SUMMARY REPORT
Grouting Operation
UPPER STILLWATER DAM

Duchesne County, Utah
US Department of the Interior
Bureau of Reclamation
Upper Colorado Region - Bonneville Unit

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Introduction - History

Work began on the Upper Stillwater Dam in 1983 and was completed in 1987. At the time this was the world’s largest RCC dam. The dam is constructed of 1,470,000 cubic yards of roller compacted concrete (RCC) and is located in Duchesne County, Utah. Constructed with no transverse contraction joints the RCC cracked at stress points throughout the dam. The cracks had been grouted previously with hydrophilic urethane materials, but had failed completely. This report is to present procedures, product information, results, testing and conclusions from using Mountain Grout Ultra, a moisture activated/cured polyurethane grout to repair the transverse cracks. The project consisted of remediation of leaks through 230’ high existing RCC dam via polyurethane injection using 21,000 gallons of Mountain Grout Ultra. The general contractor was ASI RCC Incorporated. The sub-contractor was FEC (Nicholson). Mountain Grout Ultra is a single component (with accelerator) hydrophobic polyurethane that possesses the physical properties much the same as traditional hydrophilic systems. Mountain Grout Ultra was successful in stopping the leaks and this portion of the project was completed well in advance of schedule.

The Hydrophobic Polyurethane System

This report details the material, procedure and results of chemical grouting at the Upper Stillwater Dam in Utah USA. The chemical grout used was Mountain Grout Ultra, manufactured by Green Mountain International, Inc. (www.mountaingrout.com). Ultra was chosen because of its unique properties that combine the benefits of a hydrophobic and a hydrophilic chemical grout. Ultra is technically a hydrophobic system in that it takes very little moisture to initiate the chemical reaction and the resulting elastomeric material will maintain its form for the life of the product. It will not shrink during or after cure regardless of the presence or absence of moisture. Ultra has up to 400% elongation making the system as flexible as most hydrophilic systems. Ultra is also environmentally safe to apply and completely inert when cured. All Mountain Grout Polyurethane Systems are solvent free and are shipped as non-hazardous per USDOT guidelines for ground, sea and air. Ultra is an MDI (Methylene Diphenyl Isocyanate) system. Please see attachment I, (ASI RCC 2/19/04) Memorandum for Record regards MDI monitoring at the Upper Stillwater dam project. Varying amounts of the Ultra Accelerator were mixed as job site conditions warranted. The Ultra System may be accelerated resulting in a faster reaction time.
Existing Conditions

The dam has no transverse contraction joints. The transverse cracks are continuous and irregular from upstream face to downstream face of the structure. The table below is the recorded crack data provided with the original bid package.

Table I

<table>
<thead>
<tr>
<th>Station</th>
<th>Previously Grouted?</th>
<th>Gallery Flow (gpm)</th>
<th>Downstream Face Flow (gpm)</th>
<th>Downstream Face Elevation (feet)</th>
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</thead>
<tbody>
<tr>
<td>24+10</td>
<td>No</td>
<td>130</td>
<td>&lt;2</td>
<td>Not Measured</td>
</tr>
<tr>
<td>25+20</td>
<td>Yes</td>
<td>894</td>
<td>2770</td>
<td>8114</td>
</tr>
<tr>
<td>26+50</td>
<td>No</td>
<td>&lt;2</td>
<td>10</td>
<td>8124</td>
</tr>
<tr>
<td>28+10</td>
<td>No</td>
<td>&lt;2</td>
<td>6</td>
<td>8156</td>
</tr>
<tr>
<td>28+65</td>
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<td>5</td>
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<td>29+25</td>
<td>No</td>
<td>&lt;2</td>
<td>20</td>
<td>8129</td>
</tr>
<tr>
<td>30+95</td>
<td>No</td>
<td>10</td>
<td>&lt;2</td>
<td>Not Measured</td>
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<td>&lt;2</td>
<td>3</td>
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<td>3</td>
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<td>38+55</td>
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<td>40+15</td>
<td>Yes</td>
<td>2</td>
<td>5</td>
<td>8114</td>
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<td>41+10</td>
<td>Yes</td>
<td>230</td>
<td>460</td>
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<tr>
<td>42+85</td>
<td>Yes</td>
<td>7</td>
<td>330</td>
<td>8122</td>
</tr>
</tbody>
</table>

*Drill Hole between gallery and downstream face of dam.

