NOVA Chemicals®

# Expandable Polystyrene

## Storage and Handling Safety Guide

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## INTRODUCTION

NOVA Chemicals is the largest producer of expandable polystyrene (EPS) in North America. NOVA Chemicals manufactures expandable polystyrene at two North American facilities: Beaver Valley (Monaca), Pennsylvania and Painesville, Ohio. These manufacturing facilities are certified under the International Organization for Standardization (ISO) 9002 quality standard. Supporting the manufacturing and sales of our products is our technology center at Beaver Valley, which also hosts a pilot demonstration plant. NOVA Chemicals has sales offices located throughout the world.

NOVA Chemicals' expandable polystyrene consists of spherical beads of thermoplastic polystyrene typically 0.25 mm to 2.0 mm in diameter. Our EPS contains between 3-8% by weight of a volatile, flammable blowing agent, typically pentane. NOVA Chemicals also produces ULTRA LOW™ grades of EPS containing about 3% or less of pentane.

NOVA Chemicals produces three broad types of EPS resin: Regular, Modified and Specialty. Regular EPS is our general-purpose EPS resin. NOVA Chemicals' modified EPS contains a specially formulated flame retardant. If ignited, properly aged foam products molded exclusively from these modified beads in accordance with good manufacturing practices and without the use of additional additives or lubricants will, once the source of ignition is completely eliminated, stop burning sooner than if this specially formulated additive had not been incorporated in these beads. In distribution of foam manufactured from these modified beads, no claim beyond the foregoing should be made with regard to any benefits derived from the incorporation of this specially formulated additive. NOVA Chemicals' specialty EPS includes our superior performance DYLITE® cup and container grade EPS, low and ULTRA LOW™ pentane products.

NOVA Chemicals' EPS is available with various properties and processing characteristics; and can be expanded to a broad range of densities and manufactured into a wide variety of useful applications. The broad spectrum of physical properties that are attainable with molded expanded polystyrene makes it a versatile material where low thermal conductivity, impact cushioning, moisture resistance, and lightweight are important. Details of these physical properties are summarized in our Product Data Sheet.

As a Responsible Care® company, NOVA Chemicals works to ensure the safest possible management of chemical products throughout their life cycle from the planning of new products through their manufacture, distribution, use and ultimate disposal. In support of our Responsible Care® commitment, NOVA Chemicals has compiled this document as a general guide to help our customers safely handle, store and process our EPS resin. The information provided in this Guide is believed to be accurate as of the publication date of this Guide. NOVA Chemicals does not warrant or represent the information given to be accurate or complete, and expressly disclaims all implied warranties and conditions including those of merchantability and fitness of product(s) for a particular purpose. The information contained herein is subject to change without notice and NOVA Chemicals disclaims any obligation to update the information contained herein. Responsibility for use, transportation, storage, processing, handling and disposal of the products described herein is that of the purchaser or end user.

This Guide is intended for use in conjunction with NOVA Chemicals' Material Safety Data Sheets (MSDSs). Essential information relating to the safe handling, transporting, storing and use of our EPS is detailed on the MSDS. It is important to note that government legislation/regulations and industry standards/codes for building, fire protection/prevention, environment, health and safety, processing, use and transporting of EPS must always be observed. Certain information prescribed by government regulations is summarized on the MSDSs. Please contact your NOVA Chemicals' Customer Service Representative for an up-to-date MSDS.

## APPLICATIONS

NOVA Chemicals' expandable polystyrene gives our customers the ability to develop innovative end-use products, providing convenience, safety and economy. Customers mold our expandable polystyrene into a wide variety of everyday items.

### Construction:

- Floor, Ceiling and Wall Insulation
- Structural Insulated Panels (SIPs)
- Sheathing
- Geofoam
- Door Cores
- Insulating Concrete Forms (ICF's)
- Roofing Insulation Systems
- Exterior Insulation and Finishing Systems (EIFS)

### Packaging/Shapes:

- Picnic Coolers/Buckets
- General Purpose Packaging
- Original Equipment Manufacturer (OEM) Packaging
  - Refrigeration Divider Trays
  - Air Conditioning Insulation
  - Computer Cushioning
- Thermal Protective Packaging
  - Produce/Fish Boxes
  - Pharmaceutical /Shipping Containers
  - Wine Packs
- Fabricated Packaging
  - Dunnage Trays
  - Point-of-Purchase Displays
  - End Caps
  - Edge Protectors
- Produce Packaging
- Flotation
  - Water Tank Floats
  - Marine Flotation
- Toys
- Foundry Foam Casting

### Specialty Foams:

- Foam Cups and Containers
  - Coffee Cups
  - Cold Drink Cups
  - Noodle Bowls
  - Ice Cream Bowls
  - Take-out Containers

Approval by NOVA Chemicals of any application for expandable polystyrene is neither intended nor implied by the contents of this Guide.

## EPS COMPOSITION

There are two principal components of EPS: solid styrenic polymer (polystyrene beads) and a blowing agent. The information below will detail the technical information on the components of EPS.

### Raw Base Material: Solid Styrenic Polymer (Polystyrene)

Form: Particulate Thermoplastic

Softening Point ~212°F (100°C)

(ASTM Tg Test Methods, E1640-99, E1545-00, E1824-96, E1356-98, or D3418-99)
Particulate product containing no blowing agent has a glass transition temperature (Tg) (also known as a softening point) of ~212°F (100°C). Foam products typically are more sensitive to heat than their solid equivalents. Foam products should not be continuously exposed to temperatures in excess of 175°F (79°C), (ASTM C447-85-1995e-1). Beads containing blowing agent may soften and expand in the range of 140-215°F (60-101.7°C).

