Insulation Solutions
Our Mission…

is to provide our customers with a competitive advantage through innovation, technology and quality:

- by ensuring that our products meet or exceed our customers’ expectations
- by maintaining a flexible organization that is responsive to our customer’s needs
- by continually improving operations.

Our corporate policies are guided by the following principles:

- Quality will not be compromised.
- Customers are the guiding force for everything we do. Without customers, there is no business.
- We place a top priority on honesty, integrity and fairness in our relationships with employees, customers, suppliers and the community in which we operate.

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Manufacturing Capabilities

IPT operates a clean, efficient manufacturing facility with modern, well-maintained paper making and coating/laminating machinery. The equipment shown here gives IPT the design flexibility and production capacity to modify existing materials in the development of new products as well as provide full production runs for your manufacturing requirements.

**Double disc refiner**

**Centrifugal cleaners on the 4-cylinder paper machine.**

**Precision coater/laminator.**

**Tower coater/saturator.**

**Precision coater/laminator**
- Width: 40"
- Precision coating capabilities
- Duplex laminator

**Sheeter**
- Thickness: 3 to 60 mil
- Width: 38"
- Sheet length: 12" to 72"

**3 Slitter/rewind machines**
- Thickness: 3 to 60 mil
- Width: Minimum 1/4"/Maximum 40"

**4-cylinder paper machine**
- Thickness: 3 to 30 mil
- Width: Maximum 38"
- Inorganic-based papers

**Single cylinder board machine**
- Thickness: 1/32" to 3/8"
- Board size:
  - Maximum 48" x 48"
- Inorganic-based boards

**Tower coater/saturator**
- Width: Maximum 40"
- 3 Zone, 40' tower

**Wet combiner**
- Width: 38"
- Wet lamination technique
- Triplex capabilities

**APPLICATIONS**

- Ground, phase and inter-winding insulation for dry-type transformers
- Slot, phase and wedge insulation for electric motors and generators
- Flame Barrier insulation for appliances
- Voice coil insulation for loudspeakers
- LENSWRAP for glass lens production
- Wire and cable wrap
- Coated papers for heat/pressure bonding applications
- Specialty paper base for tamper-proof labels
- Oil-filled transformers
- Battery separators
- Backing pads for heat-seal packaging
- Cast Coil transformers
- Switch gear
ThermaVolt™
Calendered Insulation Paper

Major Features and Benefits of the newest innovation from Innovative Paper Technologies

- UL Systems Recognition* – Class 220 (R)
- High Inorganic Content
- Excellent Thermal Conductivity
- Good Dielectric Breakdown Resistance
- Reduce costs with improved processability
- Low Moisture Absorption
- Thicknesses: 3 mils (.08mm) to 10 mils (.25mm)

*All electrical insulation systems testing per UL 1446 and IEC 61857

DESCRIPTION
ThermaVolt™ inorganic-based paper has been developed to meet the high-performance required for use in high-temperature, dry-type transformers. ThermaVolt offers good dielectric characteristics and thermal conductivity – making it especially suitable for use as interwinding insulation in strip-wound coils. ThermaVolt has been designed for use as major ground insulation in electrical insulation systems up to Class 220(R).

APPLICATIONS
High Temperature Electrical insulation for:

Dry-Type Transformers
- Ground Insulation
- Phase Insulation
- Layer Insulation
- Interwinding for foil wound designs

Electromagnet Coils

The data presented here are typical average values and are not to be used for specification purposes. No warranty is given or implied. It is the responsibility of the user to determine the material’s suitability for use.
## Typical Product Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Nominal Thickness</th>
<th>mils (mm)</th>
<th>3 (.08)</th>
<th>5 (.13)</th>
<th>7 (.18)</th>
<th>10 (.25)</th>
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<tr>
<td>Nominal Thickness</td>
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<tr>
<td>Basis Weight</td>
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<td></td>
<td>lb/SY</td>
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<td>Tensile Strength, MD</td>
<td>kN/m</td>
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<tr>
<td></td>
<td>lb/inch</td>
<td>6</td>
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<td>%, min</td>
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<tr>
<td>Dielectric Strength</td>
<td>kV</td>
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<td>4.0</td>
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<tr>
<td>Thermal Conductivity</td>
<td>W/mK</td>
<td>0.21</td>
<td>0.21</td>
<td>0.21</td>
<td>0.21</td>
<td></td>
</tr>
</tbody>
</table>

### Tensile Strength, lb/inch • Thickness 5 mils (.13mm)

- CeQUIN® I: 5, 10, 15, 20, 25, 30
- ThermaVolt: 5, 10, 15, 20, 25, 30
- TufQUIN® 110: 5, 10, 15, 20, 25, 30

### Thermal Conductivity, W/mK

- ThermaVolt: 0.21, 0.21, 0.21, 0.21, 0.21, 0.21
- CeQUIN® I: 0.21, 0.21, 0.21, 0.21, 0.21, 0.21
- Aramid Paper: 0.05, 0.10, 0.15, 0.20, 0.25
CeQUIN®
HIGH PERFORMANCE INORGANIC-BASED ELECTRICAL INSULATION PAPERS

The information contained below is applicable to all CeQUIN papers, laminates and boards. Please refer to individual product pages for information specific to each CeQUIN product.

FEATURES

UL® & CSA CERTIFICATION
- UL systems recognition through Class 220(R).
- CSA Component Acceptance: Temperature Class 220.

DIELECTRIC PERFORMANCE
CeQUIN® papers retain a high percentage of dielectric strength even after extended exposure to high operating temperatures. CeQUIN will also exhibit greater voltage endurance under continuous electrical stress than many other electrical insulation materials.

THERMAL CONDUCTIVITY
The high thermal conductivity of CeQUIN papers helps achieve the heat dissipation required in today’s high efficiency electrical apparatus allowing the design of smaller, more cost effective equipment.

