APPLICATION

For best results when using our spraying system, certain instructions must be followed. Below are the recommendations to be observed when applying spray polyurethane systems.

THIS POLYURETHANE SPRAY APPLICATION GUIDE IS TO BE USED ONLY AS A GENERAL REFERENCE. THE USER IS RESPONSIBLE FOR VERIFYING THE PRODUCT'S APPLICABILITY AND APPROPRIATENESS, BEFORE THE SPRAYING PROCESS IS BEGUN. BASF ASSUMES NO RESPONSABILITY FOR ANY DAMAGES THAT MAY OCCUR OR FOR ANY CLAIMS MADE BY INDIVIDUALS USING THE PRODUCT IN ACCORDANCE WITH THE GUIDELINES BELOW.

SUBSTRATE PREPARATION

The substrate being sprayed should have no traces of oil, grease, wax, rust, oxidization, dirt, or water. Certain metal surfaces will require sandblasting and the application of a primer in order to promote adhesion of the foam. On other types of surfaces that demonstrate less adhesion, mechanical means will have to be employed in order to facilitate the anchoring of the foam.

The temperature of the substrate is a key element that affects both the density and adhesion of the foam. For optimal results, surface temperature should be at least +21°C (+70°F). Since it is not always feasible to maintain the surface temperature at an ideal level, compromises must be made when temperatures are lower. The section entitled **Cold Weather Spraying** contains all of the information needed in order to complete the work under these conditions. Should there be any doubt that the expected results will be achieved, test a small area of the substrate. Water (in the form of rain, fog, condensation, etc.) reacts with the isocyanate and will affect the foam and the product's properties, particularly its adhesive qualities. If necessary, a temporary shelter should be installed to protect the work area against rain, snow, dew, etc. The foam should not be spray when relative humidity is higher than 80%, since this will affect the properties of the foam.

A wind velocity of more than 10 mph (15 kph) will result in sufficient drifting foam and consequent loss of heat to affect the foam's thermal properties and density. Under these conditions, the foam surface will be affected. When wind velocity is higher than recommended for spraying, be sure to take all necessary precautions to avoid contamination of adjacent work areas due to overspray and vapor. The use of a windbreak is suggested in these circumstances.

COLD WEATHER SPRAYING

Although it is preferable to spray polyurethane foam when the ambient and substrate temperatures are at least +21°C (+70°F), the procedure can be performed at temperatures well below 0°C (+32°F), provided the usual precautions are taken and the correct mixture is used.

Polyurethane is produced when isocyanate and a resin are mixed together in the spraygun's mixing chamber. This produces an exothermic reaction, i.e., one characterized by a release of heat. The heat produced by this chemical reaction causes the foaming agent to vaporize, creating increased foam expansion. The entire process is dependent on the type of formulation and it is important that the application of the foam be completed before it becomes rigid.

Lower temperatures will affect reactivity in two ways:

1. They slow down chemical reactions.
2. The heat of the thin chemical product layer is absorbed by the substrate upon contact.

In terms of heat loss, substrate temperature will have a much more pronounced effect than will ambient air temperature, since the liquid to air heat transfer process is much slower than liquid to solid. Consequently, if the substrate temperature is excessively low, reaction heat will be absorbed so quickly by the substrate that there would be no time for the foaming agent, which is activated at +32°C (+90°F), to vaporize, thus preventing the creation of foam.

This would lead us to believe that ambient temperature is only a secondary factor among problems related to cold weather spraying. It is not, however, the case, especially at temperatures of +5°C (+40°F) or lower. Although the reaction appears to take no more than a few minutes following application, the fact remains that the foam will generally not attain maximum resistance for another 24 to 48 hours. The lower the temperature, the longer the curing time.

As mentioned above, the foam produces an exothermic reaction and its component cells are filled with hot gas during this process. In cold weather conditions, the foam cools quickly, resulting in the compression and then liquefaction of the gas. This creates a void in the cells and, due to the extremely slow passage of air through the cell walls, considerable tension is applied through atmospheric pressure on the mass of the foam. Since the foam is at this stage only partly cured and is still in a non-rigid plastic state, it ends up shrinking under pressure.

Since the foam has not yet completely adhered to the substrate at this point, it has no capacity for resistance to the forces of shrinkage and therefore detaches itself from the substrate. The thicker the foam layer, the greater the problem. If the foam has been applied in a thin layer, it will better resist shrinkage. Consequently, the degree of adhesion of the foam layer depends on its thickness. Since a greater degree of retraction occurs along the outer edges of the foam layer, the tendency is to ″curl up″ at the edges and then to detach itself from the substrate.