Flammability: Combustible

Pyrolysis: 662-752°F (350-400°C) (ASTM E1591-00)

Auto-Ignition Temperature: ~800.6 F (427°C) (ASTM D2883-95)

Heat of Combustion: ~17,400 BTU/pound (40,500 KJ/Kg) (ASTM E1623-99)

### Blowing Agent: Pentane, liquid hydrocarbon

Pentane ($C_5H_{10-12}$) 3% to 8% by weight

| Property | Normal pentane | Isopentane | Cyclopentane |
|---|---|---|---|
| Synonyms | n-pentane | i-pentane | c-pentane |
| Molecular Formula | $C_5H_{12}$ | $C_5H_{12}$ | $C_5H_{10}$ |
| Flash Point | -56.2°F (-49°C) | -68.8°F (-56°C) | -34.6°F (-37°C) |
| Auto ignition temperature | ~ 545°F (285°C) | | |
| Density (g/cc) – Liquid | 0.626 | 0.62 | 0.751 |
| Vapor density (Air = 1.0) | 2.5 | | |
| Flammable Limits:<br>Lower (LFL)<br>Upper (UFL) | <br>1.4% by volume<br>8.3% by volume | | |
| Heat of Combustion | ~21,000 BTU/pound (48,800 KJ/Kg) | | |

## HAZARDS

As with many commercially available chemicals, products and services, there are hazards associated with expandable polystyrene resins and molded foam articles. If appropriate measures are taken, however, the risks arising from these hazards may be minimized. The following sections highlight, but are not intended to exhaustively identify or describe the most common hazards associated with EPS resins and molded foam articles: Please refer to the MSDS for additional information.

### Fire Hazards

The principal safety hazard associated with transporting, storing, handling and processing EPS is fire; EPS is flammable. The blowing agent, usually pentane (normal, iso and/or cyclo blends) evaporates from the beads during storage and processing and from molded products at different rates. The United Nations Subcommittee on the Transport of Dangerous Goods and the U.S. Department of Transportation (DOT) have classified expandable polystyrene resin as a hazard class 9 (miscellaneous hazard) and has assigned a material identification number of 2211 (polymeric beads, expandable, evolving flammable vapor).

Pentane vapors are colorless and weigh approximately 2½ times more than air. They are flammable in vapor-in-air mixtures of 1.4% to 8.3% by volume; mixtures within this range can be ignited with low intensity ignition sources. Therefore, when handling EPS, two principal efforts should be made: eliminating ignition sources (including static sparks) and preventing pentane vapor accumulation.

#### Eliminating Sources of Ignition

1. Prohibit smoking and the carrying of matches and lighters in all operating areas (receiving, processing, fabricating, storage, warehouse and shipping).

2. Separate equipment that may have open flames or generate sparks (boilers, water heaters, stoves) from operating areas described above. Fire doors should be either self-closing or kept closed.

3. Maintain equipment in good working order to avoid generation of electrical, frictional, or electrostatic sparks which can constitute an ignition source. Good electric bonding and grounding of all handling/processing equipment including transfer lines, storage bins, valves, and grinders is essential.

4. When hazardous work, such as welding, must be done in operating areas, remove combustibles from the area and perform the work under close supervision with fire extinguishers immediately available.

5. Other equipment and devices such as cellular phones and other communication equipment, circuit breakers or computers may generate electric sparks. Electronic equipment such as telephones and radios may be used as long as they are non-sparking.

6. EPS beads, pre-expanded beads or molded foam articles should be handled with caution as static electric discharge from any part of the body including skin and clothing could result in a fire. Proper grounding procedures - such as discharging static from the body before entering a potentially explosive atmosphere, wearing a wristlet connected to a ground source and using conductive footwear and flooring – are important safety controls that may reduce spark potential.

### Preventing Pentane Vapor Accumulation

1. Pentane vapors, because they are heavier than air, may accumulate in depressions, enclosed areas [trailers, containers, low spots (e.g., trenches, sumps, stairwells) or confined spaces (e.g., bulk raw material storage bins] that are not continuously ventilated. Provide positive ventilation in these and similar areas.

2. Molded foam articles may exhibit a pentane halo immediately after molding or cutting. The halo may gradually diminish thereafter, and is generally no longer evident after 7 days storage at ambient temperature. The fire hazard from pentane vapors diminishes as the pentane concentration in molded foam declines during normal post molding inspection, storage, shipment and application (10 to 14 days). Molded foam articles should be aged and stored in well-ventilated areas.

## Health Hazards

EPS beads and properly aged articles fabricated or processed exclusively from EPS beads (i.e., no mold release, lubricant, colorant, paint or any other additive) are not considered toxic solids, primary skin irritants or strong skin sensitizers. Extended exposure to foamed polystyrene and blowing agent vapors in laboratories and processing plants has not resulted in significant health problems.

Although NOVA Chemicals' EPS is considered to be non-toxic, appropriate safety precautions during the manufacturing, processing, cutting, fabrication, finishing and recycling operations, with particular emphasis on housekeeping, is recommended.

