to 80 °C.

6. Apparatus

6.1 Analytical balance

Capable of weighing, to the nearest 0.001 g, masses up to 800 g

6.2 Beaker

Made of glass, of 150 ml capacity

6.3 Sieve shaker, type Retsch 3 D[1)], RO-TAP Model B[1)]

Or equivalent, designed to hold at least three stainless steel screens and equipped with a bottom receiving pan and a lid, and grounded for avoiding static electricity

6.4 Stainless steel screens
With pore sizes of 500 µm, 250 µm, and 106 µm. Use 200-mm diameter screens for the RO-TAP Model B sieve shaker and 100-mm or 200-mm diameter screens for the Retsch 3 D (or equivalent) sieve shaker.

6.5 Brush
For example made of camel's hair, for cleaning of standard sieves

6.6 Dust mask
Adequate to meet the safety warning in note number 3

6.7 Laser light scattering particle analyzer
Using the diffraction theory, e.g. Coulter LS 1002), Sympatec[2]), Malvern[2]), Cilas[2]) or equivalent devices.

6.8 Sample divide
For example a Retsch type PT[3]).

7. Sampling

NOTE 3 **SAFETY WARNING**

Use respiratory protection, dust mask or fume hood, when handling sample amounts greater than 10 g.

7.1 Preparation of test sample

7.1.1 In order to guarantee that a representative sample is taken from the bulk material contained in a large bag or a silo truck, remove the top layer (approximately 20 cm). Take the test sample with a scoop. Place it in an airtight container of adequate size within 3 minutes after sampling.

7.1.2 Keep the test samples in a closed container and allow them to equilibrate to the ambient laboratory temperature before removing a test portion to run the test. The preferred test conditions are (23 ± 2) °C and (50 ± 10) % relative humidity. If these conditions are not available, test at ambient conditions and report the temperature and relative humidity. Measure these laboratory conditions in accordance with ISO 187.

7.2. Test portion
7.2.1 Before taking a test portion out of the container to run the test, rotate the container three to five times so as to obtain a homogeneous product. Allow the container to sit 5 minutes before opening the lid and removing the test portion.

7.2.2 Make sure the test portion is substantially free of lumps of size greater than 1 mm in diameter before proceeding with testing.

7.2.3 Using a sampling technique specified in ISO 8213, prepare, to the nearest 1 g, 100 g test portions.

7.2.4 If a Retsch sample divider PT is to be used, prepare the test portions as follows:

a) Connect 8 glasses (250 ml) to the 8 tubes of the divider
b) Weigh, to the nearest 1 g, 800 g of the representative homogeneous sample in a beaker
c) Transfer the test sample into the funnel of the sample divider
d) Start the divider and set the timer to 15 min

8. Procedure

8.1 Check screens

For damage and cleanliness and weigh, to the nearest 0.01 g, and record the mass of the bottom pan

8.2 Place the screens

In the right order on the shaker, i.e. the finest at the bottom and the coarsest at the top

8.3 Transfer the contents

From one divider tube or equivalent 100 g from another type of sample divider into a beaker, and weigh this test portion to the nearest 0.01 g (ms)

8.4 Transfer the entire test portion

To the sieve tester and pour it on the top of screens. Place the lid on the sieves and secure it in accordance with the manufacturer's instructions.

8.5 Set the sieve shaker as follows:

a) RO-TAP: (150 ± 5) beats/min and (285 ± 10) r/min
b) Retsch: (70 ± 2) % intensity

8.6 Ground the equipment

Ground the equipment to avoid static electricity. Set the shaker time to 10 min and start the shaker.

8.7 Carefully remove the screens

Weigh, to the nearest 0.01 g, the bottom pan with its contents and calculate the mass of the particles passing through the 106 µm sieve and collected in the bottom pan (m106).

8.8 Repeat 7.1 to 7.6

For each divider tube or equivalent test portion

8.9 Collect and pool the samples

Below 106 µm particle size for measurement by laser scattering

8.10 Calibrate the laser particle analyzer

Using an appropriate standard in accordance with the manufacturer's instructions (e.g. silicium carbide or equivalent)

8.11 Divide the superabsorbent powders

Collected in the bottom pan into equal aliquots. The size of one aliquot is determined by the amount which is necessary to run an analysis in the laser-light particle size analyzer.

8.12 Transfer
One aliquot to the cuvette with dry petroleum ether as described in the manufacturer's operating manual of the laser-light particle size analyzer. While measuring this aliquot, keep the remaining aliquots away from humidity (close the bottom pan or use individual closed containers for the aliquots).

8.13 Place the cuvette
in the sample holder of the laser-light particle size analyzer and run the determination according to the manufacturer's operating manual. Stir the solution during the measurement to avoid sedimentation.

8.14 Record
The percentage of respirable particles in the aliquot (p_i).

8.15 Repeat
8.12 and 8.14 with all aliquots prepared in 8.11.

8.16 Repeat
8.1 to 8.15 at least 3 times.

9. Calculation

9.1 Calculate the average percentage (p) of respirable particles from all aliquots (p_i).

9.2 Calculate the amount of respirable particles based on initial test portion mass (w_{106}), expressed as a mass fraction in percent according to equation (1):

$$W_{106} = p \frac{m_{106}}{m_s}$$

Where:

m_{106}	Is the mass, expressed in grams, of the particles passing through the 106 µm sieve and collected in the bottom pan
m_s	Is the mass, expressed in grams, of the test portion

9.3 Calculate the average amount of respirable particles on at least 3 test portions.

10. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) The type of polymer-based absorbent materials, including all technical details and source information required for the complete identification of the sample.
f) Any unusual features noted during the determination or if the reproducibility and/or repeatability criteria were not met

g) The results of the percentage of respirable particles, based on initial sample mass, w, expressed as a mass fraction in percent, for each test portion, and the average for duplicate determinations
h) Laboratory testing conditions
i) Number of specimens tested
j) For computer processed data, identify the software used and the version
k) Deviation from the standard test procedure, if any
l) Whether or not samples were conditioned prior to testing and, if so, for how long
m) Anything unusual noted during the testing

11. Precision

11.1 The data

For the repeatability $_{(r)}$ and reproducibility $_{(R)}$ limits of this method are the result of interlaboratory tests carried out in 1997 by EDANA, and are given in Annex A.

11.2 The absolute difference

Between two single test results obtained under repeatability test conditions in accordance with ISO 5725-2 shall not exceed the repeatability limit $_{(r)}$ in more than 5% of cases:

$_{r}$ = 0.011 %

11.3 The absolute difference

Between two single test results obtained under reproducibility test conditions in accordance with ISO 5725-2 shall not exceed the reproducibility limit $_{(R)}$ in more than 5% of cases:

$_{R}$ = 0.050 %

11.4 If the repeatability and reproducibility test criteria are not met

The test shall be repeated twice, each in duplicate, after ensuring that the original sample is thoroughly mixed. If these criteria are still not met, report the results as unusual, then diagnose the source of error, for example by verifying correct operation of the instruments, and testing a portion of a material with a known value.

[1] Retsch 3 D and RO-TAP Model B are examples of suitable products available commercially. This information is given for the convenience of users of this test method and does not constitute an endorsement by EDANA of this product.

[2] Coulter LS 100, Sympatec, Malvern and Cilas are examples of suitable products available commercially. This information is given for the convenience of users of this test method and does not constitute an endorsement by EDANA of this product.

[3] Retsch type PT is an example of a suitable product available commercially. This information is given for the convenience of users of this test method and does not constitute an endorsement by EDANA of this product.

ANNEX A

(informative)

Statistical results of interlaboratory tests

Figures for the repeatability and reproducibility of this method are the result of collaborative studies carried out in 1997 by EDANA. The evaluation of the interlaboratory test was carried out in accordance with ISO 5725-2 and results are as follows:

Samples	A	B	C
No. of participating laboratories	7	7	7
No. of non-eliminated laboratories	5	6	4
No. of accepted test results	15	18	12
Mean value (%)	0.007	0.040	0.011
Repeatability standard deviation, s_r	0.001	0.004	0.001
Repeatability coefficient of variation, CV_r (%)	13.2	11.8	9.6
Repeatability limit, r (2.8 x s_r)	0.003	0.011	0.003
Reproducibility standard deviation, s_R	0.005	0.018	0.005
Reproducibility coefficient of variation, CV_R (%)	64.3	44.9	47.4
Reproducibility limit, R (2.8 x s_R)	0.014	0.050	0.014

USEFUL METHOD: WSP 406.0.R1 (12)

Standard Test Method for Superabsorbent Materials — Polyacrylate Superabsorbent Powders — Determination of Dust in Collection Cassettes by Sodium Atomic Absorption/Emission Spectrometry

The number in parentheses indicates the year of the last revision

1. Scope

This test method determines the Polyacrylate (PA) superabsorbent powders in dust samples collected in polystyrene acrylonitrile air-monitoring cassettes with Teflon filters and porous plastic backing pads by measurement of sodium by atomic absorption/emission spectrometry (AAS/AES).

This method is applicable to the determination of superabsorbent powder collected within air-monitoring cassettes, containing super- absorbent powders in the range between 0.2 µg and 60.0 µg with a limit of detection near 0.2 µg superabsorbent powders.

NOTE 1 This test is designed to determine low levels of sodium and requires that very clean handling conditions be observed. The use of deionized/distilled water with very low sodium is critical for successful analysis.

The SI values are regarded as the official standard system of measurement for this standard test method.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document

2.1 ISO test methods

a) ISO/FDIS1) 17191:2001 Urine-absorbing aids for incontinence – Test methods for the measurement of airborne respirable Polyacrylate superabsorbent materials – Determination of dust in collection cassettes by sodium atomic absorption/emission spectrometry.

b) ISO 3696 Water for analytical laboratory use – Specification and test methods

c) ISO 5725-2 Accuracy (trueness and precision) of measurement methods and results – Part 2:Basic method for the determination of the repeatability and reproducibility of a standard measurement method.

d) ISO 186:1985

e) ISO 187 Paper, board and pulps – Standard atmosphere for conditioning and testing and procedure for monitoring the atmosphere and conditioning of samples

f) ISO 8213 Chemical products for industrial use – Sampling techniques – solid

[1)] Final Draft International Standard

Reference number
WSP 406.0.R1 (12) UM

Current edition approved WSP 406.0.R1 (12)
Originally published as WSP 406.0.R1 in 2012
Last approved as WSP 406.0.R1 in 2012

chemical products in the form of particles varying from powders to coarse lumps

2.2 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply

3.1 Repeatability $_{(r)}$

As determined by the test method is the variability found between the test results of randomly selected homogenous specimens, tested at one laboratory, using one technician, one instrument, and one set of environmental conditions which were found on one given day

3.2 Reproducibility $_{(R)}$

As determined by this test method is the variability found between the test results of randomly selected homogenous specimens, which were tested at different laboratories, using more than one technician at each laboratory, and tested over a two day period using standard laboratory environmental conditions which were found at each laboratory.

4. Principle

Atomic absorption analysis is used to determine the sodium content in PA superabsorbent powders collected in air-monitoring cassettes. The sodium is determined after being freed from the PA superabsorbent powder when allowed to exchange with potassium present in a potassium chloride solution. The amount of dissolved sodium is then determined using AAS and the mass of the PA superabsorbent powder calculated.

To minimize sodium contamination, an in situ analysis is done in the pre-washed cassette system to collect the superabsorbent powders.

5. Reagents and Materials

Use only reagents of recognized analytical grade, unless otherwise specified. All reagents and solutions shall be stored in plastic containers with the only exceptions being the KCI and IPA, which shall be stored in the glass containers in which they are shipped.

5.1 Pre-analyze solutions

Prepared in accordance with 7.2.1, 7.2.2 and 7.2.3 for sodium (Na) using AAS before using clean cassettes or before Na analysis

5.2 Potassium chloride (KCl)

Potassium chloride of spectroscopic quality

5.3 Water
Complying with ISO 3696, Grade 1

5.4 Isopropyl alcohol (IPA.
Isopropyl alcohol (IPA) of spectroscopic quality

5.5 Sodium standard reference solution
p (Na) = 1000 mg/l [1000 ppm]

5.6 Potassium chloride solution
p (KCl) = 2000 mg/l. Dissolve 2.0 g of potassium chloride in 1.0 L of deionized water. The solution must contain < 0.1 ppm Na

5.7 Sodium standard solutions
For AAS as follows: p (Na) = 0.1 mg/l, 0.5 mg/l, 1.0 mg/l, 2.0 mg/l. Dilute the 1000 mg/l sodium standard reference solution (5.5) with the 2000 mg/l potassium chloride (5.6) as required and add 10% v/v isopropanol (5.4)

5.8 Atomic absorption zeroing solution
2000 mg/l potassium chloride solution (5.6) with 10% v/v isopropyl alcohol (5.4).

6. Apparatus
a) Atomic Absorption Spectrometer (AAS).
b) Spray chamber and burner, — special and only for sodium determination.
c) Hollow cathode lamp sodium,
d) Pipette, — for measuring 0.5 ml.
e) Pipette, — for measuring 5 ml.
f) Plastic gloves, non-powdered.
g) Polypropylene flasks, of 100 ml capacity.
h) Air-monitoring cassettes [2])

7. Procedure
7.1 Sample preparation and precautionary measures

7.1.1 Number each cassette so that its preparation date can be traced. Keep records of the absorbance values of the water used for rinsing and the 10% blank cassettes tested.

7.1.2 Take appropriate care to avoid contaminating the cassettes. Make the assumption that fingers, work bench surfaces, the lab floor, etc. are contaminated with sodium. As little as 0.02 µg of sodium in the cassette will interfere with the analysis.

7.1.3 Remove the inlet plug from the cassette. Add 0.5 ml IPA onto the filter. Add 4.5 ml 2000 mg/l KCl and reinstall plug (using forceps).

7.1.4 Shake the cassette for 1 h on a shaker. Keep the cassette plugged until ready for analysis. It is very important to use the same chemicals and solutions for the calibration curve, samples and blanks for analysis. If all the samples cannot be prepared from the same batch of solutions, run a new calibration curve with newly prepared solutions for the remaining samples and treat the results of these samples as if they are an independent series.

7.1.5 Rinse plastic gloves with deionized water after donning and air dry. Wear plastic gloves as needed to make sure that inner cassette parts are not touched.

7.2 Determination

7.2.1 After ensuring that set-up of the AAS (5.2.1) is complete and flame stability is reached using the zeroing solution (5.1.5), run the sodium standard solutions (5.1.6) to establish the calibration curve. Make sure each standard as well as the zeroing solution contains 2000 mg/l KCl (5.1.7) and 10% IPA (5.1.5).

7.2.2 Remove the cassette inlet plug and aspirate samples and blanks directly from the cassette through the inlet hole. Make sure the sample solution is free of solid material to prevent plugging of the sample pickup tube.

7.2.3 Check the zero after running 5 samples. At that time, also check one standard solution (1.0 mg/l Na). If the absorbance value has changed, it indicates that the tube is plugged and should be checked. A complete recalibration may be needed if the standard has changed significantly after cleaning the tube.

7.2.4 Run a set of five retained blank cassettes from the same batch of cassettes for every set of samples.

8. Calculation

8.1 Plot a calibration curve

Using a second order regression fit of the data with absorbance units and sodium mass concentration as axes. This may be done within the framework of the spectrometer equipped with the Perkin Elmer Atomic Absorption Benchtop[3]) software. The response of AAS to sodium is non-linear with respect to the mass concentration. Therefore, do not use a linear regression fit.

8.2 Convert the values

Of the apparent mass concentration of sodium determined from the calibration curve to the apparent mass of PA superabsorbent powder, m_a, expressed in micrograms (µg), according to equation (1) as follows:

$$m_a = a\ Vs\ F_{Na} \qquad (1)$$

Where:

a	Is the apparent mass concentration, expressed as milligrams per litre (mg/l), of sodium extracted in the reagents added to the cassette as determined from the calibration curve.
V_s	Is the total volume of reagents added to the cassette, specified in 6.1.3 (=5 ml).
F_{Na}	Is the conversion factor for Na to PA superabsorbent powder (=5.88).

8.3 Determine the limit of detection

LOD, for superabsorbent powder by calculating the standard deviation,
SD, of the blanks and multiplying the result of the standard deviations by three.
Record the value of the mean blank, m_b, calculated using the calibration curve for each set of samples and use this value in the calculations to correct for background (LOD = m_b + 3 SD).

8.4 Subtract

The mean blank value from each sample result to obtain the corrected level of superabsorbent powders in each sample. This value, m_c, expressed in micrograms (µg), is the corrected mass of superabsorbent powder found in each cassette and is calculated according to equation (2) as follows:

$$m_c = m_a - m_b \qquad (2)$$

Where:

m_a	Is the apparent mass, expressed as milligrams, of PA superabsorbent powder determined in the cassette using equation (1).
m_b	Is the mean blank determined in 8.3.

8.5 Compare all corrected values

From 8.4, m_c, with the limit of detection for the test (8.3). Report the corrected value if greater than the limit of detection, but not those that are equal to or less than the limit of detection. Report this latter as ND (none detected) and give the limit of detection for the test. See examples below.

EXAMPLE

Mean blank, $m_b = 0.029$

Standard deviation, SD = 0.14

Limit of detection, $LOD = m_b + 3\ SD$

Limit of quantification, $LOQ = m_b + 6\ SD = 0.869$

Using equation (1):

Sample 1: cal = 0.128 mg/l thus $m_a = 0.128 \times 5 \times 5.88 = 3.76$ µg

Sample 2: cal = 0.009 mg/l thus $m_a = 0.009 \times 5 \times 5.88 = 0.26$ µg

Using equation (2):

Sample 1: $m_c = 3.76 - 0.029 = 3.73$ µg

Sample 2: $m_c = 0.26 - 0.029 = 0.24$ µg

Report:

Sample 1: $m_c = 3.73$ µg PA superabsorbent powder

Sample 2: ND (LOD = 0.45 µg)

9. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling

c) Name and address of testing institution
d) Make and model of testing equipment\
e) The type of polymer-based absorbent materials, including all technical details and source information required for the complete identification of the sample.
f) The results of the mass, expressed in micrograms, of PA superabsorbent powders in each cassette.
g) Laboratory testing conditions
h) Number of specimens tested
i) Software used and version
j) Deviation from the standard test procedure, if any
k) When calculated, the standard deviation or the coefficient of variation
l) Whether or not samples were conditioned prior to testing and, if so, for how long
m) For computer processed data, identify the software used and the version
n) Anything unusual noted during the testing

10. Precision

Statistical results of a recovery trial for this method are given in Table 1. The trial was performed on one instrument in one single laboratory.

Table 1: Precision data

Matrix	Number of values	Number of outliers	Mean value (ppm Na)	Repeatability standard deviation (ppm Na)	Variation coefficient (%)	Recovery rate (%)
Cassette blank	7	0	0.0087	0.00198	22.7	-
Cassette + spike 0.100 Na	7	1	0.1025	0.00446	4.35	102.5
Cassette + spike 1.000 Na	7	0	1.027	0.00684	0.67	102.7

[2]) Air-monitoring cassettes with the following specification have shown suitable: Cassette outlet and rings = SKC Catalogue Part #225-3; Support pad = SKC Catalogue Part #225-2902; Filter = Pall Gelman Catalogue Part #P5pj037, Zefluor filter 37 mm, 2 micron. This information is given for the convenience of the users of this test method and does not constitute an endorsement by EDANA of any particular product.

[3]) Perkin Elmer Atomic Absorption Benchtop software is an example of a suitable product for performing this regression fit and is available commercially. This information is given for the convenience of users of this test method and does not constitute an endorsement by EDANA of this product.

USEFUL METHOD: WSP 407.0.R1 (12)

Standard Test Method for Fiber Orientation Distribution of Nonwoven Fabrics

The number in parentheses indicates the year of the last revision

1. Scope

This WSP standard test method specifies the method to determine fiber orientation distribution of nonwoven fabrics.

