

DuPont™ Nomex® Pressboard

Introductory Data Sheet

Wherever there's a need for electrical insulation, there's usually a DuPont™ Nomex® brand product to fill it. In its various forms, Nomex® products have the right balance of properties for use in transformers, motors, generators and other electrical equipment. Flexible papers are available up to 30 mils (0.8 mm) in thickness. Beyond this thickness, products are available in board form. The increased thickness and rigidity of Nomex® brand pressboard sets it apart from the other forms of Nomex®.

Like Nomex® paper, however, it has a high level of electrical, chemical and mechanical integrity, which is derived from the Nomex® polymer itself.

Nomex® pressboard is comprised of multiple layers of Nomex® floc and fibrils pressed together in board form. The result is a rigid, yet resilient material with excellent thermal stability and dielectric strength. No other material provides the outstanding thermal and electrical properties with the design flexibility that you can get with Nomex® pressboard. It can be used for a range of applications, such as spacers and barriers in both liquid-filled and dry-type transformers, and as end-laminations in motors.

Enhanced Properties of Nomex® Pressboard

The electrical and mechanical properties of Nomex® pressboard generally exceed those of most existing boards, including cellulose and many advanced composite laminates used today. Nomex® pressboard also retains these excellent properties over extended periods of time and under extreme temperatures.

In transformers, the premium mechanical properties of Nomex® ensure tight windings and hence produce coils capable of withstanding short circuit, overloads and vibrations after many years of service. The mechanical toughness of Nomex® pressboard also reduces shop failures and repairs.

Of particular importance in liquid-immersed transformers, Nomex® pressboard and paper do not give off any breakdown products until exposed to temperatures of 350° C or higher. This is a major advantage, considering that water given off by cellulose when exposed to temperatures slightly above normal operating conditions is believed to be the main cause for the rapid deterioration of the cellulose-oil insulation system under those conditions.

As with most types of Nomex® papers, Underwriters Laboratories (UL) have also rated all types of Nomex® pressboard for 10 years of continuous use at 220° C in dry-type applications. Additionally, UL has designated Nomex® pressboard with a UL 94 V-0 rating (equivalent to an FV0 rating according to IEC 60695-11-20), the highest attainable "flame-resistance" rating in this norm.

Due to the relatively low moisture absorption of Nomex® pressboard, the use of Nomex® in liquid-immersed transformers has significantly reduced dry-out time prior to oil impregnation in several cases.

Applications and Benefits of Nomex® Pressboard

With the availability of Nomex® pressboard, it becomes possible to fabricate parts that were not possible with Nomex® paper products, such as: radial and axial spacers, spacer sticks, barriers, core tubes and end laminations. Details regarding parts fabrication are reviewed later in this data sheet.

Nomex® Pressboard in Liquid-Immersed Transformers

Once Nomex® pressboard was introduced to the electrical industry, it was only a matter of time before it found its way into liquid-immersed transformers. Today, Nomex® pressboard is used in small pole-mounted liquid-immersed transformers, traction transformers and even in medium-power to large-power (up to 300 MVA) transformers.

Recent experience in liquid-immersed transformers has shown that use of Nomex® brand pressboard for spacers and barriers, and Nomex® paper as conductor insulation can enable up to a 25% reduction in weight for a given kVA output. This weight reduction allows mobile substations and railway traction transformers, for example, to be designed with operating capabilities larger than before. More compactly designed transformers are revolutionizing the wind-generator marketplace in a similar manner.

Alternately, the use of Nomex® pressboard and paper in liquid-immersed transformers allows for up to 50% higher kVA rating for a given size and weight at some increase in load losses. This feature enables capacity expansion in areas where transformer weight or size has been predetermined, such as pole-top transformers (pole weight limit) or mobile substations (on-the-road load restrictions).

In the latter case, the adoption of Nomex® pressboard and paper has allowed for these units to be designed with operating capabilities larger than ever before. The use of high-temperature liquids, such as silicone or ester, permits even greater savings in size and weight.

The outstanding thermal rating of Nomex® pressboard and paper means the aging of these two materials is essentially nonexistent, even with conductor temperature rises 30° C higher than normal practice. Operation at higher temperatures without loss of life provides a dual functioning capability for a transformer enhanced with Nomex®. The unit can be sized closer to the load requirements and still handle emergency situations without deterioration of the insulation. This emergency capability can reduce the cost associated with redundancy planning. The higher temperature capability also enables more freedom during substation planning for future expansion.