Procedures
From within the gallery, a series of bore holes were drilled in a fan pattern to intersect the existing cracks. Injection ports were especially designed for the large amounts of grout that needed to travel through the cracks. The angle of the ports, when staggered, produces the fan pattern.

Drill holes ranged in depth from 51 feet to 179 feet.

Drill holes were flushed with water prior to pumping the hydrophobic polyurethane. The flushing provided several benefits:

- Flush out residual mud and organic particles
- Provide moisture to fully react the grout.
- Flush out previous grouting materials (hydrophilic)
- Verify intersection of cracks

The Mountain Grout Ultra was pumped through a Graco Bulldog unit. Pumping pressure was limited to 900 psi. Each drill hole was pumped until the Ultra was observed on the face (both sides) or until the back pressure on the pump reached 1000 psi.

**Material Handling**

The average temperature in Duchesne, Utah for January is 19° F. The elevation of the dam is 8000 ft. The Upper Stillwater Dam is 40 miles northwest of Duchesne with surrounding mountain elevations in excess of 13,000 ft. The weather at the site is harsh from November to May. In consideration of these conditions special handling and storage arrangements were implemented by ASI-RCC. Typical quantities shipped monthly between November and April were 1500 to 2000 gallons or 30 to 40 55-gallon drums. The Accelerator was packaged in five-gallon containers. Materials shipped from the Southeast were in heated trailers maintained at 55 to 70° F. The drums were then transferred to an electrically heated 40-foot shipping container insulated with Styrofoam sheeting one inch thick. The temperature within the container was maintained at 60 to 70° F. Materials were transferred to the grout pump station within the gallery as needed. When pumping was outdoors, insulated blankets and electric band
heaters were utilized to maintain proper temperature.

Polyurethane resin systems are easier to pump at temperatures above 60° F, which keeps viscosity lower and promotes reactivity.

**Results and Testing**

On-site BOR Quality Control Personnel conducted extensive monitoring. Daily logs of grouting quantities and quality were maintained. FEC/Nicholson conducted extensive coring for verification purposes. Below is a photograph of a sample core.

![Sample core](image)

Large fractures were observed in many of the cores. The pale yellow material in the photo is the polyurethane grout. The polyurethane varied in width reaching 1-½ inches (38mm) within this sample. The sample proved the superior bond strength of the hydrophobic system with no observable shrinkage. Early core samples contained latent mud, organics and “chunks” of previously installed hydrophilic grout material. The material supplier recommended flushing each drill hole extensively prior to pumping the Ultra grout to wash out as much of this latent material as possible. This proved to be appropriate advice.

![Another core verifying complete seal](image)

**Results Reference:** Bob Dunne, Project Manager ASI-RCC, Inc.

435-454-4770

Multiple cores were taken from each injection point to verify the presence,
bond and physical form of the reacted polyurethane material.
Upon return of the water to the reservoir, no leaks in the grouted zones appeared.

Attachment II

Crack movement data derived from crack monitor installed at 25+20.