EPS resin may be irritating to the eyes. EPS resin may cause irritation to the skin from repetitive handling. Skin contact with molten or heated EPS can cause burns. Eyewash stations and safety showers should be near the work location.

EPS resin and foamed articles should not be eaten. Ingestion of foamed polystyrene is similar to the hazards of ingestion of other inert solids of similar size and weight. Mechanical irritation and blockage of the digestive tract are possible.

EPS may cause irritation to the respiratory system. The blowing agent used in the product may contain n-pentane, isopentane, and/or cyclopentane. Components of the blowing agents can irritate eyes, skin and respiratory system. Inhalation of the blowing agent can cause nausea and headaches. Exposure to the blowing agent n-pentane can be narcotic if inhaled in high concentrations and can be chemically damaging to lungs if aspirated. The American Conference of Government Industrial Hygienists (ACGIH), the U.S. Occupational Safety and Health Administration (OSHA) and the National Institute for Occupational Safety and Health (NIOSH) have set the following exposure limits for these blowing agents:

n-Pentane (CAS 109-66-0)

ACGIH: 600 ppm Time Weighted Average (TWA); 1800 mg/$m^3$ TWA
OSHA: 600 ppm TWA; 1800 mg/$m^3$ TWA
750 ppm Short Term Exposure Level (STEL); 2250 mg/$m^3$ STEL
NIOSH: 120 ppm TWA; 350 mg/$m^3$ TWA
610 ppm; 1800 mg/$m^3$ (15 min)

Isopentane (CAS 78-78-4)

ACGIH: 600 ppm TWA

Cyclopentane (CAS 287-92-3)

ACGIH: 600 ppm TWA
OSHA: 600 ppm TWA; 1720 mg/$m^3$ TWA
NIOSH: 600 ppm TWA; 1720 mg/$m^3$ TWA

EPS also contains low levels of residual styrene monomer; typically well below 0.1% unless noted on the safety data sheet. Styrene monomer vapors may be released during processing and fabrication of EPS. The ACGIH, OSHA and the NIOSH have set the following exposure limits for styrene monomer:

Styrene (CAS 100-42-5)

ACGIH: 20 ppm TWA
40 ppm STEL
OSHA: 50 ppm TWA; 215 mg/$m^3$ TWA
100 ppm STEL; 425 mg/$m^3$ STEL
NIOSH 50 ppm TWA; 215 mg/$m^3$ TWA
100 ppm STEL; 425 mg/$m^3$ STEL

Certain grades of EPS also contain brominated or other flame retardants. Please refer to the MSDS.

Ensure adequate ventilation and use local exhaust, where possible, in confined or enclosed spaces. If user operations generate dusts, mists or fumes, use appropriate local exhaust ventilation to keep exposures below the recommended exposure limits. If ventilation is not sufficient to effectively prevent buildup of vapor/mist/fume/dust, appropriate respiratory protection must be provided.

Wearing personal protective equipment (such as chemical goggles, impervious gloves, protective coveralls and long sleeves, and respirators) will reduce the likelihood of exposure.

## Hazards from Decomposition Gases

Thermal decomposition products (fumes and/or vapors) can be generated during manufacturing, cutting (hot wire), fabricating (grinding and sawing) and finishing operations. Thermal decomposition gases may be irritating to the nose and eyes.

Complete thermal decomposition of regular grades of NOVA Chemicals' EPS under flaming conditions with an adequate oxygen supply will result primarily in carbon monoxide, carbon dioxide, and particulate matter (soot). Modified grades of NOVA Chemicals' EPS will also liberate trace amounts of halogenated compounds. With both grades, however, prior to and after the flaming mode of combustion, and, depending on the oxygen supply, a variety of other chemical species have been identified in the vapor phase. These species (e.g. aromatics, oxygenated organics, saturated and unsaturated aromatics) have also been identified in the vapor phase during the combustion of a variety of materials such as polystyrene, polypropylene, polymethylmethacrylate and wood. These findings are detailed in many references including "Chemical Fingerprint and Studies of Fire Atmospheres" by P J. Fardell, et. al., which concludes that while some of the oxygenated organic compounds pose an irritancy threat to the eyes and respiratory tract, carbon monoxide is, in all cases, the dominant toxic product.

Hot wire cutting of EPS foam may generate thermal decomposition products. The type and concentration of these decomposition products may be dependent on several factors, including, but not necessarily limited to, wire temperature, cutting rate, block size and foam density. Cutting operations should be located in a well-ventilated area; additional controls (e.g. exhaust fans) may assist in minimizing personnel exposure.

## Dust Hazards

Airborne particulate matter (dust) can be generated during transporting, transferring, manufacturing, finishing (cutting, stamping, grinding and sawing) and recycling (grinding and compacting) operations. Dust may be irritating to the nose and eyes. NOVA Chemicals recommends engineering controls, including the use of adequate ventilation and local exhausts. A filter mask is recommended where continuous exposure is involved.

The particle size and concentration of dust that may be generated by EPS processing operations is influenced by a range of factors including equipment type, operating conditions, such as cutting or grinding rate, and foam density. Fine dust particles may suspend in the air, form dust clouds and/or cause a dust explosion.

Good housekeeping should be employed throughout the work area to limit the build up of dust. Where practical, the following should be enforced:

- Dust from cutting and grinding operations should be collected and removed.
- All ignition sources must be strictly eliminated in areas where dust clouds might form.