Insulation systems which use primarily high-temperature materials, such as Nomex® paper and pressboard, are typically referred to as High-Temperature Insulation Systems. These systems are normally used with high-temperature liquids, where extreme thermal stresses are required in the designs. In order to build transformers that broadly utilize available materials, Nomex® paper and pressboard have been increasingly used in combination with conventional insulation, in so-called hybrid systems or mixed hybrid systems. A full definition of these systems is available in IEEE Std. C57.154-2012 or IEC 60076-14. In these cases, the Nomex® is utilized only where it is needed, in order to minimize cost and optimize the performance of the transformers.

Nomex® Pressboard in Dry-type Transformers

In dry-type transformers, Nomex® offers the possibility of manufacturing a one- or two-piece formed component for an insulating part, which traditionally, would need to be fabricated from several different materials. The Nomex® pressboard in this case not only provides a simplification in the manufacturing process, but also brings its high-temperature capability, excellent abrasion resistance and increased mechanical stability, which eliminates damage from vibration.

Nomex® Pressboard in Rotating Machines

The strength and resilience of Nomex® pressboard help extend rotating equipment life in severe operating conditions. These conditions include severe shock and vibration seen in steel mill drives and railroad traction motors, as well as the abrasion caused by thermal expansion and centrifugal forces in stand-by gas turbine generators. Unlike reinforced composites, no abrasive particles are present in Nomex® pressboard to interfere with the operation of moving parts.

Nomex® Pressboard Products

DuPont™ Nomex® 992 PSB

Nomex® 992 PSB is a low-density pressboard produced in two thicknesses—1.6 and 3.2 mm (63 and 125 mil)—with a specific gravity of 0.5. This material's low density allows easy formation of complex shapes and provides the highest saturability of the pressboard products with resins, varnishes or oil.

DuPont™ Nomex® 993 PSB

Nomex® 993 PSB is a medium-density pressboard produced in thicknesses from 1.0 to 4.0 mm (40 to 160 mil) with specific gravities from 0.7 to 0.9. This material provides a balance of rigidity and conformability along with outstanding saturability and excellent electrical properties in oil.

DuPont™ Nomex® 994 PSB

Nomex® 994 PSB is a very-high-density pressboard, available in varied thicknesses and sheet sizes with specific gravities from 1.1 to 1.2. Sheets of thicknesses 1.0, 1.5 and 2.0 mm (40, 60 and 80 mil) are available in large sheet sizes (700 x 2200 mm [28 x 86.5 in.]) for use in applications where the longer lengths provide more economical use in large coil applications. Sheets in thicknesses from 2.5 to 9.6 mm (100 to 380 mil) are available in smaller sheet sizes (355 x 1500 mm [14 x 59 in.]) for use as axial and radial spacers, wedges, etc., where thicker spaces are needed. Nomex® 994 PSB provides superior stability under compressive loads and it will also absorb oils and other fluids, but not as readily as Nomex® 992 PSB and Nomex® 993 PSB.

This brief description only touches on the potential of insulation systems enhanced with Nomex®. There are many areas of special needs where these concepts could be employed immediately and other areas where a fundamental change in operating philosophy may be required. Nomex® allows both the equipment manufacturer and the user a new degree of freedom in designing and specifying equipment to reduce overall investment. The result is to make electrical apparatus and power delivery systems more cost effective while achieving much higher levels of reliability.

Product Availability

| DuPont™ Nomex® 992 PSB | | | | | | | | | | | |
|------------------------|-----|-------------------|---------------------------|--------------------|------|-------|------|--------|----------------|-----------------|--|
| Nominal thickness | | Density | Basis weight ¹ | | | Width | | Length | | Area | |
| mm | mil | g/cm ³ | g/cm ² | oz/yd ² | mm | in. | mm | in. | m ² | yd ² | |
| 1.6 | 63 | 0.52 | 810 | 24 | 1067 | 42 | 1041 | 41 | 1.11 | 1.33 | |
| 3.2 | 125 | 0.53 | 1630 | 48 | 1067 | 42 | 2108 | 83 | 2.25 | 2.69 | |

¹ Basis weights include nominal moisture content.



