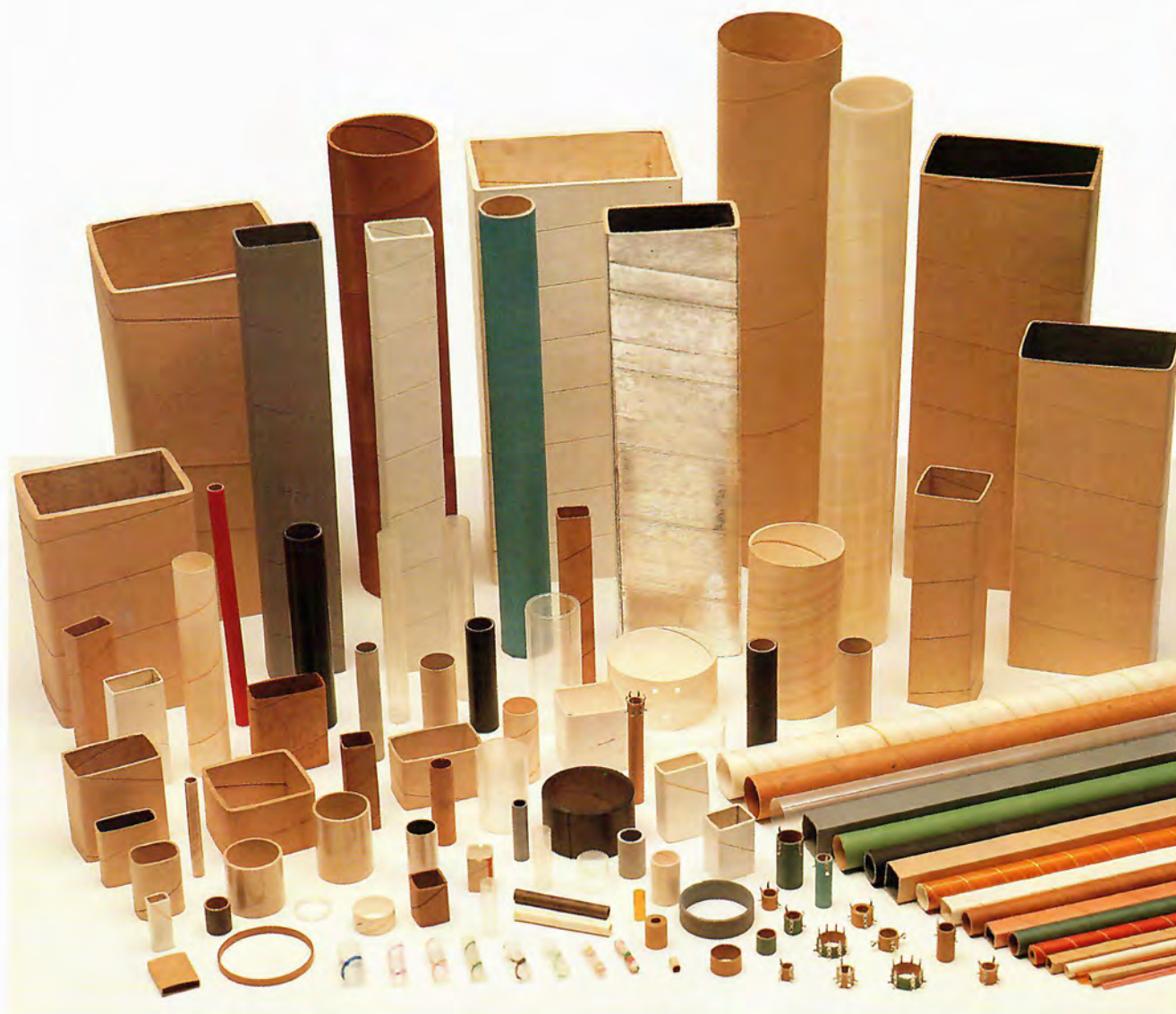




Dielectric Insulating Tubing



Precision Paper Tube Company



Precision Paper Tube Company began production of tubing for the electrical and electronic industries in 1934 and remains the preeminent producer of these types of products. Over 100,000 square feet in the main manufacturing plant are devoted to the produc-

tion of insulating parts, principally spiral wound tubing and bobbins. Specially constructed, modern, high speed equipment at Precision provides quality parts at low cost. Quality control at Precision is an integral part of the processing procedures.



