GENERAL METHOD STATEMENT
MASTERSEAL SPRAY APPLIED POLYURETHANE FOAMS

1 Scope

This documents describes the application process for **MasterSeal Spray applied Polyurethane Foams** and specifies all the general procedures and conditions. Specific requirements for each system can be found in the respective Technical Data Sheet (TDS).

2 Description

MasterSeal Spray Foam products are two component (Polyol and Isocyanate) systems. These products must be processed by a suitable machine in order to transform the components into foam.

3 Uses

MasterSeal Spray Foam systems are specially formulated for thermal insulation for all applications, such as residential and non-residential construction, industrial equipment.

Beyond its thermal insulation properties, **MasterSeal Spray Foams** contributes positively to other aspects like air tightness, water tightness, etc.

A detailed description of the principal properties is given in each **MasterSeal Spray Foam** technical data sheets (TDS), also stipulating the main uses for each product.

4 Storage Conditions

It is important to respect the following conditions in order to maintain the system properties:

4.1. Temperature

The optimal storage temperature is between +10 and +25 ºC. At higher temperatures, the blowing agent in the A Component (Polyol) may start to evaporate increasing the pressure inside the drum. This may cause a violent gas release when opening the drum. The exposition of the products to high temperatures for extended periods may damage the components. Direct sun exposure of the drums should be avoided.

Lower temperatures than +10ºC during long periods of time may cause the B component to crystalize. Crystals will obstruct the machine and spray gun filters.

4.2 Humidity

Both components A and B are sensitive to humidity and must always be kept in sealed drums or containers. Drums should be protected against humidity and especially against rain.

Water absorption by the A component may cause processing mistakes. The B component reacts with humidity forming urea solid particles and generating CO_2 gas. Crystal sediments will obstruct machine filters and the CO_2 can generate pressure inside the drums.

4.3 Shelf life

Both Part A and Part B components have an optimal established shelf life during the characteristics of the chemical reaction (Reactivity and density) and the foam obtains the declared physical properties.

The shelf life is given in each **MasterSeal Spray Foam** Technical Data Sheet (TDS).

4.4 Flash Points

Some **MasterSeal Spray Foam** products contain 141b as blowing agent. This is flammable gas, which in combination with other, non-flammable, blowing agents creates a final system without a flashpoint.

By leaving the drums opened for long periods of time, gases from the formulation can evaporate modifying its composition and potentially creating a mixture with a flashpoint. It is therefore recommended to keep the drums closed and at temperatures below 30 ºC.

5 Processing on Site

5.1 Previous Inspection

Before applying the product, an inspection of the following points should be carried out:

- Determination of the requirements for the spray foam (waterproofing, vapor permeability, compression strength, etc.)
- Substrate materials
- Surface to be insulated
- Presence of oils, grease or dust
- Substrate consistence and conditions
- Location of expansion joints, vents, etc.
- Local and national regulations (e.g.: National Building Codes)

Depending on these results, the applying technique and the spray foam system will be chosen.

5.2 Recommended Measuring Device

5.2.1 Substrate Hygrometer

One of the most frequent causes of foam defects (delamination, void formation, pin holes) is the substrate humidity. Visual inspection of the substrate is not enough, since the surface can be the driest point of the substrate. Most of the materials used in construction are porous and easily absorb humidity.

During the spraying process, due to the exothermic reaction, the humidity contained inside a substrate is evaporated and can be transferred to the foam causing defects in the foam.

Substrate hygrometers generally have 2 needles that allow the apparatus to determine the humidity up to 3 cm inside the substrate. It is not recommended to use equipment that measures just the surface properties of the material.

Universal devices exist for all substrates, while others are more specific for ceramic, wood or concrete materials.

Some modern hygrometers have just one contact instead of needles. These devices can also determine the substrate humidity with the advantage of not damaging the surface.

Needle Substrate Hygrometer

5.2.2 Surface Thermometer

As well as the substrate humidity, it is important to control the temperature of the substrate. Usually, an infrared thermometer is the most used option. Contact thermometers can also be used.

