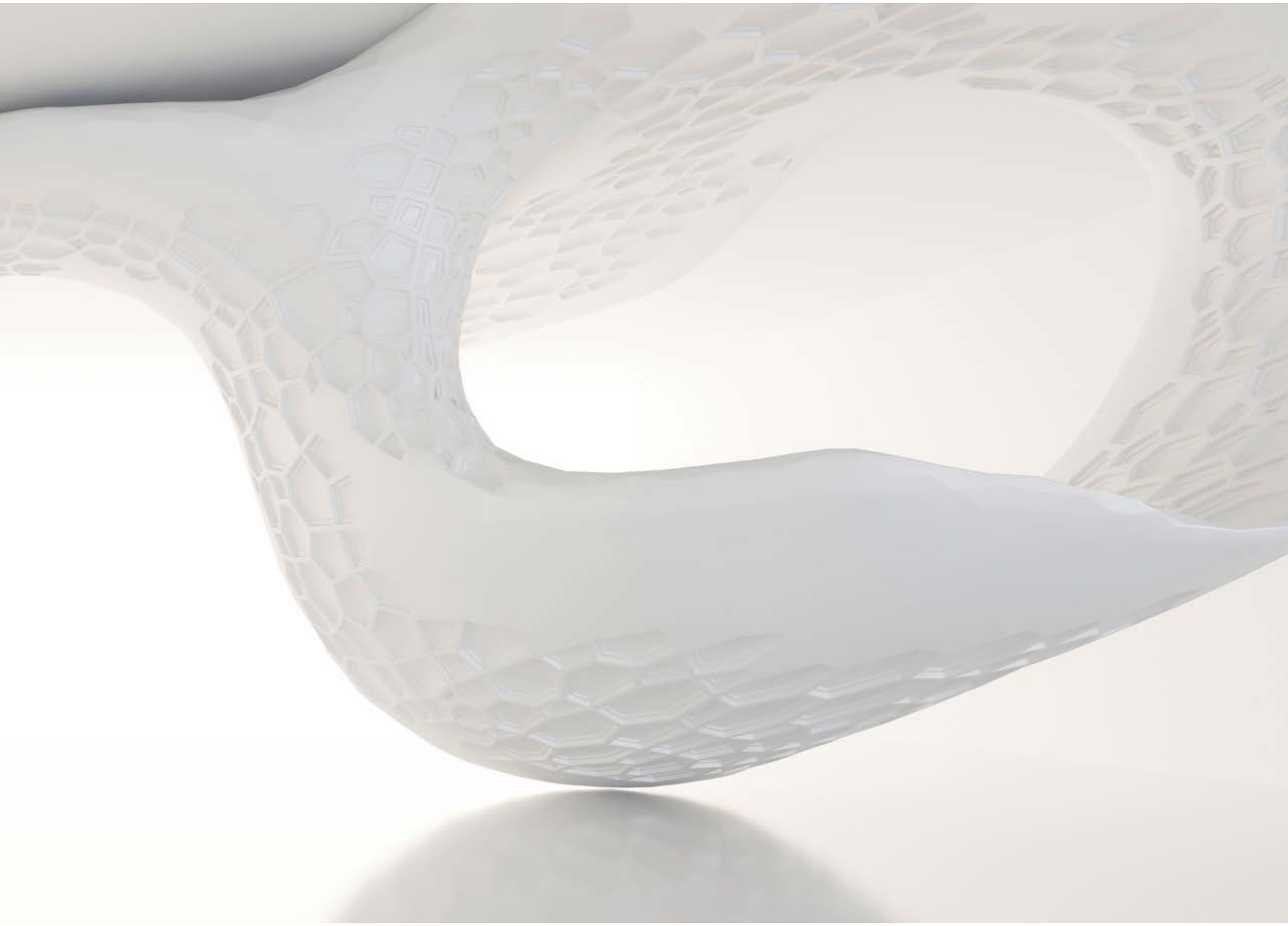

AVONITE FLEX

FORMING AND FABRICATION GUIDE

OCTOBER 2022
ENGLISH USA

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1.0 INTRODUCTION

1.1 Who We Are

For 50 years, Aristech Surfaces has produced and marketed a broad range of surface and design materials to provide quality, cost-conscious, and high-end aesthetic solutions sought by OEMs, architects, designers, and fabricators for industries around the globe. Aristech Surfaces corporate headquarters is located in Florence, KY and has multiple manufacturing facilities, distribution network and global sales force to service the needs of customers worldwide.

1.2 AVONITE® Flex Introduction

AVONITE® Flex is an unequaled material developed to provide the perfect synergy between the functional excellence of specialty sheets with unparalleled surface characteristics, tactile feel, and subtlety of solid surface.

AVONITE® Flex provides surface solutions for everything from bathtubs, thermoformed integral sinks, formed shower walls, and more, with no change to vacuum forming equiment.

This fabrication guide has been prepared to assist in the proper methods for forming, fabricating, and handling Aristech Surfaces LLC AVONITE® Flex sheet products.

Aristech Surfaces products are warranted to be free from defects at time of manufacture. Any materials found defective will be replaced promptly.

Information or references to application, code compliance or specific standards are provided for convenience only. The accuracy or suitability of any recommendations in this guide must be verified by the user, Aristech Surfaces LLC disclaims any legal responsibility.

1.3 Handling

Always carry AVONITE® Flex sheets vertically when possible. Handle full-size sheets carefully to avoid breakage or injury. It is recommended that two people carry full-size sheets. Be careful when moving AVONITE® Flex material so as not to strike it against anything which could damage the decorative surface or the edges.

1.4 Transport and Storage

No special precautions need to be taken for transport and storage. According to the transport regulations the materials described here are not categorized as dangerous goods, so no labeling is required. For storage we recommend a stiff firm base (pallets) which allow the sheets to be laid down flat. Vertical storage on the longitudinal edge is possible when leaned against a flat surface (any curvature should be avoided). Caution: risk of breakage.