VARNISH ABSORPTION
The good varnish absorption characteristics of CeQUIN can enhance its already high thermal conductivity allowing equipment to run cooler, quieter, and last longer.

LOW MOISTURE ABSORPTION
Manufactured with less than 1% moisture content, CeQUIN papers exhibit low moisture absorption even in humid environments, thereby reducing the need for extended drying cycles.

APPLICATIONS
High Temperature Electrical Insulation for:

Dry-Type Transformers
- Ground Insulation
- Phase Insulation
- Layer Insulation
- Barrier Insulation
- Core Wrap
- End Fill
- Interwinding for strip-wound coils

Traction Motors, Generators
- Interwinding for form wound coils
- Slot Fill
- Phase Insulation

Wire and Cable Wrap

Battery Separators

Capacitor and Electromagnet Layer Insulation

Switchgear Insulation

Spiral and Convolute Tubing

UL RECOGNITION

CeQUIN inorganic papers are designed to provide high-temperature performance in electrical insulation systems. CeQUIN products have undergone extensive thermal aging evaluation per UL 1446, “Standard for Systems of Insulating Materials – General,” and as a result are UL Recognized as suitable for use as major ground insulation in systems rated through Class 220(R).

Several UL Recognized Insulation Systems are listed under IPT File No. E65007 in the OBJ52 category for Class 130(B), Class 155(F), Class 180(H), Class 200 (N), and Class 220(R) applications and may be found on UL's Electrical Insulation Systems Database at http://data.ul.com/systems/. All systems listed on this database are available for use by any electrical apparatus manufacturer by contacting the nearest UL office.
Innovative Paper Technologies, LLC

CeQUIN® I, II
Cost-effective, High-temperature, High Performance Electrical Applications

DESCRIPTION

CeQUIN® I is IPT’s highest inorganic-content paper; comprised primarily of glass fibers and microfibers, inorganic fillers, and less than 10% organic binder, CeQUIN I is capable of long-term performance at operating temperatures up to 250°C. CeQUIN I is a highly flexible paper available in continuous roll stock in thicknesses ranging from 5 mil (.13mm) to 30 mil (.76mm). See Table I for Typical Product Properties of standard thicknesses of CeQUIN I, II. Other thicknesses are available on special order. Contact your Regional Sales Manager for details.

CeQUIN I

The high inorganic content of CeQUIN I provides the excellent thermal and dielectric stability that is required for today’s high performance designs. CeQUIN I electrical insulation papers will outperform competitive organic materials that cost substantially more.

CeQUIN II

CeQUIN II is a two-layer composite of CeQUIN I designed to provide thicker roll stock for barrier, end filler, and core wrap insulation applications. CeQUIN II exhibits enhanced physical and dielectric properties; it is available in thicknesses ranging from 30 mil (.76mm) to 60 mil (1.52mm).

PHYSICAL CHARACTERISTICS

The excellent thermal conductivity (see Graph 1) of CeQUIN materials helps dissipate heat build-up in electrical equipment resulting in reduced operating temperatures, longer life, and higher energy efficiency. Dry-type transformer coils wound with CeQUIN have exhibited 10-15°C lower average winding temperature rise as compared to coils of the same design wound with competitive high temperature insulation materials.

Alternatively, equipment design engineers can take advantage of the improved heat dissipation afforded by CeQUIN to design more compact coils and reduce overall costs. CeQUIN inorganic papers exhibit low moisture content and very little moisture absorption even under high humidity conditions, especially when compared to aramid paper, thus reducing the need for extended drying cycles prior to varnishing. CeQUIN papers are not susceptible to hydrolytic degradation as are some organic-based insulation materials.

CeQUIN papers are easily impregnated and fully compatible with standard varnishes and resins, yielding tightly bonded coils and further improving thermal conductivity.

The high inorganic content of CeQUIN I and II equates to excellent dimensional stability, whether exposed to varying humidity conditions or long-term thermal aging.

ELECTRICAL CHARACTERISTICS

The thermal stability of CeQUIN inorganic papers is demonstrated in their retention of dielectric strength, even after thermal aging at temperatures in excess of 300°C. Graph 2 exhibits the performance of 10 mil (.25mm) CeQUIN I vs. 10 mil (.25mm) calendared aramid paper when aged at 310°C.

The inorganic content of CeQUIN papers reduces the effect of long-term electrical stress and partial discharge on their insulation qualities. For example, when exposed to a continuous electrical stress of 1.8kV, 10 mil CeQUIN I will typically exhibit over three times the voltage endurance of 10 mil calendared aramid paper (see Graph 3).

RECOMMENDED PRACTICE FOR USING CeQUIN PRODUCTS

Optimum performance of an electrical insulation system is dependent upon many factors including proper choice of materials, acceptable design criteria, and good manufacturing procedures. CeQUIN’s resistance to moisture absorption can minimize drying time required prior to varnish impregnation or encapsulation. Varnishing is recommended for construction of equipment that may be exposed to the elements. CeQUIN papers are easily saturated and will tend to assume the aging characteristics of the resin or varnish that is used.