Infrared Thermometer

5.2.3 Anemometer

In external and some internal applications exposed to air drafts, it may be necessary to know the wind speed in order to avoid spray particle from being blown outside the area to be applied.

Anemometers are used to determine the wind speeds in a certain area. Many include a temperature and humidity sensor and therefore are also able to determine the dew point.

Anemometer

5.2.4 Foam Thickness Gauge

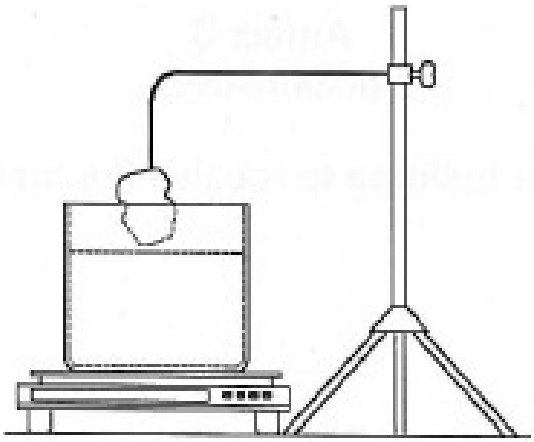
The determination of the foam thickness is done by means of a graduated poker which has a punching diameter of less than 2 mm

5.2.5 Weight

It is also highly recommended to have a small scale (accuracy=±0,1g) in order to determine the applied density by immersion.

Density determination is basic for the control of the installed product and its yield. Besides the scale, it is useful to have a tripod, a pin and a wire to immerse the foam sample and to determine the density. The volume of the sample immersed in the water in centimeters cubed is equal to the weight in grams of the displaced water. The density, obtained in grams per liter, is obtained dividing the weight of the sample (in grams) by its volume (in centimeters cubed) and multiplied by a conversion factor of 1000.

Foam Thickness Gauge



5.3 Surface Conditions

Under favorable weather conditions, the **MasterSeal Spray Foam** systems have a good adhesion to most constructions materials (concrete, brick, wood and steel). They must be clean (without dust or grease), dry and, in case of metallic substrates, free of rust. If the adhesion is not acceptable under these conditions, a previous treatment like a primer may be necessary. Before starting with the spraying process, it is recommended to do an adhesion test.

In applications with high vapor and temperature gradients (cold stores…), a vapor barrier will be installed always on the warm side of the insulation in order to avoid water condensations. It is highly recommended to cover metal surfaces with an adequate anticorrosive primer before being covered by foam.

The following table contains a description of the principal precautions that must be taken for each type of substrate before spraying.

Substrate	Comments
Wood, plaster and fibrocement	-Humidity should be lower than 20% -Some treatments may worsen adhesion. For instance, in case of presence of varnishes an adhesion test has to be carried out.
Concrete	-The surface moisture should be lower than 20% -An adhesion test should be carried out for some very smooth concrete surfaces.
Galvanized steel	-New galvanized steel has to be correctly cleaned with alcohols and dried -After a primer should be applied.

Painted substrates	-Adhesion may vary depending on the paint used. -Adhesion tests should be carried out.
Steel	-The surface has to be oil-free with no solvents or other substances that may affect adhesion -Remove dirt or particles. -Steel tanks should be previously protected with an adequate primer.
Stainless steel	-The surface has to be cleaned with alcohols or Xylene and afterwards painted with a primer. In some cases steel may need to be sanded.
Aluminum	-Clean with alcohols. -Do not use caustic solutions -Aluminum should be treated with primers against corrosion. After the foam being sprayed, acids may be formed at the aluminum surface and increase corrosion.
Glass	-Should be clean and dry -If a window is sprayed, it is important to protect it with an UV protective coating so light does not degrade the foam
PVC (Polyvinyl chloride)	-Clean with mineral alcohol. -It is important to take care when spraying this material as plasticizers lixiviation processes can seriously affect adhesion. -Flexible PVCs contain more plasticizers, while rigid one (tubes) contain fewer.
ABS (Acrylonitrile-Butadiene-Styrene)	-Clean with mineral alcohols. -Treat with a primer
Asphalt and tar.	-It has to be solvent free. -Substrate should be old enough in order to assure the absence of solvents.
Solvents	-Do not apply on surfaces containing solvents. -Primers and coatings which have solvents must be left enough time so these lose them completely
PUR Foam	-If it is really old foam affected by the sun light, clean with a wire brush and spray again.

