

## 1. RAW MATERIALS

Each supplier is assessed against Quality Assurance criteria. If the supplier meets the criteria set out, then they may be included in our “Approved Supplier List”.

Inspection and test of raw materials, when received enables us to assess the supplier as well as each batch of delivered raw material. Details are shown in Table 1.1.

**Table 1.1**

RAW MATERIAL	CHARACTERISTIC TESTED
Polyester fiber (several specifications)	Staple length Crimp level Denier Shade Supplier Certification
Polyurethane granules (several specifications)	Granularity Blocking Yellowness Supplier Certification
Tetrahydrofuran	Supplier Certification
Polyurethane film, sealing tape	Gauge Density Strength of weld – heat Strength of weld - chemical Opacity

## 2. PRODUCTION OF FELT (NON-WOVEN)

The sole raw material used in the production of felt is polyester staple fiber. The most suitable fiber specification for the particular end-use is selected (on the basis of resin type, impregnation equipment, installation conditions and cure regime).

The process should utilize state of the art equipment and technology to ensure that the nonwoven Product is fully suited to the customer’s requirements.

Continual operator inspection at each stage of the process and product, combined with the use of standard machine parameters and computerized machine monitoring ensures that the process is repeatable and consistent.

Each product is tailored to the specific requirements, and a production specification is produced by the Technical Department. The felt produced is tested against the requirements of this document to concur suitable.

Process controls are described in Table 2.1.

**Table 2.1**

PROCESS	CONTROL	CONTROL
Opening fiber	Operator inspection, set parameters	Even density and thickness
Carding	Operator inspection, set parameters, computer feedback	53 Even fiber distribution
Tacker needling	Operator inspection, set parameters, computer feedback, orientation of fibers	Permits controlled
Reorientation of fibers	Operator inspection, set parameters, computer feedback	Controls relative elongation moduli in length and cross directions
Needling	Operator inspection, set parameters, computer feedback	Density, strength, ability to weld

### 3. POLYURETHANE COATING OF FELT

The sole consumable is granular polyurethane. The polyurethane specification is selected to ensure that the coating has the correct properties to meet the requirements.

Process controls are described in Table 3.1.

**Table 3.1**

PROCESS	CONTROL	CHARACTERISTIC
Extrusion of polymer into flat die	Fully automatic temperature, pressure control	Homogeneity of extrudate
Formation of molten polymer film	Operator control of machine temperatures, pressures, speeds	Coating uniformity
Transfer of molten film onto felt	Operator control of machine temperatures, pressures, speeds. Continual monitoring of coating thickness	Weight distribution per unit area; weight distribution over entire roll area

#### 4. TESTING OF PLAIN AND COATED FELTS

Each roll of plain felt and felt for coating shall be sampled and destructively tested against the requirements of the Production Specification as shown in Table 4.1. Each coated roll undergoes testing as Table 4.2.

**Table 4.1**

CHARACTERISTIC	TEST
Density and density distribution at various applied pressures	Compression measurement at increasing pressure
Load at break in machine and cross directions	Tensile testing-Maximum Resistive Force
Secant Modulus in machine and cross directions (resistance to stretch)	Tensile testing-Maximum Resistive Force vs. Extension %

**Table 4.2**

CHARACTERISTIC	TEST
Density and density distribution at various applied pressures	Compression measurement at increasing pressure
Load at break in machine and cross directions	Tensile testing – Maximum Resistive Force
Secant Modulus in machine and cross directions (resistance to stretch)	Tensile testing – Maximum Resistive Force vs. Extension %
Coating weight and distribution	Samples weighted to determine distribution of coating in cross direction of roll
Coating adhesion and ability to weld	Peel strength of welded tape (Standard specification)
Coating surface finish	Visual inspection

#### 5. PRODUCTION OF LINERS

Liner requirements are collected shall be confirmed to the customer on our Order Acknowledgment form.

Once all requirements are known, a liner is designed which will fulfill all the requirements.

The design is detailed to the Production department as a Manufacturing Specification. This is then entered onto the Production Schedule.

The liner may be produced by one of a number of production techniques, depending on the requirements.

## 6. TESTING THE FINISHED LINER

The control and test of the liner properties are detailed in Table 6.1. From each liner produced, a sample is cut from one end for QC inspection and test. This sample is destructively tested to ensure that all of the liner properties are within the Manufacturing Specification.

**Table 6.1**

PROCESS	CONTROL	CHARACTERISTIC
Circumference of liner	Monitored at each production stage against Manufacturing Specification	Destructive test of sample. All layers are measured
Density, Gauge of liner under various applied pressures	Selection of felt layers in order that finished density and gauge are within Manufacturing Specification	Compression test of sample of all layers
Length of liner	Monitored at each production stage against Manufacturer Specification	Inspection regime includes measurement of liners against Manufacturing Specification
Coating Integrity	Continually monitored by state-of-the-art gauge	Inspected after coating, monitored throughout liner manufacture
Metal Free	Needling process is continually monitored for alignment to prevent needle damage	Each roll passes through metal detection equipment
Felt Weld Strength	All welding equipment operates to set parameters. Overlapped thermal welded	Each weld is sampled and destructively tested. Results are compared to the Manufacturing Specification
Sealing Tape Weld Strengths	All welding equipment operates to set parameters, chemically bonded seal	Each weld is sampled, specially conditioned, and destructively tested under conditions simulating the "worst case" for that liner

## Technical Information – Polyurethane Coated Liner for Hot Cure Eversion

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### SPECIFICATION:

#### Felt

- The fiber is PET Polyester staple fiber.
- The denier of the fiber for a standard hot cure eversion liner for vacuum impregnation with a polyester resin is usually selected as nominally 6 denier (+10%) (dependent on specific liner and installation details).
- The felt is manufactured to a thickness specification of  $\pm 3\%$  when measured at a compressive pressure of 0.5 bar (7.4 psi) (16 ft. water head). Standard thickness of 1.5 mm, 3mm, 4.5mm, 6mm exist.