1.5 How To Use This Guide

We at Aristech Surfaces hope you will find the following Forming & Fabrication Guide to be a useful tool. It was created to help you discover unlimited design possibilities, which will lead to wonderful solutions for you and your customers. Although many applications are covered in this guide, there will be new applications that may not be covered in detail. Our Forming & Fabrication Guide is designed to provide you with the fundamental knowledge of thermoforming and fabricating the AVONITE® Flex material. These fundamentals can be adapted for new applications.

If you have specific questions or requests, our friendly and expert technical staff is eager to help. Feel free to call your regional representative or contact us at +1 (800) 428-6648.

Important updates such as Technical Bulletins published after the printing date of this manual are also available for download. Certified fabricators should periodically check for updates and add them to this guide.
For additional copies of this guide or quick references for your clients, please visit www.aristechsurfaces.com/ AVONITE® Flex where the complete guide is available for download.

2.0 FABRICATION AND FINISHING

2.1 Machining and Tooling

The usual rules of good machining practice apply to the machining of the AVONITE® Flex material. An experienced machinist will have no difficulty handling the materials as its working properties are similar to those of brass, copper, and fine woods.

The AVONITE® Flex material can be easily machined with ordinary woodworking tools, such as routers, saws, planers, lathes, drills, and sanders. All blades and bits should be Carbide tipped.

2.2 Routing and Shaping

Woodworking shapers and overhead, or portable routers are used in edge finishing operations and for cutting flat thermoformed parts. For edging small parts, the table router is convenient. (see Figure 1.)

A portable router is useful when the part is too large or awkward to bring to the machine. (See Figure 2.)

These machines should have a minimum no-load spindle speed of 10,000 rpm. Higher speeds are desirable and should be used if they are available. Two or three flute cutters, smaller than 1.5" (38 mm) in diameter, running at high speeds, produce the smoothest cuts. At slower spindle speeds, the cutter should have more flutes, or may be larger in diameter to produce the necessary surface speeds. The cutter should be kept sharp and should have a back clearance of 10° and a positive rake angle up to 15°.

Figure 1 - Trimming Formed Part with Table Mounted Router

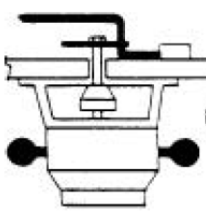
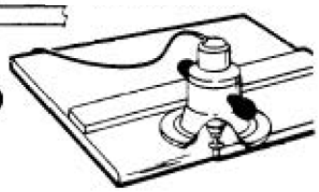


Figure 2 - Edging with a Portable Router



2.3 Drilling

When drilling the AVONITE® Flex material, best results are obtained when using standard twist drills which have been modified as follows:

1. High speed steel drills should be selected, having slow spirals and wide polished flutes.
2. Drills should first be ground to a tip angle of 60° to 90°.
3. Modify the standard twist drill by dubbing-off the cutting edge to zero rake angle.
4. Grind the back-lip clearance angles to 12° - 15°.

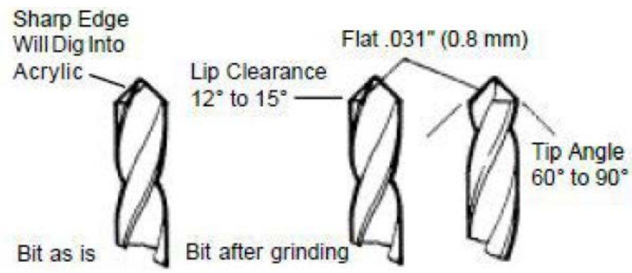


Figure 3 - Alterations to Drill Bits for Drilling AVONITE Flex

The AVONITE® Flex material may be drilled using any of the conventional tools: portable electric drills, flexible shafts, drill presses or lathes. In general, drills should rotate at high speed and feed should be slow but steady. Use the highest available speed with a drill press, usually 5,000 rpm. An exception to this rule should be made when drilling large holes where the drill speed should be reduced to 1,000 rpm. The drill should always run true since wobble will affect the finish of the hole.

When drilling holes which penetrate a second surface, it is desirable to back up the surface with wood and slow the feed as the drill point breaks through. For accuracy and safety, the acrylic should be clamped during drilling.

2.4 Cutting

As a general rule, a power saw is the best method of cutting the AVONITE® Flex material. It is sometimes advantageous to cut thin material at an elevated temperature with rule and blanking dies. Cold punching and/or shearing should not be used since these methods will fracture the material.

The type of equipment selected should be based on the work to be done. Circular saws are preferred for straight cutting. Jig saws and saber saws are suggested for cutting small radii curves and thin materials. Band saws are suggested for large radii curves and for straight cuts in thick acrylic. Routers and wood working shapers can be used for trimming the edges of formed parts.
Tempered alloy steel saw blades are the least expensive to buy, give reasonable service, and are discarded when worn out. Carbide tipped blades are more expensive, give longer service, and can be resharpened. The following table can be used as a guide in selecting the proper circular saw blade:

THICKNESS OF ACRYLIC SHEET Inches (mm)	BLADE THICKNESS Inches (mm)	TEETH PER INCH (cm)
.080 - .100 (2.0 - 2.5)	1/16 - 3/32 (1.6 - 2.4)	8 -14 (3 - 6)
.100 - .187 (2.5 - 4.7)	3/32 - 1/8 (2.4 - 3.2)	6 - 8 (2 - 3)
.187 - .472 (4.7 - 12.0)	3/32 - 1/8 (2.4 - 3.2)	5 - 6 (2 - 3)

Figure 4 - Cutting AVONITE Flex Sheet on Table Saw

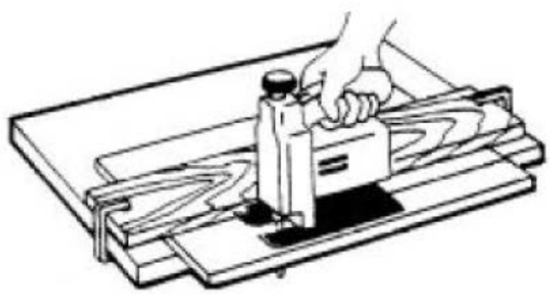


Figure 5 - Cutting AVONITE Flex Sheet with Sabber Saw

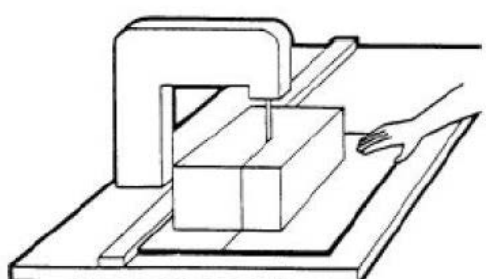


Figure 6 - Cutting Formed AVONITE Flex Sheet Part on Band Saw

Circular Saws Should:

5. Be run at 8,000-12,000 RPM.
6. Be hollow ground to aid cooling.
7. Be slotted to prevent heat warping the blade.
8. Have teeth with a uniform rake angle of 0° - 10°.
9. Have a slight set to give clearance of .010" to .015" (0.254 mm to 0.381 mm) and
10. Have teeth of uniform height.