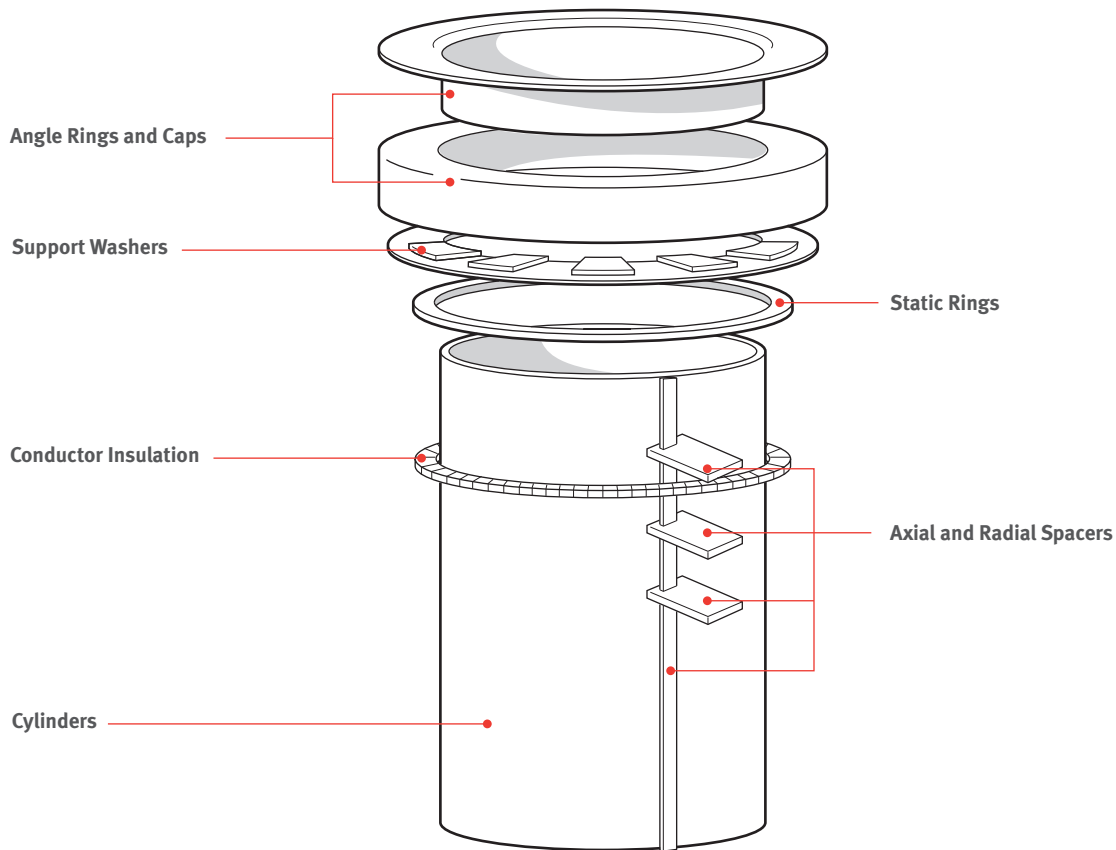
| DuPont™ Nomex® 993 PSB | | | | | | | | | | |
|------------------------|-----|-------------------|---------------------------|--------------------|-------|-----|--------|-----|----------------|-----------------|
| Nominal thickness | | Density | Basis weight ¹ | | Width | | Length | | Area | |
| mm | mil | g/cm ³ | g/cm ² | oz/yd ² | mm | in. | mm | in. | m ² | yd ² |
| 1 | 40 | 0.70 | 720 | 21 | 1067 | 42 | 1041 | 41 | 1.11 | 1.33 |
| 1.5 | 60 | 0.73 | 1050 | 31 | 1067 | 42 | 2108 | 83 | 2.25 | 2.69 |
| 2 | 80 | 0.76 | 1530 | 45 | 1067 | 42 | 3150 | 124 | 3.36 | 4.02 |
| 3 | 120 | 0.82 | 2270 | 67 | 1600 | 63 | 1575 | 62 | 2.52 | 3.02 |
| 4 | 160 | 0.87 | 3410 | 101 | 1600 | 63 | 2108 | 83 | 3.37 | 4.04 |

¹ Basis weights include nominal moisture content.