When applying the foam in cold weather, it is preferable to spray it on in several thin layers rather than in a single thick one, in order to prevent shrinkage. Because of the shrinkage problem and the need to apply the foam in thin layers, **WALLTITE® Cold Temperature Grade (CT)** works better when sprayed in cold weather.

If the foam must be sprayed on at a temperature of less than +5°C (+40°F), it would be advisable to refer to the data sheets.

SPRAYING IN THICK LAYERS

Careful attention must be paid when spraying in this fashion (where the layers are over 50 mm [2 inches] thick), since the foam must be prevented from cracking or detaching itself, especially when it is applied onto a large surface without partition walls being used as dividers. This problem can be aggravated in winter (refer to the section entitled: Cold Weather Spraying).

Spraying the foam on in 50 mm (2″) layers or less does not generally create any problems unless either the substrate or ambient temperature is less than +10°C (50°F). If the spray flow is high and the foam is applied on a large surface under these conditions, the contraction of the foam that is caused by the change from spraying temperature to ambient temperature will create tensions in the foam that exceed its resistance and cause it to detach itself from the substrate. In this type of situation, the foam will crack and may detach itself and ″curl up″ at the edges. To better understand the effects of contraction, spray the foam onto a piece of cardboard and watch the edges come away as the foam cools down.

It is sometimes necessary to apply a 101.6-152.4 mm (4-6 inches) layer, for example when building a cold-storage warehouse, a cold room, etc. It is especially important in these situations to ensure the foam does not crack or detach. There is a greater likelihood of problems arising when the foam is sprayed in thick layers, for the following two reasons:

1. **The exothermicity of a thick layer is much greater than that of a layer measuring 2 inches or less. Depending on the application method, the spray flow, the type of substrate, etc., the temperature of foam layers that are 101.6-152.4 mm (4-6″) thick can reach between 95°C and 150°C (200-300°F). During the cooling process, the foam is subjected to greater tension and the risks of failure are consequently more pronounced.**
2. **Given the importance of the mass of the foam, its adhesion to the substrate brings into play forces that are greater than in the case of thin layer application.**

As its temperature decreases, the foam has a natural tendency to shrink because of its exothermic nature in comparison to the outside cold temperatures. As a result, the gas contained inside the still warm foam cells will liquefy, creating a partial void in the cells, which in turn causes a drop in pressure. In order for it to stabilize, the foam's properties must allow resistance to these differential pressures. Furthermore, it must sufficiently adhere to the substrate in order to ensure resistance to tension during the cooling process. The use of a high quality foam will ensure sufficient initial resistance to tension when the usual precautions are taken during the application process. While being applied, the foam is not completely polymerized and will therefore demonstrate great flexibility. This will generally allow it to stretch sufficiently so that it can adapt to the substrate shape and to the shrinkage forces without cracking. While it is curing, the foam will harden in its new shape and the tension is eliminated. Special application techniques must, however, be used in order for the foam to be able to adapt to the changes described above.

The insulation foams that contain small spherical cells demonstrate greater resistance, depending on their density. When a thick layer of foam is sprayed in a single pass, the cells become elongated, following the foam's expansion direction, and the density is lower. These cells demonstrate a much lower resistance when the foam is applied in a perpendicular direction to the expansion axis. As a result, the foam is less resistant in the direction of the stronger stress produced when a layer of foam sprayed on a wall or ceiling starts to cool.

Foam layers that are sprayed on a cold substrate will show a greater tendency to crumble on the side touching the substrate, the result being reduced adhesive properties. It is therefore important to first spray a thin layer (not a flash) in order to minimize the contraction strength, until the curing process is terminated and the crumbling effects on the side in contact with the substrate have disappeared.

<u>In order to avoid the above mentioned problems, the procedure described below should be followed:</u>

1. The substrate should be carefully prepared to ensure maximum adhesion. Make sure it is dry, clean, and free of any loose mortar, dirt, oxidization, oil, grease, and wax. A primer coat should be applied on metal surfaces. The substrate must be firmly attached to the building frame, in such a manner as not to allow the foam to detach during the curing process.