This test method applies to most nonwoven fabrics providing they do not contain microfibers.

NOTE 1 Safety

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative reference

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.1 ISO test methods

a) ISO 5725 – 2: Accuracy (trueness and precision) of measurement methods and results — Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method.
b) ISO 2859-1:1999 Sampling procedures for inspection by attributes.
c) ISO 3951-1:2005 Sampling procedures for inspection by variables.

2.2 WSP test methods

a) WSP 1.0 (09) Standard Terminology Relating to the Nonwoven Industry and EDANA's and INDA's Standard Test Methods.

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Fiber orientation

Fiber orientation is direction of a fiber arranged in the fabrics expressed by orientation angle α. Fiber orientation angle, α, is a range from 0 to 180 degree and 90 degree is correspond to machine direction and 0 degree is correspond to cross-direction.

Reference number
407.0.R1 (12) UM

Current edition approved December 2009
Newly approved as WSP 60.5 A in 2009

3.2 Fiber orientation distribution function

The orientation distribution function [ODF], f (α), is a function of the orientation angle α. The integral of the orientation distribution function f (α), from an angle α 1 to α 2, is equal to the probability that a fiber will have an orientation between the angles α 1 and α 2. The function f (α) must additionally satisfy the following conditions:

$$f(\alpha + \pi) = f(\alpha)$$
$$\int_0^{\pi} f(\alpha) d\alpha = 1 \qquad \text{(equation 1)}$$

3.3 Cos Square anisotropy ratio

Other measure of anisotropy is cosine square anisotropy ratio, which is given by,

$$H_t = 2\langle cos^2\alpha \rangle - 1 \qquad \text{(equation 2)}$$

Where,

$$\langle cos^2\alpha \rangle = \int_{-\pi/2}^{\pi/2} f_t(\alpha)\, cos^2(\alpha) d\alpha.$$

It ranges from -1 to 1, where:

- 1: indicates a perfect alignment parallel to the cross-direction
- 0: indicates randomness
- -1: indicates a perfect alignment parallel to the machine direction

4. Symbols and Abbreviated Terms

4.1 ODF

Fiber orientation distribution function

4.2 α

Fiber orientation angle

4.3 MD

Machine direction of the nonwoven

4.4 CD

Cross-direction of the nonwoven

5. Principle

The properties of a nonwoven fabric will depend on the nature of the component fibers as well as the way in which the fiber are arranged. Fiber arrangement in nonwovens can be described by fiber orientation angle, α, and its distribution, namely fiber orientation distribution function (ODF).

Fiber orientation is an important structural characteristic of nonwovens. Many properties of nonwoven exhibit anisotropy, which is variation in performance and properties as function of the

direction nonwoven. Anisotropy in nonwoven is caused by anisotropic structure of nonwovens that is directional arrangement of fibers. Therefore, anisotropic properties of nonwoven fabrics are directly related to the structural anisotropy, which is measured by fiber orientation distribution function.

This method described the measurement method of planar fiber orientation distribution function through acquisition of 2D projection image of the nonwoven specimen and its analysis.

6. Apparatus

Schematics of an imaging system for fiber orientation distribution measurement are shown in Figure 1.

Basic components of an imaging system are a sample stage, backlight illumination, zoom optics, and digital camera. Imaging system is built for producing 2-D projection of the nonwoven specimen. It is necessary to have all layers be in focus simultaneously under uniform illumination with high contrast.

6.1 Backlight illumination source

It generates uniform illumination with intensity enough to penetrate a specimen. It is highly recommended to have a capability of adjusting illumination intensity.

6.2 Sample stage

Flat panels where specimen can lie on with apertures to allow backlight illumination pass through to a specimen.

6.3 Zoom optics and a digital camera

Magnification and field of view required is determined by fiber diameters in a testing specimen and a zoom lens or a microscopy can be used if necessary. A digital camera has enough sensitivity and resolution to capture an image with high contrast. The system should provide digitized images of web containing at least 1000 fibers with fiber diameters in 1 to 5 pixels. A recommended resolution and minimum viewing area is summarized in Table 1.

Fiber diameter	Resolution (μm)	Minimum image area
1-5um	1	0.5mm
5-25	5	1mm
25-50	10	2mm
50-100	20	3mm
>100	>20	5mm

Table 1

Maximum resolution of the system recommended is shown in table

7. Preparation of Apparatus

Prepare the machine according to the manufacturer's instructions. A sample stage and light, lens should be clean and no scratch or contamination.

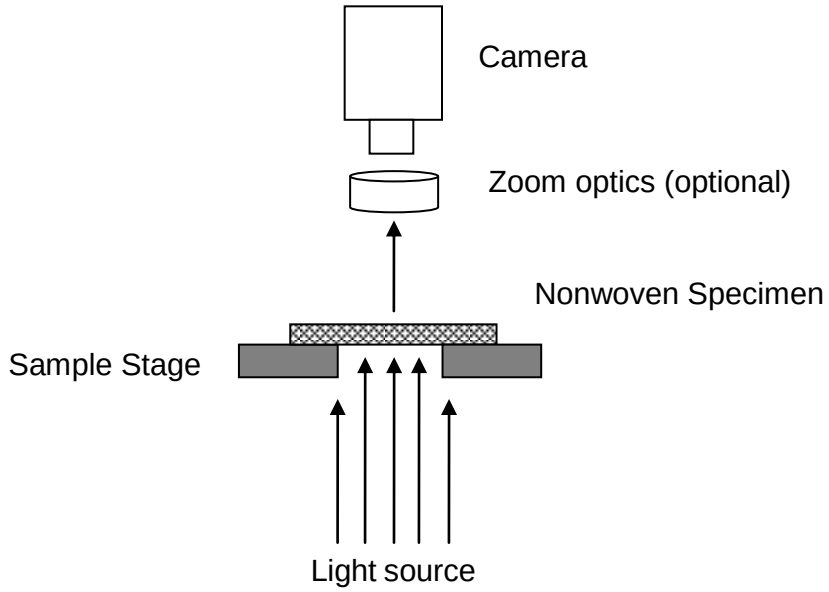


Figure 1
Imaging system for fiber orientation distribution determination

8. Calibration and Standardization

Verification of the image analysis operation
Analysis can be performed either manually or with the conjunction of proper image analysis technique. Image analytical technique should be verified by comparing results with standard images provided in this section. This verification of the operation is recommended before the first use or any changes in system made.

If the results are outside the tolerances established, recheck the total system to locate the cause for deviation.

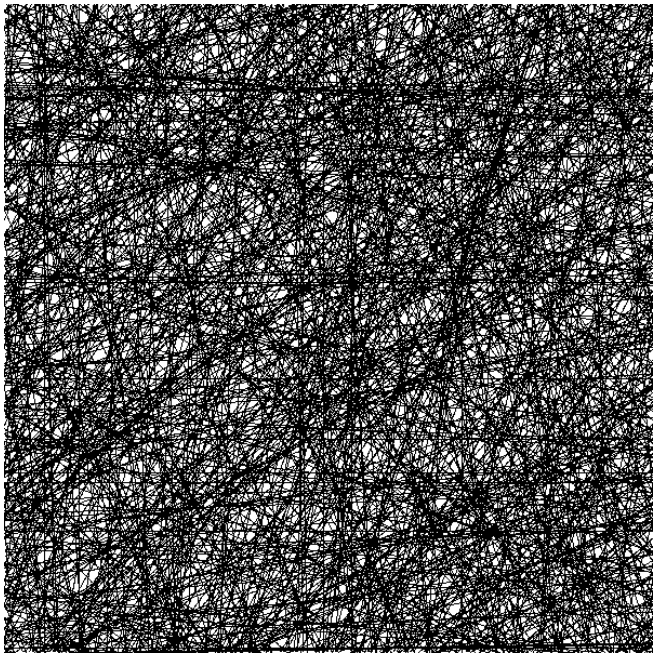
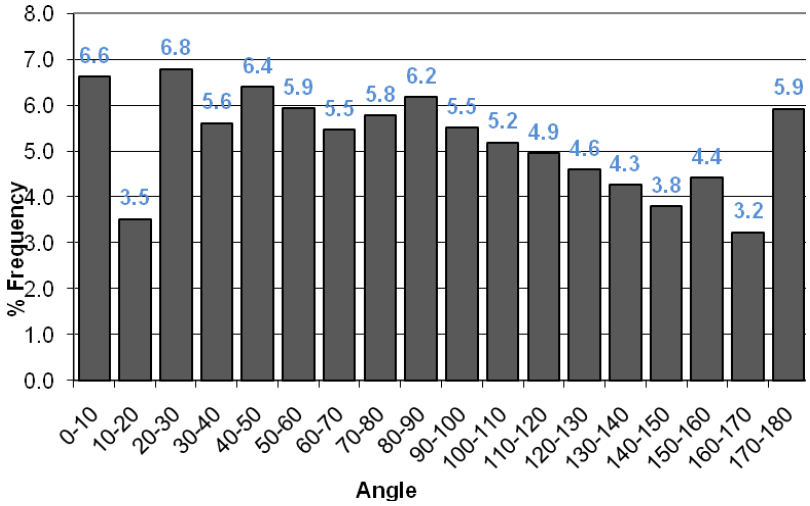


Image 1
75% Area, Uniform distribution (0-180 degree)

Angle	% Frequency
0-10	6.6
10-20	3.5
20-30	6.8
30-40	5.6
40-50	6.4
50-60	5.9
60-70	5.5
70-80	5.8
80-90	6.2
90-100	5.5
100-110	5.2
110-120	4.9
120-130	4.6
130-140	4.3
140-150	3.8
150-160	4.4
160-170	3.2
170-180	5.9
Anisotropy Ratio	**-0.086**

Key for Image 1



Bar graph for Image 1

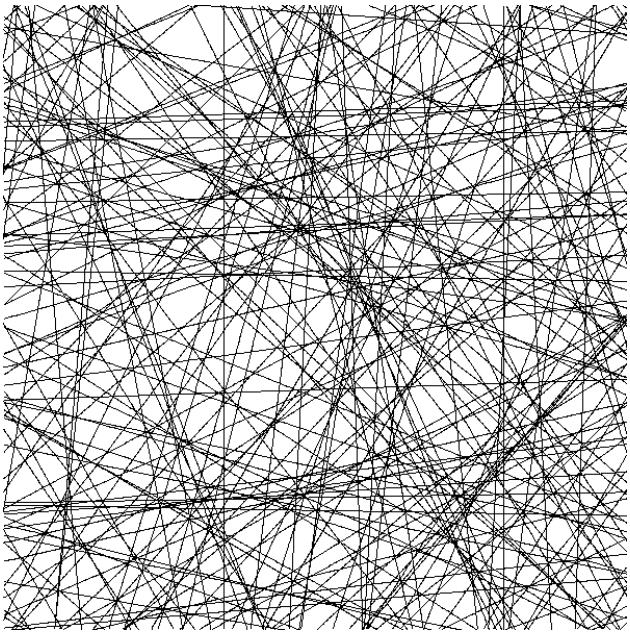
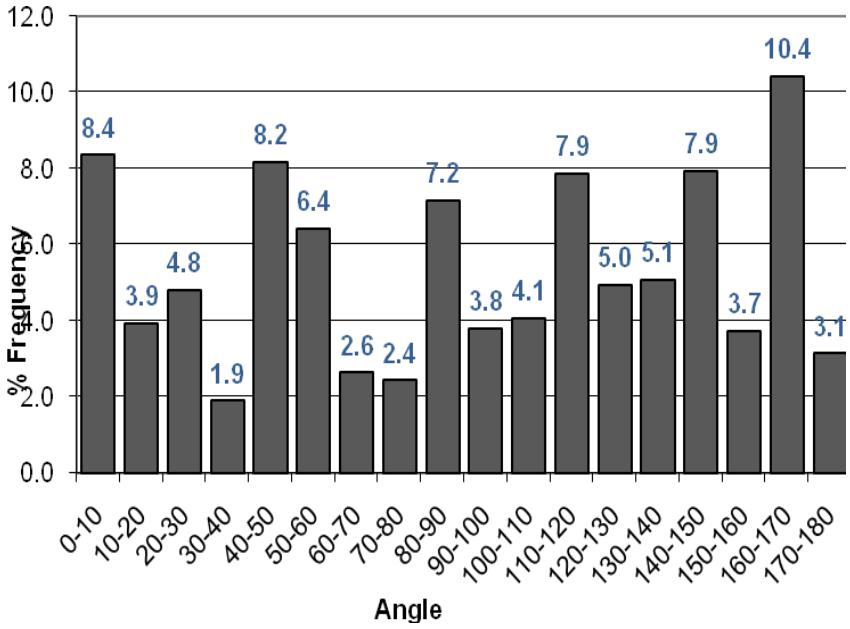


Image2
25% Area, Uniform distribution (0-180 degree)

Angle	% Frequency
0-10	8.4
10-20	3.9
20-30	4.8
30-40	1.9
40-50	8.2
50-60	6.4
60-70	2.6
70-80	2.4
80-90	7.2
90-100	3.8
100-110	4.1
110-120	7.9
120-130	5.0
130-140	5.1
140-150	7.9
150-160	3.7
160-170	10.4
170-180	3.1
Anisotropy Ratio	**0.024**

Key for Image 2



Bar graph for Image 2

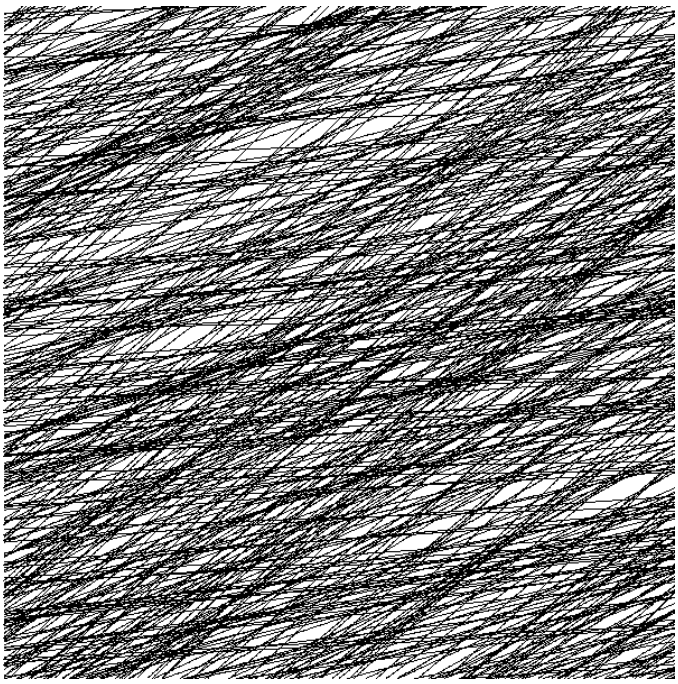
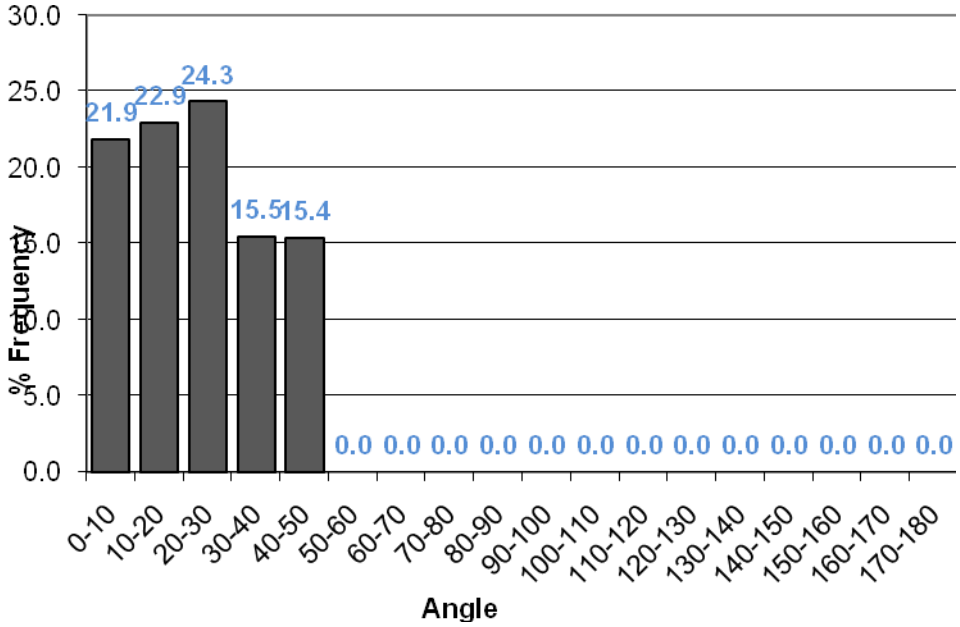


Image 3
50% Area, Uniform distribution (0-45 degree)

Angle	% Frequency
0-10	21.9
10-20	22.9
20-30	24.3
30-40	15.5
40-50	15.4
50-60	0.0
60-70	0.0
70-80	0.0
80-90	0.0
90-100	0.0
100-110	0.0
110-120	0.0
120-130	0.0
130-140	0.0
140-150	0.0
150-160	0.0
160-170	0.0
170-180	0.0
Anisotropy Ratio	**0.624**

Key for Image 3



Bar graph for Image 3

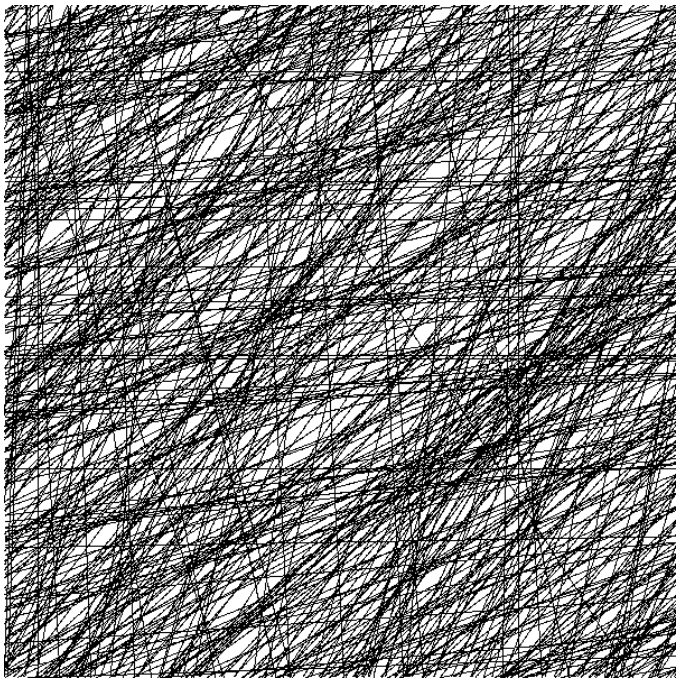
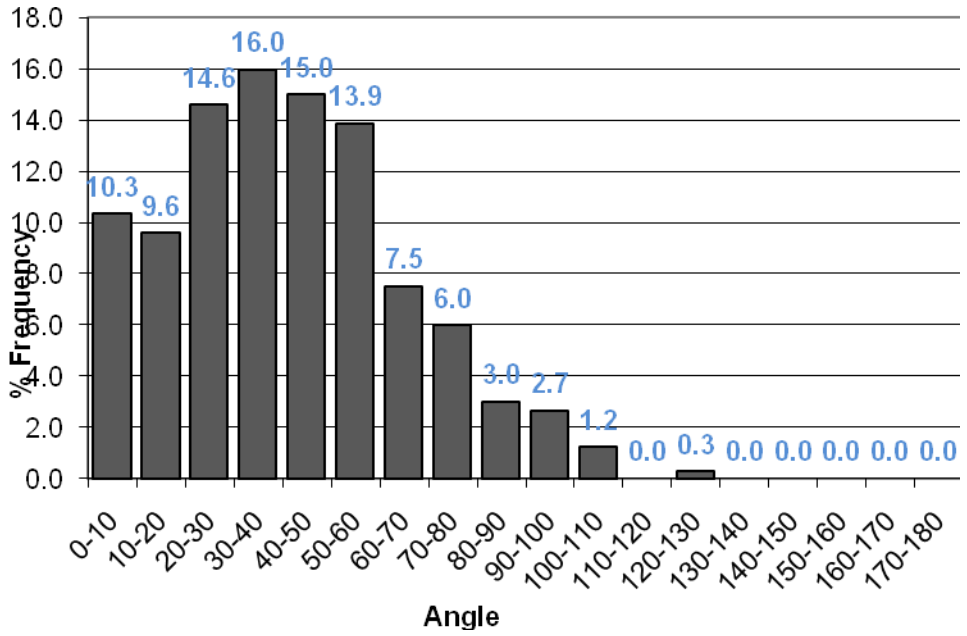