| DuPont™ Nomex® 994 PSB | | | | | | | | | | |
|------------------------|-----|-------------------|---------------------------|--------------------|-------|------|--------|------|----------------|-----------------|
| Nominal thickness | | Density | Basis weight ¹ | | Width | | Length | | Area | |
| mm | mil | g/cm ³ | g/cm ² | oz/yd ² | mm | in. | mm | in. | m ² | yd ² |
| 1 | 40 | 1.17 | 1160 | 34 | 720 | 28.3 | 2200 | 86.5 | 1.58 | 1.89 |
| 1.5 | 60 | 1.17 | 1800 | 53 | 710 | 28.0 | 2200 | 86.5 | 1.56 | 1.87 |
| 2 | 80 | 1.17 | 2320 | 68 | 700 | 27.6 | 2200 | 86.5 | 1.54 | 1.84 |
| 2.5 | 100 | 1.15 | 2940 | 87 | 355 | 14 | 1500 | 59 | 0.53 | 0.64 |
| 3 | 120 | 1.15 | 3448 | 102 | 355 | 14 | 1500 | 59 | 0.53 | 0.64 |
| 4 | 160 | 1.14 | 4554 | 134 | 355 | 14 | 1500 | 59 | 0.53 | 0.64 |
| 5 | 200 | 1.14 | 5691 | 168 | 355 | 14 | 1500 | 59 | 0.53 | 0.64 |
| 6 | 240 | 1.13 | 6768 | 200 | 355 | 14 | 1500 | 59 | 0.53 | 0.64 |
| 7 | 275 | 1.15 | 8039 | 237 | 355 | 14 | 1500 | 59 | 0.53 | 0.64 |
| 8 | 315 | 1.13 | 9068 | 267 | 355 | 14 | 1500 | 59 | 0.53 | 0.64 |
| 9.6 | 380 | 1.15 | 11069 | 326 | 355 | 14 | 1500 | 59 | 0.53 | 0.64 |

¹ Basis weights include nominal moisture content.

Sample Application Insulation Parts



Applications in Transformers

Angle Rings and Caps

Insulate windings from each other, from the core and from the tank. Angle rings and caps manufactured from Nomex® can be placed close to the winding, permitting higher operating temperatures with reduced clearances.

Support Washers

Are used both as mechanical support and as major insulation from winding to ground. By replacing cellulose washers closest to the winding with Nomex®, support washers will withstand increased temperatures.

Conductor Insulation

Is used as turn insulation to insulate turns from each other. Because it is located close to the conductor, it experiences the highest temperatures and usually becomes the limiting insulation component. Conductor insulation produced from Nomex® paper allows the windings to be operated over wider temperature ranges.

Cylinders

Function as structural support for the winding and as major insulation from winding to winding and winding to ground. Nomex® brand products have high mechanical strength, high heat resistance and improved electrical properties, which make them ideal for cylinders closest to the winding.

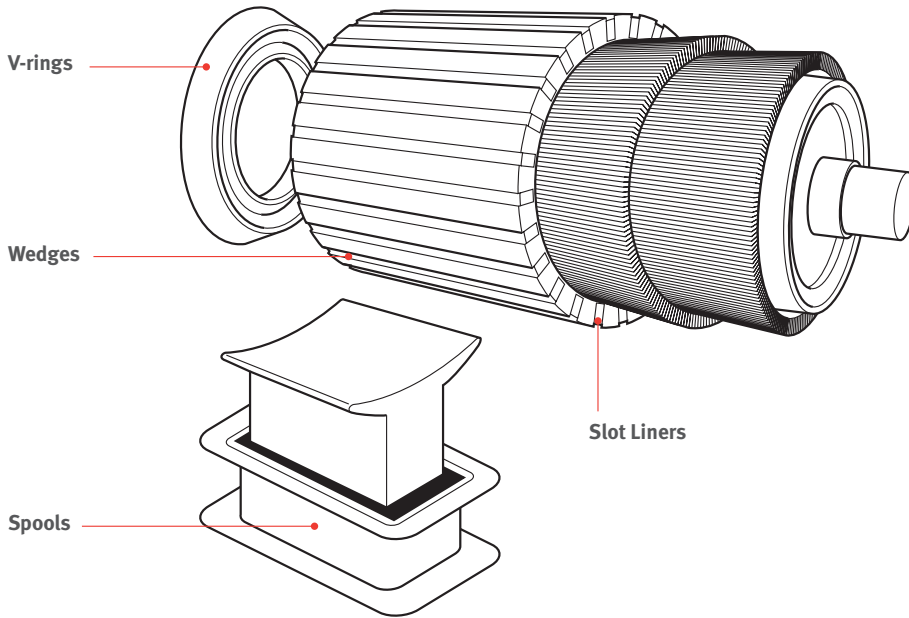
Static Rings

Equalize stress in and around high-voltage windings and grounded components, such as core legs and yokes, permitting reduced clearances. Static rings made from Nomex® withstand higher temperatures than cellulose insulation.