Custom Fabrication

All products manufactured by Precision are custom produced to the customer's specifications. Precision has the in-depth experience and the equipment to fabricate insulating tubing in a variety of shapes and forms. Thousands of arbors are available in a wide range of sizes, and specific sizes can be made at min-

imum cost. Tubing can be punched, notched, slit, cut, rolled, crimped, flared and shaped on Precision's automatic machinery. Terminals can be added in a variety of types either on the form itself or on separate collars.

Dielectric Kraft & Vulcanized Fiber

Dielectric Kraft

General Description: Tubing is made from medium density, neutral, natural, high quality, electrical grade papers that have been specifically produced for tube winding. Chemical properties, thickness and densities are closely controlled for Precision at the mill. Adhesive used is neutral and free from electrolytic corrosive action.

Advantages: The lowest cost electrical insulating material available for spiral wound tubing. Preferred for uses where low cost, good mechanical and dielectric strength are desired, and some moisture absorption can be tolerated. Material cost is used as comparison with other materials.

Minimum Wall Thickness: .006"

Suggested Uses: Coil forms, transformers, capacitor covers, pilot light shields, relays, solenoids, protecting covers, motor shaft spacers, ignition coils, fuses.

Material Properties*

Dielectric strength— VPM min.	165
AIEE Temperature Class - °C.	90(0)
Chlorides - %	.005
Ash - %	.481
Specific Gravity	.77

* As provided by mill. Based on 10 mil sheet.



Vulcanized Fiber

General Description: Vulcanized fiber (fish paper) tubing is produced from a cotton rag base paper. This is a dense material of partially regenerated cellulose in which the fibre structure is retained. Tubing has a blue-grey color.

Advantages: Vulcanized fiber has a tensile strength 80 times that of kraft. Its high strength is very useful for mechanical applications such as winding heavy wire or wire under tension. It has good arc quenching ability as well as excellent abrasion resistance. It is a tough, stiff material.

Minimum Wall Thickness: .010"

Suggested Uses: Battery covers, grommets, solenoids, capacitor covers, pilot light shields, protecting covers, motor shaft spacers, ignition coils, DC coils, relays, fuses.

Material Properties*

Dielectric Strength - VPM min.	300
AIEE Temperature class - °C.	105 (A)
Tensile Strength - min. PSI lengthwise	8000
Specific Gravity	1.15

* As provided by mill - based on 10 mil sheet.



"Thinwall" Phenolic Tubing

"Thinwall"

Pre-Impregnated Phenolic Tubing

General Description: "Thinwall" tubing is produced from a dielectric kraft paper that has been pre-impregnated with a special phenolic resin and cured to the Class B stage. After forming, tubes are baked to complete the resin cure. In this process, the phenolic and the special adhesive coalesce to form a complete homogenous product. (For round phenolic resin impregnated tubing, see "Resinite").

Advantages: This patented[†] tubing was developed to provide many of the desired properties of round Resinite phenolic impregnated tubing in both square and rectangular shapes. It has excellent mechanical strength as well as good electrical properties. Strength for strength, "Thinwall" can provide a much thinner wall than kraft, and will hold its shape better than kraft; particularly under humid conditions. The extra strength and thinner walls allow a wire saving up to 10%. It is excellent for fabrication purposes. It is available as a 100% phenolic material or can be combined with dielectric kraft for special properties and lower cost.

Minimum Wall Thickness: .010" (Combination Construction)
.015" (P-100 Construction)

Suggested Uses: Coil forms, collars, spacers, terminal rings and tubes, motor-switch hardware, high strength, corrosion resistant tubing for mechanical applications, fuse parts, shafts.