## Slipping Hazards

Any amount of EPS beads on a walking or working surface will pose a slipping hazard. Good housekeeping is essential to avoid accumulations of spilled EPS material. Personnel should be prevented from walking on spilled EPS beads and foamed articles. Precautions for storing and handling any foam product that was spilled should be as rigorous as for storing and handling EPS beads.

## Static Hazards

EPS beads, prepuff/prefoam, and un-aged molded foam articles should be handled with caution as electrostatic discharges from any part of the body (including skin and clothing) or handling equipment (including transfer pipes, conveyors, pallet jacks and fork trucks) could result in a flash fire. Use of non-static accumulating and fire-resistant protective coveralls and long sleeves is recommended. Footwear with conductive soles is also recommended. Commercial synthetic clothing, unless specifically treated, carries a risk in a fire situation and can generate dangerous static electricity if donned or doffed in a flammable atmosphere.

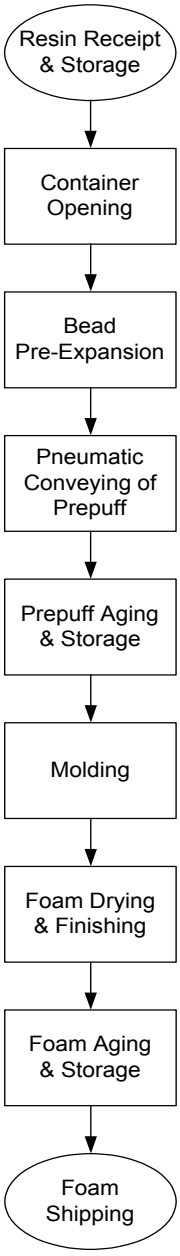
Since EPS is an electrical insulator, electrical charges can accumulate on its surfaces. As such, significant charge accumulation could result in a potentially dangerous condition since uncontrolled discharge (in the form of an electrostatic spark) could ignite the flammable pentane-blowing agent. Prevention of the uncontrolled discharge significantly reduces the chances of a flash fire.

Appropriate electrical bonding and grounding of processing and handling equipment may help in safely dissipating accumulated electrical charges. Bonding equipment together with suitably conductive materials can help to minimize the difference in electrical charge between the bonded items. Grounding equipment with suitably conductive materials may help in providing a safe pathway for accumulated charge to travel and dissipate into the earth. Consult a qualified electrical expert for specific information on bonding and grounding system installations. Only qualified electricians should be permitted to install, maintain, and regularly monitor electrical bonding and grounding systems. Regular periodic testing of all bonding and grounding systems by a qualified electrician is necessary to support the safe dissipation of electrical charges.

Also, since moisture typically acts as an electrical conductor, the accumulation of charge on EPS is most likely to occur when the beads, prepuff/prefoam, or molded foam articles are dry. Due to this factor, there are many steps in the EPS converting process (see Figure 1 on the following page) where appropriate measures can be taken to minimize the opportunities for uncontrolled static discharges. Humidified air (>40% relative humidity) may assist in minimizing static electricity build-up.

## PLANT HAZARD ANALYSIS

The operations shown in the figure below are common to many EPS converting facilities. While the figure is not intended to depict every EPS converting facility, it is nonetheless important to understand the potential hazards associated with operations that can commonly be found in many manufacturing processes These potential hazards are discussed in the following sections.




Please note that all structures and buildings should be constructed, occupied and protected in accordance with applicable jurisdictional building and fire codes.

## Raw Bead Receipt and Storage

### Transportation and Unloading

Depending upon the EPS resin grade and manufacturing location, NOVA Chemicals' unexpanded EPS is shipped in one of the following containers:

- 1000 pound (454 kg) corrugated boxes
- 1000 kg (2204 pounds) flexible intermediate bulk containers (i.e., bulk bags)

To minimize the loss of the pentane blowing agent, EPS corrugated boxes and bulk bags have a plastic EVA/Nylon liner.

Each 1000 pound corrugated box is strapped on a wooden pallet. The 1000 pound boxes can be shipped in 20-foot and 40-foot ocean containers. 20-foot containers are loaded with up to twenty-four 1000-pound boxes and 40-foot containers are loaded with about forty-two boxes. Forty-two 1000 pound boxes are typically shipped in domestic trailers. Boxes are typically double stacked in the containers and trailers.

Bulk bags can be shipped in 20-foot and 40-foot ocean containers. 20-foot containers are loaded with up to ten 1000 pound boxes and 40-foot containers are loaded with up to twenty. Twenty bulk bags are typically shipped in domestic trailers. Bulk bags are typically double stacked in the containers and trailers.

When the truck trailer/ocean container is ready to be opened, ensure that all ignition sources are removed from the area. Transporters, carriers and receiving personnel should be advised to carefully open doors and leave open for a reasonable period in order to disperse any pentane vapors prior to unloading. If corrugated boxes or bulk bags are damaged during transit, or suspected to be damaged, or if pentane vapors are present in the ocean container or trailer, allow additional time for ventilation. As the pentane is diluted with air, the pentane-in-air concentration may pass through the flammable range (between the LFL and the UFL). The mixture should be below the LFL and safe to handle before unloading.

A hydrocarbon analyzer (also known as an explosimeter) should be used to monitor the pentane level to determine if the pentane levels pose a fire hazard. Strategic location of these meters throughout the receiving/handling/storage/shipment areas is highly recommended.