An 8" (20.3 cm) diameter blade is used for light work and a 12" (30.5 cm) blade for heavy work. A two horsepower motor is suggested for driving these blades.

Masking tape applied over the area to be cut will reduce the tendency to chip during cutting. Acetone, toluene, or methylene chloride can be used to clean blades. Tallow or bar soap applied to the blade, helps to prevent gum build-up on the blade when cutting sheet masked with adhesive backed paper.

Traveling saws cutting at 10 to 25 feet (3 to 7.6 meters) per minute are recommended for making straight cuts longer than 3 feet (91 cm) and for cutting sheets when it would be undesirable to slide them across the saw table.

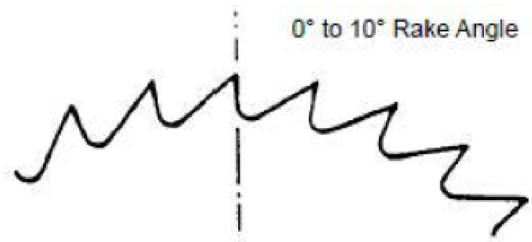


Figure 7 - Typical saw Blade for Cutting AVONITE Flex Sheet

AVONITE® Flex material, backed with fiberglass reinforced plastics, are best cut by diamond abrasive wheels. Carbide tipped blades will do a good job but require frequent resharpening. Small diameter disposable alloy steel blades on high speed air powered saws are also effective, especially in portable situations.

Variable speed band saws, which can run at 5,000 feet (1524 m) per minute and have a 28" to 36" (71 to 91 cm) throat, are best suited for production work. Metal cutting blades are the best type for cutting the AVONITE® Flex material. The following table can serve as a guide for selection of a blade:

MINIMUM RADIUS TO BE CUT Inches (mm)	BLADE WIDTH Inches (mm)	BLADE THICKNESS Inches (mm)	TEETH PER INCH (cm)
1/2 (12.7)	3/16 (4.7)	0.028 (.71)	7 (3)
3/4 (19)	1/4 (6.3)	0.028 (.71)	7 (3)
1-1/2 (38)	3/8 (9.5)	0.028 (.71)	6 (3)
2-1/4 (57)	1/2 (12.7)	0.032 (.81)	5 (2)
3 (76)	5/8 (15.9)	0.032 (.81)	5 (2)
4-1/2 (114)	3/4 (19)	0.032 (.81)	4 (1.5)
8 (203)	1 (25.4)	0.035 (.89)	4 (1.5)
12 (305)	1-1/4 (31.7)	0.035 (.89)	3 (1.5)
20 (508)	1-1/2 (38.1)	0.035 (.89)	3 (1.5)

The blade speed should be approximately 4,500 RPM for AVONITE® Flex sheet thicknesses from 0.125” to 0.375” (3.2 to 9.5 mm) thick. Fine teeth with no set will produce a smooth cut if fed slowly. Sheets should be fed continuously and with even pressure to prevent the blade from binding and breaking. The blade should enter and leave the work slowly to prevent chipping. Should a burr form on the cut edge due to overheating, it can be removed with a scraper or other straight edged tool.

2.5 Finishing

The original surface of the AVONITE® Flex sheet is manufactured with a high gloss finish. This surface finish changes once the sheet has been heated and then thermoformed, bent, or stretched. The resulting finish that is achieved after forming will vary depending on the depth of draw and the degree of bending. In general, a satin finish is achieved on the deck (or top portion) of the formed part. The surface of the inner walls and base of a part formed in a female mold will result in a matte finish. The AVONITE® Flex sheet will show more matting (or dulling) of the surface as the sheet is stretched and its thickness is decreased.

However, a more consistent matte finish can be achieved with the Enhanced-Matte version of the AVONITE® Flex sheet. This product option consists of a factory finished surface to the sheet resulting in a uniform, matte surface finish throughout the formed part. The surface finish will also remain uniform when comparing a flat sheet to a formed part.

2.6 Sanding

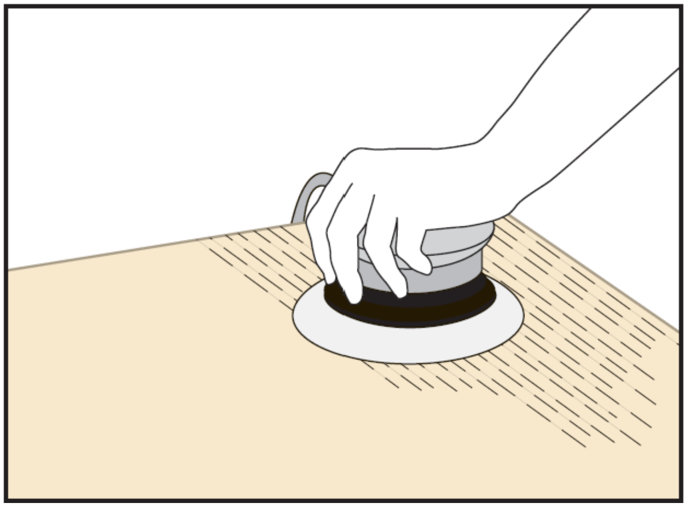
Similar to other solid surface products, AVONITE® Flex material can be sanded to achieve different surface finishes. Using a 6” (152 mm) or 8” (203 mm) random orbital sander will reduce your sanding time by HALF over conventional vibrating sanders and will achieve a more uniform finish. Whenever possible, use a sander with a vacuum attached (especially if the tops are polished) to minimize grinding dust back into the top.