Image 4
50% Area, Normal distribution (Mean =30 degree, Standard deviation =30)

Angle	% Frequency
0-10	10.3
10-20	9.6
20-30	14.6
30-40	16.0
40-50	15.0
50-60	13.9
60-70	7.5
70-80	6.0
80-90	3.0
90-100	2.7
100-110	1.2
110-120	0.0
120-130	0.3
130-140	0.0
140-150	0.0
150-160	0.0
160-170	0.0
170-180	0.0
Anisotropy Ratio	**0.118**

Key for Image 4



Bar graph for Image 4

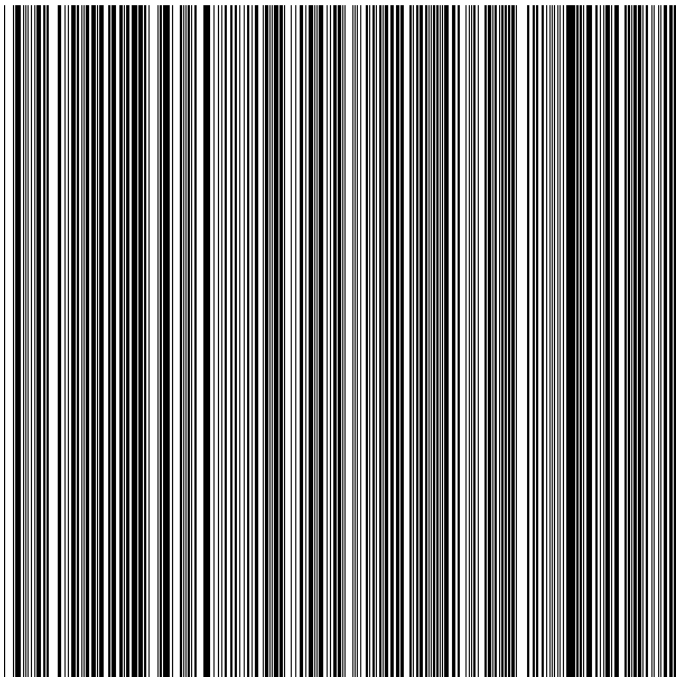
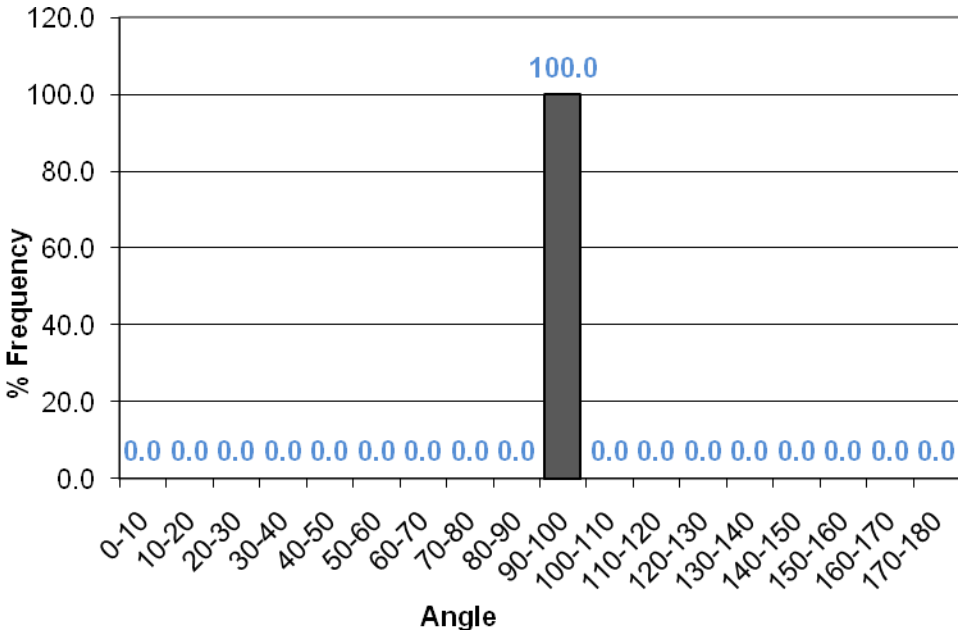


Image 5
50% Area, Normal distribution (Mean =90 degree, Standard deviation =0)

Angle	% Frequency
0-10	0.0
10-20	0.0
20-30	0.0
30-40	0.0
40-50	0.0
50-60	0.0
60-70	0.0
70-80	0.0
80-90	0.0
90-100	100.0
100-110	0.0
110-120	0.0
120-130	0.0
130-140	0.0
140-150	0.0
150-160	0.0
160-170	0.0
170-180	0.0
Anisotropy Ratio	**-0.985**

Key for Image 5



Bar graph for Image 5

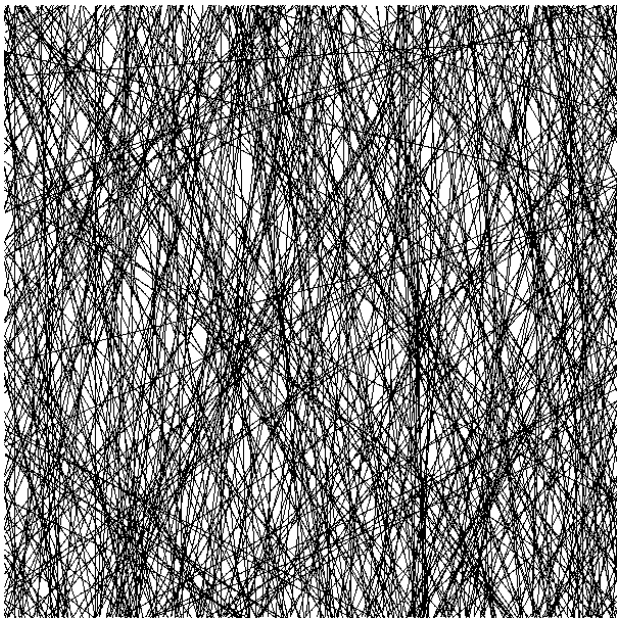
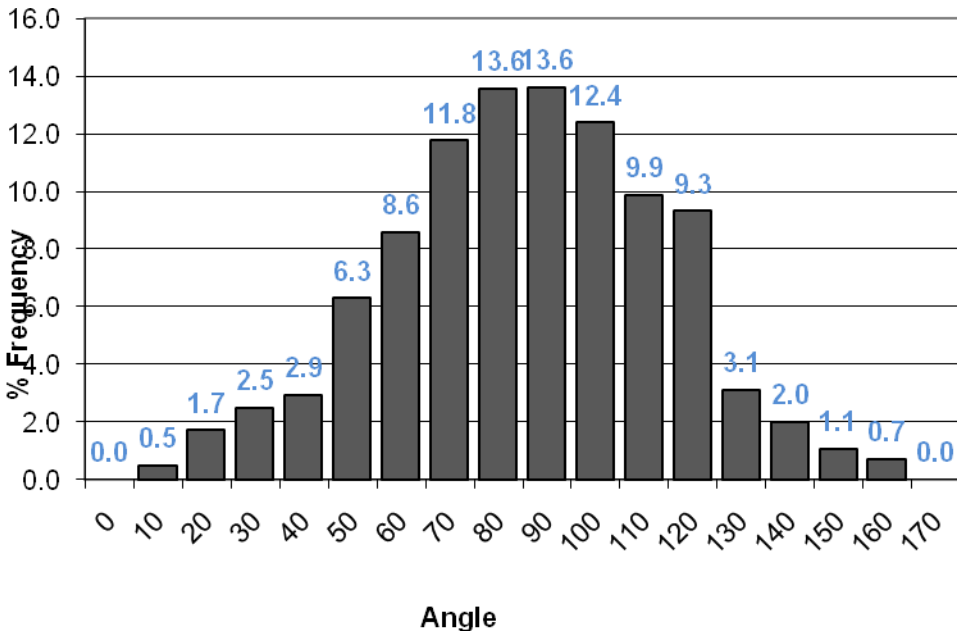


Image 6
50% Area, Normal distribution (Mean =90 degree, Standard deviation =30)

Angle	% Frequency
0-10	0.0
10-20	0.5
20-30	1.7
30-40	2.5
40-50	2.9
50-60	6.3
60-70	8.6
70-80	11.8
80-90	13.6
90-100	13.6
100-110	12.4
110-120	9.9
120-130	9.3
130-140	3.1
140-150	2.0
150-160	1.1
160-170	0.7
170-180	0.0
Anisotropy Ratio	**-0.606**

Key for Image 6



Bar graph for Image 6

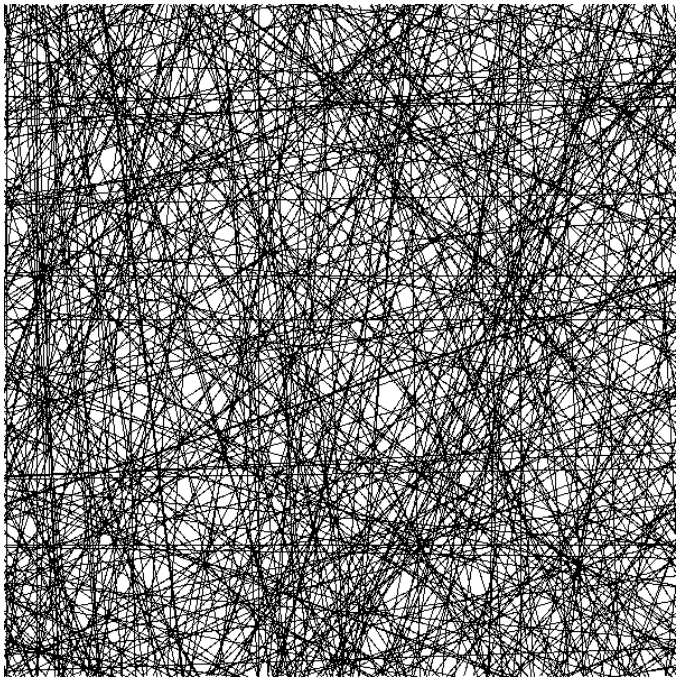
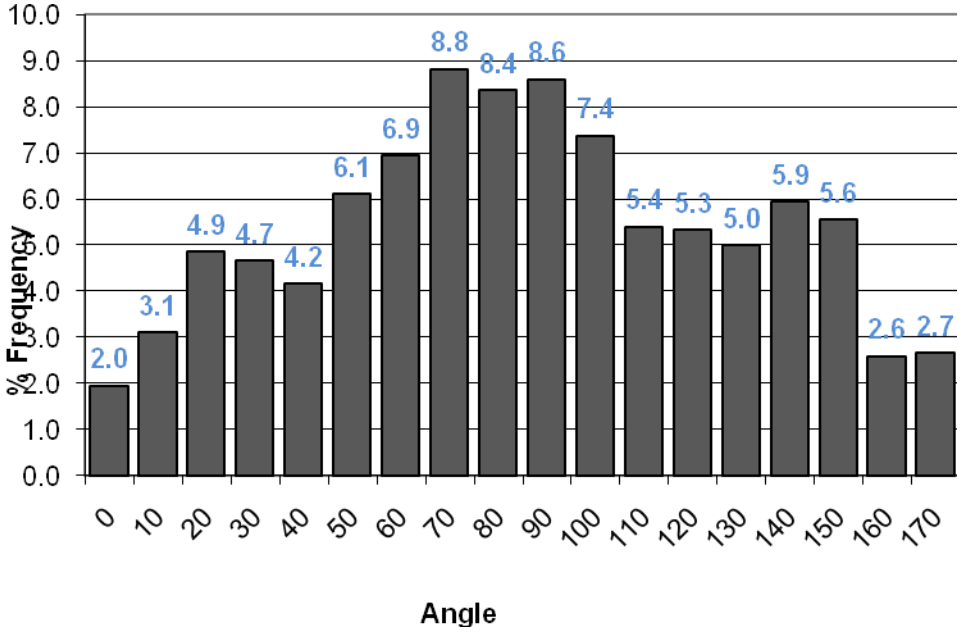


Image 7
50% Area, Normal distribution (Mean =90 degree, Standard deviation =60)

Angle	% Frequency
0-10	2.0
10-20	3.1
20-30	4.9
30-40	4.7
40-50	4.2
50-60	6.1
60-70	6.9
70-80	8.8
80-90	8.4
90-100	8.6
100-110	7.4
110-120	5.4
120-130	5.3
130-140	5.0
140-150	5.9
150-160	5.6
160-170	2.6
170-180	2.7
Anisotropy Ratio	**-0.254**

Key for Image 7



Bar graph for Image 7

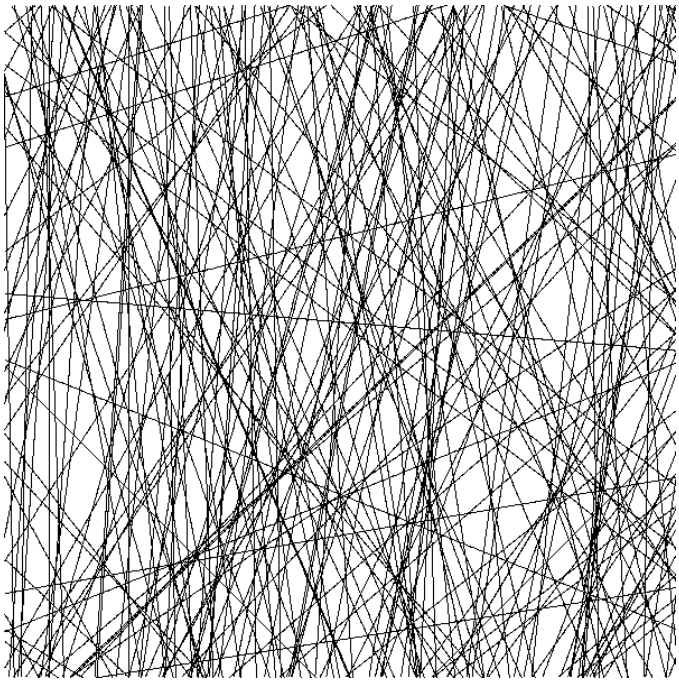
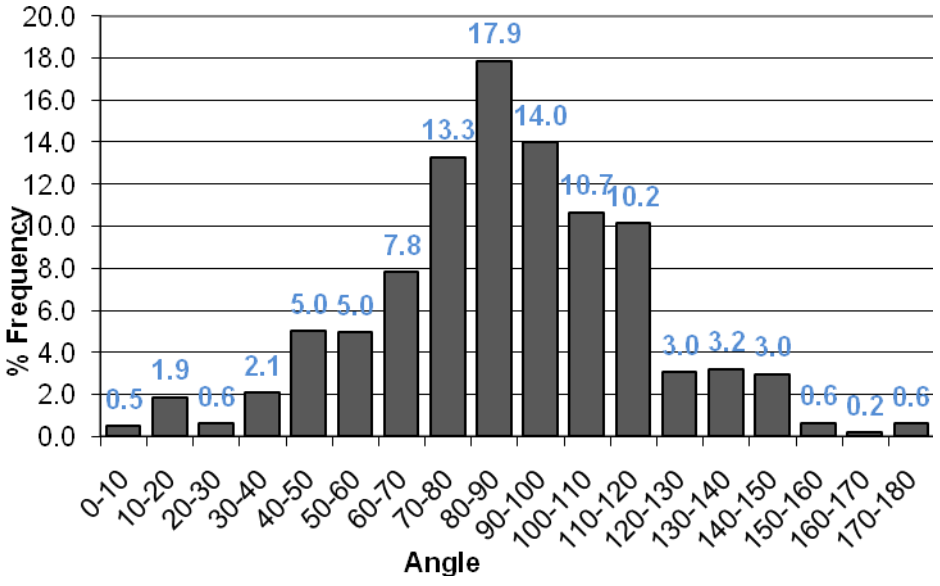


Image8
25% Area, Normal distribution (Mean =90 degree, Standard deviation =30)

Angle	% Frequency
0-10	0.5
10-20	1.9
20-30	0.6
30-40	2.1
40-50	5.0
50-60	5.0
60-70	7.8
70-80	13.3
80-90	17.9
90-100	14.0
100-110	10.7
110-120	10.2
120-130	3.0
130-140	3.2
140-150	3.0
150-160	0.6
160-170	0.2
170-180	0.6
Anisotropy Ratio	**-0.616**

Key for Image 8



Bar graph for Image 8

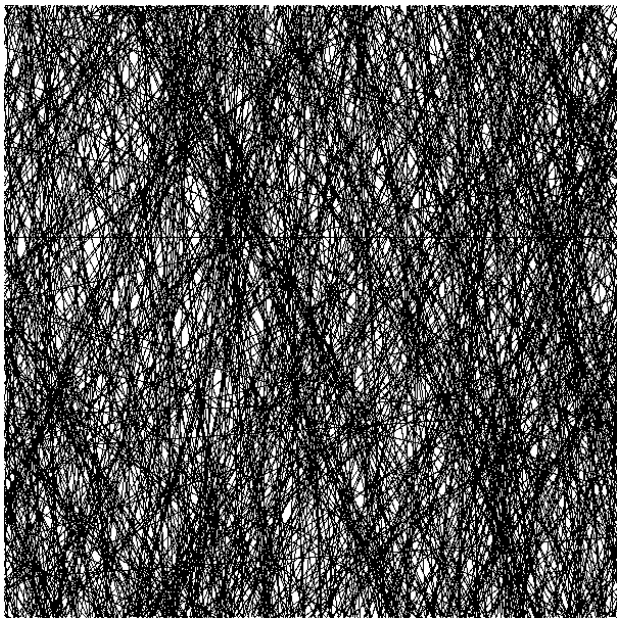
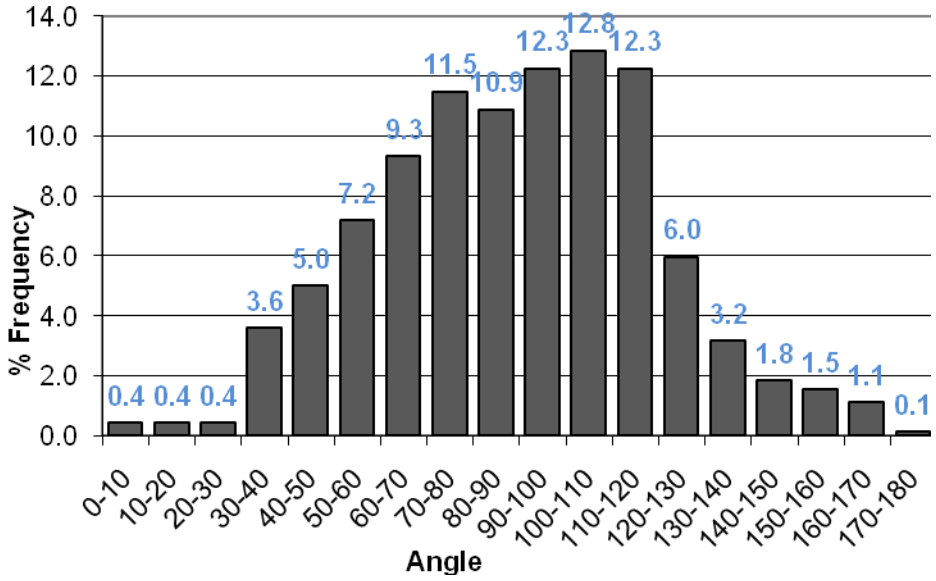