Contact information regarding the Upper Stillwater Dam Project.
U.S. Bureau of Reclamation
UC Region, Regional Director
125 South State Street
Room 7223
Salt Lake City, UT (USA) 84138
801-524-3761
ASI-RCC, Inc.
John Bowen, Vice President
28221 County Road 319
Buena Vista, CO (USA) 81211
719-395-8625
ASI-RCC, Inc.
Bob Dunne, Project Manager
28221 County Road 319
Buena Vista, CO (USA) 81211
801-971-2493
Nicholson Construction Company
(Formally FEC)
Ron Hall, Superintendent
P.O. Box 7
Mascot, TN (USA) 37806
865-933-3111
Green Mountain International, LLC.
Bill H. Phillips, Vice President Operations
235 Pigeon Street
Waynesville, NC 28786
828-456-9970
www.mountaingrout.com

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Malcom Dunstan and Associates
Hayford Hall
Buckfastleigh
Devon TQ11 0JQ U.K.
44-136-464-3058
www.rccdams.com
Memorandum for Record

Subject: MDI Monitoring Within the Gallery of the Upper Stillwater Dam, Dam Rehabilitation Phase 1,

Background

ASI and FEC are grouting a number of cracks within the Upper Stillwater Dam in support of the Dam’s rehabilitation by the US Bureau of Reclamation. Mountain Grout Ultra, a hydrophobic polyurethane system was selected as the grout material to support the rehabilitation program. Mountain Grout Ultra is combined with varying quantities of Mountain Grout Ultra Accelerator to activate the grouting system. Typical accelerator mixing requirements were expected to range between 2 to 6.5 Per cent.

Mountain Grout Ultra is within the chemical family of Polyisocyanate (Synonymous with MDI). Previous experience by the Bureau of Reclamation using a TDI type grouts and the MSOS # GM7312 criteria developed concerns for the levels of exposure the MDI product may present during the mixing and grouting operations within the Gallery of the dam structure.

ASI implemented an individual monitoring plan to monitor and assess the levels of risk presented during the grouting operations in accordance with US Bureau of Reclamation requirements. ASI provided supplemental ventilation in accordance with ventilation plans to provide additional airflow in the grouting areas. Technical representatives from Green Mountain International were additionally present during the initial startup and grouting operations within the Gallery of the Dam (a 6' wide, 9' tall passage running the length of the Upper Stillwater Dam).

The supplemental ventilation enhanced the existing ventilation within the dam, substantially increasing the velocities and volumes of air passing through the gallery. Two additional fans were installed to increase the airflow three fold, on the order of 50 to 80 FV/Min within the Gallery adit and to 200 FV/Min within the main Gallery.
The objective of the ventilation and personal monitoring program was to maintain exposure levels at or below the PEL mandated by OSHA of 0.05 ppm on an 8 hr average work shift. The difficulty of this requirement is that isocyanates are odorless and do not register or impact a P100 vapor/mist respirator cartridges regardless if the cartridge has an end of life indicator.

This additionally requires that the company needed to adopt a regular change out schedule for changing the cartridges even if they were still able to function on an adequate level.

On 29 October 2003 ASI-RCC and FEC began grouting activities the Upper Stillwater Dam Gallery at Station 42+85, using the Mountain Grout Ultra two component mix (grout and accelerator). Mountain grout contains the chemical (diphenylmethane diisocyanate); concern was specifically focused on the potential for the vaporization of the grout mix during both the mixing process during the addition of the accelerator to the grout. Additional concern was the exposure levels to grouting personnel within the limited confines of the dam gallery when grout discharged from the cracks within the structure into the Gallery.

The concern was more acute when the process was performed within the Dam Gallery's confined space, based on the information within the "Mountain Grout" MSDS. A key parameter to observe was the air quality within the confined space which was addressed by hiring a ventilation engineering company to do a thorough study of the existing facilities ventilation system. Considerable additional ventilation of the Gallery was required based on the parameters identified within the materials MSDS.

Coordination with Grean Mountain resulted in the use of MDI monitoring badges (Safe Air) as manufactured by KSM Environmental, attached directly to the employees involved in mixing and injecting the product into the crack zones via drilled holes from designated stations along the axis of the dam. The "Safe Air" monitoring badges provided the means to establish a baseline MDI exposure for the Project.