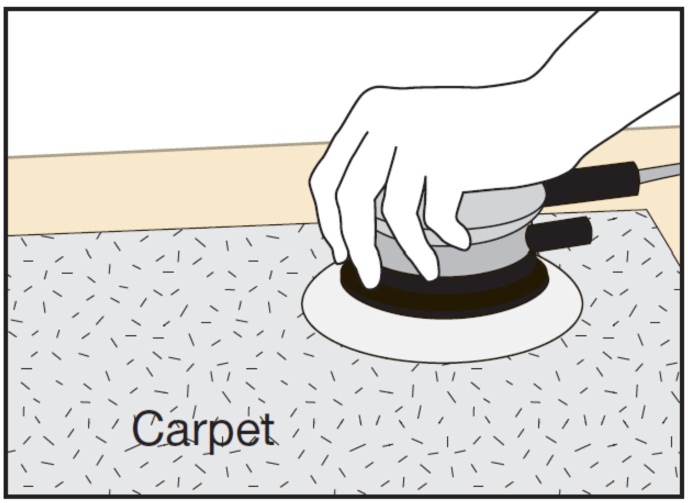
The Enhanced-Matte finish can be achieved by sanding the top surface of the AVONITE® Flex sheet prior to heating and forming. Best practices include sanding the flat sheet using a random orbital sander (as described above) with 320 grit (or 40 micron) paper and following the sanding process described below.

Sanding Process

1. Move the sander in a back and forth direction.
2. Overlap each pass by 50%. 3. Sand at a slow and even pace, approximately 1 to 2 inches (25.4 to 50.8mm) per second.
3. Sand the surface until the high gloss finish is not visible.
4. Keep micron paper clean from sanding dust. This is easily done by putting the sanding pad on a piece of carpet while running and hold it down for a few seconds (check paper frequently).

**Each sheet of micron paper will sand 10 sq. ft (about 1 sq. M) of Aristech Surfaces AVONITE® Flex material.*





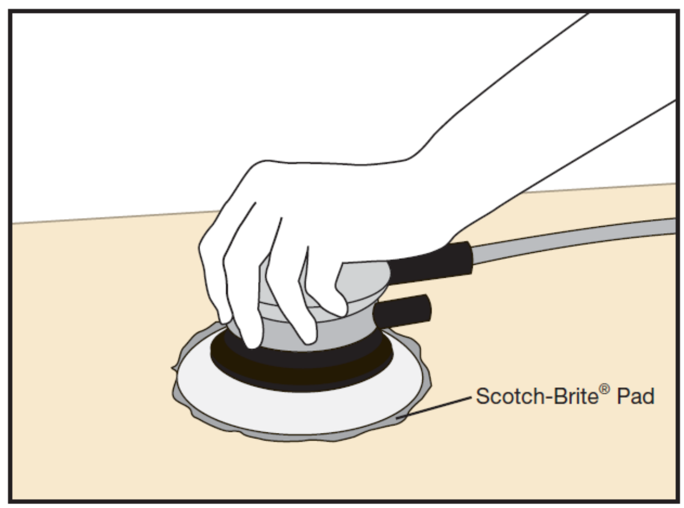
Matte Finish
Using 40 micron paper, place a Scotch-Brite® pad, (#7447 Red) under the sanding pad to even out the finish. The matte finish is easily maintained and is usually the most suitable for lighter colors.

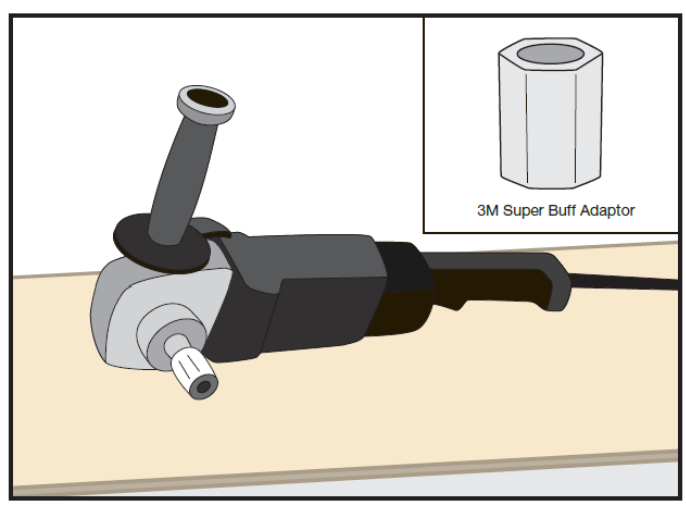
Satin Finish
Sand with 40 micron paper, repeat sanding process with 30 micron paper. Place Scotch-Brite® pad (#7448 light gray) under sanding pad. Sand with Scotch-Brite® #7448 and soapy water. Homeowners may maintain this finish using a white Scotch-Brite® and Soft-Scrub®.

Polished Finished
After sanding with 40 micron paper, repeat the sanding process with 30 micron paper. Use a 3M Super Buff adapter to prevent the arbor of the polisher from damaging

Abrasive Grade Comparison

Micron Grade	Industrial U.S. Mesh	FEPA or P-Grade	Japanese J15 Grade	Emery
100u	#150			
80	180			
60	220	P240	#240	
	240		280	
40	280		320	
	320	P360	360	
	360	P500	400	1/0
30	400		500	2/0
	500	P1000	600	3/0
15	600		1000	
	800		1200	
12		P1200		
9	1200		2000	4/0
5			2500	
3			4000	
2			6000	
1			8000	
0.3				





2.7 Bonding and Seaming

Strong joints and seams can be obtained in bonding actions of AVONITE® Flex sheet together, and with other materials, by giving careful attention to preparation of the mating surfaces, proper choice of adhesives/cements and following correct bonding techniques.