Axial and Radial Spacers

Provide mechanical support and direct oil flow. Spacers manufactured from Nomex® pressboard should be used near the winding because they offer higher dielectric strength, higher compressive strength and higher temperature capability.

Sample Rotating Application Parts



Applications in Rotating Apparatus

V-rings

Are the insulation between the commutator bars and the motor shaft. V-rings of Nomex® brand pressboard are formed from single sheets and, as a result, demonstrate increasing electrical and mechanical strength, as well as simplify the manufacturing process.

Wedges

Are driven into retaining grooves to hold the windings in the armature slot. Their design ensures maximum, safe, high speeds in the armature. The high mechanical

strength and compression resistance characteristic of Nomex® pressboard provide greater reliability in this application.

Spools

Are the structural insulation component where field coils are wound. With the coils wound on a spool, a rigid frame permanently insulates the coils from grounds and stops any chafing caused by motor vibration. The formability of Nomex® increases product integrity and simplifies the design of the spools.

Slot Liners

Are the insulation between the windings and the walls of the armature slots. Additionally, slot liners facilitate the insertion of the windings into the slots during the assembly process.

Cutting and Machining of Nomex® Pressboard

Introduction

No special equipment is required to cut, mill, sand, drill, rout or punch Nomex® brand pressboard. Standard equipment used with other insulating materials such as cellulose board or polyester/glass laminates works very well.

Since all pressboard is sensitive to moisture, prolonged exposure to a humid environment is not advised. Store pressboard in low relative humidity areas and/or wrap it in plastic or a similar air impermeable material.

In addition to facilitating efficient cutting and machining, the tools, methods, and recommendations outlined in this brochure also encourage high-yield operations with limited waste. Waste can add substantial cost to the finished product.

Be sure to follow all standard safety precautions when performing any of the various cutting or machining operations outlined in this brochure. Power equipment will generate dust. Use a dust collection system or wear a NIOSH-approved mask.

Cutting Shears

Pressboard 992 PSB and 993 PSB

Pressboards with thicknesses up to .160" (4.0 mm) may be cut with shears.

Pressboard 994 PSB

Pressboard with thicknesses up to ~0.080" (2.0 mm) can be cut with shears. Since Type 994 is more dense, thicker varieties are best cut with a circular saw, band saw, or reciprocating saw.

Cutlery Products and Services

(315) 449-3050

Fiskar Industrial

(800) 289-8288
www.fiskars.com

Gingher Inc.

(800) GINGHER
www.gingher.com

Izumi International

(864) 288-8001
www.izumiinternational.com

Pen Associates, Inc.

(302) 239-6866

John A Eberly

(800) 532-3759
www.jaeberly.com

| Circular Saw | | | | | |
|--------------|-----------|---------------------|----------------|----------------|----------------|
| | Cellulose | Poly/glass laminate | Nomex® 992 PSB | Nomex® 993 PSB | Nomex® 994 PSB |
| Blade | 60 teeth | 60 teeth (min)* | 60 teeth | 60 teeth | 24–40 teeth |
| Speed | Max | Max | Max | Max | Max |
| Feed | Fast | Slow | Fast | Fast | Fast |

Note: Table comparison using 10" (250 mm) diameter blade.

* Back the exit side of the material with masking tape. In addition, use masonite, Lucite® or an equivalent material as an exit side bushing.

Circular Saw

Use any fine-tooth, raker set blade that is appropriate for wood (e.g., 10" [250 mm] diameter, carbide tipped for longer life, 60 teeth or 7¼" [184 mm] diameter carbide blade with 24 teeth).

BLACK+DECKER (saw & blades)

(800) 544-6986
www.blackanddecker.com

DeWalt (saw & blades)

(800) 4DEWALT
www.dewalt.com

DoAll Company (blades)

(847) 495-6800
www.doall.com

Wire—Diamond Wire

Wire cutting generates very little heat. Kerf loss is small and yield is high.