During the initial grouting activities, the mixing station was located outside of the dam and materials hard carried to the pump injection area, while concurrently directing the interior airflow away from the grout station, pumps and employees. Placing a suction fan directly over the grout pumping equipment. This combination of outside mixing and ventilation management provided a further reduction of employee exposure due to possible MDI levels anticipated or possible within the gallery area.
Monitoring Methodology to-date

The onset of grouting activities included the following:

1. Employees were medically checked by a physician and fitted with approved half mask respirators which were equipped with P-100 Vapor /Mist cartridges approved for MDI exposure. These cartridges do not have an “end of life indicator”, which would have made it possible to know when to change the cartridges. As such, ASI decided to change cartridges after an eight hour shift until we had sufficient data from the MDI monitoring badges attached to the employee's lapels.
2. Each person involved in the grouting procedure was fitted with a monitoring badge regardless of where they were stationed and the badges were checked every fifteen to twenty minutes throughout the mixing and injecting of the grout.

ASI/FEC worked the initial grouting shift from 0830 to 1600. Only one “Safe Air” badge registered any MDI results and that particular badge had a fingerprint right on the area of the badge reserved for color comparison. It was obvious that during the grouting procedure the employee had touched the badge with his glove which contained mixed grout. The badge registered a 2.5 PPB color comparison which is one half of the 8 HR. P.E.L. of 5 PPB / HR.

The second day of grouting, because of the low to “non-existent” exposure levels of the day before, the mixing station was moved into the inspection gallery at the area of the act / inspection gallery intersection. Again, all personnel were fitted with half- mask respirators and MDI monitoring badges and checked on a regular basis for any indicators from the color indicating badges. The air was monitored as before for velocities and quality prior to employees beginning the task.

Velocities were maintained in the 60 to 70 F.P.M. range as agreed upon by the USBOR and ASI. Oxygen was monitored at 21.1 to 20.9 during the shift. As on the previous shift, no indication of MDI exposure was detected near the P.E.L. during the entire shift.

As an end result of our initial MDI exposure levels, the Project shifted to an Area Monitoring approach in lieu of individual monitoring. Area monitors were established using “Safe Air” badges at key points in the grouting program, specifically at the grout mixing area and the injection pump. To date the Project has injected over 8000 gallons of Green Mountain Ultra grout with no indication of MDI at any level within the Dam Gallery throughout the program.

Regards

Bob Dunne
ASI-RCG Project Manager

Mountain Grout

Technical Data:

Ultra

Hydrophobic Polyurethane System

CRACK REPAIR
**Description:** Mountain Grout Ultra is a multi-purpose injection resin designed to seal leaking cracks, voids or fractures in concrete structures. This single component system is hydrophobic in nature, but possesses physical properties much the same as traditional hydrophilic systems. Ultra may be used with Ultra Accelerator to “adjust” the reaction profile as needed for job site conditions. The system is normally accelerated to achieve a 35-second reaction time by mixing one pint of Mountain Grout Ultra Accelerator to 5-gallons of Ultra. Faster reaction times may be achieved by use of additional Ultra Accelerator.

<table>
<thead>
<tr>
<th>Typical Properties - Liquid</th>
<th>Results</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity, 77°F, cps</td>
<td>600</td>
<td>ASTM D-1638</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>1.06</td>
<td></td>
</tr>
<tr>
<td>Physical State</td>
<td>Liquid</td>
<td></td>
</tr>
<tr>
<td>Color</td>
<td>Clear</td>
<td>Accelerator is Green</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Typical Properties – Cured</th>
<th>Highly Restricted Rise</th>
<th>Lightly Restricted Rise</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density, lbs./ft³</td>
<td>65</td>
<td>10</td>
<td>ASTM D-1622</td>
</tr>
<tr>
<td>Elongation, percent</td>
<td>400</td>
<td>400</td>
<td>ASTM D-638</td>
</tr>
<tr>
<td>Tensile Strength, psi</td>
<td>2200</td>
<td>300</td>
<td>ASTM D-638</td>
</tr>
<tr>
<td>Tear Strength, psi</td>
<td>400</td>
<td>55</td>
<td>ASTM D-624</td>
</tr>
</tbody>
</table>