The surface of the AVONITE® Flex material is also capable of bonding to with FRP rigidizing systems. Surface preparation of the AVONITE® Flex material prior to spray application of FRP resins is similar to that of AVONITE® Flex sheet.

Prevention of Internal Stresses

AVONITE® Flex sheets need to be acclimated to ambient room temperatures prior processing. The AVONITE® Flex sheet is not sensitive to humidity and moisture. Heat generated by machining operations, and/or thermoforming at reduced temperatures, will often induce internal stresses which make the material susceptible to crazing after contact with solvents and certain adhesives/cements. Such stresses can be avoided by the proper choice of thermoforming or machining conditions or can be relieved by heat treating. Refer to the Annealing Section in Technical Bulletin 135 for proper heat treating conditions.

Joint Preparation

Surfaces to be jointed should be clean and fit together with uniform contact throughout the joint. In order to obtain close fitting edges, which is especially important, it may be desirable to accurately machine the mating surfaces. **Edge buildups such as stacked edges and exposed layered edges should not be used with Avonite Flex.**

Prior to applying the joint adhesive, using a 100 grit sandpaper on hardwood block, lightly score the edges/surfaces to be seamed together. This step aids in the adhesion between the two surfaces. Make one or two passes only. Be careful not to sand the top edge of the sheet, or the outer edges of the formed part. After the dry fit is complete, clean edges/surfaces with isopropyl alcohol.

Joining

AVONITE® Adhesive

Our adhesive is a pre-tinted two-part adhesive and cures in approximately 40 minutes and is available in 250 ml. cartridges. The adhesive is available in several colors and clear for excellent color matches. It is specially formulated to offer superior bond strength for all AVONITE® products.

Cartridges

Each cartridge contains 250 ml (10 oz.) of adhesive and will adhere 35 to 45 feet (12.1M) of 1/2" (12.7mm) seam. The adhesive flows through a static mixer tube and is ready for use. Two mixer tubes are included with each cartridge. To assure positive flow of activator, dispense a small quantity of adhesive before installing mixer tube. 50ml sizes are also available.

FABRICATION TIP

From time to time the bead of adhesive dispensed with the AVONITE® Solid Surface Adhesive cartridge will not contain the prescribed amount of hardener. This may arise for a variety of reasons, but the end result is that small sections of the seam may not set up as rapidly as others. There are techniques that will reduce the variation in setup time. Once the bead of adhesive has been dispensed, a popsicle stick applicator may be used to spread the adhesive over the bonding surface. This serves to blend the adhesive more uniformly with the hardener and prevents variation in the curing time of the adhesive. Another helpful technique used frequently is to dispense two thin beads as opposed to one thick bead. This method overlaps any possible gap in the hardener and prevents uneven hardening.

When a small amount is needed there is no reason to waste a mixing tube. Simply remove the end plug and squeeze the adhesive into a paper cup and stir for one minute

Other Types of Adhesives

AVONITE® Flex material can also be joined together with the monomer-polymer solvent type or the monomer-polymer-catalyst type of adhesives

Monomer-Polymer-Solvent Type Cements

These types of cements usually consist of methyl methacrylate monomer, methyl methacrylate polymer and assorted solvents. M-P-S type cements available are Weld-On 16 and Weld-On 1802. M-P-S cements do not allow rapid assemblies. Usually 15 to 30 minutes after cement is applied, part can be handled very carefully. High to medium strength joints are obtained which have good to fair weathering resistance.

Monomer-Polymer-Catalyst Type Cements
These type cements consist of methyl methacrylate monomer, Methyl Methacrylate Polymer (Part A) and a catalyst (Part B). M-P-C cements available are Weld- On 10, Weld-On 28, and Weld-On 40. These type cements yield excellent bond strengths, and weathering resistance. Assembly times are slow.

2.8 Annealing

When plastics parts are molded, fabricated, or formed in any fashion these processes inherently induce stress into the part. Just like glass, ceramic and metals, this stress can be relieved by a process called annealing. In annealing we heat the part heating to near the glass transition temperature, maintaining this temperature for a set period of time, and then slowly cooling it to room temperature.

A part undergoing annealing should be completely supported. If it is simply a sheet it can be laid flat in the oven. More complicated parts can require jigs to ensure that the part is not distorted during the annealing process.

For AVONITE® Flex, the typical temperature that it is heated to is 80°C and then cooled slowly. Generally, you heat the sheet one hour for each millimeter of thickness. It is critical that the sheet be cooled at a controlled rate.

If you took the part out of the oven after it achieved 80°C and cooled it under running water, you would build more stress into it rather than relieve it. Specially configured annealing ovens can program the annealing schedule. Most ovens will require that you reset the temperature at intervals. The part does not have to be cooled all the way to room temperature before removing it from the oven. It can be removed once the temperature goes below 60°C.

If the part has been cemented/glued it must be allowed to cure at least five hours before annealing. Rapid solvent evaporation can cause bubble formation.

Annealing Schedule

Thickness	Heating Time (hours)	Cooling Time (hours)	Heating Rate (degrees Celsius per hour)
2.0	2	2	15
2.5	2.5	2	15
3.0	3	2	15
3.2	3.2	2	15
4.5	4.5	2	15
6.0	6	2	15
9.5	9.5	2.5	12
12	12	3.5	11

3.0 THERMOFORMING

These Thermoforming Parameters are basic guidelines for fabricators to thermoform AVONITE® Flex material. The parameters listed below are recommendations, which are a direct result of actual forming of AVONITE® Flex material. This testing was conducted by the AVONITE® Flex Technical Service Department, but values are approximate. We suggest re-testing for varying conditions.

Material Preparation
When preparing material to be formed, it is recommended that material be cut to size. Then, remove all chips or gouges on the edge of the material. Any chip or gouge left on an edge may cause the material to tear during forming. Thermoforming Temperature Temperatures given here are approximate and represent a starting point to establish the conditions you need for your project. If material is too cool or too hot it may crack or tear while bending.

Oven Options
Below are thermoforming guidelines for conventional and platen style ovens. Every oven is unique and calibrations may be necessary. Be sure the oven used is large enough for the entire piece to be formed.