For design purposes, it is recommended that operating electrical stresses in electrical apparatus not exceed 40 V/mil (1.6 kV/mm) in order to minimize the risk of partial discharge.
Table 1 - Typical Product Properties

<table>
<thead>
<tr>
<th>ASTM Test Method</th>
<th>CeQUIN® I</th>
<th>CeQUIN® II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal Thickness mil</td>
<td>D-645</td>
<td>mm .13 .18 .25 .38 .63 .76 .76 1.0 1.5</td>
</tr>
<tr>
<td>Basis Weight kg/m²</td>
<td>D-202</td>
<td>.13 .19 .27 .41 .67 .81 .81 1.08 1.67</td>
</tr>
<tr>
<td>Basis Weight lb/sq yd</td>
<td>D-202</td>
<td>.24 .35 .50 .75 1.24 1.5 1.5 1.99 3.07</td>
</tr>
<tr>
<td>Tensile Strength kN/m MD</td>
<td>D-828</td>
<td>1.0 1.6 2.1 2.8 3.5 4.0 8.9 9.6 10.6</td>
</tr>
<tr>
<td>Elongation, MD %</td>
<td>D-828</td>
<td>&lt;2 &lt;2 &lt;2 &lt;2 &lt;2 &lt;2 &lt;2 &lt;2 &lt;2</td>
</tr>
<tr>
<td>Dielectric Breakdown Strength kV</td>
<td>D-149</td>
<td>1.0 1.3 1.8 2.6 3.2 3.8 6.5 8.8 9.2</td>
</tr>
<tr>
<td>Moisture Absorption %</td>
<td>D-644</td>
<td>&lt;1 &lt;1 &lt;1 &lt;1 &lt;1 &lt;1 &lt;1 &lt;1 &lt;1</td>
</tr>
</tbody>
</table>

GRAPH 1 – Thermal Conductivity

Thermal Conductivity of CeQUIN I vs. calendered aramid paper; tested at 180°C per ASTM E 1530.

CeQUIN I, 10 mil (.25 mm) .195
Aramid Paper, 10 mil (.25 mm) .115

GRAPH 2 – Effect of Thermal Aging on Dielectric Strength

Percent of Original Dielectric Strength

CeQUIN I 10 mil (.25 mm)
Aramid Paper 10 mil (.25 mm)

Hours Aged at 310°C

10¹ 10² 10³

GRAPH 3 – Voltage Endurance at 7 kV/mm

Voltage Endurance of CeQUIN I vs. calendered aramid paper; average of five data points for each material; materials tested concurrently on same machine at 20°C, 50% RH.
CeQUIN® 3000

DESCRIPTION
CeQUIN® 3000 is a modified version of CeQUIN® I developed by IPT's research and development team to provide high strength thin papers. By introducing a small percentage of organic fiber reinforcement along with a high-strength binder system, CeQUIN 3000 papers may be produced in 3 mil and 5 mil thicknesses. CeQUIN 3000 is composed of approximately 74% inorganic content as compared to the 90% inorganic content of CeQUIN I. CeQUIN 3000 may be laminated with polyester film, or glass fabric to enhance initial dielectric strength or improve mechanical manageability. CeQUIN 3000 is available in continuous roll stock, up to 36 inches wide, as slit tapes or sheets.

| DESCRIPTION | CeQUIN® 3000 is a modified version of CeQUIN® I developed by IPT's research and development team to provide high strength thin papers. By introducing a small percentage of organic fiber reinforcement along with a high-strength binder system, CeQUIN 3000 papers may be produced in 3 mil and 5 mil thicknesses. CeQUIN 3000 is composed of approximately 74% inorganic content as compared to the 90% inorganic content of CeQUIN I. CeQUIN 3000 may be laminated with polyester film, or glass fabric to enhance initial dielectric strength or improve mechanical manageability. CeQUIN 3000 is available in continuous roll stock, up to 36 inches wide, as slit tapes or sheets. |
BENEFITS OF CeQUIN INORGANIC PAPERS

- High temperature capabilities
- Long-term dielectric strength
- Good thermal conductivity
- Low moisture absorption
- Cost effective

... COMBINED WITH THE ADDED BENEFITS OF POLYESTER FILM

- Higher mechanical strength
- Improved cut-through resistance
- High initial dielectric strength

UL® AND CSA CERTIFICATION

- UL Systems Recognition Through Class 220(R)
- CSA Component Acceptance Temperature Class 220C

DESCRIPTION

IPT composites of CeQUIN® inorganic-based papers laminated with polyester film have been developed to provide a balanced blend of electrical, physical, and thermal capabilities on a cost effective basis. The polyester film is bonded to either CeQUIN I or CeQUIN 3000 using a high temperature resin system. A variety of two-ply and three-ply laminates are available; the different constructions are designated as follows:

CeQUIN IF:
a two-ply composite of CeQUIN I inorganic paper bonded to polyester film.

CeQUIN IFI:
a three-ply composite of CeQUIN I paper bonded to both sides of a polyester film.

CeQUIN FIF:
a three-ply composite of polyester film bonded to both sides of CeQUIN I paper.

CeQUIN 30F:
a two-ply composite of CeQUIN 3000 inorganic paper bonded to polyester film.

CeQUIN 30F30:
a three-ply composite of CeQUIN 3000 paper bonded to both sides of a polyester film.

PHYSICAL CHARACTERISTICS

CeQUIN® paper/polyester film laminate insulations are designed to meet the high performance requirements of Class 220(R) coil winding applications, as well as wrapping for wire and cable applications rated 250°C and above.

CeQUIN inorganic papers provide the long-term thermal stability and dielectric strength required for continuous operations at temperatures up to 220°C. The polyester film provides added mechanical strength, improving the overall handleability of the CeQUIN paper, makes it easier to use in coil winding and wire wrapping processes.

Together the materials form a flexible laminate uniquely suited for high temperature electrical insulation applications.

Note the following advantages of using CeQUIN paper with polyester film laminates:

- CeQUIN/film laminates exhibit high tensile strength and excellent resistance to tear initiation for ease of handling in manufacturing operations.
- The high inorganic content of CeQUIN papers provides excellent long-term voltage endurance when compared to other high temperature insulation materials such as aramid papers.
- CeQUIN/film laminates are non-hygrosopic and exhibit low moisture absorption characteristics, thus reducing the need for extended drying cycles prior to varnishing or encapsulation.
- The high thermal conductivity of CeQUIN papers and film laminates promotes cooler running equipment, leading to longer insulation life, better reliability, and more efficient use of power.
- The lamination of polyester film to CeQUIN papers yields improved initial dielectric strength making it easier to proof test coils at high voltages prior to varnishing or encapsulation.