#### Coating

- The coating is a thermoplastic polyester polyurethane. The nominal weight may be 400 - 500, 500 - 600 or 600 - 700 grams per square meter. It is usual for the 400 - 500 gsm spec to be used. This affords an average coating thickness of 0.33mm for 400 gsm, 0.41mm for 500 gsm.
- All coating weights are applied in a minimum of two passes to ensure that pin holes are avoided.

#### Liner

- The liner is assembled from layers of plain felt and an outer layer of coated felt. Each inner plain layer is overlapped approximately 50mm (2") at each joint and welded by hot fusion techniques to give the requisite weld strength to support the installation pressure (with a safety factor included). The safety factor is in excess of 2.
- The outer coated layer has a high strength felt strip fusion welded across the inside of the joint and a sealing tape of polyurethane welded over the coating to give a seal and a barrier of comparable thickness to the coating.
- The finished liner thickness is measured at the installation head and is toleranced at -0 + 5% on nominal ordered thickness.

## Certification

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This certifies that Applied Felts manufactured tubes meet the material requirements of ASTM F1216-93. In support of ASTM D5035, specifically as it relates to tensile strengths, our liner tensile properties average 1100 psi. The minimum tensile strength is 750 psi as per ASTM D5813-95 item 6.1 *Fabric Tube Strength* (see Page 10). All our materials are tested to ensure suitability to the application. Each liner is typically tested in 28 different ways and traceable test data is available for any particular liner.

Recommendations for minimum, maximum and ideal pressures are provided for each and every liner that Applied Felts manufactures. This ensures that the installer understands the requirements for holding the tube against the existing conduit and the maximum allowable pressure so as not to damage the tube. A head pressure chart is attached as examples for various tube sizes.

Applied Felts has provided polymer coated felt tubes for use in Cured-in-Place Pipe (CIPP) lining for more than twelve years, and supplied materials for the CIPP industry for more than twenty years. Over 22 million feet of our liner has been successfully installed worldwide, of which 10 million feet has been installed in the United States. Over 97,476 feet of our liner with diameter 36" and above have been installed in the U.S.

Applied Felts also certifies that all liners manufactured will meet the minimum requested finished thickness (or greater) as ordered by its customers.

Applied Felts is a registered ISO 9002 company.





## Recommended Handling and Storage for Liners

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### **1 Avoid extremes of temperature.**

Freezing may cause the coating structure to degrade locally, especially areas where the coating is in tension or compression, at bends and edges and immediately adjacent to seam welds.

Recommended storage temperature 5 to 35 degrees C.

Shelf life at this temperature: in excess of 1 year.

### **2 Avoid extremes of humidity.**

Very high relative humidity (especially at high temperature such as tropical countries) will accelerate the hydrolysis of the polyurethane coating, consequently reducing the shelf life.

Recommended storage humidity 25% rh to 65% rh.

Shelf life at 65%, 35 degrees C: 1 year.

### **3 Avoid prolonged wet storage.**

As with high humidity, the coating more susceptible to degradation at higher temperatures, and even further susceptible if pH of liquid in contact is below 7.

Wet storage is not recommended.

### **4 Avoid direct sunlight of incident UV radiation.**

Prolonged exposure to ultra violet light will accelerate the degradation of the polyurethane.

It is recommended that liners remain in the original packaging until they are required for use. Failing this, the liner should be covered to prevent exposure.

## **5 Mechanical damage should be avoided.**

In order to ensure that the liner is not damaged, the following recommendations should be followed:

- a) Ensure that liner is not placed directly onto grit or gravel floor. Sweep and cover floor first.
- b) Ensure personnel are instructed not to walk on liner.
- c) Handle liner with care.
- d) Ensure nip rollers clean, and liner is not in contact with any sharp edges or snags anywhere during impregnation and installation.
- e) Large liners will require special handling considerations (especially when wet-out), as their weight will preclude manual handling. Cranes or conveyors may be required. If a liner is to be lifted with a crane sling, it is important that the sling should be sufficiently wide to prevent it from “biting” into the liner. It should be set up in such a way that the sling does not grip the liner (i.e. both loops of the sling onto the crane hook).

## **6 Styrene and Chemical Attack**

Avoid prolonged contact with solvents and chemicals.

On impregnation with styrene-based resin, the solvent/monomer may start to swell the coating, giving an orange peel appearance. In time, this effect will increase to severe wrinkling (stretch by 60%).

If the contact time is sufficient, the coating will feel tacky. At this stage, the product should not be used.

Recommended shelf life after impregnation will vary dependant on the proportion of styrene in the resin, the nature and proportion of thixotropes, inhibitors, accelerators and catalysts, and the storage temperature.

As a general rule, the impregnated liner should be stored below 10 degrees C. The typical shelf life at this temperature, with a polyester resin system, is maximum 7 days. With some resin systems, this shelf life is reduced to less than 24 hours. If using an unfamiliar system, it is recommended a section of coated felt is soaked in resin and assessed periodically to determine shelf life. With experience, this may be judged visually by the degree of wrinkling.