Image 9
70% Area, Normal distribution (Mean =90 degree, Standard deviation =30)

Angle	% Frequency
0-10	0.4
10-20	0.4
20-30	0.4
30-40	3.6
40-50	5.0
50-60	7.2
60-70	9.3
70-80	11.5
80-90	10.9
90-100	12.3
100-110	12.8
110-120	12.3
120-130	6.0
130-140	3.2
140-150	1.8
150-160	1.5
160-170	1.1
170-180	0.1
Anisotropy Ratio	**-0.574**

Key for Image 9



Bar graph for Image 9

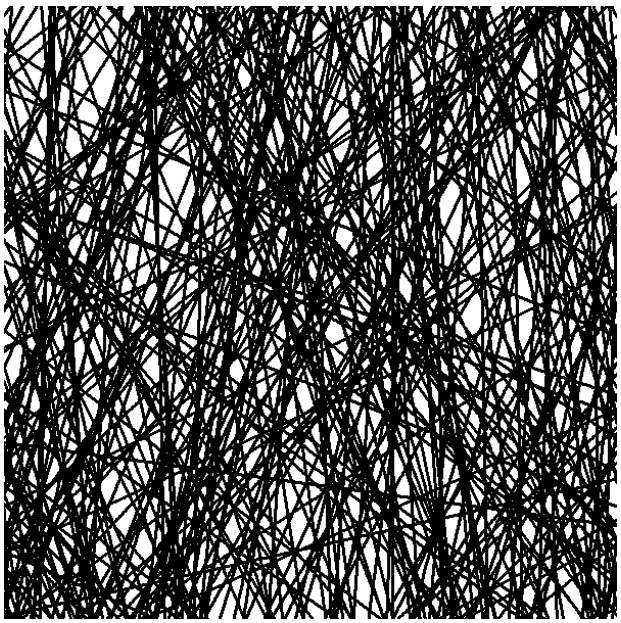
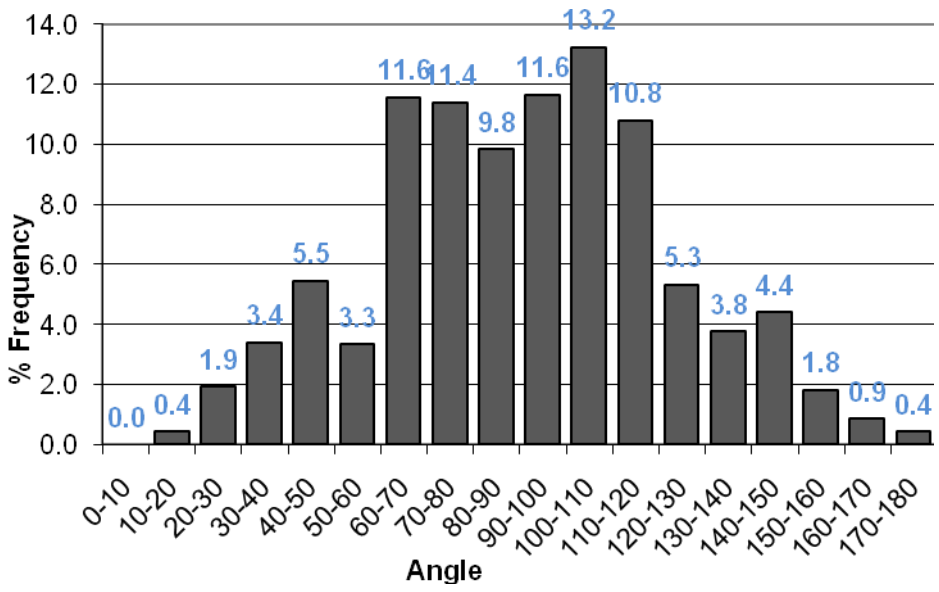


Image 10
70% Area, thickness = 3, Normal distribution (Mean =90 degree, Standard deviation =30)

Angle	% Frequency
0-10	0.0
10-20	0.4
20-30	1.9
30-40	3.4
40-50	5.5
50-60	3.3
60-70	11.6
70-80	11.4
80-90	9.8
90-100	11.6
100-110	13.2
110-120	10.8
120-130	5.3
130-140	3.8
140-150	4.4
150-160	1.8
160-170	0.9
170-180	0.4
Anisotropy Ratio	**-0.536**

Key for Image 10



Bar graph for Image 10

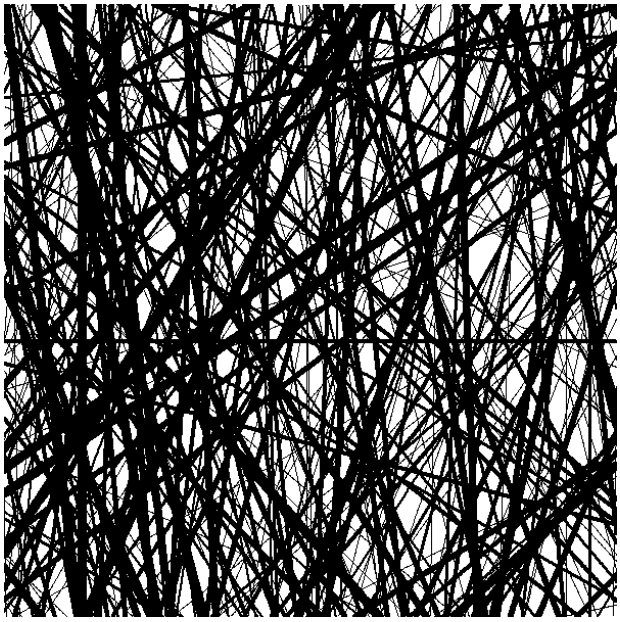
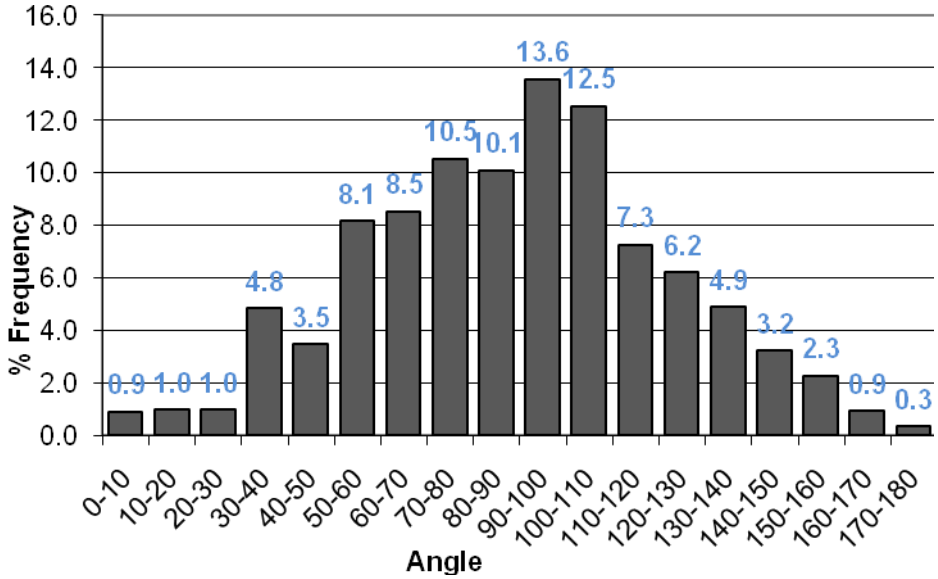


Image 11
70% Area, thickness = 3 (std=3), Normal distribution (Mean =90, Std=30)

Angle	% Frequency
0-10	0.9
10-20	1.0
20-30	1.0
30-40	4.8
40-50	3.5
50-60	8.1
60-70	8.5
70-80	10.5
80-90	10.1
90-100	13.6
100-110	12.5
110-120	7.3
120-130	6.2
130-140	4.9
140-150	3.2
150-160	2.3
160-170	0.9
170-180	0.3
Anisotropy Ratio	**-0.509**

Key for Image 11



Bar graph for Image 11

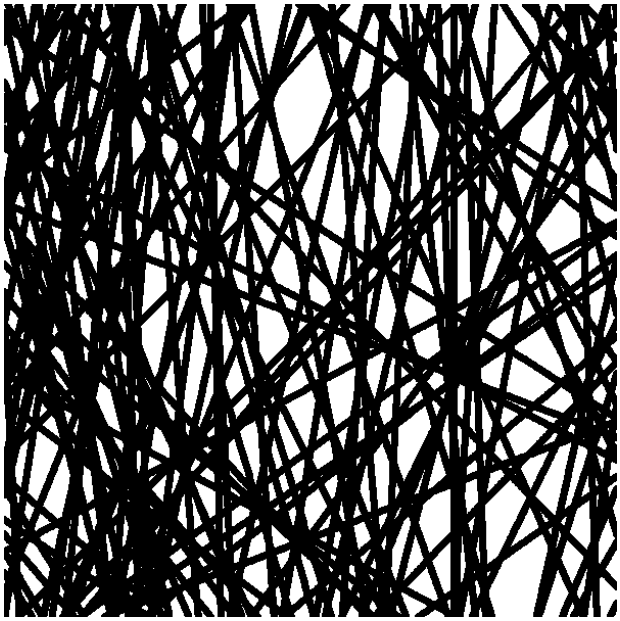
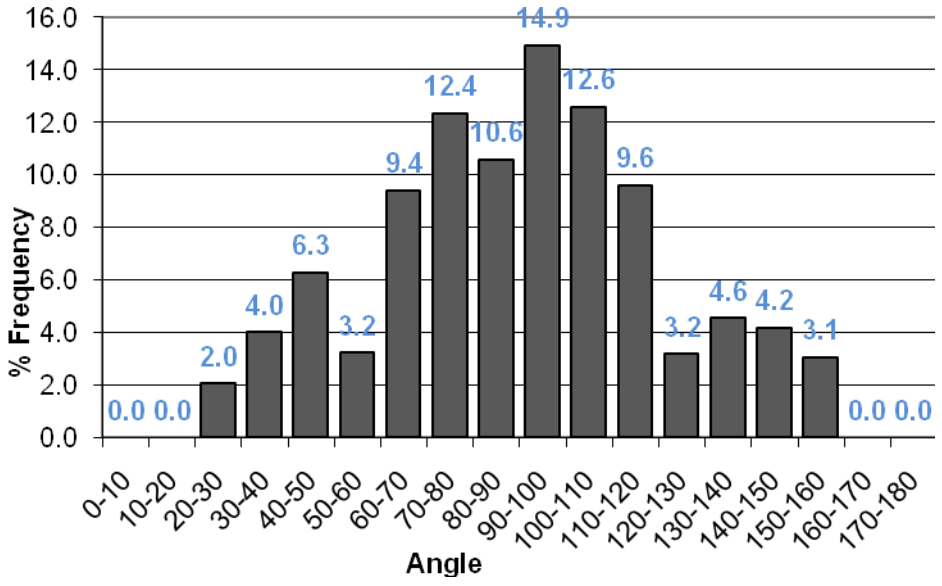


Image 12
70% Area, thickness = 3 (std=3), Normal distribution (Mean =90 degree, Standard deviation =30)

Angle	% Frequency
0-10	0.0
10-20	0.0
20-30	2.0
30-40	4.0
40-50	6.3
50-60	3.2
60-70	9.4
70-80	12.4
80-90	10.6
90-100	14.9
100-110	12.6
110-120	9.6
120-130	3.2
130-140	4.6
140-150	4.2
150-160	3.1
160-170	0.0
170-180	0.0
Anisotropy Ratio	**-0.550**

Key for Image 12



Bar graph for Image 12

9. Conditioning

Prior condition is not required for this test method.

10. Sampling

10.1 Lot Size

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

10.2 Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (Sampling procedures for inspection by attributes) or ISO 3951-1:2005 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

NOTE 2 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

10.3 Laboratory Samples

From each roll or portion of fabric selected from the lot sample, cut at least one laboratory sample the full width of the fabric and at least 300 mm from each outside edge.

10.4 Test Specimens

Take the test specimens from areas of the sample that are free of folds, wrinkles and any distortions that would make these specimens abnormal from the rest of the test materials.

11. Procedure

11.1 Carefully Place the specimen on the sample stage.

Align machine direction of samples to 90 degree direction. Specimen should be free of wrinkles and other distortions.

11.2 Adjust focus, light and magnifications and acquire an image.

As a rule, magnification should be matched with fiber diameter such that a fiber is no more than a few pixels thick. Melt blown nonwovens typically require much higher magnification than all others and need to be imaged using a microscope. Others can be imaged using a macro lens setup. The images need to have high contrast between the fibers and the background. The images need to appear to be in focus. The images must have sufficient depth of field as the nonwoven structures are composed of several layers of fibers.

11.3 Determines fiber orientation distribution function

Determine % frequency of fibers fall in each fiber orientation angle ranges or bin. Bin size should be larger than 5 degree, but the bin size of 10 or 18 degree is recommended. Analysis can be performed either by manual measurement of orientation angle of all fibers in the image captured or by use of proper image analysis technique to measure % frequency of fibers in each bin range. If image analytical technique is used, it should be verified by comparing results with standard images provided in section 6.

11.4 Calculate cosine square anisotropy.

From fiber orientation distribution determined in 10.3, calculate d cosine square anisotropy using equation 2.

11.5 Continues until the desired numbers of specimens have been tested

Unless noted in the specification, test a minimum of ten specimens.

12. Calculation or Interpretation of Results

Calculate average and standard deviation of % frequency in each bin to the nearest 0.1%. Average and standard deviation of cosine square anisotropy are also calculated and reported.

Note 3
Some samples features with textures, printed patterns, presence of fiber bundles may interfere with testing results. Therefore, the possible effects on these features may need to be addressed.

13. Report

In addition to the precise test result, the report shall included the following information

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) % frequency of fibers in each bin (average and standard deviation of all specimen tested)
d) Cosine square anisotropy ratio (average and standard deviation of all specimen tested)
e) Analysis areas and pixel resolution used (average and standard deviation of all specimen tested)
f) Software used and version if software is used for analysis

14. Annexes

Examples of useful image analysis technique, which can be used to determine fiber orientation, are described as the guidance.

14.1 Fourier Transform

An image of a nonwoven structure is composed of spatial details in the form of brightness transitions cycling from light to dark and from dark to light. Spatial frequencies, the rate at which these transitions occur, in a nonwoven image are related to the orientation of the fibers; fibers are shown in black on a white background (or vice versa). Thus, if the fibers are predominantly oriented in a given direction in a nonwoven fabric, the rate of change in frequencies in that direction will be low and the rate of change in frequencies in the perpendicular direction will be high.

A Fourier transform decomposes an image from its spatial domain of intensities into a frequency domain with appropriate magnitude and phase values. The frequency form of the image is also depicted as an image where the gray scale intensities represent the magnitude of the various frequency components. Then this property of the Fourier transform to obtain information on fiber orientation distribution in a nonwoven fabric.

There are a number of transform techniques that are routinely used in the field of image analysis. The most common transform method is that of the discrete Fourier transform or a faster version of the same known as the fast Fourier transform. The Fourier transform is useful in determining the frequency of the rate at which intensity transition occur in a given direction in the image. Thus, if the fibers are predominantly oriented in a given direction in a nonwoven fabric, the rate of change in frequencies in that direction will be low and the rate of change in frequencies in the perpendicular direction will be high. We use this property of the Fourier transform to obtain information on the fiber orientation distribution in a nonwoven fabric. The basics of the Fourier transformation are given below. The Fourier transform of a continuous function f(x) is defined as

$$F(u) = \int_{-\infty}^{\infty} f(x) exp(-j2\pi ux) dx$$

Where $j = \sqrt{-1}$. The inverse Fourier transform is given as,

$$f(x) = \int_{-\infty}^{\infty} F(u) \exp(j2\pi ux) du$$

The power spectrum for the function F(u) is given by,

$$P(u) = |F(u)|^2 = R^2(u) + I^2(u)$$

Where, R(u) and I(u) refer to the real and imaginary components of the function F(u).

In two dimensions, the corresponding direct Fourier Transform is givens as where *f(x,y)* is the image and *F(u,v)* is its transform, *u* refers to the frequency along x direction, and *v* represents to the frequency along the y-axis. The orientation of elements is related to the frequency changes in the image and thus to its transform but it is offset by 90 degree. The magnitude of each frequency is indicated by the intensity of the pixel at that location. Then, orientations may be directly computed from the transform image (by selecting annulus of width w at a radius r from the center of the image and scanning the image radically). An average value of the transform intensity is found for each of the angular cells. Since orientation is limited for fibers to a range of 0 to 180, the results are averaged fro that range and its radically symmetric counterpart. Note that the width and the radius of the annulus can influence the results. The spatial resolutions as specified by the number of pixels per unit area influences the results obtained using Fourier transform. Therefore, appropriate magnification and area coverage become issues that need special attention (calibration and recommendation).

The Fourier method models its frequency representation of the original image on the presumption that the image is periodic, thus discontinuities in images will cause erroneous spatial frequency component because the Fourier transform will attempt to model the discontinuities. Therefore it is recommended use windowing functions to impose continuity in images. Some typical ones are the Hamming, Welch and Triangular. Windowing functions attempt to reduced the edge discontinuities thereby minimizing spatial distortion artifacts. Note that while it is true that most windowing functions reduced the spatial frequency errors, non can remove the problem entirely but sharply improve analysis results.

14.2 References:

1. Pourdeyhimi, B. and Dent, R., Measuring Fiber Orientation in Nonwovens, Part III: Fourier Transform, Textile Res. J., 67(2), 143-151, (1997)
2. Wood, E. J., Applying Fourier and Associated Transforms to Pattern Characterization in Textiles, Textile Res. J., 60, 212-220 (1990).
3. Bracewell, R. M., The Fast Fourier Transform and its application, McGraw-Hill, (1986).
4. Gonzalez, R. C. and P. Wintz, Digital Image Processing, Addison-Wesley, (1983).
5. Brigham, E.O., The Fast Fourier Transform and its Applications, Prentice-Hall, (1988).
6. Pourdeyhimi, B. and Ramanathan, R., Measuring fiber orineation in nonwovnes, Part I: simulation, Textile Research Journal, 1996: 66: 713

7. Pourdeyhimi B.; Dent R.; Jerbi A.; Tanaka S.; Deshpande A , Measuring Fiber Orientation in Nonwovens -- Part V: Real Webs. Textile Research Journal, Mar. 1999, Vol. 69 Issue 3, p185, 8p;

14.3 Direct tracking: Chord algorithm

This algorithm only can be used in binary images (black and white), where fibers are black solid objects on a white background (or vice versa). Binary images can be produced through thresholding. Thinning or skeletonizing procedure is recommended to apply to the image with thick fibers prior to measuring.
This tracking algorithm is based on the property of a chord stating that every line drawn between any two pixels of a digital line must be within one pixel of the digital line to be considered as part of that line (chord property).

Starting a pixel on a fiber, all its eight neighboring pixels are scanned to find connectivity. If there is more than one possible direction for the search, an initial direction is chosen randomly form the possible candidates, and the second pixel is added to the set. The third pixel in the set is chosen by scanning the +45 to -45 ranges about the initial direction. Search continues +45 to -45 range about the direction of the last joining line, and the pixel chosen is selected on the basis of the chord property test until the image boundary reached or when the next added pixel would cause any of the previously tracked pixels to not lie within one pixel of the line. This procedure is repeated for a predetermined number of searches or until all features in the image have been tracked. As each fiber is tracked, its orientation is measured by determining the orientation of the end-to-end chord of the segment track along the fiber.

14.4 References:

1. Pourdeyhimi, B. and Ramanathan, R., Measuring fiber orientation in nonwovens, Part II: Direct tracking, Textile Research Journal , 1996, 66, 747

15. Precision

TBD

STANDARD TEST: WSP 600.0.R2 (12)

Standard Test Method for Fiber Glass Mats: The use of Modified TAPPI Procedures for Sampling and Lot Acceptance, Stiffness, Tear Resistance, and Thickness

The number in parentheses indicates the year of the last revision

1. Scope

The information and data contained in this document was prepared by a technical committee at TAPPI.