CeQUIN inorganic papers laminated to polyester film are available in a wide variety of standard constructions. Nonstandard combinations are available on special order to meet your specific requirements. No need to overdesign; choose the combination that is most cost effective for your application. See table 1 for typical product properties of some of the standard CeQUIN/film combinations.
Why use polyester film?
This is one of the most frequent questions we hear from equipment manufacturers. The answer is simple – the polyester film component is considered to be mechanical support for the CeQUIN paper, in essence, a processing aid to help you better utilize IPT's high performance papers. However, the explanation is quite complex when considering thermal, mechanical, electrical, and UL factors.

What are the thermal capabilities of polyester film?
The major concern of most people is the thermal capabilities of polyester film. It is true that polyester film is component rated as a 130°C material, and that it will shrink and embrittle when aged at high temperatures. The primary mode of this degradation is oxidation. However, lamination will help slow this process, as will a properly varnished or impregnated unit, and as the film slowly oxidizes, it breaks down into its constituent chemicals. These chemicals do not attack other components, such as the magnet wire coating or the varnish, nor does the film carbonize. This “friendly” degradation is one of the reasons that polyethylene terephthalate (PET) polyester film is so widely used in electrical insulation applications. Others are concerned that it will melt because it is “only a 130°C material.” The actual melting point of PET polyester film is over 240°C. Although it will begin to lose mechanical strength at high temperatures, polyester film can withstand short-term thermal excursions if protected from oxidation.

Won’t polyester film shrink and embrittle at high temperatures?
Shrinkage and embrittlement due to thermal aging can be addressed through equipment design. In a tightly wound unit, the CeQUIN/polyester film laminate will be held in place, greatly reducing shrinkage. Likewise, a tightly wound, well-varnished coil will significantly reduce mechanical stress and vibration that could affect the polyester film portion of the laminate as it ages.

How long have polyester film laminates been used?
From a historical perspective, inorganic papers laminated with polyester film have been used successfully for more than 30 years in Class 220(R) coil applications ranging from small H.I.D. ballast transformers to medium size dry-type distribution transformers. CeQUIN IF is used as a wire wrap in the manufacture of a 250°C rated appliance wiring material (UL Style 5288/CSA Class 1, Group A/B) for use in high temperature, severe environments. The acceptance of CeQUIN paper/polyester film laminates for use in these high performance applications speaks for itself.

Recommended Practices For Using CeQUIN Products
Optimum performance of an electrical insulation system is dependent upon many factors including proper choice of materials, acceptable design criteria, and good manufacturing procedures. CeQUIN’s resistance to moisture absorption can minimize drying time required prior to varnish impregnation or encapsulation. Varnishing is recommended for construction of equipment that may be exposed to the elements. CeQUIN papers are easily saturated and will tend to assume the aging characteristics of the resin or varnish that is used.

Table 1 - Typical Properties of CeQUIN/Film Laminates

<table>
<thead>
<tr>
<th>Laminate Construction</th>
<th>ASTM Test Method</th>
<th>IF</th>
<th>IFI</th>
<th>FIF</th>
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<th>30F30</th>
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<tbody>
<tr>
<td>mm Nominal Thickness</td>
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<td></td>
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<tr>
<td>mil</td>
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<td>7-1</td>
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<td>kg/m²</td>
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<td>lb/sq yd</td>
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<td>Strength kV</td>
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<td>13</td>
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<tr>
<td></td>
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<td>5.0</td>
<td>4.5</td>
<td>4.5</td>
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<tr>
<td>Moisture Absorption %</td>
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<td></td>
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<td>&lt;1</td>
<td>&lt;1</td>
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</table>

These are just a few of the CeQUIN/Film Laminates available from IPT. Please contact your local IPT Sales Representative for a complete listing or call IPT Headquarters in Tilton, New Hampshire.
CeQUINBORD® CGA
For Cost-Effective, High-Temperature Electrical Insulation Applications

DESCRIPTION
CeQUINBORD® CGA is a high inorganic content board composed primarily of glass fibers and microfibers, inorganic fillers, and less than 10% organic binders. It is capable of long-term performance at temperatures exceeding 250°C. CeQUINBORD CGA is available as trimmed 48" x 48" (1220 mm x 1220 mm) boards in thicknesses ranging from 1/32" (.79 mm) to 3/8" (9.5 mm).

PERFORMANCE CHARACTERISTICS
CeQUINBORD CGA is directly related to IPT’s CeQUIN I inorganic papers and exhibits many of the same high-performance capabilities of these products in semi-rigid board form. The high inorganic content of CGA boards provides exceptional thermal and dielectric stability for high temperature electrical insulation applications, along with good thermal conductivity to help dissipate heat build-up in electrical equipment. CGA boards are easily impregnated and fully compatible with standard varnishes and resins, and since they do not readily absorb moisture, they do not require extended drying time prior to saturation.

CeQUINBORD CGA is UL Recognized as suitable for use in electrical insulation systems rated from Class 130(B) through Class 220(R).

CeQUINBORD CGA is a UL Recognized Component with both 94V-0 and 94-5VA Flame Class Ratings. It can be used in applications requiring flame retardant materials or where maximum resistance to flame burn-through is required.