### Storage and Stacking

Unopened corrugated boxes and bulk bags should be stored in a cool (preferably below 80°F or 26oC) and well-ventilated room from which sources of ignition, such as open flame, space heaters, and unguarded tow motor exhausts, etc., have been eliminated. All corrugated boxes and bulk bags, whether full or partially full of EPS, should be sheltered from direct sunlight.

All unopened EPS corrugated boxes and bulk bags should be stacked in accordance with all applicable safety, fire and building regulations and codes. The overall stack heights should be stable and the boxes'/bags' integrity should not be compromised as a result of overstacking. Ceiling sprinkler systems/heads should be clear. Local conditions, such as humidity, may influence a box/bag's performance and the maximum safe stacking height. The condition/stability of stacked boxes/bags should be assessed through periodic monitoring.

Storage of EPS resin in tightly sealed spaces may result in accumulation of flammable pentane vapors. However, as long as the original boxes/bags are intact, quantities of vapor sufficient to create a flammable mixture with air, are not expected to be present.

## Handling of EPS Shipping Corrugated Boxes and Bulk Bags

### Corrugated Boxes

EPS corrugated boxes are shipped on wooden pallets and are most easily transported using a forktruck or pallet jack. Use caution when maneuvering forktrucks to prevent accidental "spearing" of boxes, which may result in a spill and slipping hazard. Ensure that all handling equipment is properly rated for the load it will experience when transporting boxes.

### Bulk Bags

All bulk bags are equipped with 4 lift loops located at each of the top corners of the container. A forktruck with a proper capacity rating should be used to lift bulk bags using all four of the lift loops. Consult with your forktruck manufacturer to determine if inverting the forks is acceptable in order to address mast height restrictions. Long forks (48 inches) or removable fork extenders may be required to properly lift the bulk bag. Alternatively, hydraulic bag clamping devices may be used to transport bulk bags

Bulk bags should be visually inspected. "Ballooning" of a bulk bag may occur due to gas accumulation at the top of the bulk bag. Do not stack additional bulk bags or articles on top of a ballooned bulk bag.

If double stacking bulk bags, NOVA Chemicals advises limiting the outside rows to only one bag high. This will help prevent the top double-stacked bag from rolling forward and falling onto the floor, possibly rupturing.

Do not attempt to patch or repair a damaged bulk bag unless it is resting on the ground by itself, with no other load on top of it. Attempting repair to a bulk bag that is stacked on top of another bulk bag, is located beneath another bulk bag, or is suspended from the forks of a fork truck, may cause the damaged bulk bag to become unstable and possibly fall and cause serious injury. Necessary repairs should be completed when the bottom of the bag is resting on a solid floor and there is minimal risk of bulk bag instability.

Following are several practices that should be employed when handling bulk bags:

- Ensure that the forktruck forks are adjusted to the same width as the distance between the lift loops.
- Never attempt to lift a bulk bag using less than four lift loops.
- Avoid dragging the bulk bag across the floor or rubbing the bag against a trailer or building wall to prevent damage and accidental release of material.
- Use caution when maneuvering forktrucks to prevent accidental "spearing" of bulk bags, which may result in a slipping hazard.
- Avoid sharp edges on forks (pad if necessary) and ensure that the forks are long enough to prevent the bulk bag from rubbing against the mast of the forktruck.
- Use a safety frame to support the bulk bag while opening the discharge spout.
- Never allow anyone underneath or close to an unsupported, filled bulk bag.
- If using a single chain hoist or crane, use a spreader bar or extended straps to ensure that the lift loops remain vertical during lifting.
- To upright a fallen bulk bag, insert a sling, rope or webbing through all four lift loops, secure and lift using one fork of the forktruck.

## Container Opening

### Initial Opening

Upon opening, an EPS corrugated box or bulk bag may have a flammable mixture of pentane-in-air, or may be above the flammable range in the free space over the beads. As such, all containers should only be opened in well-ventilated areas. Exercise extreme caution when opening the inner liner as it may have acted as an insulator and may have accumulated static charge. Minimize moving the liner as it is stretched over the lip of the box or over the top part of the bulk bag. Motion between the liner and the beads may generate an electrostatic discharge.

After opening the container in a well-ventilated area, allow at least 15 minutes for the pentane vapors to dissipate. As the pentane is diluted with air and vapors disperse, the pentane-in-air concentration may pass through and out of the flammable range (between the LFL and UFL). After a minimum of 15 minutes, the mixture should be below the LFL and safe to handle. Maintain sufficient air circulation and ventilation to prevent flammable concentrations from forming, especially in low-lying areas. Humidified air (>40% relative humidity) may assist in minimizing static electricity build-up.

### Corrugated Boxes

Remove the box lid and exercise extreme caution when opening the liner and exposing the top surface of the beads. Gently fold the edge of the liner over the lip of the box and allow the box to ventilate for a minimum of 15 minutes.

### Bulk Bags

Bulk bags are designed with top and bottom spouts to permit top and bottom unloading as required. Before transferring EPS beads from the bulk bag to the pre-expander or hopper, gently open and roll back the top spout of the bulk bag and the liner to permit the pentane vapors to dissipate. Allow the top of the bulk bag and liner to remain open for at least 15 minutes before processing. Leaving the top spout open may also assist material flow during bottom unloading.