| Typical Reaction Profile – Mixed with 2 ½% water | | |
|-----------------------------------------------|---------------------------------|-------------------|---|
| Ultra Accelerator percentage                  | 0%                              | 2 ½%              | 5% |
| Cream Time (in minutes: seconds)              | 1:30                            | 0:35              | 0:20 |
| Expansion Time (in minutes)                   | 15                              | 3                 | 2  |

**Shipping & Handling**

<table>
<thead>
<tr>
<th>USDOT Shipping Data</th>
<th>Unregulated, Class 55</th>
</tr>
</thead>
<tbody>
<tr>
<td>Packaging</td>
<td>5-gallon pails, 50 gallons in 55-gallon drums</td>
</tr>
<tr>
<td>Storage</td>
<td>Store in airtight containers. Product should not be exposed to the atmosphere until application. Product is moisture sensitive. Avoid contact with moisture.</td>
</tr>
<tr>
<td>Shelf Life</td>
<td>6 months minimum in unopened containers.</td>
</tr>
</tbody>
</table>

MSDS should be read before using Mountain Grout products.
Material Safety Data Sheet
MSDS # GM7312

10-07-03
GREEN MOUNTAIN INTERNATIONAL, LLC.
235 PIGEON ST.
WAYNESVILLE, NC 28786
Emergency Spill, Leak, Fire, Exposure or Accident: Chemtrec – 800-424-9300
Green Mountain International, LLC.
800-942-5151 US/Canada 828-456-9970 International

Section I – General
Trade Name: Mountain Grout
Formula Trade Name: Ultra
Chemical Family: Polyisocyanate
Chemical Name: Diisocyanate Diamine
Synonyms: MDI, ISO, “A” Component
CAS Number: Mixture

Section II – Ingredients

<table>
<thead>
<tr>
<th>CAS#</th>
<th>Approx. %</th>
<th>Current TLV/TWA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Section III – Hazardous Summary

This material is designed and intended to be pumped, not sprayed. The inhalation hazard increases as MDI is atomized (sprayed). The following data is derived from tests performed when the material is sprayed and should be considered, but may not apply to pumping operations as recommended by the manufacturer.

Potential Health Effects: At room temperature, MDI vapors are minimal due to low vapor pressure. However, heating, foaming or otherwise dispersing (drumming, venting or pumping) operations may generate more vapor or aerosol concentrations of isocyanate. Excessive exposure may cause irritation of the eyes, upper respiratory tract and lungs. Severe overexposure may lead to pulmonary edema. Respiratory sensitization with asthma-like symptoms may occur in susceptible individuals. MDI concentrations below the exposure guidelines may cause allergic respiratory reactions in individuals already sensitized. Symptoms may include coughing, dryness of the throat, headache, nausea, difficulty breathing and a feeling of tightness in the chest. Effects may be delayed for several hours after exposure. Impaired lung function (decreased ventilator capacity) has been associated with overexposure to isocyanates.

PERSONS WITH KNOWN RESPIRATORY OR ALLERGY PROBLEMS MUST NOT BE EXPOSED TO THIS PRODUCT.

Skin: May cause allergic skin reaction in susceptible individuals. Prolonged or repeated contact may cause skin irritation. May stain the skin.

Eyes: As a liquid or dust, may cause irritation, inflammation and/or damage to sensitive eye tissue. Symptoms include watering or discomfort of eyes. Corneal injury is unlikely.

Ingestion: This is not considered a common route of exposure and single dose toxicity is low. Can result in irritation and corrosive action in mouth, stomach tissue and digestive tract.