APPLICATIONS
High Temperature Electrical Insulation for:

- Dry-Type Transformer
  - Spacer Sticks
  - Core Tubes
  - Barrier Insulation
  - Pads
  - End Fill

- Traction Motors, Generators

- Switchgear

Flame Barrier insulation for:
- Home appliances (washers, dryers)
- Electronic devices (TVs, computers, microwave ovens)

- Heat Sinks
- Specialty Gaskets

Table 1 - Typical Product Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>ASTM Test Method</th>
<th>CeQUINBORD CGA</th>
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<tbody>
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<td>1.6 1/16</td>
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<td>2.4 3/32</td>
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<td></td>
<td>1.81 3.3</td>
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<tr>
<td></td>
<td></td>
<td>2.6 4.8</td>
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<td></td>
<td>3.52 6.5</td>
</tr>
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<td>5.18 9.5</td>
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<tr>
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<td></td>
<td>6.8 12.5</td>
</tr>
<tr>
<td>Tensile Strength, MD kN/m lb/inch</td>
<td>D-828</td>
<td>10 55</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14 80</td>
</tr>
<tr>
<td></td>
<td></td>
<td>23 130</td>
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<td></td>
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<td>33 190</td>
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<td>38 215</td>
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<td>42 240</td>
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<td>Elongation, MD %</td>
<td>D-828</td>
<td>&lt;2</td>
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<td></td>
<td></td>
<td>&lt;2</td>
</tr>
<tr>
<td>Dielectric Breakdown Strength kV</td>
<td>D-149</td>
<td>4.5 12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14 20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>24 28</td>
</tr>
<tr>
<td>Moisture Absorption %</td>
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</tr>
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<td></td>
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<tr>
<td></td>
<td></td>
<td>&lt;1</td>
</tr>
</tbody>
</table>
TufQUIN®
HIGH PERFORMANCE INORGANIC-BASED ELECTRICAL INSULATION PAPERS

TOUGH, FLEXIBLE, HIGH-TEMPERATURE PAPERS AND LAMINATES

The information contained below is applicable to all TufQUIN® papers and laminates. Please refer to individual product pages for information specific to each TufQUIN product.

DESCRIPTION
This family of innovative electrical insulation materials is the result of IPT’s continued investment in R&D to develop safe, cost-effective, high-performance products for the electrical/electronic industry.

TufQUIN products are a hybrid inorganic/organic paper based upon advanced manufacturing techniques. TufQUIN offers the high-temperature capabilities of inorganic materials combined with the high mechanical strength gained by the use of organic fiber. TufQUIN papers can be combined with polyester film to form a flexible laminate uniquely suited for high temperature electrical insulation applications.

PRODUCT FEATURES
• Physically tough
• Maintains dielectric strength under high humidity
• Cost effective
• Excellent stiffness
• High thermal conductivity
• UL® Systems Recognition through Class 200(N)
• CSA Component Acceptance: Temperature Class 200°C

APPLICATIONS
• Transformers, Coils, Reactors (layer, barrier and end-turn insulation for dry-type)
• Spiral- and Convolute-wound Tubing
• Motors and Generators (slot, phase and wedge insulation)
• Wire and Cable Wrap
• Switchgear Insulation
• Capacitor Layer Insulation
• Pressure Sensitive Tapes

UL RECOGNITION
TufQUIN products are a combination of inorganic and organic ingredients designed to optimize the thermal and mechanical properties required in today's demanding applications. TufQUIN products have undergone extensive thermal aging evaluation per UL 1446, “Standard for Systems of Insulating Materials – General,” and as a result are UL Recognized as suitable for use as major insulation in electrical insulation systems through Class 200(N).

Several UL Recognized Insulation Systems are listed under IPT File No. E65007 in the OBJS2 category for Class 130(B), Class 155(F), Class 180(H) and Class 200(N) applications and may be found on UL's Electrical Insulation Systems Database at http://data.ul.com/systems/. All systems listed on this database are available for use by any electrical apparatus manufacturer by contacting the nearest UL office. TufQUIN TFT laminate insulations utilizing at least the minimum total thickness of TufQUIN per UL System requirements are acceptable for use in these systems.
**TufQUIN® 110, 120**

**For High Performance Electrical Applications**

**TufQUIN® 110**

TufQUIN 110 is flexible, conformable paper exhibiting physical toughness in the form of high tensile strength and excellent tear resistance. TufQUIN 110 offers good dielectric characteristics and thermal conductivity in conjunction with high temperature performance.

**TufQUIN® 120**

Generically the same as TufQUIN 110, TufQUIN 120 employs a modified manufacturing process that yields thicker constructions while maintaining conformability.

**PHYSICAL CHARACTERISTICS**

TufQUIN 110 and 120 have a combination of tensile strength, tear resistance, stretch and stiffness that yields a tough but conformable sheet. Typical Product Properties are shown in Table 1. Note the following advantages:

- TufQUIN products offer improved tear resistance and toughness that make them suitable for use in more rigorous winding applications. TufQUIN is especially well suited for layer insulation in aluminum strip coils.

- TufQUIN retains a high percentage of its dielectric strength after extended thermal aging. See Graph 1.

- TufQUIN exhibits low moisture content and very little moisture absorption, especially when compared to aramid paper (see Table 2), thus reducing the need for extended drying cycles prior to varnishing.

- Good thermal conductivity allows more compact design, resulting in lower cost, cooler running units. See Graph 2. TufQUIN is easily impregnated with varnish, further enhancing thermal conductivity and coil bonding characteristics.

- TufQUIN 110 is available in thicknesses from 2 to 10 mil; TufQUIN 120 is available in thicknesses from 7.5 to 20 mil.

**RECOMMENDED PRACTICE FOR USING TufQUIN PRODUCTS**

Optimum performance of an electrical insulation system is dependent upon many factors including proper choice of materials, acceptable design criteria, and good manufacturing procedures. TufQUIN's composition provides for very good resistance to moisture absorption thereby minimizing the drying time required prior to varnish impregnation or encapsulation. Varnishing is recommended for construction of equipment that may be exposed to the elements.