Bituminous membrane	-The membrane has to adhere correctly to the substrate.

The foam must not be sprayed over flexible or badly fixed substrates. Those substrates have to be treated or properly fixed. If it is not possible, the substrate has to be removed.

Expansion joints must be properly treated when covering with foam. For guidance on how to treat expansion joints, ask for technical assistance.

5.4 Spraying Conditions

For an optimal product processing result and in order to reach the ideal properties it is important to pay attention to the following conditions:

5.4.1 Weather Conditions

Weather conditions are critical when applying spray foam. They can affect the spraying yield significantly and can influence the foam quality.

The previously explained recommended equipment is used to control the ambient conditions, such as humidity, temperature and wind speed.

5.4.2 Ambient and Substrate Temperature

During the spraying process, ambient and substrate temperatures should not be below +10ºC or above 40ºC. Specific systems exist, which are specially formulated to be processed at lower temperatures. The technical data sheet will specify temperatures in these cases.

Lower temperatures may affect the adhesion of the foam to the substrate and lower the yield. On the other hand, higher temperatures can cause the expansion of the foam to be too rapid and uncontrolled, potentially obstructing the mixing chamber in the spray gun.

5.4.3 Ambient and Substrate Humidity

The relative humidity of the air has to be lower than 85% during the application of the foam. In porous substrates such ceramic or concrete materials, the moisture content should not be higher than 20%.

Water drops on the substrate will create voids and a lower density making the foam weak in those regions. Pinholes inside the foam can be a sign of water on the surface. The compressed air used to activate the spray gun must also be completely dry.

Humidity both ambient and on the substrate produces a very porous foam with poor mechanical properties and adhesion.

When spraying on existing foam, it is important to make sure that there is no condensation on the surface before spraying again.

5.4.4 Wind Speed

In general, exterior spraying with wind speeds of more than 30 km/h is not recommended. Wind will lead to higher consumption since particles are blown away and do not arrive on the substrate. This also creates irregular surfaces. Special care has to be taken with nearby cars or buildings that can be stained by spray particles being blown away from the spray area.

Protective screens can be used to protect the application against the wind. However, the installer should evaluate in each case whether the wind can affect the foam quality or not.

5.4.5 Machine Conditions

Spray machines are specially designed for this application, operating with a pressure and temperature range suitable for these systems. They are usually high pressure, fixed mixing ratio machines.

Electric Spraying Machine

Hydraulic Spraying Machine

5.4.6 Mixing Ratio

The mixing ratio used to spray each system is specified in its technical data sheet. Typically, machines have a fixed mixing ratio of 100:100 by volume. When working with variable mixing ratio machines, the high-pressure pumps are adjusted to the desired mixing ratio.

The mixing ratio has to be checked regularly and the variation must be smaller than 5%. There are several ways to check the mixing ratio of the machine. One option is to meter out the components separately and the other one is by the means of a flow meter. However, the easiest way of checking the mixing ratio is through the consumption of the components throughout a working day.

It is important to control the content of the drum while spraying making sure that there is always some product left. Once the drum is empty, the transfer pump will start to pump air, causing a mixing ratio imbalance. Should this occur, the affected component should be recirculated until the air is purged completely out of the circuit.

5.4.7 Components Temperature and Pressure

The machine should have separate controls to regulate the temperature of the component pre-heaters and the hose heater. The working temperature should be regulated between 30 – 50 ºC (90 – 120 ºF) depending on the external weather conditions.

The components pressure has to be adjusted between 60 and 120 Bar in high pressure machines.