Mold Design
When forming we recommend that male and female molds be made. The molds need to be designed so they can accommodate clamps to hold them together while material is cooling.

Cool Down
Allow material to cool for one hour, or when the temp reaches 100°F / 37°C, to prevent the material from springing back. If material is not allowed to cool adequately, it may spring back as much as 10 % which will make any further fabrication of the application difficult.

Fabrication: Finishing/Seaming
Finishing formed sheet stock is no different from standard finishing. However, it is important that any seaming/joining be done after forming. The heat to which the material is subjected will weaken the seamed areas of the pieces, which may result in seam failures.

3.1 Thermoforming Temperatures and Cycles

The following curves (Figures 15 & 16) were derived from tests performed at Aristech Surfaces. Due to the large variety of heating equipment available, heating times may vary. The following heating cycles should be used as a starting point only in obtaining optimum forming temperature times and cycles. The temperature and cycle times depend upon the thickness of the AVONITE® Flex sheet as well as the type of heating and forming equipment used.

Surface temperatures should not exceed 380 °F (194°C). It is common practice, especially in high production operations, to allow surface temperatures to exceed 380 °F (194 °C). Higher temperatures can be tolerated up to 30 seconds depending on sheet thickness in most cases. But due to blistering potential, it is not recommended to exceed 380 °F (194 °C).

Figure 16 outlines the heating cycles when using electric infra-red radiant heaters on one or two sides. Again, heating times can vary depending on the type of heating equipment used, percentage times, distance between sheet and heaters, and heat loss factors.

Several other methods can be used to determine if a sheet has been sufficiently heated. The most common is the ripple method by which the operator shakes the heated sheet with a non-combustible object (See note). When the sheet ripples uniformly across the surface, it is ready for forming. Another commonly used technique is the "sag method". By trial and error, the amount of sag in a hot sheet can be correlated with the optimum time to be thermoformed. The best procedure for determining when the sheet is ready for forming is to accurately control the temperature using heat sensors and/or temperature indicating stickers. The actual cycle, temperature settings and techniques most suitable for a particular forming job are best determined on one's own equipment.

Note: Care must be taken to make sure the operator does not endanger him/herself due to exposure to electricity, hot oven components, or hot sheet.

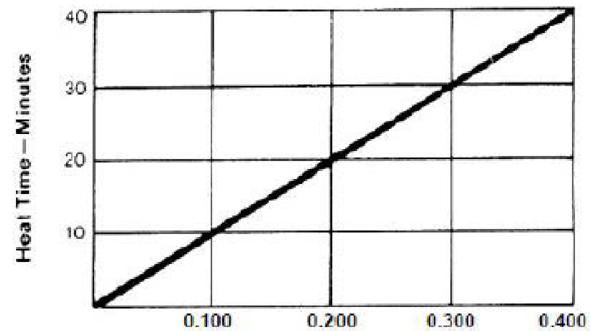


FIGURE 15 - Forced Air Circulating Oven at 350 °F (177 °C)

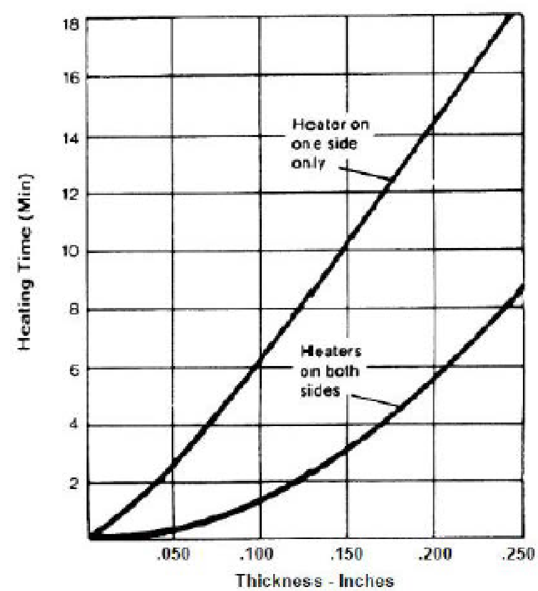


FIGURE 16 - Electric Infra-Red Radiant Heating

3.2 Demolding Formed Part

AVONITE® Flex sheets need to demold, or separate the shell from the mold, at a temperature range of 150°F to 170°F. It is also necessary to be very careful with the use of air pressure to assist in the separating of the shell from the mold. This is often referred to as "air eject".

These temperatures are still below the heat distortion temperature for the AVONITE® Flex material, It may also be necessary to hold the part in the clamp frame for a short time after de-molding until it reaches the normal temperature of 135°F to 150°F for standard handling of the shells.

When measuring the de-mold temperature, you should be looking at the areas where the material remains thickest. This would be the deck areas of tubs or shower bases.

If you have sticking problems with your molds you should find that use of talc or baby powder in the areas of sticking will most often help. The sticking can occur around the corners of the deck area, or near the drain end of the baths. That is when you may find it necessary to use the assistance of air injected into the mold to help relieve the vacuum effect of the part fitting tightly into the mold.

Should you encounter any problems with handling or processing of this new and exciting material please don’t hesitate to contact the Aristech Technical Service department for assistance and advise.

Conventional Oven			
Product Group	Temperature	Time (minutes)	Minimum Radius
AVONITE® Flex 3.2 mm (1/8")	370 °F 187 °C	4-6	0
AVONITE® Flex 6 mm (1/4")	370 °F 187 °C	5-10	0
AVONITE® Flex 10mm (2/5")	370 °F 187 °C	15-20	0
Platen Oven			
AVONITE® Flex 3.2mm (1/8")	302 °F 150 °C	3	0
AVONITE® Flex 6mm (1/4")	302 °F 150 °C	6	0
AVONITE® Flex 10mm (2/5")	302 °F 150 °C	10	0