## Bulk Emptying

Some processes employ manual tools to transfer beads from the box/bag to the hopper of the pre-expander, while others use automatic transfer devices. Manual tools such as scoops, buckets ,and shovels should be either (1) non-sparking (for example, made entirely of wood) or, (2) constructed entirely of metal. Manual tools constructed of mixed component materials (for example, plastic buckets with metallic handles) should never be used to transfer or carry EPS beads or prepuff/prefoam. All metallic scoops, buckets, and shovels should always be properly grounded to earth by means of a conductive cable rigidly fixed to the tool. Consult a qualified electrical expert for specific information on grounding system installations. Only qualified electricians should be permitted to install, maintain, and regularly monitor electrical bonding and grounding systems.

When automatic electrical transfer devices (e.g., augers, vacuum tubes) are used, proper bonding and grounding is necessary to avoid static build-ups and electrostatic discharges. All components in an auger system should be made entirely of metal, be properly grounded, and be inspected frequently to prevent unwanted metal-to-metal contact. Vacuum tubes should also be made entirely of metal. Vacuum hoses should have an internal grounding cable in direct contact with the pick-up tube at one end, and must be properly grounded to earth at the opposite end.

### Corrugated Boxes

As described in the preceding section, acceptable methods for emptying a corrugated box of EPS beads include vacuum tubes and manual tools (as long as appropriate safety measures are taken, again as described above).

NOVA Chemicals does not recommend the practice of tipping/dumping of containers to remove EPS beads from corrugated boxes. If this practice is employed, however, appropriate systems should be in place to ensure that the lip of the box liner is pulled completely over the edge of the box and is placed so that the dumping mechanism holds the liner to prevent it from falling into the bead hopper. If the liner falls into the hopper and must be retrieved, extreme care should be taken to do so very slowly to avoid causing a static spark. Personnel performing this task should position themselves in a manner which would minimize the potential for injury due to flash fire. As with many other pieces of equipment that can be found in an EPS molding facility, ensure that the

carton tipper is adequately grounded to earth. Avoid situations which may generate unwanted metal-to-metal contact to reduce the chances of a spark occurring.

### Bulk Bags

Bulk bags may be unloaded from either the top spout or the bottom spout.

#### Top Unloading of a Bulk Bag

Top unloading of a bulk bag can be accomplished through the use of a vacuum tube as described at the beginning of this Section. For ease of material removal, the bag should be supported via the four lift loops to prevent the bag from collapsing as it empties. Use of manual tools (scoops, buckets, etc.) to unload bulk bags may be difficult due to the diameter of the top spout (<20 inches).

#### Bottom Unloading of a Bulk Bag

Bulk bags can be successfully unloaded through the bottom spout via a number of commercially available bulk bag discharge systems. For example, Control and Metering Ltd. offers an extensive line of bulk bag handling and discharge equipment (http://www.controlandmetering.com). Ensure that the bulk bag is properly secured/supported before reaching under the bulk bag to open the discharge spout. Also, ensure that all discharge equipment is properly bonded, grounded, used and maintained in accordance with manufacturer recommendations.

## Partially Emptied Boxes/Bags

At times, it may be necessary to re-seal a container (corrugated box or bulk bag) that has been only partially emptied of EPS resin. When this happens, the liner should be securely sealed in a manner that minimizes the free space between the beads and the liner (minimizes the space for vapor accumulation). Avoid liner movement within the box/bag. Corrugated boxes and bulk bags from which liners have been removed should not be used for storage of EPS resin. Do not stack anything on top of a partially emptied corrugated box or bulk bag to avoid the risk of collapse.

When ready to remove the remaining EPS resin from a partially emptied box/bag, treat the box/bag as if it were full and refer to the “Initial Opening” section of this guide.

## Complete Emptying

Use manual tools or automatic transfer systems to empty the liner of the remaining beads, avoiding movement of the liner to minimize the creation of an electrostatic discharge.

Use caution when leaning over or reaching into an open EPS box/bag to:

- Minimize the potential for injury in the event of a flash fire, and
- Avoid falling into the open box/bag

## Liner Removal, Disposal and Recycling of Packaging

Use caution when removing the plastic liner from corrugated boxes and bulk bags as a static charge may have accumulated on the surface of the liner. Excess movement of the liner may result in an electrostatic discharge.

Packaging materials such as plastic liners, corrugated boxes, bulk bags, and wooden pallets are combustible. Where possible, these materials should be removed from the EPS bead and foam storage areas and away from sources of ignition. Disposal and recycling of these materials should be performed in accordance with applicable regulations.

Bulk bags can be reused if they are recycled through an approved bulk bag recycling company. Contact your NOVA Chemicals representative for further information on approved bulk bag recyclers.

## Pre-Expansion

Pre-expansion of EPS resin involves the liberation of pentane from the beads. Adequate ventilation is necessary in the pre-expansion area because of the amount of pentane released. Ignition sources must be eliminated in the pre-expansion area.

Fresh prepuff/prefoam has a lower pentane content than unexpanded resin and may have a high moisture content as a result of steam condensation from the pre-expansion process. Regardless, all pre-expansion equipment including pre-expanders, hoppers, transfer devices and piping should be properly bonded and grounded to earth.

## Pneumatic Conveying of Prepuff/Prefoam

Pneumatic conveying is essentially the transfer of prepuff/prefoam between two points using air as the motive force or carrier. This process typically involves high volumes of air (by means of a fan or blower) relative to the available pentane in the conveying system. Because some moisture is typically removed during pneumatic conveying, and because there is a high degree of motion within the conveying system, the greatest hazard associated with this process is the accumulation of static charge. Ensure that all equipment, including fans, blowers and piping, are constructed of a conductive material and are properly bonded and grounded. Avoid flexible rubber or plastic transfer piping, as these materials are difficult to bond and/or ground.