The purpose of this standard practice is to list existing TAPPI test methods which provide procedures for sampling and lot acceptance, stiffness, tear resistance, and thickness, and to suggest modifications to these methods for use in the sampling and testing of fiber glass mats.

This test method provides the values in both SI units and inch-pound units. Inch-pound units are the customary units used in the United States and these values will be in parentheses in the body of this method. The International System of Units (SI units) are the customary metric units used in most of the rest of the world.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document:

2.1 ISO test methods

a) ISO 5725–2: Accuracy (trueness and precision) of measurement methods and results — Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method

b) ISO 139 2005 Standard Conditioning

c) ISO 3951-1:2005 Sampling procedures for inspection by variables

d) ISO 2859-1:1999 Sampling procedures for inspection by attributes

Reference number
WSP 600.0.R2 (12) A

Current edition approved WSP 600.0.R2 (12)
Originally published as WSP 600.0.R2 in 2012
Last approved as WSP 600.0.R2 in 2012

2.2 TAPPI test methods

a) T 1006 - Testing of fiber glass mats: use of modified TAPPI procedures for sampling and lot acceptance, stiffness, tear resistance, and thickness

b) T 400 - Sampling and Accepting a Single Lot of Paper, Paperboard, Containerboard, or Related Products

c) T 489 - Stiffness of Paper and Paperboard (Taber-type)

d) T 1007 - Sample Location

e) T 414 - Internal Tearing Resistance of Paper (Elmendorf-type method)

f) T 411 - Thickness (Caliper) of Paper, Paperboard, and Combined Board

2.3 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Fiber diameter

The measurement (expressed in hundred-thousandths) of the diameter of individual filaments.

3.2 Glass fibers

Glass which has been extruded into extremely fine filaments. These filaments vary in diameter, and are measured in microns. Glass filaments are treated with special binders and processed similar to textile fibers. These fibers come in many forms such as roving, woven roving, mat and continuous strands.

An individual filament made by mechanically drawing molten glass. A continuous filament is a glass fiber of great or indefinite length—a staple fiber is a glass fiber of relatively short length (generally less than 17 inches).

3.3 Fiber glass mats

Randomly oriented strands of glass fibers formed into a felt and held together with a binder, usually of thinned polyester resin in a powder-like form.

3.4 Tear strength

The force required either to start or to continue or propagate a tear in a fabric

3.5 Thickness

In nonwovens thickness is the distance between the upper and lower surfaces of the material, measured under a specified pressure. Thickness is usually determined as the distance between an anvil, or base, and a presser foot used to apply the specified pressure.

3.6 Stiffness

The ability of a fabric to resist bending.

4. Sampling and Lot Acceptance

a) Use TAPPI T 400 “Sampling and Accepting a Single Lot of Paper, Paperboard, Containerboard, or Related Product.”
b) The method of sampling and lot acceptance may be applied to each of the physical properties to be determined.
c) Any alternate sampling method, agreeable to both buyer and seller, may be employed.

5. Stiffness

a) Use TAPPI T 489 “Stiffness of Paper and Paperboard (Taber-type).”
b) Obtain samples in accordance with TAPPI T 1007 “Sample Location.”
c) Test specimens shall be cut in each principal direction, machine direction and cross machine direction.
d) Conditioning: for referee testing, condition samples for 5 h at 77 ± 2°F (25 ± 1°C) and 50 ± 3% relative humidity.
e) Under routine circumstances, samples may be conditioned for 30 minutes and tested at ambient laboratory conditions.
f) Measure thickness in accordance with TAPPI T411 standard method.

6. Tear Resistance

Use TAPPI T 414 “Internal Tearing Resistance of Paper (Elmendorf-type method)” except:
a) Obtain sample in accordance with TAPPI T 1007 “Sample Location.”
b) Disregard Section 7.5 in TAPPI T 414. The line of tear of many fiber glass mats will not pass through the top of the specimen due to the nature of the mat.
c) Use either an 800- or 1600-g pendulum instrument and test with a single ply of mat so that the resultant scale reading on the instrument is between 20% and 80% of pendulum capacity.
d) Test 10 individual test samples for each direction (MD & CD) and record the average of the individual results as the test result.

7. Thickness

7.1 Use TAPPI T 411 Thickness (Caliper) of Paper, Paperboard, and Combined Board, except:
a) The anvil shall have a diameter of 64 mm (2.5 in) and the presser foot shall have a diameter of 51 mm (2 in).
b) The pressure used at measurement shall be 19.1 g/cm2 or 387 g load for the 51 mm (2 in) diameter presser foot.
c) Obtain sample in accordance with TAPPI T 1007 “Sample Location.”

7.2 Other presser foot diameters and other pressures may be used
If agreed upon between user and supplier. However, it is recognized that such differences may result in different reported values of thickness for the same sample of mat.

8. Test Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model of testing equipment
e) Laboratory testing conditions
f) Number of specimens tested
g) For computer processed data, identify the software used and the version
h) Deviation from the standard test procedure, if any
i) When calculated, the standard deviation or the coefficient of variation
j) Whether or not samples were conditioned prior to testing and, if so, for how long
k) Anything unusual noted during the testing
l) Report the average tear strength in each direction (MD and CD).
m) Report the standard deviation of the result in each direction (MD and CD).

STANDARD TEST: WSP 601.0.R2 (12)

Sample Location for Fiber Glass Mat Sheets

The number in parentheses indicates the year of the last revision

1. Scope

This method covers the location from which samples are taken from a sheet of fiber glass mat used as a sample test unit for physical property determination.

The information and data contained in this document were prepared by a technical committee of the (TAPPI) Association. The committee and the Association assume no liability or responsibility in connection with the use of such information or data, including but not limited to any liability under patent, copyright, or trade secret laws. The user is responsible for determining that this document is the most recent edition published.

This test method provides the values in both SI units and inch-pound units. Inch-pound units are the customary units used in the United States and these values will be in parentheses in the body of this method. The International System of Units (SI units) are the customary metric units used in most of the rest of the world.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document:

2.1 ISO test methods

a) ISO 3951-1:2005 Sampling procedures for inspection by variables
b) ISO 2859-1:1999 Sampling procedures for inspection by attributes

2.2 TAPPI test methods

T 1007 - Sample location for fiber glass mat sheets
(Location for cutting test specimens can be viewed in this (TAPPI) procedure)

Reference number
WSP 601.0.R2 (12) A

Current edition approved WSP 601.0.R2 (12)
Originally published as WSP 601.0.R2 in 2012
Last approved as WSP 601.0.R2 in 2012

2.3 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Glass fibers

Glass which has been extruded into extremely fine filaments. These filaments vary in diameter, and are measured in microns. Glass filaments are treated with special binders and processed similar to textile fibers. These fibers come in many forms such as roving, woven roving, mat and continuous strands.

An individual filament made by mechanically drawing molten glass. A continuous filament is a glass fiber of great or indefinite length—a staple fiber is a glass fiber of relatively short length (generally less than 17 inches).

3.2 Fiber glass chopped strand mats

A fiberglass reinforcement consisting of short strands of fiber arranged in a random pattern and held together with a binder. Mat is generally used in rolls consisting of ¾ oz/ft^2 material to 2 oz/ft^2 material.

3.3 Fiber glass mats

Randomly oriented strands of glass fibers formed into a felt and held together with a binder, usually of thinned polyester resin in a powder-like form.

4. Principle

This arrangement of sample locations is distributed in a manner designed to represent cross-web (CD) and machine-web (MD) variations in the area covered by the sample of the fiber glass mat for each physical property to be tested.

5. Sampling

5.1 Sample cutting template

A metal sample cutting template may be prepared to facilitate sample cutting from any specific web. Stainless steel sheet (10 gauge) has been found suitable for templates and the dimensions of openings should be cut to within 0.25 mm (0.010 in). Slots, 6.4 mm (0.25 in) long and 0.8 mm (0.032 in) wide, should be cut at each corner of each opening to facilitate cutting of sharp corners by a standard utility knife or single-edged razor blade.

5.2 A typical template

Used for sampling material from a 91.4 cm (36 in) wide web is shown in (TAPPI) method T -1007 Figure 2. Two or three sheets can be cut simultaneously to provide the desired number of test specimens. Other geometries are acceptable provided they accomplish the purpose of described in TAPPI method T 1007 clause 3 and provide the size and number of samples specified in the test method.

5.3 Lot Size

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

5.4 Collecting samples

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (*Sampling procedures for inspection by attributes)* or ISO 3951-1:2005 (*Sampling procedures for inspection by variables)* can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

6. Procedure

6.1 Remove all damaged layers of mat from the outside of the roll to be sampled

In addition, remove at least two undamaged layers and discard. Obtain sample unit from the next layer of mat. Cut sample unit(s) from the full width of the roll and of sufficient length (or number) to enable all samples to be cut from adjacent lengths (convolutions) of the roll.

6.2 Cut test specimens

Specimens are to be cut from the sample unit at the locations indicated in TAPPI method T-1007 Figure 1 (a to e) or annex A of WSP 601.07, to the dimensional tolerance specified in each of the individual test methods.

6.3 Cutting specimens from different size mats

If the width of the mat is in excess of 91.4 cm (36 in), the lateral spaces between samples should be proportionately increased to assure representative sampling across the full width of the sheet.

7. Report

Report that sampling location complied with the requirements of this method, or, if different than specified, report the actual sample location and reason for deviation.

8. Precision

A statement of precision is not applicable for this standard procedure.

9. Key Words

Fiber mats, Glass fibers, Sampling

ANNEX A

(informative)

The following tables can be used as a guide, but the scale used on these tables no longer applies (¼ = 1 inch). All dimensions used in these tables are still in inches.

A-1

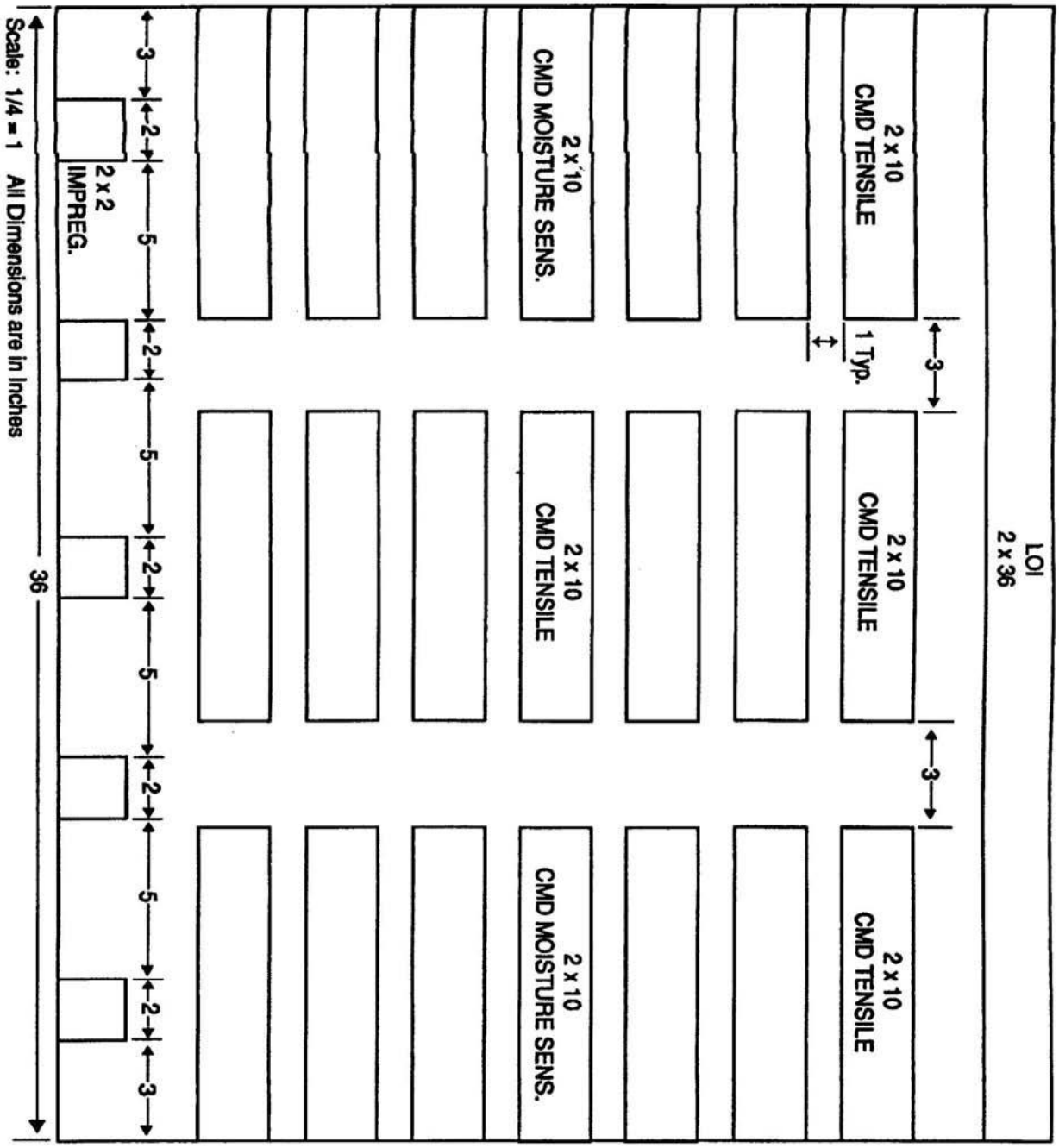


Fig. 1a. Location of test specimens.

A-2

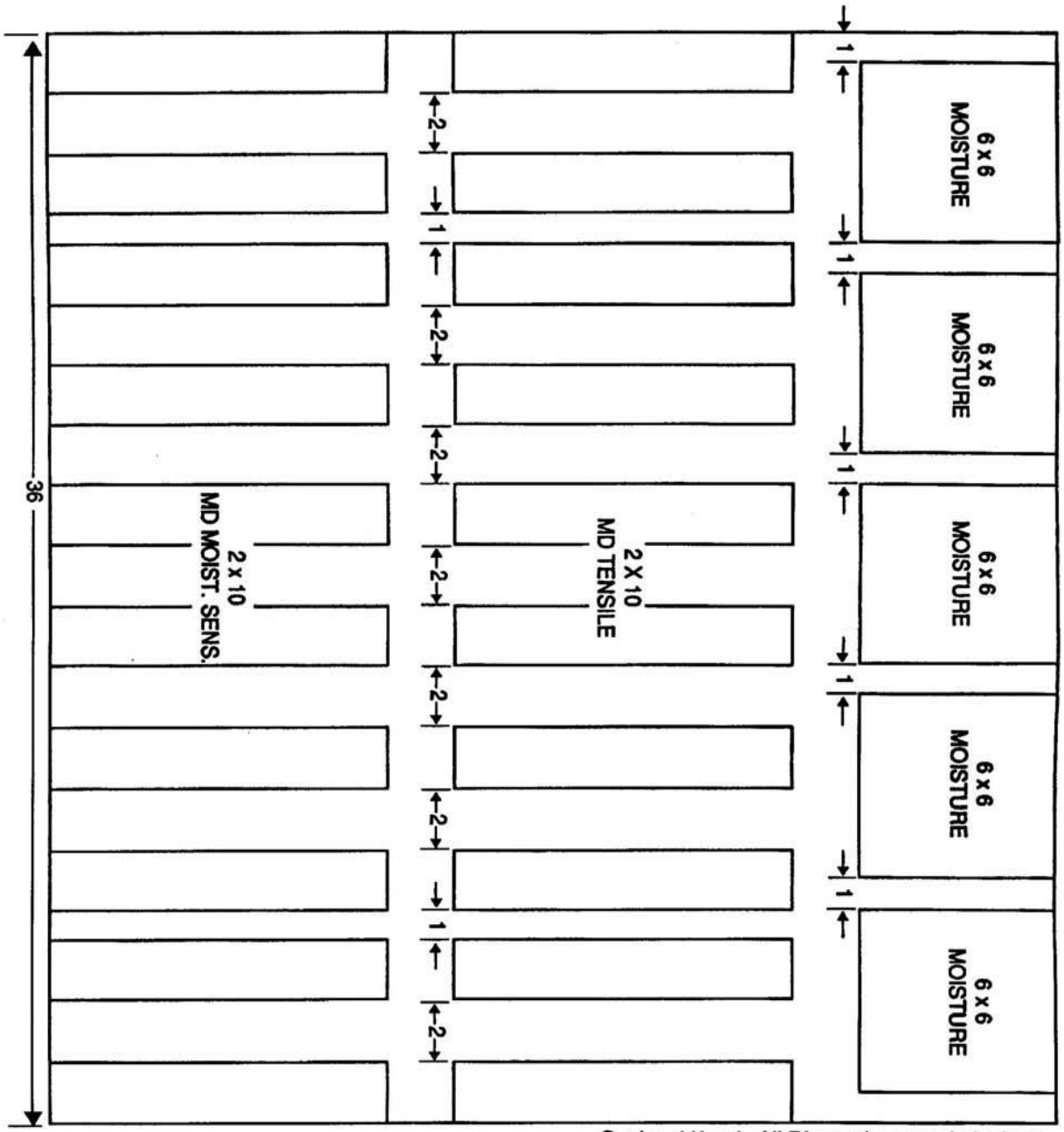


Fig. 1b. Location of test specimens.

A-3

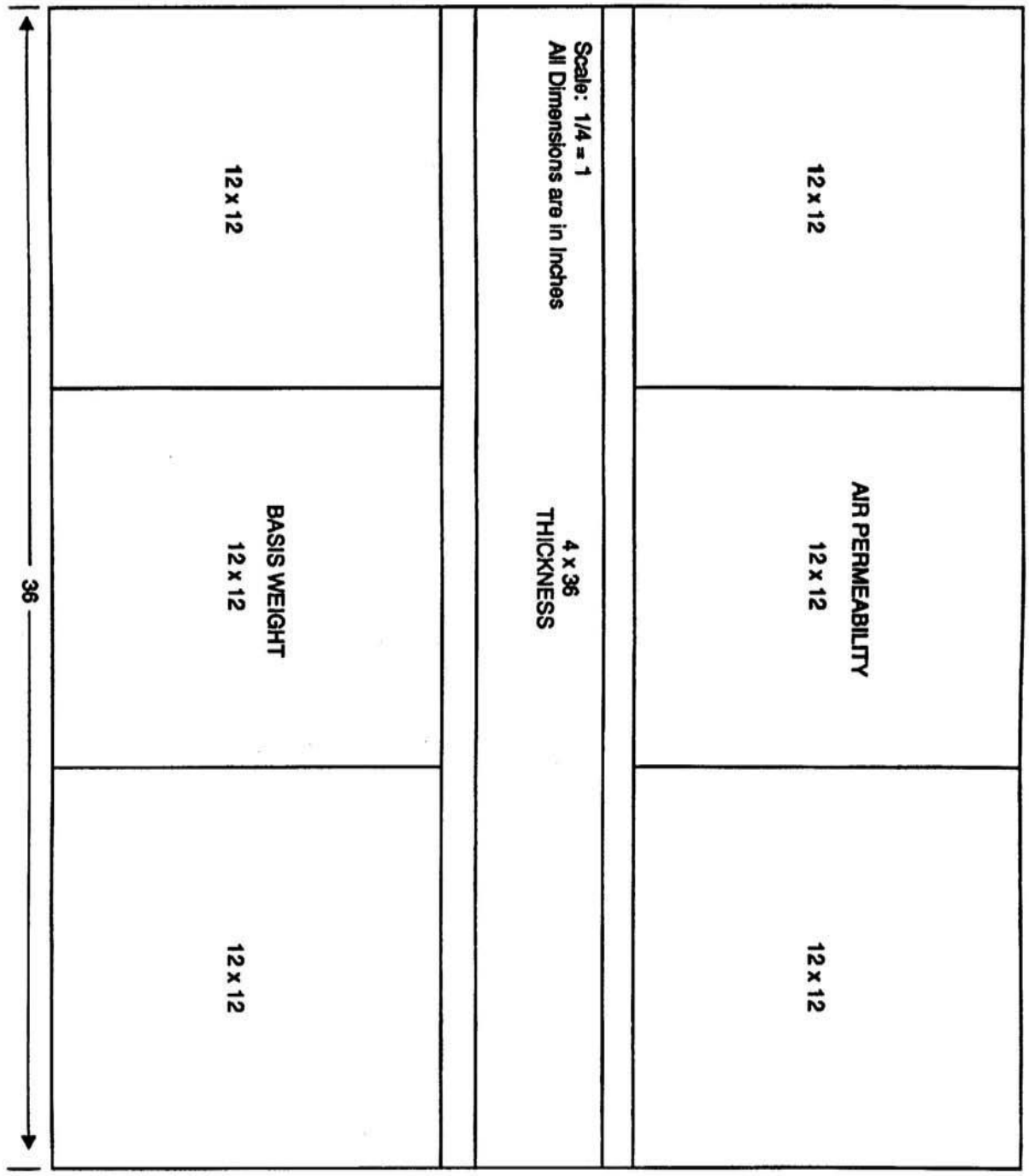


Fig. 1c. Location of test specimens.