Wire diameter: 0.010" (0.25 mm)
Wire speed: 200"/min (5.1 m/min)
Cut gap: 0.012" (0.30 mm)
Feed rate: 0.50"/min (12.7 mm/min)

BLACK+DECKER (regular wire)

(800) 544-6986
www.blackanddecker.com

Laser Technology West Ltd (diamond wire)

(800) 394-8270

Sears (regular wire)

(800) MYSEARS
www.sears.com

High-speed Jewelers Saw Blade

This is an effective, high-yield method for cutting pressboard; however, it is slow.

Diameter: 2" (51 mm)
Cut gap: 0.030" (0.76 mm)
Thickness: 0.032" (0.81 mm)
Speed: 12,500 RPM (water lube)
Feed rate: 3"/min (76 mm/min)

Thurston Manufacturing

(401) 232-9100
www.thurstonmfg.com

| Band Saw | | | | | |
|----------|------------------|----------------------------------|------------------|------------------|------------------|
| | Cellulose | Poly/glass laminate | Nomex® 992 PSB | Nomex® 993 PSB | Nomex® 994 PSB |
| Blade | 14 TPI raker set | 6 TPI* raker set, carbide tipped | 14 TPI raker set | 14 TPI raker set | 14 TPI raker set |
| Speed | Max | Max | Max | Max | Max |
| Feed | Normal | Slow | Fast | Fast | Fast |

* Back the exit side of the material with masking tape. In addition, use masonite, Lucite® or an equivalent material as an exit side bushing.

Band Saw

Some fuzz will occur on bottom of cut; however, fuzzing can be reduced by closing the tolerance on the support plate.

Backing the pressboard also reduces fuzzing. Use tempered masonite or equivalent as an exit side bushing. At the minimum, if this material is unavailable, back the pressboard with masking tape.

Saw speed: 5,200'/min (1585 m/min)
 Blade type: Raker set
 Blade depth: 3/16" (4.8 mm)
 Blade thickness: 0.014" (0.36 mm)
 Teeth per inch: 14
 Feed rate: 24"/min (610 mm/min)
 Cut gap: 0.023" (0.58 mm)

DoAll Company (saws and blades)

(847) 495-6800
www.doall.com

L.S. Starrett Co. (blades)

(978) 249-3551
www.starrett.com

Sears (blades)

(800) MYSEARS
www.sears.com

Simmons Engineering (blades)

(800) BLADE81
www.simcut.com

Water Jet Cutter

Causing no warpage, delamination or fuzzing on the edges, the water jet is an excellent way to cut pressboard; however, pressboard is sensitive to moisture and must be wiped dry soon after cutting. Be sure to store it on a flat surface in a dry area with low relative humidity.

Equipment is expensive, but there are businesses available that provide water jet cutting for hire.

Cut gap: 0.035" (0.89 mm) width cutting stream (often depends on machine specs)

Nozzle orifice: 0.009" (0.23 mm)
 (often depends on machine specs)

Pressure: 40,000–45,000 lb/in²
 (27.6–31.0 kN/cm²)

Feed rate: 24"/min (610 mm/min)
 (with or without sand; with for a much better cut); rate depends on the thickness of the material and the finish requirements

Note: Because all pressboard is sensitive to moisture, prolonged exposure to a humid environment is not advised. Store pressboard in low relative humidity areas and/or wrap it in plastic or a similar air impermeable material.

Flow International (equipment)

(800) 446-3569
www.flowwaterjet.com

Jet Edge Corp. (equipment)

(800) 538-3343
www.jetedge.com

Ultrasonic Cutting

Because they cut pressboard in a slicing action, ultrasonic machines can leave a slightly raised edge, which, depending on processing requirements, may require some light sanding. In addition, ultrasonics can cause some discoloration due to the "charring" of the pressboard.

Note: There is no waste with this method.

A handheld ultrasonic cutting knife is available for light cutting and trimming. For your safety, wear a protective glove of DuPont™ Kevlar® on the non-cutting hand. Heavy-duty ultrasonic knives can cut Nomex® 994 PSB.

American GFM (all types)

(757) 487-2442
www.agfm.com

Branson Ultrasonic (handheld)

(203) 796-0400
www.branson-plasticsjoin.com

Laser Cutter

Particles can distort the laser beam to cause inaccurate cutting. In addition, laser cutting causes “charring” (discoloration) along the edges of the Nomex® brand pressboard.