Due to the organic content in TufQUIN 110 and 120, they are not recommended for use in applications above Class 200(N). TufQUIN 110 and 120 will undergo some shrinkage at elevated temperatures as noted in Graph 3. This shrinkage factor should be considered in designing end-use equipment. Varnishing will minimize the shrinkage characteristics of TufQUIN products.

---

### Table 1 - Typical Product Properties

<table>
<thead>
<tr>
<th>ASTM Test Method</th>
<th>TufQUIN 110</th>
<th>TufQUIN 120</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal Thickness</td>
<td>.05 .06 .08 .13 .25</td>
<td>.19 .30 .38 .51</td>
</tr>
<tr>
<td>Basis Weight</td>
<td>2 2.5 3 5 10</td>
<td>7.5 12 15 20</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>2.1 2.6 3.5 4.2 8.7</td>
<td>6.3 9.6 13 19</td>
</tr>
<tr>
<td>Elongation, MD</td>
<td>10 12 15 19 18</td>
<td>14 14 14 15</td>
</tr>
<tr>
<td>Dielectric Breakdown Strength</td>
<td>.4 .6 .7 .8 2.0</td>
<td>1.0 1.9 2.1 3.3</td>
</tr>
</tbody>
</table>

### TABLE 2. Moisture Absorption TufQUIN® vs. Aramid Paper

<table>
<thead>
<tr>
<th>Material</th>
<th>Moisture Absorption,1 %</th>
<th>Total Moisture Content, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>TufQUIN 110</td>
<td>1.0</td>
<td>1.5</td>
</tr>
<tr>
<td>Aramid Paper</td>
<td>2.2</td>
<td>6.3</td>
</tr>
</tbody>
</table>

1.005° samples preconditioned at 50% RH, 20°C; conditioned 24 hours at 95% RH, 20°C.
GRAPH 1
Effect of Thermal Aging on Dielectric Strength of TufQUIN® 110

GRAPH 2
Thermal Conductivity at 180°C per ASTM E1530

GRAPH 3
Total Shrinkage After Thermal Aging

GRAPH 4
Dielectric Constant vs. Frequency

5 mil TufQUIN 110 preconditioned 3 hours at 190°C; tested at 50% RH.
The polyester film middle ply provides an excellent dielectric barrier and adds stiffness and snapback characteristics to the composite. Together the two materials form a flexible laminate that is uniquely suited for high temperature electrical insulation applications. Note the following advantages of using TufQUIN TFT laminate insulation:

- TFT laminates exhibit excellent resistance to tear initiation and tear propagation in both the machine direction and across the machine direction. See graph 1.
- Good elongation characteristics let TFT laminates absorb the stress of heavy duty winding applications.
- The inorganic content in TufQUIN provides excellent resistance to hot cut-through in high temperature applications.
- The high thermal conductivity of TufQUIN/film laminates promotes cooler running equipment, leading to longer insulation life, better reliability, and more efficient use of power. See graphs 2 & 3.
- TFT laminates are non-hygroscopic and exhibit low moisture absorption characteristics, thus reducing the need for extended drying cycles prior to varnishing or encapsulation. See Table 2.

TufQUIN film laminates are available in a variety of standard constructions. Non-standard combinations are available on special order to meet your specific requirements. No need to over-design; choose the combination that is most cost effective for your application.
### APPLICATIONS
- Slot cell, phase and wedge insulation for motors and generators through Class 180(H)
- Layer and ground insulation for dry-type transformers
- End laminates
- Spiral wound tubes
- Wire & cable wrap
- Breaker panels
- Buss bar insulation
- Capacitor insulation
- Current carrying and wire devices
- DC field coil insulation

### Table 1 - Typical Product Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>TFT-3-3-3</th>
<th>TFT-3-5-5</th>
<th>TFT-3-7.5-5</th>
<th>TFT-3-14-3</th>
<th>TFT-5-3-5</th>
<th>TFT-5-5-5</th>
<th>TFT-5-10-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness mm/mil</td>
<td>.23</td>
<td>.28</td>
<td>.36</td>
<td>.51</td>
<td>.33</td>
<td>.38</td>
<td>.51</td>
</tr>
<tr>
<td>Basis Weight kg/m² lb/sq yd</td>
<td>.30</td>
<td>.37</td>
<td>.46</td>
<td>.68</td>
<td>.40</td>
<td>.47</td>
<td>.64</td>
</tr>
<tr>
<td>Tensile Strength, MD kN/m lb/inch</td>
<td>D-202</td>
<td>D-828</td>
<td>D-828</td>
<td>D-149</td>
<td>D-689</td>
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<tr>
<td>Elongation, MD %</td>
<td>18</td>
<td>23</td>
<td>30</td>
<td>47</td>
<td>18</td>
<td>23</td>
<td>39</td>
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<tr>
<td>Dielectric Breakdown Strength kV</td>
<td>10</td>
<td>14</td>
<td>16</td>
<td>20</td>
<td>10</td>
<td>14</td>
<td>22</td>
</tr>
<tr>
<td>Elmendorf Tear grams MD/CD</td>
<td>320</td>
<td>320</td>
<td>990</td>
<td>750</td>
<td>640</td>
<td>1100</td>
<td>1100</td>
</tr>
</tbody>
</table>

### Table 2. Moisture Content
TufQUIN® TFT vs. Aramid Materials

<table>
<thead>
<tr>
<th>Material</th>
<th>Moisture Content, %</th>
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<tbody>
<tr>
<td>TFT-5-5-5</td>
<td>0.8</td>
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<tr>
<td>NMN-5-5-5</td>
<td>1.8</td>
</tr>
<tr>
<td>Aramid Paper</td>
<td>4.1</td>
</tr>
</tbody>
</table>

.015" samples preconditioned at 50% RH, 20°C; dried 24 hours at 155°C
**GRAPH 1**
**Elmendorf Tear Strength**