Material Properties*

Dielectric strength-VPM min. 165
Temperature Class - °C 90(0) to 105(A)
Specific Gravity85

*Based on 10 mil sheet, as provided by mill before forming.

[†]Patent No. 3,314,133.



Thinwall - Kraft Constructions

P-100: 100% phenolic impregnated material in square or rectangular forms. No kraft is used. Strength is maximum and is approx. 40% stronger than kraft. P-100 offers minimum cutting burrs. For relatively large coils where rigidity is required. Pieces may break off in lead picking if care is not exercised.

P-60: 60% phenolic - 40% kraft buried. Offers minimum cutting burrs. Tubing made with this construction is approx. 30% stronger than kraft. With the addition of the buried kraft, it will not shatter. Best general purpose "Thinwall" tubing.

PL-60: 60% phenolic lined - 40% kraft overwrap. Same strength as P-60. Phenolic lining aids in insertion of laminations. Kraft overwrap provides easier lead picking.

PO-60: 60% Phenolic on outside - 40% kraft lining. Choice of PO-60 or PL-60 depends on whether minimum cutting burrs are required on outside or inside of tube wall.

PB-60: 60% phenolic buried within 40% kraft. Kraft acts like a protective covering. This construction has some cutting burrs but less than kraft alone.

P-30: 30% phenolic - 70% kraft buried. Lowest cost construction that still retains increased strength over kraft alone. Approx. 20% stronger than kraft. Helps prevent twisting. Still provides minimum burrs with phenolic on outside.

PL-30: 30% phenolic lined - 70% kraft overwrap. Same strength as P-30. Phenolic lining aids in insertion of laminations.

PO-30: 30% phenolic on outside - 70% kraft lining. Choice of PO-30 or PL-30 depends on whether minimum cutting burrs are required on outside or inside of tube wall.

PB-30: 30% phenolic buried within 70% kraft. Basically, a kraft tube but with higher strength and less tendency to twist. "Thinwall" is a registered trademark of Precision Paper Tube Co.

"Resinite" Phenolic Impregnated Tubing

General Description: "Resinite" tubing is wound from neutral, natural, electrical grade kraft paper which is then vacuum impregnated with high quality, electrical grade, phenolic resins. After impregnation, the tubing is baked at 300°F. in order to cure the resin and to form an homogeneous product that has its own, special, high quality characteristics for electrical and mechanical applications. Resinite tubing may be centerless ground to close tolerances and is again resin coated for a complete seal. It is available in round forms only.

Advantages: Resinite tubing presents a unique combination of low cost coupled with high mechanical strength and good dielectric properties. It will support lugs and terminals and can be fabricated by punching, slitting, milling, cutting and turning. Its heat resistance is such that it will readily accept dip or hand soldering of terminals. Resinite tubing may be embossed to accept threaded iron cores.

Minimum Wall Thickness: .006"

Suggested Uses: Collars, Insulators, Fuse Parts, Spacers, Protecting Covers, Terminal Rings, Motor Spacers, Mechanical Cores, IF & RF Coil Forms, Flyback Transformers, Electrical Transformers, Shafts & Tuning Rods.

Resinite Tubing Properties:

RG-8108: A formulation that is intended primarily for mechanical applications where higher phenolic content is not required.

Dielectric Strength— VPM 210
 Temperature Classification - °C 90 (0)
 Moisture Absorption (72hrs., 100%hum., 105°F) 12%
 Coefficient of Thermal Expansion— parts/°C 1.3×10^{-5}

RB-8111: The standard grade "Resinite" tubing that is used for most electrical applications. It has high strength and extremely favorable electrical qualities.

Dielectric Strength— VPM 260
 Temperature Classification - °C 105 (A)
 Volume Resistivity-ohms/cm. (.013"wall,.280"OD) .. 1.2×10^{12}
 Dielectric Constant (@ 1MHz) 3.32
 Moisture Absorption (72hrs., 100%hum., 105°F) 2.86%
 Coefficient of Thermal Expansion—part/°C 1.02×10^{-5}

RS-8717: A superior grade of tubing that provides extremely high strength with the best stability over a wide temperature range. Best grade for machining.