A-4

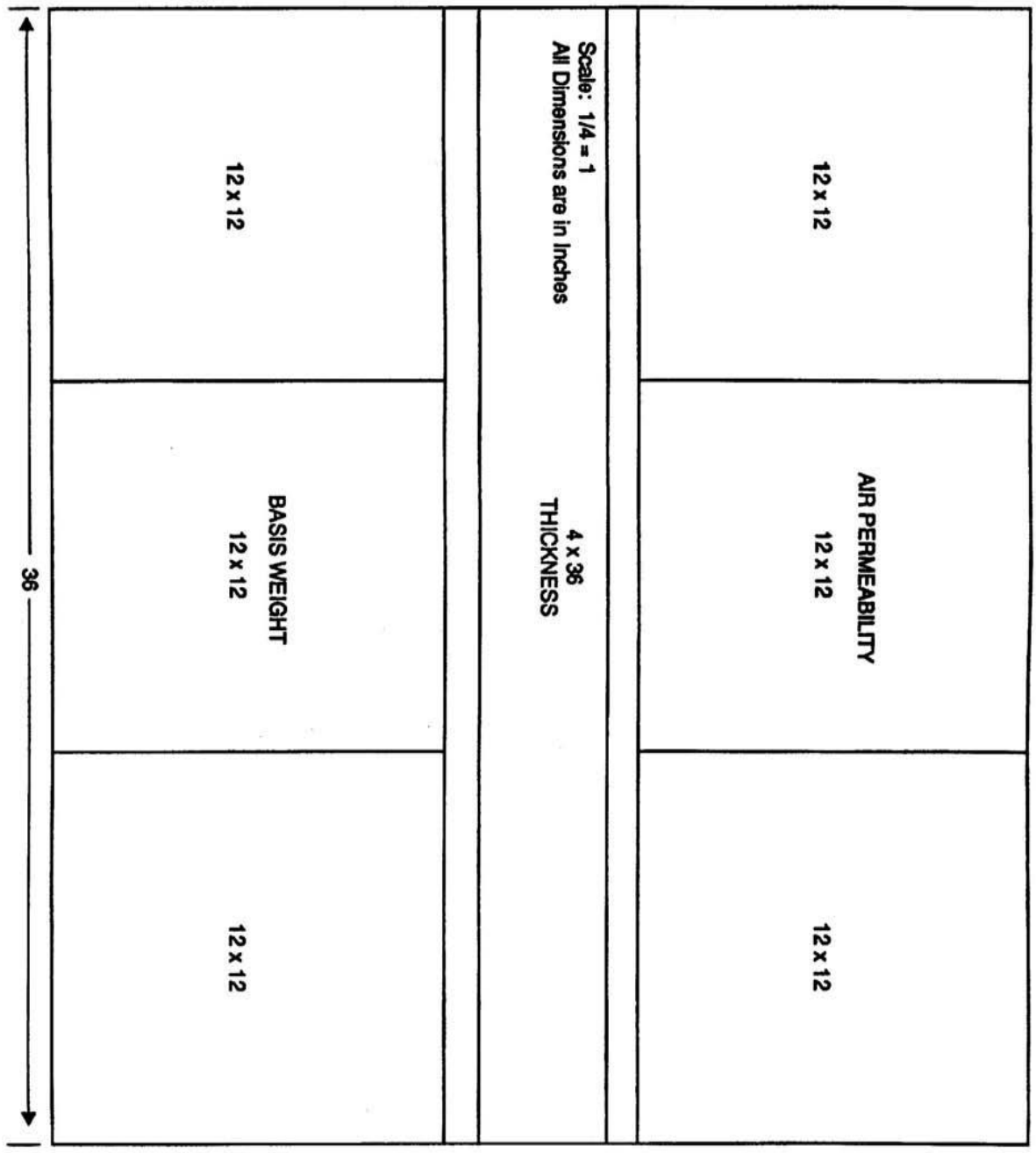


Fig. 1c. Location of test specimens.

A-5

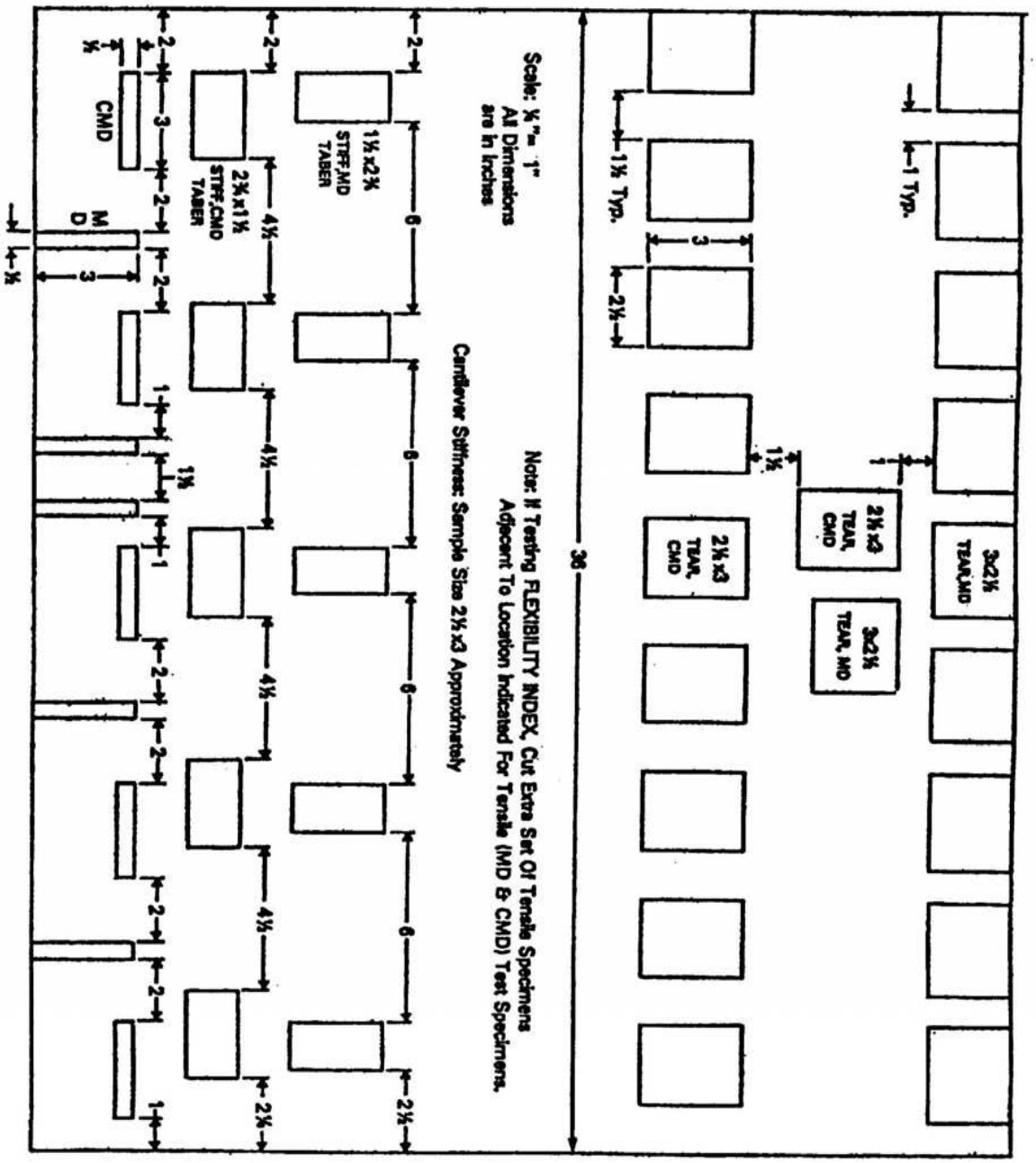


Fig. 1e. Location of test specimens.

A-6

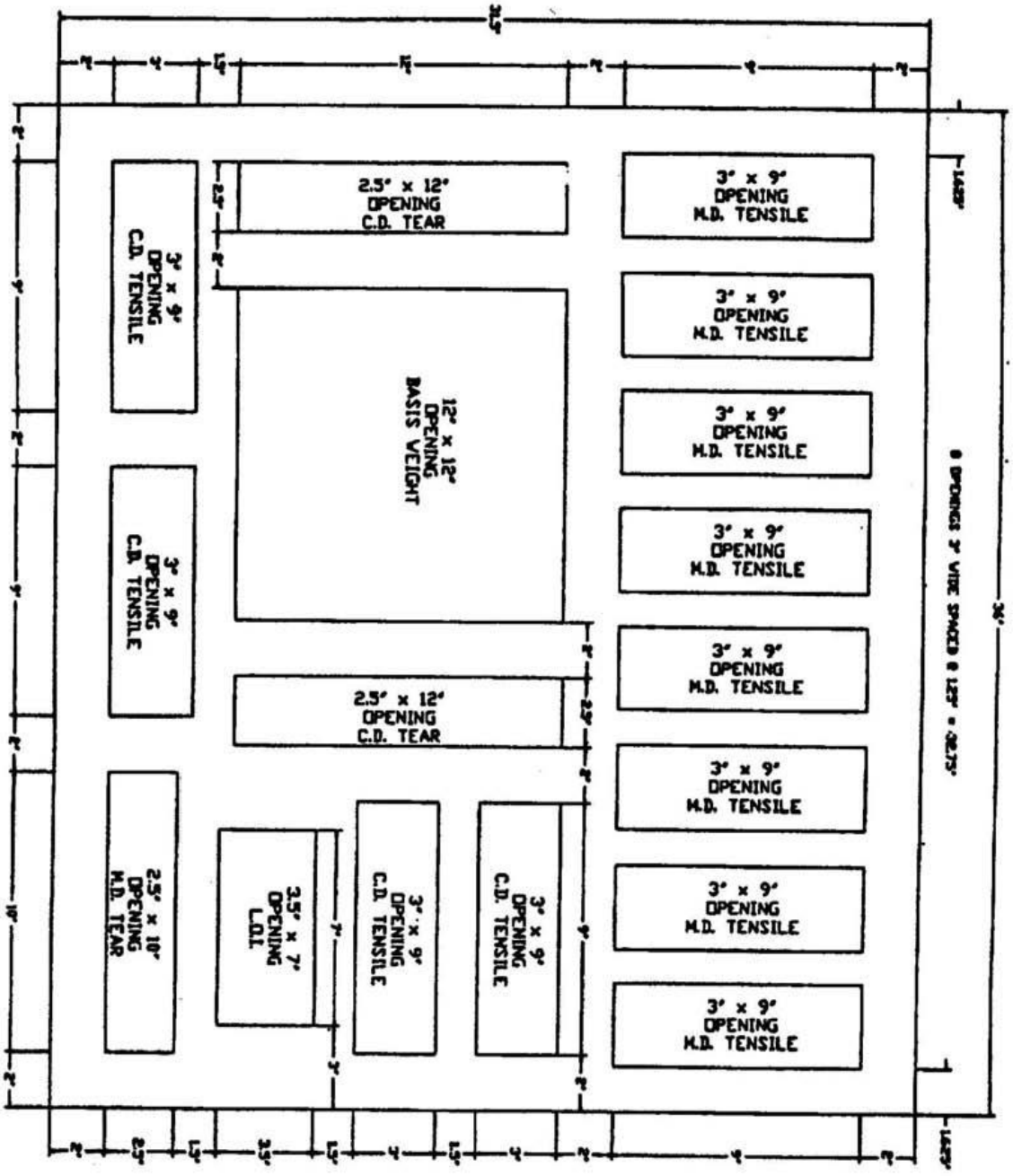


Fig. 2. Typical template for sampling from a 36-in.-wide web.

STANDARD TEST: WSP 602.0.R2 (12)

Test conditions for Fiber Glass Mat Test Methods

The number in parentheses indicates the year of the last revision

1. Scope

This method defines the test conditions for testing fiber glass mats.

The information and data contained in this document were prepared by a technical committee of the (TAPPI) Association. The committee and the Association assume no liability or responsibility in connection with the use of such information or data, including but not limited to any liability under patent, copyright, or trade secret laws. The user is responsible for determining that this document is the most recent edition published.

This test method provides the values in both SI units and inch-pound units. Inch-pound units are the customary units used in the United States and these values will be in parentheses in the body of this method. The International System of Units (SI units) are the customary metric units used in most of the rest of the world.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document:

2.1 ISO test methods

a) ISO 3951-1:2005 Sampling procedures for inspection by variables
b) ISO 2859-1:1999 Sampling procedures for inspection by attributes

2.2 TAPPI test methods

T 1008 - Test conditions for fiber glass mat test methods
(Location for cutting test specimens can be viewed in (TAPPI) T 1008 procedure)

Reference number
WSP 602.0.R2 (12) A

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Originally published as WSP 602.0.R2 in 2012
Last approved as WSP 602.0.R2 in 2012

2.3 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Glass fibers

Glass which has been extruded into extremely fine filaments. These filaments vary in diameter, and are measured in microns. Glass filaments are treated with special binders and processed similar to textile fibers. These fibers come in many forms such as roving, woven roving, mat and continuous strands.

An individual filament made by mechanically drawing molten glass. A continuous filament is a glass fiber of great or indefinite length—a staple fiber is a glass fiber of relatively short length (generally less than 17 inches).

3.2 Fiber glass mats / Conditioning

A process of allowing testing materials to reach equilibrium with the moisture and temperature of the surrounding atmosphere. The atmosphere may be a standard such as 50 ± 3% percent relative humidity and 77 ± 2°F (25 ± 1°C) or any other testing conditions may be employed if agreed upon by both buyer and seller.

3.3 Fiber glass mats

Randomly oriented strands of glass fibers formed into a felt and held together with a binder, usually of thinned polyester resin in a powder-like form.

4. Principle

Mat characteristics are sensitive to changes in ambient conditions; therefore, test conditions are defined to facilitate comparison of results between different laboratories.

5. Conditions

a) General test conditions:
Under normal conditions, specimens may be tested at ambient laboratory conditions within the temperature range of 65 to 80°F (18 to 27°C) and a relative humidity range of 30 to 75%, except as specifically noted in the individual test method.

b) Referee test conditions:
For referee testing, the general test conditions should be as noted in the individual test method or, 77 ± 2°F (25 ± 1°C) and 50 ± 3% relative humidity.

c) Alternate conditions:
Other test conditions may be employed if agreed upon by both buyer and seller.

6. Report

Report that the test conditions specified in this practice were employed in the generation of the test results, or, if different conditions were employed, report the conditions and the reason for the deviation.

7. Precision

A statement of precision is not applicable for this procedure.

8. Keywords
Fiber mats, Glass fibers, Controlled atmospheres

STANDARD TEST: WSP 603.0.R2 (12)

Tensile Strength and Elongation at Break for Fiber Glass Mats

The number in parentheses indicates the year of the last revision

1. Scope

This method covers the determination of the tensile strength and elongation at break of nonwoven fiber glass mats.

The information and data contained in this document were prepared by a technical committee of the (TAPPI) Association. The committee and the Association assume no liability or responsibility in connection with the use of such information or data, including but not limited to any liability under patent, copyright, or trade secret laws. The user is responsible for determining that this document is the most recent edition published.

This test method provides the values in both SI units and inch-pound units. Inch-pound units are the customary units used in the United States and these values will be in parentheses in the body of this method. The International System of Units (SI units) are the customary metric units used in most of the rest of the world.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document:

2.1 ISO test methods

a) ISO 3951-1:2005 Sampling procedures for inspection by variables
b) ISO 2859-1:1999 Sampling procedures for inspection by attributes
c) ISO 527 Plastics -- Determination of tensile properties -- Part 1: General principles
d) ISO 10012 Measurement management systems — Requirements for measurement processes and measuring equipment

Reference number
WSP 603.0.R2 (12) A

Current edition approved WSP 603.0.R2 (12)
Originally published as WSP 603.0.R2 in 2012
Last approved as WSP 603.0.R2 in 2012

2.2 TAPPI test methods

a) TAPPI T 494 “Tensile Breaking Properties of Paper and Paperboard (Using Constant Rate of Elongation Apparatus).”

b) TAPPI T 1007 “Sample Location.” a) T 1016 - Average fiber diameter of fiber glass mats (Location for cutting test specimens can be viewed in TAPPI T 1016 procedure)

c) TAPPI T 1200 “Interlaboratory Evaluation of Test Methods to Determine TAPPI Repeatability and Reproducibility” test results

2.3 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA’s and INDA’s Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Glass fibers

Glass which has been extruded into extremely fine filaments. These filaments vary in diameter, and are measured in microns. Glass filaments are treated with special binders and processed similar to textile fibers. These fibers come in many forms such as roving, woven roving, mat and continuous strands.

An individual filament made by mechanically drawing molten glass. A continuous filament is a glass fiber of great or indefinite length/a staple fiber is a glass fiber of relatively short length (generally less than 17 inches).

3.2 Fiber glass mats

Randomly oriented strands of glass fibers formed into a felt and held together with a binder, usually of thinned polyester resin in a powder-like form.

3.3 Tensile strength

The ability of a material to resist breaking under tensile stress is one of the most important and widely measured properties of materials used in structural applications. The force per unit area (MPa or psi) required to break a material in such a manner is the **ultimate tensile strength** or **tensile strength at break** . The rate at which a sample is pulled apart in the test can range from 0.2 to 20 inches per minute and will influence the results. The analogous test to measure tensile properties in the ISO system is ISO 527. The values reported in the ASTM D638 and ISO 527 tests in general do not vary significantly and either test will provide good results early in the material selection process.

3.4 Tensile Elongation

The elongation of an engineering material is the percentage increase in length that occurs before it breaks under tension

4. Principle

The average tensile strength and elongation of fiber glass mat is determined by fixing the test specimen in place with a suitable clamping mechanism and then applying a smoothly

increasing load until the specimen breaks.

Tensile strength and elongation are fundamental properties associated with fiber glass mats since both properties are influenced by the kind and treatment of the fiber, by the manner in which the sheet has been formed and by the binder and curing conditions employed in the mat production. Tensile strength and elongation measurements indicate the potential resistance to breaking when the fiber glass mat is subjected to stress during subsequent converting operations or in the finished product.

5. Apparatus

5.1 Tensile testing machine, having the following characteristics:

5.1.1 Two jaws, 3 in. (76 mm) wide with clamping surfaces in the same plane parallel to the direction of motion of the applied stress and so aligned that they hold the test specimen in that plane throughout the test without slippage and without damage to the sample. The four faces of the jaws should be padded with a thin strip of soft gasket rubber to prevent slippage and damage to the test specimen. At the start of the test, the edges of the jaws are set apart at 6 ± 0.1 in. (152 ± 2 mm) for both the constant rate of strain tester and the pendulum-type tester.