<table>
<thead>
<tr>
<th>Material</th>
<th>1000 MD</th>
<th>2000 MD</th>
<th>3000 MD</th>
<th>4000 MD</th>
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</thead>
<tbody>
<tr>
<td>TFT-5-5-5 (15 mils)</td>
<td>1100 MD</td>
<td>915 MD</td>
<td>928 MD</td>
<td>890 MD</td>
</tr>
<tr>
<td>DMD100-5-5-5 (15 mils)</td>
<td>1504 CD</td>
<td>2715 CD</td>
<td>2175 CD</td>
<td>1660 CD</td>
</tr>
<tr>
<td>NMN-5-5-5 (15 mils)</td>
<td>1504 CD</td>
<td>2715 CD</td>
<td>2175 CD</td>
<td>1660 CD</td>
</tr>
<tr>
<td>Aramid Paper (15 mils)</td>
<td>1504 CD</td>
<td>2715 CD</td>
<td>2175 CD</td>
<td>1660 CD</td>
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</table>

**GRAPH 2**
**Comparison of Thermal Conductivity**

**GRAPH 3**
**Thermal Conductivity at 180°C**

<table>
<thead>
<tr>
<th>Material</th>
<th>Thermal Conductivity, w/m-K</th>
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<tr>
<td>TFT-5-5-5 (15 mils)</td>
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<tr>
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<td>Aramid Paper (15 mils)</td>
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</table>

**GRAPH 4**
**Moisture Content of Insulation Materials**

<table>
<thead>
<tr>
<th>Material</th>
<th>Moisture Content</th>
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<td>TFT-5-5-5 (15 mils)</td>
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<tr>
<td>NMN-5-5-5 (15 mils)</td>
<td>1.8</td>
</tr>
<tr>
<td>Aramid Paper (15 mils)</td>
<td>4.1</td>
</tr>
</tbody>
</table>
High-Performance Flexible Laminates

COST-EFFECTIVE, HIGH RELIABILITY MOTOR AND GENERATOR INSULATION

PRODUCT FEATURES
- Excellent dielectrics
- Physical toughness
- Good thermal conductivity
- Stiffness and snapback
- UL® Systems Recognition for Class 130(B), Class 155(F), Class 180(H)
- CSA Component Acceptance: Temperature Class 180°C

DESCRIPTION
IPT DMD180® composites are a family of three-ply laminates of non-woven polyester fiber mat bonded to both sides of polyester film, then over-coated with a high performance inorganic-filled resin system. This proprietary product is based on the technology developed at IPT for our TufQUIN® high temperature product line.

The result is a tough, formable motor insulation that will provide the high reliability found in our Class 180(H) materials at a price competitive with standard Class 155(F) materials. DMD180 laminates are designed to provide the same physical and handling characteristics that have made standard DMD laminates the material of choice in Class 155(F) motors and generators for over thirty years. Typical properties for standard combinations of DMD180 laminates are presented in Table 1.

APPLICATIONS
DMD180 laminate insulations are designed for use as slot cell, phase and wedge insulation for motors and generators.

DMD180 laminates offer exceptional value and performance. They allow electrical equipment manufacturers presently using standard DMD100 materials to upgrade to the high reliability of a Class 180(H) material without any subsequent cost penalties.

DMD180 laminates may be formed, cuffed or punched to meet the specific requirements of your electrical insulation application. They are also suitable for automatic insertion operations.

PHYSICAL CHARACTERISTICS
DMD180 flexible electrical insulation laminates are designed to provide high reliability in insulation systems rated through Class 180(H). The smooth, abrasion-resistant surface of DMD180 lends itself to automatic insertion operations, yet allows excellent bonding to standard dipping varnishes and encapsulating resins. DMD180 is a tough, tear-resistant, thermally stable insulation that is well suited to the rigorous demands of high-speed coil winding applications.

The center core of polyester film provides an excellent dielectric barrier, as well as adding stiffness and snapback characteristics to the composite. Note the following advantages of using DMD180 laminate insulation:
- DMD180 laminates exhibit excellent resistance to tear initiation and tear propagation in both the machine direction and across the machine direction. See Graph 1.
- Good tensile strength and elongation characteristics allow DMD180 laminates to absorb the stress incurred in heavy-duty winding applications.
- The inorganic content in DMD180 overcoating provides resistance to hot cut-through in high stress areas.
- The high thermal conductivity of DMD180 promotes cooler running equipment, leading to longer insulation life, better reliability, and more efficient use of power. See graph 2.

DMD180 laminates are non-hygroscopic and exhibit low moisture absorption, thus reducing the need for extended drying cycles prior to varnishing or encapsulation. See Graph 3.

DMD180 laminates are available in a variety of standard constructions. Non-standard combinations are available on special order to meet your specific requirements. No need to over-design; choose the combination that is most cost effective for your application.
UL RECOGNITION
DMD180 laminates have undergone extensive thermal aging evaluation per ANSI/UL 1446, “Standard for Systems of Insulating Materials – General,” and as a result are UL Recognized for use as major insulation in electrical insulation systems designated QT-130PLUS and QT-155PLUS as listed under IPT File No. E65007 and may be found on UL’s Electrical Insulation Systems Database at http://data.ul.com/systems/. All systems listed on this database are available for use by any electrical apparatus manufacturer by contacting the nearest UL office.

To demonstrate the high reliability capabilities of DMD180, these laminates were also evaluated as the major insulation component of a Class 180(H) electrical insulation system per ANSI/UL 1446. Motorettes were constructed utilizing DMD180 laminates as one of the major components and were then thermally aged at three different temperatures – 200°C, 220°C, 240°C – to evaluate their life expectancy under accelerated conditioning. As a result of this testing, DMD180 laminates are recognized for use as a major insulation component in the Class 180(H) insulation system designated QT-180PLUS.