## Prepuff/Prefoam Aging and Storage

Prepuff/prefoam aging and storage accomplishes three primary tasks:

- Permits surface pentane to disperse, thereby making the prepuff/prefoam less heat-sensitive during molding.
- Allows moisture to evaporate, producing a dry prepuff/prefoam.
- Provides time for air to penetrate into the prepuff/prefoam cells to displace the vacuum that was created during pre-expansion.

Since a significant amount of pentane is released during aging and storage, it is essential to have adequate ventilation in these areas. As with all other EPS processing areas, all sources of ignition must be removed and kept out of and away from the aging and storage areas.

There are two primary types of prepuff/prefoam aging and storage vessels: woven cloth or mesh bags and metal silos. Regardless of the type of vessel, appropriate ventilation and electric charge dissipation are critical.

### Woven Cloth or Mesh Bags

Some converting operations employ woven cloth or mesh bags that are either suspended from above or are supported by a structure built around the bag. Typically, the fibers used to create the woven cloth or mesh are nonconductive. As such, a means to dissipate accumulated static charge must be employed. Conductive wires sewn into the seams during fabrication, or sewn onto the fabric before use, provide a pathway for charge to dissipate as long as they are bonded and grounded appropriately. Ensure that a valid, physical connection is made between the conductive cables and the inlet and outlet piping on the bag.

### Metal Silos

Another type of aging and storage vessel is a conductive metal silo. As with all other metallic devices in an EPS converting facility, proper bonding and grounding of the silo is essential. Ensure that bonding connections span insulating gaskets at flanges and other piping connections. Dilution or make-up air can be an effective means of ventilating accumulated pentane vapors and reducing the risk of fire.

## Molding Areas

Due to the large amounts of steam liberated from molding presses, adequate ventilation in molding areas is important. While the typical high humidity found in molding areas may reduce the chances for uncontrolled electrostatic discharges, proper grounding of the molding presses is still important to reduce the opportunity for electric shock. Good housekeeping is essential to avoid accumulations of spilled prepuff/prefoam or scrap beneath and around the molding machines.

## Molded Foam Drying and Finishing Operations

### Drying

During the drying of molded parts, pentane continues to be released. Heating devices or systems should be configured to prevent the introduction of flames and/or sparks into drying rooms. Proper ventilation with adequate make-up air is necessary and may assist in preventing the accumulation of flammable pentane-in-air mixtures.

### Finishing Operations

Finishing operations may include hot wire cutting, hot stamping, laminating, printing and coating. EPS finishing equipment should be properly grounded, and the finishing area adequately ventilated.

Airborne particulate matter (dust) can be generated during finishing (grinding and compacting) operations and in other areas.

There are three main risks associated with hot wire cutting – electrocution, thermal burns and fires. Please refer to your equipment manufacturers' safety, health and maintenance guide for additional information. Hot wire cutting can be dangerous if wires break and arc upon grounding with the frame of the cutter. The resulting spark can ignite the pentane vapor liberated from the expanded polystyrene block by the cutting operation. Ventilation in this area should be supplemented with additional, properly bonded and grounded, fans and fume hoods to dissipate the pentane vapors along with the other vapors from cutting. Fire fighting equipment should be readily available in this area. Controls for the cutter should be remote from the cutter itself, so that they may be shut off in case of fire.

EPS foam that will be hot-wire cut should be adequately conditioned (aged) to minimize the likelihood of fire. Consideration must be given to block size, foam density, conditioning time and conditioning temperature to ensure pentane concentrations at the hot wire cutter do not create dangerous conditions.

## Aging and Storage

After molding expandable polystyrene, finished goods should be properly aged until the parts are adequately conditioned and the amount of residual blowing agent has diminished. Until the parts are properly conditioned, the residual pentane may form a “halo” around them. If ignited, this halo could burn with a blue flame and may generate sufficient heat to promote the complete destruction of the foam article and the spread of fire to surrounding materials.

During processing, typical losses of pentane occur as follows:

20-30% pre-expansion,
15-25% puff aging/maturing,
5-20% molding,
30-40% remains in the final molded part (immediate)
5-10% Initial storage (2-3 days)

The data shown above is for illustration purposes only, and is not representative of all EPS molding operations. Products containing mixtures of different pentane types may lose their pentane at different rates than products that contain 100% normal pentane.

Remaining pentane will continue to diffuse slowly over prolonged periods.

The aging of the parts, therefore, presents a potential hazard in the plant, and must take place in a well-ventilated area. All ignition sources are to be avoided. Both modified and regular (unmodified) grades of expandable polystyrene foam are combustible. Foam articles molded from unmodified grades will normally continue to burn following ignition until entirely consumed. Modified foams can be expected to stop burning after the source of ignition is removed. Warehousing and storage must be in accordance with local building and fire codes which may reference requirements such as: National Fire Protection Association codes, Factory Mutual standards and Industrial Risk Insurers.

## Shipping

Prohibit smoking and open flames in the vicinity of all EPS foam.