5.1.2 Means for applying a smoothly increasing force to the test specimen until it breaks, the increase being such that the additional force applied each second is not different by more than 10% from the additional force applied in the previous second.
The recommended maximum rate of extension is 12 in/min (30 cm/min) for pendulum testers and 2 in./min (5 cm/min) for load cell test machines. For more accurate measurement of elongation, slower rates of extension are necessary for some materials.

NOTE 2 This condition is fulfilled by most motor-driven tensile breaking testers, including the pendulum-type and constant rate of strain-type.

5.1.3 Means of indicating elongation of the specimen at failure to within 1%.

5.2 Paper cutter
Template or other specimen cutting device of suitable size to prepare specimens. The cutting edge of the device should produce specimens with clean, parallel edges without distorting the test specimens.

6. Calibration
Calibration of the instrument should be accomplished in accordance with ISO 10012 and the manufacturer's instructions in both procedure and frequency.

7. Conditioning
For conditioned testing:
Condition all specimens prior to test at 77° ± 5°F (25° ± 3°C) and with 50 ± 5% relative humidity for at least one-half hour. Specimen should remain in conditioned atmosphere until test is run.

8. Sampling

8.1 Lot Size

A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

8.2 Collecting samples

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (*Sampling procedures for inspection by attributes)* or ISO 3951-1:2005 (*Sampling procedures for inspection by variables)* can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

8.3 Sample preparation

a) Obtain samples in accordance with TAPPI T 1007 “Sample Location.” For each sheet direction to be tested, cut at least 10 specimens with clean, parallel edges to a width within 1/32 in. (0.8 mm) of that specified. Avoid abnormalities, creases, and wrinkles.
b) Specimens tested on a constant rate of extension-type tester and pendulum-type tester shall be 3 x 12 in. (75 x 300 mm).
c) Alternate specimen sizes may be used, e.g. 3 x 9 in. (7.6 x 22.9 cm) or 2 x 10 in. (5.1 x 25.4 cm), provided that the gauge length (clamp separation) is not less than 6 in. (15.2 cm) and the specimen width is not less than 2 in. (5 cm).

9. Procedure

9.1 Clamp the specimen carefully

In the top jaw, being certain that the specimen is aligned, and held securely enough so that the specimen will not slip, but not so tightly as to damage the specimen. When specimen is aligned, clamp securely in lower jaw.

9.2 Operate the constant rate of extension tester

At 2 in./min (50 mm/min) crosshead speed, and pendulum-type tester at 12 in./min (300 mm/min) driven clamp speed.

9.3 When to reject readings

If the specimen slips or breaks in or at the edge of the jaw face.

9.4 Record the results

Of each individual breaking force to the number of significant figures recommended by the manufacturer of the testing instrument.

10. Calculation

10.1 Directly read or calculate

The percent elongation in accordance with the procedure recommended by the manufacturer of the testing instrument, using the instrument recorder.

10.2 Calculate

The average breaking force and average percent elongation for each specimen set.

11. Report

In addition to the precise test results, the report shall include the following information:

a) Report the average value of the breaking force as the tensile strength for both the machine and cross machine direction of the fiber glass mat to the nearest 0.1 lbf/3 in. (0.006 kN/m) of width, or 0.1 lbf/in. (0.02 kN/m) of width.
b) Report the average value of elongation for both the machine and cross machine direction of the fiber glass mat to the nearest 0.1%.
c) Reference the test method used
d) Complete identification of all materials tested and method of sampling

e) Name and address of testing institution
f) Make and model and capacity of testing equipment
g) Laboratory testing conditions
h) For computer processed data, identify the software used and the version
i) Deviation from the standard test procedure, if any
j) When calculated, the standard deviation or the coefficient of variation
k) Whether or not samples were conditioned prior to testing and, if so, for how long
l) Anything unusual noted during the testing
m) Cross head speed.
n) Specimen size.
o) Distance between jaws at start of test.
p) Number of specimens tested in each direction.

12. Precision

Referee testing was done under laboratory conditions 77° ± 2°F (25° ± 1°C) and 50 ± 3% relative humidity. All the testing results are listed in Annex A

13. Keywords

Fiber mats, Glass fibers, Tensile strength, Elongation, Stretch

Annex A

On the basis of studies made in accordance with TAPPI T 1200 “Interlaboratory Evaluation of Test Methods” test results, each representing an average of 10 determinations from the same sample (commercial 2.0 lbs / 100 square feet fiberglass mat), are expected to agree within the amounts stated below. The study included five laboratories.

A.1	Average machine direction tensile strength	96.4 lbs/3 in.
	Repeatability	20 % - 19.6 lbs/3 in.
	Reproducibility	21 % - 20.5 lbs/3 in.
A.2	Average machine direction elongation	1.35%
	Repeatability	14 % - 0.19 elongation %
	Reproducibility	17 % - 0.23 elongation %
A.3	Average cross-machine direction tensile strength:	67.0 lbs/3 in.
	Repeatability	24 % - 16.1 lbs/3 in.
	Reproducibility	25 % - 16.5 lbs/3 in.
A.4	Average cross-machine direction elongation	1.19%
	Repeatability	16 % - 0.19 elongation %
	Reproducibility	20 % - 0.20 elongation %

STANDARD TEST: WSP 604.0.R2 (12)

Standard Test Method for the Basis Weight of Fiber Glass Mats

The number in parentheses indicates the year of the last revision

1. Scope

This method covers the determination of the basis weight of fiber glass mat. The basis weight includes the fiber, binder and other materials incorporated into the finished web. Weight is reported as pounds per 100 square feet (i.e., not customary TAPPI paper units).

The information and data contained in this document were prepared by a technical committee of the (TAPPI) Association. The committee and the Association assume no liability or responsibility in connection with the use of such information or data, including but not limited to any liability under patent, copyright, or trade secret laws. The user is responsible for determining that this document is the most recent edition published.

This test method provides the values in both SI units and inch-pound units. Inch-pound units are the customary units used in the United States and these values will be in parentheses in the body of this method. The International System of Units (SI units) are the customary metric units used in most of the rest of the world.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative references

The following referenced documents are indispensable for the application of this document.

2.1 ISO test methods

a) ISO 139:Textiles — Standard atmospheres for conditioning and testing
b) ISO 3951-1:2005 Sampling procedures for inspection by variables
c) ISO 2859-1:1999 Sampling procedures for inspection by attributes

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2.2 TAPPI test methods

a) TAPPI T 410 “Grammage of Paper and Paperboard (Weight per Unit Area).”
b) TAPPI T 1007 “Sample Location.”

2.3 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA’s and INDA’s Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Glass fibers

Glass which has been extruded into extremely fine filaments. These filaments vary in diameter, and are measured in microns. Glass filaments are treated with special binders and processed similar to textile fibers. These fibers come in many forms such as roving, woven roving, mat and continuous strands.

An individual filament made by mechanically drawing molten glass. A continuous filament is a glass fiber of great or indefinite length — a staple fiber is a glass fiber of relatively short length (generally less than 17 inches).

3.2 Fiber glass mats

Randomly oriented strands of glass fibers formed into a felt and held together with a binder, usually of thinned polyester resin in a powder-like form.

3.3 Basis weight

The weight of a unit area of fabric. Examples are ounces per square yard and grams per square meter.

4. Principle

The basis weight of fiber glass mat is determined by weighing nine 1-ft^2 (0.093-m^2) samples of the mat.

5. Apparatus

5.1 Balance

The balance shall be capable of weighing accurately to the nearest 0.01 g. The balance may be a specifically constructed sheet-weighing device that indicates the basis weight in pounds per 100 square feet when a 12 x 12 in. (305 x 305 mm) sample is weighed.

5.2 Sample cutter

Specimens may be cut with a sharp knife using a 12 x 12 in. (305 x 305 mm) template, a die cutter with alignment guide, or a paper cutter having an attachment for ensuring parallelism of opposite edges can also be used.

5.3 Oven
A forced draft convection oven capable of maintaining 220° ± 5°F (105° ± 3°C).

6. Sampling

6.1 Lot Size
A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

6.2 Sampling
If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (*Sampling procedures for inspection by attributes)* or ISO 3951-1:2005 (*Sampling procedures for inspection by variables)* can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 to1200	35

NOTE 2 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

6.3 Test specimen

The sample shall consist of nine 12 x 12 in. (305 x 305 mm) specimens cut as shown in TAPPI T 1007 "Sample Location." The dimensional tolerance of each cut specimen is ± 0.05 in. (1 mm).

7. Procedure

7.1 Place in oven

Place each of the test specimens in the convection oven which has been stabilized at 220° ± 5°F (105° ± 3°C) for 5 ± 1/2 min.

7.2 Remove from oven

Remove specimens from the oven with forceps and place in a desiccator (see Note 3) until cooled to room temperature.

NOTE 3 Experience has shown that the low mass of typical industrial mats facilitates rapid cooling in a normal laboratory environment. Therefore, a desecrator may not be necessary provided that convection current effects are avoided in weighing and that the weighing is done in a sufficiently short time to avoid significant re-absorption of water from the ambient atmosphere.

7.3 Weigh and record

The weight of each specimen to the nearest 0.01 g. (Provide for grounding to eliminate static electricity if necessary to assure accuracy in weighing.)

7.4 Convert

Convert each specimen weight to pounds per 100 square feet by:

B x 0.2205 = unit weight in pounds per 100 square feet.

B = weight in grams of a 12 x 12 in. (305 x 305 mm) sample.

8. Calculation

Calculate the average weight for each lane.
Calculate the average weight for all nine specimens.

9. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Report average basis weight of each lane to the nearest 0.01 pounds per 100 square feet.
d) Report average basis weight of all nine samples to the nearest 0.01 pounds per 100 square feet.
e) Make and model of testing equipment

f) Laboratory testing conditions
g) Number of specimens tested and note CD and/or MD if significant
h) For computer processed data, identify the software used and version
i) Name and address of testing institution
j) Deviation from the standard test procedure, if any
k) When calculated, the standard deviation or the coefficient of variation
l) Whether or not samples were conditioned prior to testing and, if so, for how long
m) Anything unusual noted during the testing

10. Precision

a) On the basis of studies made in accordance with TAPPI T 1200 “Interlaboratory Evaluation of Test Methods to Determine TAPPI Repeatability and Reproducibility” test results, each representing an average of 5 determinations from the same sample (commercial 2.0 lb / 100 square feet fiberglass mat), are expected to agree within the amounts stated below. The study included five laboratories.

b) Average basis weight 2.00 lbs / 100 square feet
Repeatability 6% - 0.12 lbs / 100 square feet
Reproducibility 9% - 0.18 lbs / 100 square feet

STANDARD TEST: WSP 605.0.R2 (12)

Standard Test Method for the Moisture Content of Fiber Glass Mats

The number in parentheses indicates the year of the last revision

1. Scope

This method covers the determination of the moisture content of fiber glass mat.
The moisture content of fiber glass mat is a physical property which may be of interest in the conversion of the material into a finished product.

The information and data contained in this document were prepared by a technical committee of the (TAPPI) Association. The committee and the Association assume no liability or responsibility in connection with the use of such information or data, including but not limited to any liability under patent, copyright, or trade secret laws. The user is responsible for determining that this document is the most recent edition published.

This test method provides the values in both SI units and inch-pound units. Inch-pound units are the customary units used in the United States and these values will be in parentheses in the body of this method. The International System of Units (SI units) are the customary metric units used in most of the rest of the world.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative references

The following referenced documents are indispensable for the application of this document.

2.1 ISO test methods

a) ISO 139 : Textiles — Standard atmospheres for conditioning and testing
b) ISO 3951-1:2005 Sampling procedures for inspection by variables
c) ISO 2859-1:1999 Sampling procedures for inspection by attributes

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2.2 TAPPI test methods

a) TAPPI T 1012“Moisture content of fiber glass mats
b) TAPPI T 1007 “Sample Location.”

2.3 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA’s and INDA’s Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Glass fibers

Glass which has been extruded into extremely fine filaments. These filaments vary in diameter, and are measured in microns. Glass filaments are treated with special binders and processed similar to textile fibers. These fibers come in many forms such as roving, woven roving, mat and continuous strands.

An individual filament made by mechanically drawing molten glass. A continuous filament is a glass fiber of great or indefinite length — a staple fiber is a glass fiber of relatively short length (generally less than 17 inches).

3.2 Fiber glass mats

Randomly oriented strands of glass fibers formed into a felt and held together with a binder, usually of thinned polyester resin in a powder-like form.

3.3 Moisture content

The amount of moisture in a material determined under prescribed conditions, and expressed as a percentage of the mass of the moist specimen, that is, the mass of the dry substance plus the moisture present.

4. Principle

The moisture content of fiber glass mat is determined by placing the test specimen in a suitable oven and measuring the volatiles lost during heating and cooling, under the conditions specified; the volatiles are assumed to be moisture.

5. Apparatus

5.1 Balance

A balance that is accurate to 0.001 g

5.2 Oven

A forced draft convection oven capable of maintaining 220° ± 5°F (105° ± 3°C).

5.3 Desiccator

Using a desiccant of sufficient volume to contain the 6 x 6 in. (152 x 152 mm) specimens.

5.4 Forceps
Sufficient size to retrieve the specimens from the oven.

5.5 Sample cutter
Specimens may be cut with a sharp knife using a 6 x 6 in. (152 x 152 mm) template, a die cutter with alignment guide, or a paper cutter having an attachment for ensuring parallelism of opposite edges can also be used.

6. Sampling

6.1 Lot Size
A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

6.2 Sampling
If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (*Sampling procedures for inspection by attributes)* or ISO 3951-1:2005 (*Sampling procedures for inspection by variables)* can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 to1200	35

NOTE 2 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

6.3 Test specimen

Obtain samples in accordance with TAPPI T1007 "Sample Location." Cut five 6 x 6 in. (152 x 152 mm) specimens across the width of the roll.

7. Procedure

NOTE 3 Fiberglass mats are extremely sensitive to environmental conditions (temperature, humidity) and must be allowed to equilibrate before moisture testing. Moisture content of fiberglass mats tested immediately after manufacturing might differ after shipment to a laboratory.

7.1 Weigh

Weigh each of the prepared specimens to the nearest 0.001 g and record this weight as *A* (in the formula).

7.2 Oven

Place each of the specimens in the convection oven which has been stabilized at 220° ± 5°F (105° ± 3°C) for 5 ± 1/2 min (or to constant weight).

7.3 Remove from oven

Remove specimens from the oven with forceps and place in desiccator (see Note 4) until cooled to room temperature.

NOTE 3 Experience has shown that the low mass of typical industrial mats facilitates rapid cooling in a normal laboratory environment. Therefore, a desiccator may not be necessary provided that convection current effects are avoided in weighing and that the weighing is done in a sufficiently short time to avoid significant re-absorption of water from the ambient atmosphere.

7.4 Remove from desiccator

Remove each of the specimens from desiccator and rapidly weigh to the nearest 0.001 g and record this weight as *B*.

7.5 Weigh and record
Calculate the percent of moisture for each of the five specimens to the nearest 0.1% as follows:

[(*A*-*B*) X 100] / *B*

8. Calculation

Calculate the average weight for each lane.
Calculate the average weight for all nine specimens.

9. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Report the average percent moisture of the five specimens to the nearest 0.1%.
c) The average percentage of moisture.
d) The number of specimens tested for each determination.
e) The standard deviation for each specimen set.
f) Complete identification of all materials tested and method of sampling
g) Make and model of testing equipment
h) Laboratory testing conditions
i) Name and address of testing institution
j) Deviation from the standard test procedure, if any
k) When calculated, the standard deviation or the coefficient of variation
l) Whether or not samples were conditioned prior to testing and, if so, for how long
m) Anything unusual noted during the testing

10. Precision

a) On the basis of studies made in accordance with TAPPI T 1200 “Interlaboratory Evaluation of Test Methods to Determine TAPPI Repeatability and Reproducibility” test results, each representing an average of 5 determinations from the same sample (commercial 2.00 lb/100ft2 fiberglass mat), are expected to agree within the amounts stated below. The study included five laboratories.

b) Average moisture content 1.55 %
Repeatability 14 % - 0.21 moisture %
Reproducibility 15 % - 0.24 moisture %

STANDARD TEST: WSP 606.0.R2 (12)

Standard Test Method for the Loss on Ignition of Fiber Glass Mats

The number in parentheses indicates the year of the last revision

1. Scope

This method covers the determination of the percent loss on ignition of fiber glass mats. This ignition loss can be considered to be the binder content.

The information and data contained in this document were prepared by a technical committee of the (TAPPI) Association. The committee and the Association assume no liability or responsibility in connection with the use of such information or data, including but not limited to any liability under patent, copyright, or trade secret laws. The user is responsible for determining that this document is the most recent edition published.

This test method provides the values in both SI units and inch-pound units. Inch-pound units are the customary units used in the United States and these values will be in parentheses in the body of this method. The International System of Units (SI units) are the customary metric units used in most of the rest of the world.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative references

The following referenced documents are indispensable for the application of this document.

2.1 ISO test methods

a) ISO 139: Textiles — Standard atmospheres for conditioning and testing
b) ISO 3951-1:2005 Sampling procedures for inspection by variables
c) ISO 2859-1:1999 Sampling procedures for inspection by attributes

2.2 TAPPI test methods

a) TAPPI T 658 “Properties of Diatomaceous Silica” (Section 5).
b) TAPPI T 1007 “Sample Location.”
c) TAPPI T 1013 Loss on ignition of fiber glass mats

Reference number
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Last approved as WSP 606.0.R2 in 2012

2.3 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Glass fibers

Glass which has been extruded into extremely fine filaments. These filaments vary in diameter, and are measured in microns. Glass filaments are treated with special binders and processed similar to textile fibers. These fibers come in many forms such as roving, woven roving, mat and continuous strands.

An individual filament made by mechanically drawing molten glass. A continuous filament is a glass fiber of great or indefinite length — a staple fiber is a glass fiber of relatively short length (generally less than 17 inches).

3.2 Fiber glass mats

Randomly oriented strands of glass fibers formed into a felt and held together with a binder, usually of thinned polyester resin in a powder-like form.

3.3 Loss on ignition

Weight loss, usually expressed as percent of total, after burning off an organic sizing from glass fibers, or an organic resin from a glass fiber laminate.

4. Principle

Fiber glass mat is ignited in a muffle furnace at 1157° ± 45°F (625° ± 25°C) until only an ash and the glass fiber remain. The residue is weighed and the percent loss on ignition of the moisture-free mat is calculated. (Appropriate ventilation should be used when conducting this test to avoid exposure to potentially hazardous products of combustion.)

The loss on ignition of fiber glass mat may consist of: binders used to hold the glass fibers together, fibers with an ignition temperature lower than 1157°F (625°C), and materials used to coat the glass fibers.

5. Apparatus

5.1 Balance

Balance accurate to 0.001 g.

5.2 Drying oven

Equipped with a means of constant temperature regulation and mechanical air convection.

5.3 Electric muffle furnace

Capable of maintaining a temperature of 1157° ± 45°F (625° ± 25°C).

5.4 Crucible
High form, 250 mL.

5.5 Desiccator

5.6 Forceps
Sufficient size to retrieve the specimens from the oven.

5.7 Sample cutter
Specimens may be cut with a sharp knife using a 6 x 6 in. (152 x 152 mm) template, a die cutter with alignment guide, or a paper cutter having an attachment for ensuring parallelism of opposite edges can also be used.

6. Sampling

6.1 Lot Size
A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

6.2 Sampling
If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (*Sampling procedures for inspection by attributes)* or ISO 3951-1:2005 (*Sampling procedures for inspection by variables)* can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 to1200	35

NOTE 2 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

6.3 Test specimen

a) Obtain samples in accordance with TAPPI T 1007 "Sample Location."
b) Use a 5 to 10g specimen cut into pieces small enough to fit into crucible.
c) Place sample in crucible.