3.3 Heating Equipment

Forced Air Circulating Ovens

Forced air circulating ovens generally provide uniform heating at a constant temperature with the least danger of overheating the AVONITE® Flex sheet. Electric fans should be used to circulate the hot air across the sheeting at velocities of approximately 150 ft./minute (46 m/minute). Suitable baffles should be used to distribute the heat evenly throughout the oven. Heating may be done with gas or electricity. Gas ovens require heat exchangers to prevent the accumulation of soot from the flue gas. Electric ovens can be heated with a series of 1000-watt strip heating elements. An oven with a capacity of 360 ft3 (10 m3), for example, will require approximately 25,000 watts of input. About one-half of this input is required to overcome heating losses through the insulation, leaks, and door usage. An oven insulation at least two inches thick is suggested. Oven doors should be narrow to minimize heat loss, but at least one door should be large enough to permit reheating of formed parts which may require reforming. The oven should have automatic controls so that any desired temperature in the range of 250 to 450 °F (121 to 232 °C) can be closely maintained. In addition, temperature recording devices are desirable, but not essential. Uniform heating is best provided when the sheet is hung vertically. This can be accomplished by hanging the sheets on overhead racks designed to roll along a monorail mounted in the oven roof or in a portable unit. Precautions should be taken so that the sheet cannot fold or come in contact with another. A series of spring clips or a spring channel can be used for securely grasping the sheet along its entire length.

Infra-Red Heating

Infra-red radiation can heat AVONITE® Flex sheet three to ten times faster than forced-air heating. This type of heating is often used with automatic forming machines where a minimum cycle time is important. Temperature control, however, is much more critical and uniform heating is more difficult to obtain by this method. AVONITE® Flex absorbs most of the infra-red energy on the exposed surface, which can rapidly attain temperatures of over 360 °F (182 °C). The center of the sheet is heated by a slower conduction of heat from the hot surface. This usually causes temperature gradients across the thickness. The gradient is more severe with infra-red heating from one side only. (See Figure 17). Infra-red radiant heat is usually supplied with reflector backed tubular metal elements, resistance wire coils or a bank of infra-red lamps.

More uniform heat distribution can sometimes be accomplished by mounting a fine wire-mesh screen between the sheet and the heat source. A temperature Controlled technology, such as a solid state PLC or percentage timer on older apparatus should always be used for consistent results. Top infra-red heaters should be approximately 12” (30 cm) from the sheet. Bottom heaters can be 18 to 20” (45 to 50 cm) away.

Types of Infra-Red Heating

A. Gas: Can be open flame (less common) or gas catalytic. Economical to run but poor control of the heat, impossible to control the heat profile.

B. Calrod: Electrical resistance elements such as the type used in domestic ovens. It is a nichrome wire surrounded by a silicon or mica insulator.

C. Nichrome Wire: An exposed nichrome wire without insulation usually set into channels in a ceramic or other insulative panel.

D. Ceramic Heating Elements: A nichrome wire embedded in an insulator and then sheathed in a ceramic tube.

E. Infrared Panel Heaters: Tungsten wire elements mounted in channels within an insulator panel.

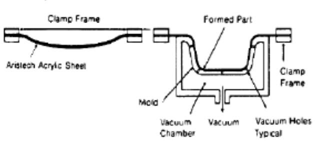
F. Quartz Heating Element: The most common type of heating. You can better control the heat profile either by screening off sections or if the system has it, automated control of each heating zone. They use a tungsten wire element encased in a quartz tube.

G. Halogen: Like the quartz heating element, this heat source is a tungsten wire encased in a quartz tube, but the tube is sealed and filled with an inert halogen gas preventing oxidation of the element. This allows the element to go to much higher temperatures without burning out. The very best control of heat profile and heat flow. Halogen not as common because these systems are comparatively more expensive.

3.4 Three-Dimensional Forming

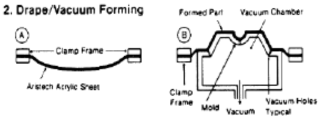
Techniques for three-dimensional forming of plastic generally require vacuum, air pressure, mechanical assists, or combinations of all three to manipulate the heated sheet into the desired shape. The basic forming techniques used for AVONITE® Flex sheet are illustrated in the following drawings and described below.

1. Vacuum Forming



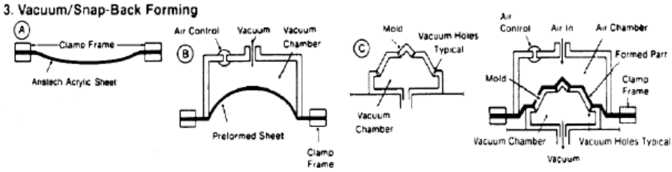
A. Heated sheet in clamp frame.
B. Mold is mechanically positioned to heated sheet, forming a seal. Vacuum is then applied to form part.

2. Drape/Vacuum Forming



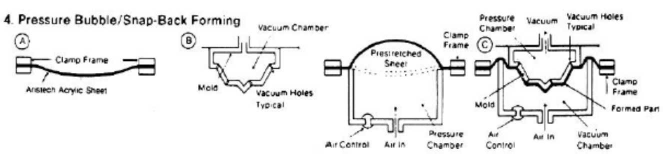
A. Heated sheet in clamp frame.
B. The mold is forced into the sheet to a depth that forms a seal around the periphery. Vacuum is then applied to form the part.

3. Vacuum/Snap-Back Forming



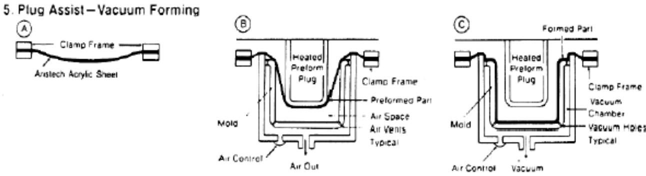
A. Heated sheet in clamp frame.
B. Position vacuum chamber to heated sheet to form seal. Apply vacuum to form bubble to predetermined height.
C. Insert mold into heated/prestretched sheet to form seal. Air control relieves vacuum in preform vacuum chamber. Apply vacuum to mold to form part.