Proper aging of EPS foam articles before shipping will reduce the risk of an undesirable pentane-in-air concentration in shipping containers. Transporters, carriers and receiving personnel should be advised to carefully open truck trailer/ocean container doors and leave open at least fifteen minutes prior to unloading. EPS foam articles should not be shipped in vapor tight containers. EPS should be shipped in accordance with applicable jurisdictional regulations.

## SPILL CLEAN-UP

Spilled EPS beads may create a dangerous slipping hazard and should be cleaned up immediately. Good housekeeping is essential to avoid accumulations of spilled EPS material.

Eliminate all sources of ignition (such as cigarettes, sparks, etc.) from areas surrounding spills. Flammable vapors can be released from EPS spills. Consider evacuating the spill or leak area immediately until ambient air sampling results indicate that the pentane vapor concentration is below the flammable range.

Combustion engines and catalytic converters, such as those that can be found on motor vehicles and heavy equipment, may generate sparks or temperatures high enough to act as ignition sources. Extreme caution should be used when operating these and other types of engine-powered equipment (including chain saws, electrical generators, welders, etc.) in the vicinity of EPS beads (whether spilled or in boxes/bags). Regardless of the quantity of EPS spilled, extreme care should be taken to eliminate ignition sources and prevent unwanted metal-to-metal contact or spark generation.

Appropriate protective equipment and clothing (chemical goggles, impervious gloves, protective coveralls and long sleeves) should be worn during clean-up of spilled material. Persons not wearing appropriate protective equipment should be excluded from the area of spill until clean-up has been completed.

Small spills of EPS can be cleaned up by using appropriate non-sparking tools. Spilled material can be placed in an appropriate waste disposal container. Adequate ventilation should be provided in waste areas.

A water spray curtain can be used to divert flammable vapor drift. Prevent entry into sewers, basements, or confined areas; dike if needed. Large spills of EPS can be cleaned up with bulldozers, backhoe, and other power vehicles provided appropriate precautions are taken to avoid such equipment generating sparks or temperatures high enough to act as ignition sources. The use of vacuum trucks is not recommended for clean-up of large EPS spills.

Ensure legislative/regulatory reporting requirements in the applicable jurisdiction are met.

## RECYCLING and DISPOSAL

Preferred methods of waste management include the following:

- Clean and reuse, if possible
- Resin broker
- Plastics recycler
- Incinerate with waste heat recovery
- Landfill

Do not dispose of scrap or waste EPS by uncontrolled ignition (burning).

Scrap or waste EPS should be kept in well-ventilated areas before reuse, recycle or disposal.

Grinding and/or compacting equipment for managing/recycling scrap and waste EPS should be properly bonded and grounded. Adequate ventilation should be provided in the grinding/compacting areas. Dust should be collected and removed. All ignition sources should be eliminated in areas where dust clouds may form.

All reuse, recycling, storing/staging, treating, transporting and disposal must be in accordance with applicable federal, state/provincial and local legislation/regulations.

## INTERNET RESOURCES/LINKS

The following Internet resources and links are provided for your convenience in obtaining additional information that may or may not be referenced in this Guide. NOVA Chemicals assumes no liability for the content or accuracy of information obtained from such sources. Access to and use of such resources and links is at the sole risk of the user.

### NOVA Chemicals

www.novachemicals.com

Trade Associations:

| | |
|---|---|
| Alliance of Foam Packaging Recyclers | www.epspackaging.org |
| American Chemistry Council | www.americanchemistry.com |
| American Plastics Council | www.plastics.org |
| EPS Molders Association | www.epsmolders.org |
| Foodservice and Packaging Institute | www.fpi.org |
| Polystyrene Packaging Council | www.polystyrene.org |
| The Styrene Information and Research Center | www.styrene.org |

### U.S. Government/Regulatory Agencies:

| | |
|---|---|
| Department of Transportation | www.dot.gov |
| Environmental Protection Agency | www.epa.gov |
| Food and Drug Administration | www.fda.gov |
| Occupational Safety and Health Administration | www.osha.gov |

### Industry Standards:

| | |
|---|---|
| American Conference of Governmental Industrial Hygienists | www.acgih.org |
| American Society for Testing and Materials | www.astm.org |
| American National Standards Institute | www.ansi.org |
| Building Officials and Code Administrators International | www.bocai.org |
| Factory Mutual | www.fmglobal.com |
| Institute of Electrical and Electronics Engineers | www.ieee.org |
| International Code Council | www.intlcode.org |
| International Conference of Building Officials | www.icbo.org |
| International Organization for Standardization (ISO) | www.iso.org |
| National Fire Protection Association | www.nfpa.org |
| National Institute for Occupational Safety and Health (NIOSH) | www.cdc.gov/niosh |
| Southern Building Code Congress International | www.sbcci.org |
| Underwriters Laboratories Inc. | www.ul.com |

## GLOSSARY

**Flash Point** – The minimum temperature at which a flammable or combustible material will give off sufficient vapors to form an ignitable mixture with air near the surface or in the container, but will not sustain combustion.

**Lower Flammability Limit (LFL)** – The minimum concentration of a substance that, when mixed with air, will burn in the presence of an ignition source

**Upper Flammability Limit (UFL)** – The maximum concentration of a substance that, when mixed with air, will burn in the presence of an ignition source

**Vapor Density** – Weight of a volume of gas compared to the weight of an equal volume of dry air at the same temperature and pressure:

- If less than 1.0, the gas is lighter than air and will rise
- If greater than 1.0, the gas is heavier than air and will sink



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