Dielectric Strength— VPM 290
 Temperature Classification - °C 105 (A)
 Volume Resistivity-ohms/cm. (.013"wall,.280"OD) .. 1.2×10^{12}
 Dielectric Constant (@ 1MHz) 3.32
 Moisture Absorption (72hrs., 100%hum., 105°F) 2.10%
 Coefficient of Thermal Expansion—part/°C 1.01×10^{-5}



Flame Retardant Resinite & Nomex®

Flame Retardant Resinite

General Description: Resinite FR9120 and FR9120-1 are spiral wound, neutral, natural, dielectric kraft tubing that has been impregnated with special, flame retardant resins. FR9120 is the standard grade tubing for basic coil winding and bobbin use and FR9120-1 is the fabricating grade where further fabrication is required, such as punching, notching, threading, lugging or slitting.

Advantages: For the first time, a low cost, moisture resistant, paper base tubing for electrical and electronic uses in flame retardant applications. This tubing has all the attributes of well know Resinite tubing but in a flame retardant grade.

Minimum Wall Thickness: .015"

Suggested Uses: Applications that must meet flame retardant specifications in electrical and electronic devices; particularly those that require the mechanical qualities of Resinite such as transformers and coil forms, switch covers, pilot light shields, etc.

Material Properties:	FR9120	FR9120-1
Dielectric strength— VPM	250	250
Temperature Class - °C.	105(A)	105(A)
Volume Resistivity (Ohms/cm.)	1.1×10^{12}	1.5×10^{12}
Dielectric Constant (@ 1 MHz)	2.62	2.73
Moisture Abs.(72hrs.@ 100%hu.) ..	2.91%	3.12%
Color (Surface)	Blue/Green	Brown/Black



Nomex†

General Description: "Nomex" is a polyamide paper that has superior high temperature and high dielectric qualities. It also has excellent chemical stability and resistance to deformation. Tubing is available in round, square and rectangular forms and can be punched, lugged and slit.

Advantages: "Nomex" is recognized for its excellent electrical, thermal and mechanical properties. Precision has developed a method of fabricating this tubing using a compatible binder that provides a laminated, thermally stable, Class "H" insulating tubing that can be used in flame retardant applications.

Minimum Wall Thickness: .005" (round), .010" (rect.)

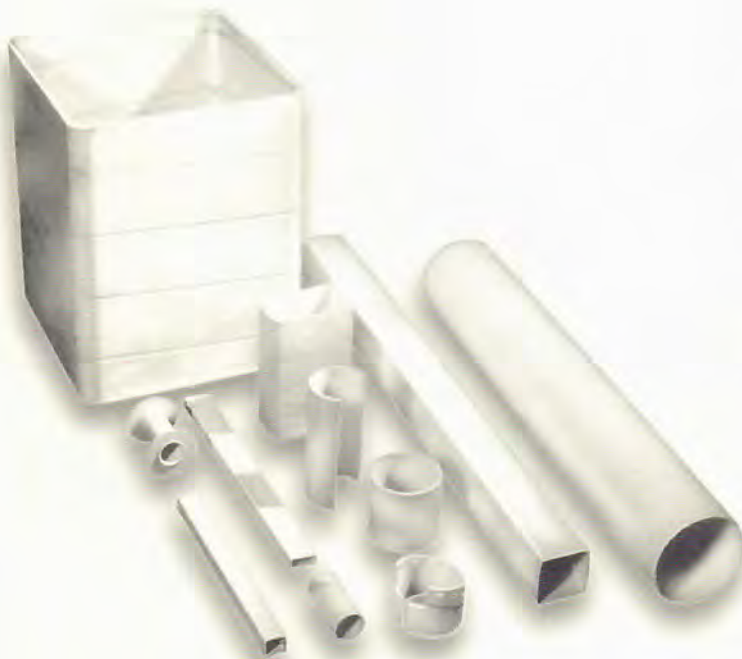
Suggested Uses: Transformer forms and collar supports; voltage regulator transformers; primary coil forms; as bobbins in high temperature, continuous run motors; motor shaft insulators and spacers for industrial type, heavy duty tools; high temperature potting cases; heat insulators and shields; flame proofing applications.