4. Pressure Bubble/Snap-Back Forming



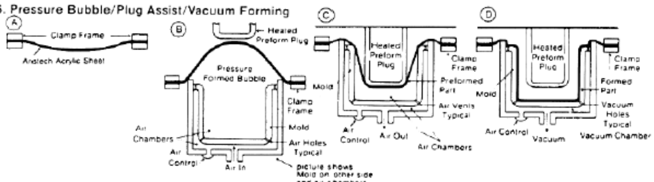
A. Heated sheet in clamping frame.
B. Position pressure chamber into heated sheet to form seal. Apply pressure to prestretched sheet to controlled height.
C. Insert mold into prestretched bubble at a controlled rate. Insert to depth required to form a seal.

5. Plug Assist—Vacuum Forming



A. Heated sheet in clamping frame.
B. Position mold into heated sheet to form seal. Insert heated plug at controlled rate to the depth required for preforming.
C. Apply vacuum to form part.

6. Pressure Bubble/Plug Assist/Vacuum Forming



A. Heated sheet in clamping frame.
B. Position mold into heated sheet to form pressure seal. Apply pressure to prestretch sheet to controlled height.
C. Insert heated plug into bubble at a controlled rate to the depth required for preforming.
D. Apply vacuum to form part.

3.5 Molds

WOOD
Wooden molds are easily fabricated, inexpensive and can be altered readily. Wood molds are ideal for short production runs where mold markoff is not important and for prototyping.

EPOXY
Epoxy molds yield the least amount of mold mark off of any of the mold materials used. Epoxy molds can be used for medium production runs and have good durability provided they are properly fabricated.

ALUMINUM
Aluminum molds are used in high production operations. Aluminum molds will last indefinitely with little maintenance required.

Problem	Probable Cause	Corrective Action
Blistering.	Sheet too hot.	Reduce time heaters or reduce voltage. Move heater farther away. use screening if localized.
Poor definition of detail. Incomplete forming.	Sheet too cold. Low vacuum. Sheet too thick. Low air pressure.	Increase heat input to sheet. Check for leaks in vacuum system. Increase number and/or size of vacuum holes. Add vacuum capacity. Use thinner caliper sheet. Increase volume and/or pressure.
Excessive thinning at bottom of draw or corners.	Poor technique. Sheet too thin. Drawdown too fast.	Change forming cycle to include billowing or plug assist. Use screening to control temperature profile. Use thicker sheet. Decrease rate of drawdown.
Extreme wall thickness variations.	Uneven sheet heating. Mold too cold. Sheet slipping. Stray air currents.	Check temperature profile. Change heaters to provide higher uniform mold surface temperature. Check cooling system for scale or plugs. Adjust clamping frame to provide uniform pressures. Provide protection to eliminate drafts.
Excessive sag.	Sheet too hot.	Reduce time or temperature.
Pits or pimples.	Vacuum holes too large. Vacuum rate too high. Dirt on mold or sheet.	Use smaller holes. Decrease vacuum rate or level. Clean mold and/or sheet.
Part sticking to mold.	Rough mold surface. Undercuts too deep. Not enough draft.	Polish mold. Reduce undercuts. Change to split mold. Increase draft of mold.
Mark-off.	Dirt on sheet. Dirt on mold. Dirt in atmosphere. Sheet too hot.	Clean sheet. Clean mold. Clean vacuum forming area. Isolate area if necessary and supply filtered air. Reduce heat and heat more slowly.
Distortion in finished part.	Part removed too hot. Uneven heating.	Increase cooling time before removing part. Check cooling system. Check temperature profile. Correct mold design — stiffen to eliminate.

4.0 REPAIR AND RENEW

4.1 Repair Instructions for Light Colors

Lighter colors such as Pure Alabaster 8701, Alabaster Wave 8705 and European White 8704 can be repaired with the instructions below.

Care And Maintenance
Each customer must receive AVONITE® Flex Care & Maintenance information to ensure they understand the proper care and maintenance for the AVONITE® Flex installation and to register for the 15-Year Limited Warranty, or the new Installed Warranty as appropriate. The AVONITE® Flex Care & Maintenance information, as well as all warranty information is available online at www.aristechsurfaces.com

Cleaning
Soap and water will clean most stains. For more stubborn stains use a green Scotch-Brite® pad and an abrasive cleanser.

Scratches
To remove scratches, start sanding with 320 grit paper and then clean with an abrasive cleanser and a green Scotch-Brite® pad. Remember to periodically go over the entire matte surface with a dry, green Scotch Brite® pad to return the original finish.

4.2 Repair Instructions for Dark Colors

Darker Colors such as Pure Ebony 8702 can be repaired with the instructions below.

1. Wet sand using 3M Trizact red for approximately 10-15 seconds, cleaning with a wet cloth before proceeding to the next step.

2. Wet sand using 3M Trizact green for approximately 10-15 seconds, cleaning with a wet cloth before proceeding to the next step.

3. Wet sand using 3M Trizact blue for approximately 10-15 seconds, cleaning with a wet cloth before proceeding to the next step.

4. Wet sand using 3M Trizact orange for approximately 10-15 seconds, cleaning with a wet cloth before proceeding to the next step.

5. Use a wet 3M Maroon Scotchbrite pad for approximately 10-15 seconds, cleaning with a wet cloth before proceeding to the next step.

6. Use a wet 3M Gray Scotchbrite pad for approximately 10-15 seconds, cleaning with a wet cloth before proceeding to the next step.

7. Use a wet 3M White Scotchbrite pad for as long as needed to achieve a matching finish, approximately 5-10 seconds. If too glossy, repeat Gray Scotchbrite and refinish with White scotchbrite until the gloss matches the remaining sheet.

For cautions and other information relating to handling of an exposure to this product, please see the applicable material safety data sheet published by Aristech Surfaces LLC.

These instructions are based upon experience with Aristech Surfaces products only. Experience with products of other manufacturers is specifically disclaimed. For most uses, check for local code approval and test for application suitability. These procedures, techniques and suggested materials should only be used by personnel who are properly trained in the safe handling of the chemicals and the equipment with which they are working. Avoid aromatic solvents, clean with mild soap and water, avoid abrasives. These suggestions are based on information believed to be reliable, however, Aristech Surfaces makes no warranty, guarantee, or representation and assumes no obligations or liability as to the absolute correctness or sufficiency of any of the foregoing, or that additional or other measures may not be required under particular conditions or circumstances.

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