NOTE 3 With appropriate care, a specimen of mat can be subjected to this test without use of a crucible; see Note 4 after Section 7.8.

7. Procedure

7.1 Precondition each test specimen

By drying for 1 h at 105° ± 3°C (220° ± 5°F), unless otherwise specified. Remove the test specimens from the drying oven and cool in the desiccator for 30 min in the standard atmosphere for testing glass textiles.

7.2 Place empty containers

In the muffle furnace at 625° ± 25°C (1157° ± 45°F). After 30 min, remove and cool in the standard atmosphere (TAPPI T 1008) for 30 minutes.

7.3 ID each container

Identify each container with respect to each test specimen.

7.4 Weigh empty container

Weigh the empty container to the nearest 0.001 g. Record this as the tare mass, *T*.

7.5 Placement of test specimen

Place the test specimen in the container and weigh to the nearest 0.001 g. Record this as the initial mass, *A*.

7.6 Place in muffle furnace

Place the test specimen and container in the muffle furnace and ignite at 625° ± 25°C (1157° ± 45°F).

7.7 Remove from muffle furnace

After ignition for at least 30 min, remove the test specimen and container from the muffle furnace and cool in the desiccator for 30 min in the standard atmosphere (TAPPI T 1008).

7.8 Weigh immediately

Remove each container and test specimen separately from the desiccator, and immediately weigh to the nearest 0.001 g. Record this as the ignited mass, *B*.

NOTE 4 When it is known that no ash residue separates from the specimen during the weighing and igniting process, the specimen may be weighed separately without the container. When this occurs, *T* equals zero. With appropriate care, a single piece of mat can be dried, weighed intact, and placed with tongs into the ignition oven on appropriate refractory supports. When the ignition time is complete, the sample may be removed as an intact fragile web and weighed directly on a pan balance.

8. Calculation

Calculate the percentage of ignition loss of the glass textile for each specimen as follows:

Ignition loss, % = 100 x (A – B)/(A – T) where:

A = initial mass of container and specimen before ignition, g

B = mass of container and glass residue after ignition, g

T = mass of container (Note 3).

9. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Report the percent loss on ignition of the glass mat to the nearest 0.1%.
c) The average percentage of moisture.
d) The number of specimens tested for each determination.
e) The standard deviation for each specimen set.
f) Complete identification of all materials tested and method of sampling
g) Make and model of testing equipment
h) Laboratory testing conditions
i) Name and address of testing institution
j) Deviation from the standard test procedure, if any
k) When calculated, the standard deviation or the coefficient of variation
l) Whether or not samples were conditioned prior to testing and, if so, for how long
m) Anything unusual noted during the testing

10. Precision

a) On the basis of studies made in accordance with TAPPI T 1200 “Interlaboratory Evaluation of Test Methods to Determine TAPPI Repeatability and Reproducibility.” test results, each representing an average of 5 determinations from the same sample (commercial 2.00 lb/100ft2 fiberglass mat), are expected to agree within the amounts stated below. The study included five laboratories.

b) Average loss on ignition 25.1 %
Repeatability 3.2 % - 0.8 weight loss %
Reproducibility 6% - 1.5 weight loss %

STANDARD TEST: WSP 607.0.R2 (12)

Standard Test Method for the Moisture Sensitivity of Fiber Glass Mats

The number in parentheses indicates the year of the last revision

1. Scope

This method covers the determination of the percent loss on ignition of fiber glass mats. This ignition loss can be considered to be the binder content.

The information and data contained in this document were prepared by a technical committee of the (TAPPI) Association. The committee and the Association assume no liability or responsibility in connection with the use of such information or data, including but not limited to any liability under patent, copyright, or trade secret laws. The user is responsible for determining that this document is the most recent edition published.

This test method provides the values in both SI units and inch-pound units. Inch-pound units are the customary units used in the United States and these values will be in parentheses in the body of this method. The International System of Units (SI units) are the customary metric units used in most of the rest of the world.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative references

The following referenced documents are indispensable for the application of this document.

2.1 ISO test methods

a) ISO 139 : Textiles — Standard atmospheres for conditioning and testing
b) ISO 3951-1:2005 Sampling procedures for inspection by variables
c) ISO 2859-1:1999 Sampling procedures for inspection by attributes

Reference number
WSP 607.0.R2 (12) A

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2.2 TAPPI test methods

a) TAPPI T 658 “Properties of Diatomaceous Silica” (Section 5).
b) TAPPI T 1007 “Sample Location.”
c) TAPPI T 1014 Moisture sensitivity of fiber glass mats

2.3 WSP test methods

a) WSP 001.0.R2 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA’s and INDA’s Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Glass fibers

Glass which has been extruded into extremely fine filaments. These filaments vary in diameter, and are measured in microns. Glass filaments are treated with special binders and processed similar to textile fibers. These fibers come in many forms such as roving, woven roving, mat and continuous strands.

An individual filament made by mechanically drawing molten glass. A continuous filament is a glass fiber of great or indefinite length — a staple fiber is a glass fiber of relatively short length (generally less than 17 inches).

3.2 Fiber glass mats

Randomly oriented strands of glass fibers formed into a felt and held together with a binder, usually of thinned polyester resin in a powder-like form.

3.3 Loss on ignition

Weight loss, usually expressed as percent of total, after burning off an organic sizing from glass fibers, or an organic resin from a glass fiber laminate.

4. Principle

Fiber glass mat is ignited in a muffle furnace at 1157° ± 45°F (625° ± 25°C) until only an ash and the glass fiber remain. The residue is weighed and the percent loss on ignition of the moisture-free mat is calculated. (Appropriate ventilation should be used when conducting this test to avoid exposure to potentially hazardous products of combustion.)

The loss on ignition of fiber glass mat may consist of: binders used to hold the glass fibers together, fibers with an ignition temperature lower than 1157°F (625°C), and materials used to coat the glass fibers.

5. Apparatus

5.1 Balance

Balance accurate to 0.001 g.

5.2 Drying oven
Equipped with a means of constant temperature regulation and mechanical air convection.

5.3 Electric muffle furnace
Capable of maintaining a temperature of 1157° ± 45°F (625° ± 25°C).

5.4 Crucible
High form, 250 mL.

5.5 Desiccator

5.6 Forceps
Sufficient size to retrieve the specimens from the oven.

5.7 Sample cutter
Specimens may be cut with a sharp knife using a 6 x 6 in. (152 x 152 mm) template, a die cutter with alignment guide, or a paper cutter having an attachment for ensuring parallelism of opposite edges can also be used.

6. Sampling

6.1 Lot Size
A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

6.2 Sampling
If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (*Sampling procedures for inspection by attributes)* or ISO 3951-1:2005 (*Sampling procedures for inspection by variables)* can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 to1200	35

NOTE 2 An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of nonwoven fabric and between specimens from a swatch from a roll of material to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

6.3 Test specimen

a) Obtain samples in accordance with TAPPI T 1007 "Sample Location."
b) Use a 5 to 10g specimen cut into pieces small enough to fit into crucible.
c) Place sample in crucible.

NOTE 3 With appropriate care, a specimen of mat can be subjected to this test without use of a crucible; see Note 4 after Section 7.8.

7. Procedure

7.1 Precondition each test specimen

By drying for 1 h at 105° ± 3°C (220° ± 5°F), unless otherwise specified. Remove the test specimens from the drying oven and cool in the desiccator for 30 min in the standard atmosphere for testing glass textiles.

7.2 The Placement of empty containers

In the muffle furnace at 625° ± 25°C (1157° ± 45°F). After 30 min, remove and cool in the standard atmosphere (TAPPI T 1008) for 30 minutes.

7.3 ID each container

Identify each container with respect to each test specimen.

7.4 Weigh empty container
Weigh the empty container to the nearest 0.001 g. Record this as the tare mass, *T*.

7.5 Placement of test specimen
Place the test specimen in the container and weigh to the nearest 0.001 g. Record this as the initial mass, *A*.

7.6 Place in muffle furnace
Place the test specimen and container in the muffle furnace and ignite at 625° ± 25°C (1157° ± 45°F).

7.7 Remove from muffle furnace
After ignition for at least 30 min, remove the test specimen and container from the muffle furnace and cool in the desiccator for 30 min in the standard atmosphere (TAPPI T 1008).

7.8 Weigh immediately
Remove each container and test specimen separately from the desiccator, and immediately weigh to the nearest 0.001 g. Record this as the ignited mass, *B*.

NOTE 4 When it is known that no ash residue separates from the specimen during the weighing and igniting process, the specimen may be weighed separately without the container. When this occurs, *T* equals zero. With appropriate care, a single piece of mat can be dried, weighed intact, and placed with tongs into the ignition oven on appropriate refractory supports. When the ignition time is complete, the sample may be removed as an intact fragile web and weighed directly on a pan balance.

8. Calculation

Calculate the percentage of ignition loss of the glass textile for each specimen as follows:

Ignition loss, % = 100 x (A – B)/(A – T) where:

A = initial mass of container and specimen before ignition, g

B = mass of container and glass residue after ignition, g

T = mass of container (Note 3).

9. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Report the percent loss on ignition of the glass mat to the nearest 0.1%.
c) The average percentage of moisture.
d) The number of specimens tested for each determination.
e) The standard deviation for each specimen set.
f) Complete identification of all materials tested and method of sampling
g) Make and model of testing equipment
h) Laboratory testing conditions
i) Name and address of testing institution
j) Deviation from the standard test procedure, if any
k) When calculated, the standard deviation or the coefficient of variation
l) Whether or not samples were conditioned prior to testing and, if so, for how long
m) Anything unusual noted during the testing

10. Precision

a) On the basis of studies made in accordance with TAPPI T 1200 “Interlaboratory Evaluation of Test Methods to Determine TAPPI Repeatability and Reproducibility.” test results, each representing an average of 5 determinations from the same sample (commercial 2.00 lb/100ft2 fiberglass mat), are expected to agree within the amounts stated below. The study included five laboratories.

b) Average loss on ignition 25.1 %
Repeatability 3.2 % - 0.8 weight loss %
Reproducibility 6% - 1.5 weight loss %

STANDARD TEST: WSP 608.0.R2 (12)

Standard Test Method for the Fiber Glass Mat Uniformity (visual defects)

The number in parentheses indicates the year of the last revision

1. Scope

This method is a description of fiber glass mat attributes that define visual uniformity in the finished mat product.

The information and data contained in this document were prepared by a technical committee of the (TAPPI) Association. The committee and the Association assume no liability or responsibility in connection with the use of such information or data, including but not limited to any liability under patent, copyright, or trade secret laws. The user is responsible for determining that this document is the most recent edition published.

This test method provides the values in both SI units and inch-pound units. Inch-pound units are the customary units used in the United States and these values will be in parentheses in the body of this method. The International System of Units (SI units) are the customary metric units used in most of the rest of the world.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative references

The following referenced documents are indispensable for the application of this document.

2.1 ISO test methods

a) ISO 139 : Textiles — Standard atmospheres for conditioning and testing
b) ISO 3951-1:2005 Sampling procedures for inspection by variables
c) ISO 2859-1:1999 Sampling procedures for inspection by attributes

2.2 TAPPI test methods

a) TAPPI T 1015 Fiber glass mat uniformity (visual defects)

Reference number
WSP 608.0.R2 (12) A

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Originally published as WSP 60080.R2 in 2012
Last approved as WSP 608.0.R2 in 2012

2.3 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA's and INDA's Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Glass fibers

Glass which has been extruded into extremely fine filaments. These filaments vary in diameter, and are measured in microns. Glass filaments are treated with special binders and processed similar to textile fibers. These fibers come in many forms such as roving, woven roving, mat and continuous strands.

An individual filament made by mechanically drawing molten glass. A continuous filament is a glass fiber of great or indefinite length — a staple fiber is a glass fiber of relatively short length (generally less than 17 inches).

3.2 Fiber glass mats

Randomly oriented strands of glass fibers formed into a felt and held together with a binder, usually of thinned polyester resin in a powder-like form.

4. Principle

This method is intended to list the possible visual defects of glass mat.

The visual inspection should be made during the manufacturing process of glass mat. This inspection can take place at the unwind stand prior to packaging/conversion.

5. Attributes (visual defects)

Specific definitions of the degree of non-conformity of mat to a prescribed guideline must be agreed upon between buyer and seller.

a) The mat is to be of uniform thickness and have a smooth surface.
b) The mat shall be free from oil, grease, and dirt.
c) The mat shall be free from wrinkles, ripples, folds, or creases.
d) The mat shall be free from torn edges and holes greater than 1/2 in. (12.7 mm) in diameter.
e) The mat shall be free from wet binder spots, thin areas, fiber clumps, and stringers.
f) The mat shall be free from delamination.
g) The mat shall be free from fuzzy or unbonded loose surface and edge fibers.
h) The mat shall not exhibit telescoping in excess of 1.5 in. (38 mm) and telescoped ridges in excess of 3/4 in. (19 mm) high and less than 1 in. (25 mm) wide.
i) The mat shall not exhibit core misalignment greater than 3/4 in. (19 mm).

6. Precision

A statement of precision is not applicable to this practice.

STANDARD TEST: WSP 609.0.R2 (12)

Average Fiber Diameter of Fiber Glass Mats

The number in parentheses indicates the year of the last revision

1. Scope

This method covers the determination of the average fiber diameter (or distribution of diameters) of fibers used in nonwoven fiber glass mats.

The information and data contained in this document were prepared by a technical committee of the (TAPPI) Association. The committee and the Association assume no liability or responsibility in connection with the use of such information or data, including but not limited to any liability under patent, copyright, or trade secret laws. The user is responsible for determining that this document is the most recent edition published.

This test method provides the values in both SI units and inch-pound units. Inch-pound units are the customary units used in the United States and these values will be in parentheses in the body of this method. The International System of Units (SI units) are the customary metric units used in most of the rest of the world.

SI values are regarded as the official standard system of measurement for this standard test method. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. Normative References

The following referenced documents are indispensable for the application of this document:

2.1 ISO test methods

a) ISO 3951-1:2005 Sampling procedures for inspection by variables
b) ISO 2859-1:1999 Sampling procedures for inspection by attributes
c) ISO-8036-1 Optics and optical instruments -- Microscopes -- Part 1: Immersion oil for general use in light microscopy

Reference number
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Originally published as WSP 609.0.R2 in 2012
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2.2 TAPPI test methods

a) T 1016 - Average fiber diameter of fiber glass mats
(Location for cutting test specimens can be viewed in TAPPI T 1016 procedure)

b) TAPPI T 1200 “Interlaboratory Evaluation of Test Methods to Determine TAPPI Repeatability and Reproducibility” test results

2.3 WSP test methods

a) WSP 001.0.R3 (12) Standard Terminology Relating to the Nonwoven Industry, EDANA’s and INDA’s Standard Test Methods

3. Terms and Definitions

For the purpose of this document, the following terms and definitions apply:

3.1 Fiber diameter

The distance in microns across the circular cross section of the glass fiber.

3.2 Nonwoven fiber glass mat

Randomly distributed glass fibers, bonded together with a polymeric binder system.

3.3 Binder

The polymeric agent used to bond the glass fibers to one another in the mat.

3.4 Sigma

Sum of components in a set.

4. Principle

Samples of glass fiber extracted from the mat are cut into short lengths. The fibers are then mounted onto a glass slide and placed on a microscope stage. Fiber diameters are recorded for each sample and the average fiber diameter is recorded as the average of these readings.

The fiber diameter of the fiber glass used in the nonwoven fiber glass mat has a bearing on the properties of the finished mat product. This method permits the determination of that diameter or distribution of diameters if more than one fiber size or type is present.

5. Apparatus

5.1 Microscope

Capable of 1000 magnification with an 100x oil objective,

5.2 Micrometer Disc

a glass disc with a scale or grid mounted to the ocular or eyepiece diaphragm used for measurement.

5.3 Immersion Objective
Most common is the 100x oil objective. Oil is placed on the cover glass of the slide which (and sometimes on the top element of the condenser) to produce a high magnification and high resolving power of the objective when immersed in the oil. This produces the full Numerical Aperture of objective lens.

5.4 Immersion Oil
Description: Type A immersion oil, non-drying. Conforms to ISO-8036-1 specifications.
For use with oil immersion objective lens

5.5 Furnace
Muffle furnace capable of maintaining a temperature of 1157° ± 45°F (625° ± 25°C).

5.6 Miscellaneous
Scissors, crucible, microscope slide, cover glass, dissecting needle.

6. Sampling

6.1 Lot Size
A lot should be established based on a logical break in the process or a prescribed by a regulation or traceability requirements.

6.2 Collecting samples
If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1:1999 (*Sampling procedures for inspection by attributes)* or ISO 3951-1:2005 (*Sampling procedures for inspection by variables)* can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer's risk, consumer's risk, acceptable quality level, limiting quality level and cost need to be established,

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.

Attributes (1.0 AQL, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 150	13
151 to 280	32
281 to 500	50
501 to 1200	80

Variables ("s" method, General Inspection Level II)

Number of units in the lot inclusive	Number of units that comprise the lot sample
1 to 15	3
16 to 25	4
26 to 50	6
51 to 90	9
91 to 150	13
151 to 280	18
281 to 500	25
151 t01200	35

6.3 Sample preparation

a) Place dry mat in the crucible and then place the crucible in the muffle furnace at a temperature of not more than 1157° ± 45°F (625° ± 25°C), for 15 ± 0.5 min, or until all the carbonaceous material has disappeared. Remove from furnace and allow to cool.

b) Hold several strands in a bundle and using scissors, cut 1/16 in. to 1/8 in. (1.59 mm to 3.18 mm) samples onto a clean microscope slide. Add an adequate number drops (1 to 5) of Immersion oil to the slide and, using the dissecting needle, mix until all fibers are thoroughly wetted. Fibers should be arranged until they are approximately parallel to each other (the low power on the microscope may facilitate this). Place one edge of a cover glass in contact with the slide and allow it to settle slowly on the sample to facilitate removal of air bubbles.

7. Procedure

7.1 Place the prepared slide on the microscope stage. Examine the fibers at 1000X magnification (this is the oil immersion lens).

7.2 Locate a specific fiber and focus so as to obtain a thin black line on both sides of the fiber. Align the grid with the fiber. Set the grid line on the outside edge of the black fiber edge line and take a reading at the outside edge of the other black fiber edge lines. Record reading. Repeat this step for all fibers visible at a single location on the slide.

7.3 When all fibers have been measured and recorded, move the microscope stage to bring a new area of the slide into view. Repeat above measurements until at least 50 individual fibers have been measured and recorded.

7.4 Repeat the process for each separately identifiable fiber type if more than one type of fiber is present.

8. Calculation

Report the average diameter as:
Average fiber diameter in microns = $\sum X / \sum Y$

where

X = micron reading for diameter
Y = number of occurrences for each reading

If more than one fiber type is present, report the results for each identifiable type. If a wide distribution of diameters is present, report the distribution and range of diameters in lieu of the average diameter.

9. Report

In addition to the precise test results, the report shall include the following information:

a) Reference the test method used
b) Complete identification of all materials tested and method of sampling
c) Name and address of testing institution
d) Make and model and capacity of testing equipment
e) Laboratory testing conditions
f) For computer processed data, identify the software used and the version
g) Deviation from the standard test procedure, if any
h) When calculated, the standard deviation or the coefficient of variation
i) Whether or not samples were conditioned prior to testing and, if so, for how long
j) Anything unusual noted during the testing

10. Precision

10.1 On the basis of studies made in accordance with TAPPI T 1200 “Interlaboratory Evaluation of Test Methods to Determine TAPPI Repeatability and Reproducibility” test results, each representing an average of 50 determinations from the same sample (commercial 2.00 lb/100 ft^2 fiberglass mat), are expected to agree within the amounts stated below.

The study included three laboratories.

Average fiber diameter	15.7 microns
Repeatability	6 % - 0.9 microns
Reproducibility	6 % - 1.0 microns

11. Keyword

Fiber diameter, Fiber glass mats