Material Properties*

Dielectric strength. — VPM min. (50% hum.)	720
High Temperature Range -°C	220
Volume Resistivity - Ohm/Cm. (@25°C.)	10^{16}
Dielectric Constant (@10 ³ Hz)	2.9
Specific Gravity	.91

†DuPont Reg. Trademark *As supplied by producer.

Thermoform -700, which is Precision's material designation for tubing made of Nomex.



Kapton†

General Description: "Kapton" polyimide film is an extremely strong, transparent (amber) film that retains its high dielectric strength over a very wide range of temperatures. It remains flexible at liquid helium temperature (-269°C) and does not lose its strength until it reaches a temperature of +815°C. The tubing properties shown below are in a lower range as the sealing agent used to produce Kapton tubing limits its high temperature usage.

Advantages: Tubing made of "Kapton" offer a rare combination of a high dielectric strength within an extreme temperature range. "Kapton" is flame resistant and begins to char only above 800°C. It does not melt and is self-extinguishing. It has excellent mechanical properties and is practically unaffected by moisture. There is no known organic solvent for "Kapton".

Wall Thickness: .003" to .010" Tubing ID: .090" to 1.5"

Suggested Uses: Coil forms, capacitor and resistor covers, spacers, bobbins, slip-on wire insulation.

Material Properties:*

Temperature Range - °C	-269 to +400
Dielectric Strength - VPM (@ 25°C.)	7,000
Volume Resistivity - ohm/cm. (@ 200°C.)	1.0×10^{16}
Moisture Absorption (@ 23.5°C., 50% RH)	1.3%
Flammability	Self-Extinguishing

† DuPont Registered Trademark *As provided by supplier.



Mylar® & Heat Shrinkable Mylar®

Mylar†

General Description: "Mylar" polyester film is an exceptionally strong, durable, transparent film with high tensile, tear and impact strength. It is moisture and vapor resistant and is unaffected by, and does not transmit, oils, greases and volatile aromatics. It not only retains these properties but remains tough and voltage stable from -80°F. to over 300°F.

Advantages: "Mylar" has one of the highest dielectric strengths available in a tube form. Even at its top rated service temperature of 150°C., its dielectric strength is still 5,000 VPM. It is also completely inert to water and therefore offers excellent dimensional stability with no reduction in dielectric strength that may be caused by moisture absorption in other materials.

Minimum Wall Thickness: .003"

Suggested Uses: Coil forms, capacitor covers, spacers, electrical insulators; all applications where superior moisture resistance and dielectric strength are desired.

Material Properties*

Dielectric Strength - VPM (@25°C., 60 cycles) 7,000
Temperature Range - °C. -60 to +150
Moisture Absorption - % 0.8
Fungus Resistance Inert
Specific Gravity 1.39

*As provided by producer. Based on a 1 mil sheet.

†DuPont Registered trademark



Heat Shrinkable Mylar†

General Description: A superior, high dielectric insulating tubing that is shrinkable as much as 50% in order to provide an immovable, tight fit. Temperature requirements are approximately 90°C. for shrinking purposes with a heat cycle as short as 1 second. May be shrunk by various methods such as heat guns, boiling water, electrical coil heaters or in ovens.

Advantages: Heat shrinkable "Mylar" tubing has a dielectric strength far exceeding other shrinkable materials. It is extremely tough and forms an excellent mechanical barrier. It can be used at both low and high temperatures. It is moisture & vapor resistant and is unaffected by oils, greases and volatile aromatics.