Threshold Limit Value (ACGIH): TLV is .005 PPM TWA (MDI)

Permissible Exposure Limit (OSHA): PEL is .02 PPM (MDI)

Section IV – Emergency & First Aid Procedures

Eyes: Flush with clean water at low pressure for at least 15 minutes, occasionally lifting eyelids. CONSULT A PHYSICIAN IMMEDIATELY.

Skin: Remove contaminated clothing. Wash exposed area with warm soapy
water thoroughly. Some organic materials such as corn oil or propylene glycol are effective in decontaminating MDI from the skin when applied immediately. Contaminated clothing should be properly laundered.

Inhalation: Remove patient from area of exposure to safe area. If not breathing, give mouth-to-mouth resuscitation. If breathing is difficult, give oxygen. Consult a physician immediately.

Ingestion: If swallowed, drink 1 to 2 glasses of water or milk. Do not induce vomiting due to the irritating nature of this compound. If gastrointestinal symptoms develop, consult medical personnel. Never give anything by mouth to an unconscious person.

* NOTE TO PHYSICIAN: No specific antidote. Symptomatic and supportive care as needed. Treatment based on judgment of physician in response to reactions of the patient. The manifestations of respiratory symptoms, including pulmonary edema, resulting from acute exposure, may be delayed. Following severe exposure, medical follow-up should be monitored for at least 48 hours.

**Section V – Fire & Explosion Data**

Flash Point: over 230°F 110°C (ASTM D-93 Closed Cup)

Extinguishing Media: Dry chemical extinguishers such as monoammonium phosphate, potassium sulfate, and potassium chloride. Additionally, carbon dioxide, high expansion (proteinic) chemical foam, and water spray for large fires. If water is used, use large amounts, as the reaction between hot isocyanates and water can be vigorous. Use self-contained breathing apparatus and body covering (protective clothing).

Unusual Fire and Explosion Hazards: At temperatures over 400°F, polymeric MDI can polymerize and decompose which will cause pressure to build up in closed containers. Explosive rupture is possible. Water contamination will produce carbon dioxide. Do not reseal contaminated containers as pressure buildup may rupture them. Downwind personnel must be evacuated.

Fire Degradation Products: Toxic fumes are released in fire situations. Isocyanate vapor and mist, carbon dioxide, carbon monoxide, nitrogen oxides and traces of hydrogen cyanide.

Protective Equipment: Wear positive pressure self-contained breathing apparatus with full-face piece and full protective clothing.

**Section VI– Spill or Leak Procedures**

Emergency Spill, Leak, Fire, Exposure or Accident: Call Chemtrec at 800-424-9300.

CERCLA Reportable Quantity: 4,4’ Diphenylmethane Diisocyanate = 5,000 lbs.

Minor Spills: Contain the spilled material and then cover with a loose, absorbent material such as oildry, vermiculite, sawdust, or Fuller's Earth. Shovel waste material into proper waste containers. DO NOT make pressure tight. Transport to a well-ventilated area and treat with a neutralizing solution consisting of a mixture
of water and 3-8% concentrated ammonium hydroxide or 5-10% sodium carbonate. Add about 10 parts of neutralizer per part of isocyanate with mixing. Allow to stand 48 hours letting evolved CO2 escape.

Major Spills: Call Green Mountain Int'l Inc. immediately @ (800) 942-5151. If it is a transportation spill, notify CHEMTREC @ (800) 424-9300. Evacuate and ventilate spill area. Dike spill to prevent entry into the environment. Wear full protective equipment, including respiratory protection, during clean up.

Clean Up: Decontaminate area using water/ammonia solution with 1-2% added detergent, letting it stand over effected area for at least 10 minutes. Cover mops, brooms, etc. used for this with plastic and dispose of properly, often by incineration.