Thus, you may be rest assured that DMD180 will give you that extra measure of performance and reliability available from a recognized Class 180(H) components when used in your motor and generator insulation applications.

ADDITIONAL INFORMATION
The DMD180 constructions listed in Table 1 are typical thickness combinations. Additional combinations may also be produced for your specific insulating requirements. IPT has an active R&D staff eager to develop custom-made products for unique customer requirements. Please contact your IPT Sales Representative for further information or call IPT Headquarters in Tilton, New Hampshire.

APPLICATIONS
• Slot Cell, Phase and Wedge Insulation for Motors and Generators
• End Laminates
• Spiral Wound Tubes
• Wire & Cable Wrap
• Breaker Panels
• Buss Bar Insulation
• Capacitor Insulation
• Current Carrying and Wire Devices
• DC Field Coil Insulation

GRAPH 1
Elmendorf Tear Strength

<table>
<thead>
<tr>
<th>Construction</th>
<th>MD</th>
<th>CD</th>
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</thead>
<tbody>
<tr>
<td>DMD180 5-5-5</td>
<td>1080</td>
<td>2780</td>
</tr>
<tr>
<td>DMD100 5-5-5</td>
<td>915</td>
<td>2715</td>
</tr>
<tr>
<td>NMN 5-5-5</td>
<td>928</td>
<td>1504</td>
</tr>
</tbody>
</table>

200(N) 180(H) 155(F) 130(B) 95(A)
Table 1 - Typical Product Properties

<table>
<thead>
<tr>
<th>ASTM Test Method</th>
<th>3-3-3</th>
<th>3-5-3</th>
<th>3-7.5-3</th>
<th>3-14-3</th>
<th>5-3-5</th>
<th>5-5-5</th>
<th>5-10-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness mm/ mil</td>
<td>.23</td>
<td>.28</td>
<td>.36</td>
<td>.51</td>
<td>.33</td>
<td>.38</td>
<td>.51</td>
</tr>
<tr>
<td>Basis Weight kg/m²/lb/sq yd</td>
<td>D-202</td>
<td>.27</td>
<td>.34</td>
<td>.42</td>
<td>.66</td>
<td>.37</td>
<td>.44</td>
</tr>
<tr>
<td>Tensile Strength, MD kN/m/lb/inch</td>
<td>D-828</td>
<td>18.6</td>
<td>26.3</td>
<td>29.6</td>
<td>42.0</td>
<td>20.5</td>
<td>25.0</td>
</tr>
<tr>
<td>Elongation, MD %</td>
<td>D-828</td>
<td>42</td>
<td>40</td>
<td>40</td>
<td>38</td>
<td>36</td>
<td>36</td>
</tr>
<tr>
<td>Dielectric Breakdown Strength kV</td>
<td>D-149</td>
<td>8.5</td>
<td>11.0</td>
<td>15.0</td>
<td>20.5</td>
<td>8.8</td>
<td>11.5</td>
</tr>
<tr>
<td>Elmendorf Tear grams MD</td>
<td>D-689</td>
<td>455</td>
<td>470</td>
<td>490</td>
<td>1060</td>
<td>570</td>
<td>1080</td>
</tr>
</tbody>
</table>

GRAPH 2 – Thermal Conductivity of Insulation Materials

GRAPH 3 Moisture Content
ENVIRONMENTAL SAFETY AND HEALTH

IPT products meet all current OSHA requirements for health and safety with normal handling and good work practices. IPT papers, boards and laminates fall within the Threshold Limit Values for Chemical Substances in the Work Environment as specified by the American Conference on Governmental Industrial Hygienists. Notwithstanding this, it is incumbent upon the customer to use suitable work practices, good housekeeping and proper industrial hygiene. If necessary, protective clothing, safety glasses, face masks and a dust collection system should be used in order to provide a safe work environment. It is a prudent practice to reduce the workers’ exposure to any respirable material to the lowest practical level.

For all IPT products Material Safety Data Sheets are available upon request.

The particulates and fibers in IPT products are encapsulated in saturants and binders. This minimizes the amount of airborne dust generated during handling and fabrication. Any dust which is generated contains a small amount of glass fiber which sometimes will cause itchiness or a mild case of dermatitis in some individuals. This discomfort is usually temporary. Most workers become acclimated after several days of working with the material.

All waste should be disposed of in accordance with local landfill requirements.
QUALITY

IPT has an unwavering commitment to quality. More than 20% of the annual operating budget is devoted to installing new equipment and refining processes to produce better quality products more efficiently.

Woven throughout the process of design, manufacturing and marketing is a common thread … quality.

The quality system at IPT is certified to be in accordance with ISO 9001 requirements. In addition, IPT is continually monitoring and improving its quality system to meet or exceed customer requirements.

IPT products meet many national and international performance standards. They are also recognized for use in numerous electrical insulation systems.

Your call and your challenge are both welcome at IPT. Among the standards met by IPT products are those of:

- IEC
- UL
- IEEE
- ANSI
- ASTM
- MIL SPEC
- NEMA

ISO 9001 REGISTERED FIRM

Your call and your challenge are both welcome at IPT.

PRODUCT WARRANTY

IPT products are warranted free from defects in workmanship and in material. THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

The sole and exclusive remedy against IPT for breach of its limited product warranty shall be, at the option of IPT, either refund of the invoice value of defective products, or repair or replacement F.O.B its plant or other shipping point.

IN NO EVENT SHALL IPT BE LIABLE TO ANY BUYER OR ANY THIRD PARTY FOR ANY SPECIAL, INCIDENTAL, AND/OR CONSEQUENTIAL DAMAGES.

IPT assumes no obligation of liability for any advice furnished by it or results obtained with respect to these products. All such advice is given and accepted at the buyer’s risk. It is subject to revision as additional knowledge and experience are gained.

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