Minimum Wall Thickness: .002"

Suggested Uses: Capacitor covers, RF & IF coil insulation, varnish masking, roller covers, lead binding & holding, battery covers, color coding, insulation between coils, sleeving insulation over wire leads, protective coverings.

Material Properties*

Dielectric Strength - VPM min. 3,000
Service Temperature Range - °C. -60 to +150
Melting Point - °C above 245
Dielectric Constant 3.5 to 3.9

*As provided by producer. Based on 65 gauge film.

†DuPont Registered Trademark



Combining Tubing Materials



Many of the materials listed in this catalog may be combined to provide a tube with specific requirements not available in a single material. Some of the more useful combinations and their suggested applications are shown below. We will be glad to work with you in developing a combination for your particular use.

Mylar—Kraft The high dielectric strength of Mylar is combined with the low cost and mechanical strength of kraft.

Fish Lined—Kraft The higher strength and good abrasion resistance of vulcanized fiber (fish paper) along with the filling ability of kraft, provides an excellent core where metal laminations are inserted into the inside of the tube.

Resinite—Mylar A Mylar lined Resinite tube that is threaded by embossing, provides a smooth surface for iron cores. Due to the low coefficient of friction the core will not bind. Resinite provides an excellent low cost tubing of high mechanical strength. Mylar can also be buried in a Resinite tube.

Nomex—Kraft The high temperature properties of Nomex are combined with the mechanical strength of dielectric kraft.

Nomex—Resinite For even higher mechanical strength, Nomex is combined with Resinite phenolic impregnated tubing. And for a completely flame retardant tube, Nomex can be combined with FR-9120 Resinite. In most cases, the Nomex is wound on the outside of the tube.



Convolute Laminated Tubes, Rods & Spacers



Convolute Tubing Grades

NEMA Grade	Application Requirements	Color	Base Material
X	Good electrical properties in both dry and humid conditions. Fair machining qualities.	Natural, Black	Paper
XX	Suitable for most electrical applications. Good machinability. Better moisture resistance than Grade X.	Natural, Black	Paper
XXX	Good electrical characteristics under humid conditions. Good machinability.	Natural	Paper
C	Good physical and machining properties. Fair electrical properties.	Natural	Cotton Cloth
CE	Good structural strength. Excellent machinability.	Natural	Cotton Cloth
L	Excellent machinability.	Natural	Cotton Cloth
LE	Low moisture absorbtion. Excellent machinability. Good acid resistance.	Natural	Cotton Cloth

For special applications requiring an extremely fine surface finish, or which call for an especially strong tube, rod or spacer, Precision can furnish convolute wound tubing in a variety of materials.

Laminated tubing is made of thermosetting resins combined with various base materials such as dielectric paper or cotton cloth. The tubing is convolutely (using the entire width of the sheet) wound under high pressure and heat. The resulting product is a dense homogeneous material that can be machined, polished, painted and printed on.

Laminated tubing is easy to saw, drill, tap, thread and punch with ordinary tools. The materials have excellent electrical insulating properties.

Currently, laminated tubing is available in maximum lengths from 36" to 48" depending on the grade. They can also be furnished cut to specified length. Diameters range from 3/32" to 6" ID with wall thickness from .010" to 1.00" depending on the diameter of the tube. Larger sizes can be furnished on request.

Finishes include ground, polished, painted or lacquered. Tolerances are to NEMA standards. For special tolerances, please give us a call.

Laminated Rods are also available in convolute wound, laminated materials. The resulting product is a dense homogeneous material which is milled to exacting diameters from 1/16" to 4" (metric diameters are also available). Lengths are produced to your specifications.

Laminated rods are lighter, more economical and, in many applications, stronger than metal. They are produced from insulating materials and are corrosion and moisture resistant. They, too, may be sawed, drilled, tapped, punched, and threaded with ordinary tools.

Laminated spacers and threaded standoffs can also be produced from convolute wound insulating materials. Their insulating properties, resistance to extreme temperatures and light weight make them particularly desirable for use in electronic and electrical equipment. They also provide excellent resistance to compression, impact, vibration, corrosion and moisture. The materials may also be machined with ordinary tools.