2. In order to ensure higher density when applying high quality foam cells to the substrate, the first layer sprayed should be between 12.5 and 50 mm (0.5-2″) thick. Leave the foam to cool, preferably overnight, and check the adhesion of this layer before spraying over it.
3. It is extremely important to prevent excessive heat accumulation inside the foam. Do not spray the layers in a thickness of more than 50 mm (2″), and allow each layer to cool completely before applying a second coat.
4. In cold water begin spraying in the corners and at the wall-ceiling intersection points, applying foam in 0.3048-0.6096 meter (1-2′) sections in each direction. Following this process will help ensure complete curing of the foam in these locations, thus preventing it from detach from the substrate in the corners.
5. Begin spraying again 0.6096 to 0.914 meters (2-3′) away from the 3-4.5 m (10-15′) strips already applied to the walls or ceiling, and repeat until the desired thickness is achieved (the accumulation of thick coats must be avoided). Before spraying the next strip, leave a space of 0.6096-0,914 meters (2-3′).
6) Finally, fill the empty spaces between the strips as well as those in the corners (allow at least 4 hours curing time).
7) If feasible, keep the foam at ambient temperature (the highest possible) for at least 48 hours before reducing the temperature of the room. Cool the room down gradually – no more than 5°C (10°F) every 24 hours. This allows for complete curing at regular temperatures and relieves the foam's thermal tension before it is subjected to any other heat variations.
8) Take the following precautions:

A) Avoid applying the foam in an arc when spraying overhead. It would be helpful for the applicator to be positioned with his/her head just a few inches from the ceiling, thus ensuring the arms are pointing downward; this makes it easier to achieve the desired results at the end of each pass.

B) Each pass of the sprayer should be narrow enough that the applicator should not need to stretch or to spray the foam at an acute angle, which would result in an accumulation of trapped air and reduced adhesion. The spray gun should, as much as possible, be held at right angles to the surface, i.e., pointing directly toward the substrate rather than being held at an angle.

C) Check the substrate continuously for condensation. If it has occurred, stop spraying and wait for conditions to return to normal. This phenomenon is likely to occur when foam is being sprayed in a cold room in winter. Heat is released by exothermic reaction that occurs when the foam comes in contact with a cold surface, resulting in condensation on both walls and ceilings which often goes undetected.

D) Spraying the foam in wide and thick sections is only effective if adhesion is good and heat accumulation inside the product is avoided. Should cracking occur even though adhesion is good, the foam will not detach from the substrate and the crack can be filled in later on. In order to promote adequate foam adhesion, the substrate must be kept warm, clean, dry, sturdy, and be prepared with a primer if necessary.

It is evident that the information set out above is general in nature. Following its application, each layer of foam should be carefully examined, keeping in mind the above guidelines. An adequate spraying system should be developed in order to ensure satisfactory work.

EQUIPMENT

The foam's adhesion, spray pattern, and finished surface are all governed by the temperature at which the chemicals are applied and the mixing ratio. All polyurethane foam spray equipment manufacturers have established optimal operating ranges based on ideal spraying temperatures.

A company may, for example, indicate that the primary heater temperature must be between +110 and 120°F, and that hose temperature should be no lower than +5°F to +15°F.

In all cases – no matter what brand of equipment is being used – the primary heater and hose temperatures must be adjusted based on spraying conditions.

This ratio can be easily verified by examining the foam's appearance. If the foam is dry and brittle, this indicates an insufficient quantity of resin. If it is soft and spongy, the isocyanate quantity needs to be increased. Current equipment is set up with preestablished mixing ratios.

Before beginning an actual spraying operation, the applicator should check the quality of the foam by test spraying a piece of cardboard or another disposable substrate. It is possible in this way to check reactivity, density, and foam cell quality.

FACTORS AFFECTING FOAM DENSITY

A. Foam density is affected by substrate and/or ambient air temperature.
B. Thickness of layers – Generally, density will decrease and lifespan will increase as the thickness of the layers increases.
C. Number of passes needed – Overall density will increase if the foam is applied in several consecutive layers. This is due to the formation of skins.
D. Temperature of chemicals – If the products are not at the right temperature when projected from the spray gun, the spray pattern will not be correct. As a result, the foam properties could be different from those desired, including a higher density and consequently a lesser lifestyle.
E. Consistency of layers – Many projects will require a minimum thickness of layers. When assessing the job, chemical product consumption could be 20-30% higher than the theoretical density values calculated on paper.
F. With all loss factors being taken into account, along with some of the other factors mentioned above, it is quite common for the chemical product quantity required to be 40-50% higher than the theoretical filler density calculations performed on site. The calculation method utilized becomes an important factor in determining the amount of foam consumption required for a project.