The pressure and temperatures need to be regulated in function of the spray gun and mixing chamber to ensure a good mixing quality and spray pattern to properly apply the foam.

5.4.8 Spraying Instructions

When the requirements are fulfilled and the machine parameters are properly set, the spraying process can be started.

Due to the short reaction times the foam can be sprayed on vertical walls as well ceilings without adhesion problems. The curing and hardening of the foam is very fast. After only few minutes the foam can support mechanical loading; however, the complete curing time is considered to be approximately 24 hours depending on ambient temperatures.

When spraying on very cold surfaces or those with high heat absorption, like metal, stone or concrete, a very thin layer (1-2 mm) of foam should be sprayed as a primer (flash coat) to improve the adhesion to the substrate. Once this thin layer is correctly cured (dry to the touch), the subsequent layers can be applied until the final desired thickness is reached.

It is important to make sure that the product is projected correctly as a liquid when it leaves the spray gun, turning to solid foam as soon as it touched the surface.

Application of primer layer over a ceramic substrate

The distance between the gun and the surface can vary, but it is recommended to be around 60-80cm. The foam will be sprayed in sections. When insulating a section, the product should be sprayed in a continuous way from left to right, or top to bottom, slowly advancing as the wave of the expanding foam grows behind the allied section.

Application of the foam between rafters in a wood roof

The spraying should be done in horizontal or vertical directions checking that there are no points with excessive product accumulation. Spraying should be as perpendicular as possible to the substrate.

The spray pattern should be regular and circle shaped or fan shaped for flat output mixing chambers. The output should also be constant and homogeneous without flow variations.

The final thickness is achieved by spraying several layers. The maximum and minimum layer thickness may vary from each PU foam products. Please consult Master Builder Solutions Technical Services for detailed information.

Higher than recommended layer thicknesses, cause a decrease in density and worse dimensional stability of the foam. Very thin layers will increase the density and decrease product yield.

In order to check the thickness easily, use the Master Builders Solutions thickness gauge.

Wen measuring the final installed thickness, it is important to respect the current standards or work instruction. In cases where specific measuring system is established, the installer should reach an agreement with his customer. The basic measuring method consists of a series of measuring points, choosing areas of apparent high and low thicknesses. The average of all points is then calculated.

When working with high thicknesses (>6 cm), it is important to make brief pauses between layers (2-3 minutes). Longer pauses are necessary for thicknesses above 10 cm. Applying various layers quickly will cause the foam to reach very high temperatures. This can lead to high tensions inside the foam during cooling and therefore foam shrinkage. Excessive temperatures can also cause the foam to catch fire.

5.5 Sampling

Sometimes it may be necessary to spray samples for laboratory analysis. Whenever possible, samples should be taken from a finished sprayed area and re-sprayed after the sample has been extracted.

For a smoother surface when spraying over an area where a sample has been extracted, cut the edges to a 45º angle.
Sometimes, taking a sample from a sprayed section will not be possible due to the sample size or because of the substrate (For example undulated fiber cement). In these cases samples are generated simulating the same conditions as the ones on site.

The following video on YouTube shows the steps to prepare samples: http://www.youtube.com/watch?v=Rf2TCEdE6AI&feature=related

5.6 Trouble Shooting of the Spraying Process

The following table shows some of the principal problems during the spraying process and some of the possible solutions.

Gun problems		
Problem	**Possible cause**	**Solution**
Irregular output	Gun needle poorly calibrated	Adjust its position
	Dirty mixing chamber	Clean mixing chamber
Differently colored output	Bad mixing due to partial obstruction of one component	Check pressure manometers. Obstruction of the components may be detectable by irregular pressures.
Differently colored output	Big difference of viscosities between components	Adjust component temperatures Increase temperature of the most viscous component
Small and narrow spray pattern	High viscosities of the components	Increase components temperature
	Low working pressure	Increase pressure
Big or wide spray pattern	Guns airflow too high	Decrease guns airflow
	High mixing pressure	Decrease pressure
	High temperatures	Decrease temperatures
Correct flow but slow reactivity	Cold surface	Look for better temperature conditions of the substrate
	Temperature wrongly regulated	Increase hoses temperature
	Expired product	Check with Master Builder Solutions Technical
The gun gets dirty frequently	High temperatures	Decrease hoses temperature

5.7 Safety

All the safety protocols on the construction site should be respected, such as the use of safety shoes, harnesses when necessary, safety helmets, etc.