If you have a need for convolute wound, laminated tubing, rods or spacers, please give us a call or FAX us your drawings and specifications. We'll be glad to furnish information and prices.



Material Considerations and Comparisons

The tables on the right give you a comparison of the three major factors in determining the right material to use: dielectric strength, temperature resistance, and cost. Usually the more resistant the first two the higher the cost. But sometimes a good, lower cost substitute can be found.

Cost a problem? Maybe Dielectric Kraft can be substituted for a more expensive product or perhaps tubing made of "Resinite" will solve the problem while giving you a mechanically stronger product.

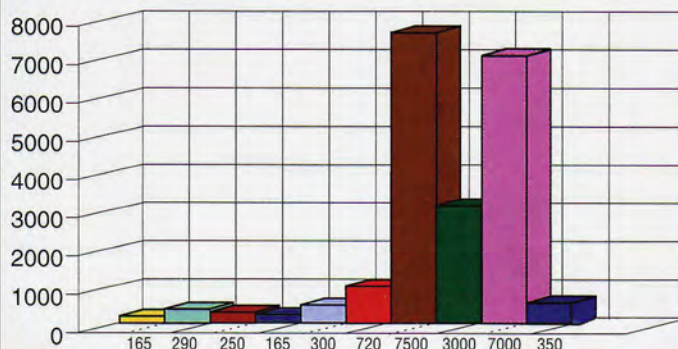
Speaking of strength, Vulcanized Fiber (fish paper) has a tensile strength some 80 times that of kraft and yet is still quite cost effective.

If your product must conform to flame retardant specifications then either Flame Retardant Resinite or "Nomex" can do the job. FR Resinite is about half the cost of "Nomex" but sometimes the job requires the extremely high dielectric strength and temperature classification of the latter product. Again, we can be a good guide in helping you determine the best way to go.

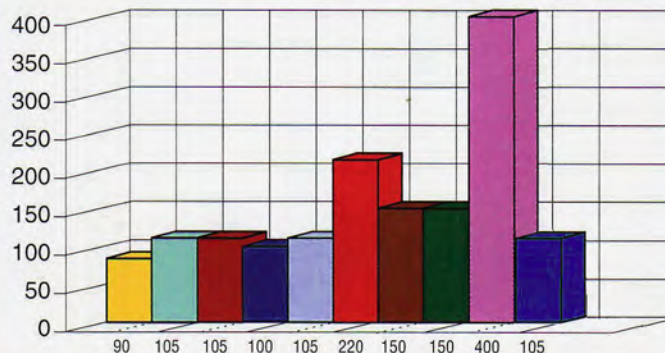
We are only too glad to work with you and to supply samples for your inspection and testing.

Note: The materials and specifications in this catalog are published only as a helpful suggestion in your own experimentation. The information is not intended to be used as design data. Our engineering departments will be glad to work with you on individual problems.

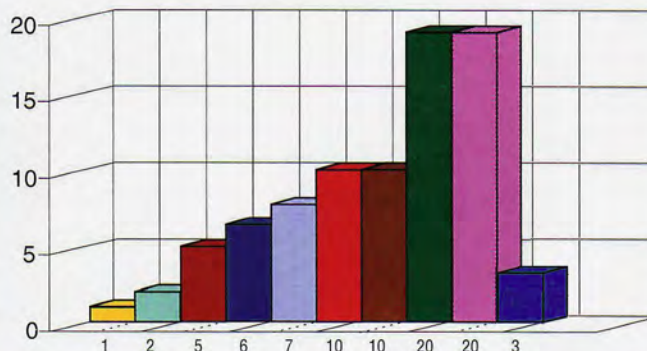
Dielectric Strength VPM



Temperature Deg. C.



Basic Cost Comparison



Material Key

■ Kraft	■ Resinite	■ FR Resinite	■ Thinwall
■ Vulcanized Fiber	■ Nomex	■ Mylar	■ HS Mylar
■ Kapton	■ Convolute		