Note: This cutting method is not recommended.

Cast Cutter

For specialty work, when speed is not a consideration, the cast cutter is a surprisingly safe and effective way to cut pressboard. High-speed oscillation produces the cutting action. The blade cuts on both the forward and the backward stroke, and if it touches the operator, in most cases, it will do no harm.

Blades: #840-40-300 Ti-Ni Coated SST, 2" (51 mm) or #840-40-350 Ti-Ni Coated SST, 2½" (64 mm)

Stryker Instruments

(800) 253-3210
www.inst.strykercorp.com

Die Cutting

Die cutting is a quick, efficient method ideal for mass production work. There are all sorts of dies available to processors, including steel ruled dies, pre-sharpened self-standing dies, heavyweight forged dies and machined dies for complicated cuts. Matching the right die to the application is essential. Key considerations are the pressboard type and thickness and the edge quality requirements. A consultation with a professional die/punch manufacturer can be most beneficial.

In all cases, be sure to back the pressboard with a high-quality cutting pad made of nylon, rubber composition or polypropylene. Mount the pad to a 1" (25 mm) thick die board or marine plywood to ensure quality results. After extensive use, cutting pads can be resurfaced by sanding or milling. As a general rule, the cutting pad should be as hard as, or harder than, the material being die cut. For Nomex® 994 PSB, die cutting is usually limited to thicknesses no greater than 0.125" (3.2 mm).

Note: Die cutting may leave a slightly raised edge.

Ontario Die Company of America

(810) 987-5060
www.ontariodie.com

Prima Die Co., Inc.

(323) 268-3434
www.primasales.com

Progressive Service Die Co.

(910) 353-4836
www.psdcdies.com

Sanding

When working with a belt sander, use 120- to 320-grit aluminum oxide or silicon carbide sanding belts. It is always a good idea to experiment first with different sanding belts to determine which work best. A rotary sander will also work well.

Use standard equipment. No special equipment is required. Remember, power equipment will create dust. Use a dust collection system or wear a NIOSH-approved mask.

BLACK+DECKER

(800) 544-6986
www.blackanddecker.com

Snap-on Tools™

(800) 926-5544
www.snapon.com

| Milling | | |
|---|------------------|---------------------|
| | Spindle speeds* | Feed rate |
| Planing (0.062" [1.55 mm] depth of cut) | 2000 to 4000 RPM | 150" (381 cm) / min |
| End milling | 2000 to 4000 RPM | 75" (190 cm) / min |
| Dovetail milling | 4000 RPM | 40" (120 cm) / min |
| Drilling | 3000 RPM | Slow |

*Dependent on cutter diameter.

Milling

Nomex® 992 PSB and Nomex® 993 PSB

Use standard milling equipment, the same equipment used with cellulose board.

Nomex® 994 PSB

Because of its density, Nomex® 994 PSB can melt if cut too fast. It's best to work at slower speeds to prevent the material from overheating. It's advisable to first test feed and speed rates.

International Carbide Corp. (bits)

(800) 422-8665
www.icctool.com

Punching

When punching Nomex® brand pressboard, as with die cutting, key considerations include the type and thickness of the pressboard and the edge quality requirements. Unfortunately, misapplication of tooling is quite common because processors all too often opt for too much rather than what is appropriate to do the job. A consultation with a professional punch/die manufacturer can be most beneficial.

Pressboard options: Use a punch and die set with tight tolerances—0.0002"—0.0005" (5.1–12.7 µm) maximum on the diameter. Ideally, the punch should be made of tungsten carbide and used to size the tool steel die. In some situations, a male/female tool in a die set for use in a punch press is appropriate. In others, a simple hole punch and a quality cutting pad made of nylon, rubber composition or

polypropylene (to back the pressboard) will suffice. Once again, matching the right tool to the application is fundamentally important. For Nomex® 994 PSB, punching is usually limited to thicknesses no greater than 0.125" (3.2 mm).

Note: Punching may leave a slightly raised edge.

Progressive Service Die Co.

(910) 353-4836
www.psdcdies.com

Drilling

Use bits normally recommended for wood and masonite. The carbide-tipped variety will have a much longer life span. A typical twist drill will work well at speeds above 1,000 RPM. For best hole quality, use a brad point drill with two flutes at 3,000 RPM.

Normally, this drill type is not required. With both drill types, a slow feed rate works best.