Furthermore, when using chemical products it is important to take the following safety precautions:

5.7.1 Body Protection

- Hand protection: The use of nitrile gloves is necessary when using Isocyanates and/or Polyols.
- Eye protection: The use of safety goggles is required.

5.7.2 Spraying of the Product

During the spraying process some additional safety precautions should be followed:

- Use of breathing filter: The most suitable are filters type ABEK-P3. For an effective protection, proper maintenance and changing of filters must be performed.
- Use of complete facial masks with positive air pressure: The use of these masks is recommended in enclosed spaces. Fresh air is delivered to the mask from an external source. In this case the use of glasses is not necessary.

The use of complete protective clothing is necessary. These suits should be disposable. Should it be unavoidable to have skin exposed during spraying, the use of protective creams is recommended.

The safety data sheet of the components should read and understood by all workers. Furthermore, the document “Security and Precaution in Polyurethane Systems Manipulation“ can be obtained from our technical or sales department.

When using solvents to clean the machine parts, it is important to pay attention to the manufacturer’s instructions.

Example of Safety Goggles

Example of Breathing Filter

Example of Facial Mask with positive air pressure

5.8 Protection of the Foam

MasterSeal Spray Foam is a lasting product that guarantees its properties during the whole life of the insulated element. One of the few things that can degrade the rigid polyurethane foam is prolonged exposure to UV light. The surface of the any rigid polyurethane foam turns brown and degrades due to prolonged exposure to sunlight. It is therefore highly recommended to protect foam that will be exposed to sunlight for a long period of time.

The degradation takes place on the surface of the foam. The affected layer acts as a protection of the rest of the foam; however, wind and water will, over time, erode some of the degraded foam, leaving fresh foam again exposed to the sun. The speed of the degradation process depends heavily on the ambient conditions (wind, intensity of the sun, rain, etc.). In general, degradation occurs at approximately 1 mm per year.

MasterSeal Spray Foam on exterior roofs is often covered directly by a layer of concrete, shingles or loose gravel. The foam can also be coated by UV protective paints or elastomeric coatings. There are many kinds of coatings on the market: acrylic, rubber/butyl, neoprene, vinyl, silicones, asphalt, one and two- component polyurethanes, etc.

Master Builder Solutions Construction Chemicals also supplies **MasterSeal** ranges of coatings. For further details, please contact a Master Builder Solutions Representative.

6.0 Foam Troubleshooting

The following table contains some of the principal problems concerning the foam properties, their possible causes and prevention:

Problem	Possible cause	Prevention
Foam delamination	Very cold surface	Avoid spraying below 5°C
	Surface with no adhesion or with dust	Do an adhesion test[1]
	Presence of moisture	Verify that the substrate is dry
	Loose material on surface	Ensure the surface is solid
	The first thin foam layer (primer, flash coat) curing time was too short after applying the next layer	Assure layers are cured before applying the next one
Excessive shrinkage or deformation of the foam	Layers are too thick	Apply layer thicknesses according to the technical information

	The components have absorbed moisture	Drums should be tightly closed until their use
Excessive shrinkage or deformation of the foam	Addition of blowing agents or other substances	Do not add any component to the formulation unless otherwise indicated by the Master Builder Solutions Technical Department
Very rough finish	Component pressure too low, bad temperature regulation	Adjustments temperatures to obtain the correct reaction conditions and the right spray pattern
	Application in high wind conditions	Avoid spraying under high wind conditions or use wind screens.

Surfaces such as plastics (polyethylene, polypropylene, PVC, polyester) or metals (aluminum, galvanized steel) may present adhesion problems. In such cases it is recommendable to apply a primer first.