International Carbide Corp. (brad point drill)

(800) 422-8665
www.icctool.com

Snap-on Tools™

(800) 926-5544
www.snapon.com

Routing

Use a split helix router bit (tungsten carbide for longer life) with either two or four helixes. Operating speed should be between 20,000 and 27,000 RPM.

BLACK+DECKER (router)

(800) 544-6986
www.blackanddecker.com

Cooper Power Tools (Dotco) (router)

(800) 845-5629
www.cooper-powertools.com

International Carbide Corp. (router bits)

(800) 422-8665
www.icctool.com

Pen Associates, Inc. (router bits)

(302) 239-6866

| Methods and Yields Comparison Chart - Rectangular Sticks (0.5" x 59" x 0.24" strips from a 14" x 59" board) | | | | | | | |
|---|------------------------|-------------------|-------------------|----------------------|------------------|------------------------|------------------|
| | Circular blade cutting | Cast blade cutter | Water jet cutting | Diamond wire cutting | Band saw cutting | Jewelers blade cutting | Ultrasonic knife |
| Stick length | 59" | 59" | 59" | 59" | 59" | 59" | 59" |
| Stick width | 0.5" | 0.5" | 0.5" | 0.5" | 0.5" | 0.5" | 0.5" |
| Stick thickness | 0.24" | 0.24" | 0.24" | 0.24" | 0.24" | 0.24" | 0.24" |
| Cut gap | 0.166" | 0.1" | 0.035" | 0.01" | 0.022" | 0.03" | N/A |
| Sticks/board | 21.02 | 23.33 | 26.1 | 27.45 | 26.8 | 26.4 | 28.0 |
| Cut yield | 0.7508 | 0.8333 | 0.9346 | 0.9804 | 0.9579 | 0.9434 | 1.00 |
| Sticks/board | 21 | 23 | 26 | 27 | 26 | 26 | 28 |
| Parts yield | 0.75 | 0.8214 | 0.9285 | 0.9643 | 0.9285 | 0.9285 | 1.00 |
| Cutting speed | Fast | Slow | Fast | Slow | Medium | Slow | |

| Methods and Yields Comparison Chart - Rectangular Sticks (12.7 x 1500 x 6.0 mm from a 355.6 x 1500 mm board) | | | | | | | |
|--|------------------------|-------------------|-------------------|----------------------|------------------|------------------------|------------------|
| | Circular blade cutting | Cast blade cutter | Water jet cutting | Diamond wire cutting | Band saw cutting | Jewelers blade cutting | Ultrasonic knife |
| Stick length | 1500 mm | 1500 mm | 1500 mm | 1500 mm | 1500 mm | 1500 mm | 1500 mm |
| Stick width | 12.7 mm | 12.7 mm | 12.7 mm | 12.7 mm | 12.7 mm | 12.7 mm | 12.7 mm |
| Stick thickness | 6.0 mm | 6.0 mm | 6.0 mm | 6.0 mm | 6.0 mm | 6.0 mm | 6.0 mm |
| Cut gap | 4.22 mm | 2.54 mm | 0.89 mm | 0.25 mm | 0.56 mm | 0.76 mm | N/A |
| Sticks/board | 21.02 | 23.33 | 26.1 | 27.45 | 26.8 | 26.4 | 28.0 |
| Cut yield | 0.7508 | 0.8333 | 0.9346 | 0.9804 | 0.9579 | 0.9434 | 1.00 |
| Sticks/board | 21 | 23 | 26 | 27 | 26 | 26 | 28 |
| Parts yield | 0.75 | 0.8214 | 0.9285 | 0.9643 | 0.9285 | 0.9285 | 1.00 |
| Cutting speed | Fast | Slow | Fast | Slow | Medium | Slow | |

Source Address and Contact Information

American GFM

1200 Cavalier Blvd.
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Fax (203) 796-9838
www.branson-plasticsjoin.com
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Cooper Power Tools (Dotco)

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(803) 359-1200
Fax: (803) 359-0822
www.cooper-powertools.com
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www.dewalt.com
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DoAll Company

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(800) 92DOALL
(847) 495-6800
Fax: (847) 824-4340
www.doall.com
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Fiskar Industrial

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Wausau, WI 54402-1405
(800) 289-8288
(715) 845-3802
Fax: (715) 848-3342
www.fiskars.com
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www.gingher.com
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www.izumiinternational.com
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Thurston Manufacturing

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