Waste Disposal Methods: Waste material may be incinerated at proper facilities or disposed of under local, state and federal regulations controlling environmental protection.

Section VII – Storage and Handling

Storage Temperature (min/max): 64° and 95° F (18° and 35° C)
Average Shelf Life: Six months from date of manufacturing.
Special Sensitivity (heat, light, and moisture): This product is reactive with water. Containers should be tightly sealed to prevent moisture contamination. A nitrogen blanket should be used for bulk storage. Store at a temperature of 64°F - 95°F. Protect from freezing. Should freezing occur, the material must be thawed thoroughly and mixed until uniform. Opened containers must be handled properly to prevent moisture contamination.

Precautions in Handling & Storage: If contamination of the MDI is suspected, DO NOT reseal container because of possible rupture due to pressure buildup. Always slowly vent container when opening to relieve any pressure buildup. Use personal protective equipment when transferring material to or from drums, totes or other containers. Use only with adequate ventilation to ensure that the occupational exposure limit is not exceeded. Do not smoke or use naked lights, open flames, space heaters or other ignition sources near pouring or frothing operations.

Section VIII – Employee Protection Recommendations/Exposure Control

Exposure: Use with adequate ventilation to keep airborne isocyanate level below TLV or 0.005 ppm, TWA and PEL 0.02 ppm ceiling. These control limits do not apply to previously sensitized individuals or to individuals with existing respiratory disease, such as bronchitis, emphysema or asthma. Respiratory protection may be needed where material is heated, sprayed or used in a confined space. PERSONS WITH KNOWN RESPIRATORY OR ALLERGIC PROBLEMS MUST NOT BE EXPOSED TO THIS PRODUCT.

Eyes: Liquid chemical goggles or full-face shield. No contact lenses should be worn.
Skin: Wear clothing and gloves impervious to MDI under conditions of use. Materials may include butyl rubber, nitrile rubber, neoprene and Saranex® coated Tyvek®.
Respiratory: Because of the low vapor pressure of isocyanates, local exhaust ventilation is usually sufficient to keep vapors below the TLV at room temperatures. Exceptions are when the material is heated or sprayed. If airborne concentrations exceed or are expected to exceed the TLV, use a MSHA/NIOSH approved positive pressure, self-contained breathing apparatus.

Ventilation: Use local exhaust ventilation to maintain airborne concentrations below the TLV. Suitable respiratory equipment should be used in cases of insufficient ventilation or where operational procedures demand it. Spills or other emergencies may require more forceful ventilation means.

Other: Safety showers and eye wash stations should be provided in all work areas. All employees should be properly trained.

Section IX – Physical Data

Appearance: Liquid
Color: Clear
Odor: Pungent
Boiling Range: Over 300 °F (149 °C)
Viscosity @ 25 °C: 600 cps

Specific Gravity: 1.06

Solubility in Water: Reacts

Section X – Stability and Reactivity Data

Stability: Stable under recommended storage conditions
Polymerization: May occur with incompatible reactants, especially strong bases, water or temperatures over 320 °F (160 °C). Temperatures over 110 °F (43 °C) accelerate the reaction with water.

Incompatibility (Materials to avoid): Water, acids, bases, metal compounds, and surface-active materials. Avoid water as it reacts to form heat, CO2 and insoluble urea. The combined effect of the CO2 and heat can produce enough pressure to rupture a closed container. Some reactions are violent in the presence of the above-mentioned materials.

Hazardous Decomposition Products: Isocyanate vapor and mist, carbon dioxide, carbon monoxide, nitrogen oxides and traces of hydrogen cyanide.

Section XI – Toxicological Information

Polymeric MDI: Oral LD50 (rat) > 5,000 mg/kg

Dermal LD50 (rabbit) > 5,000 mg/kg

Inhalation LC50 (rat) = 490 mg/M3 (4 hours exposure to respirable aerosol)

Carcinogenicity: The ingredients of this product are not classified as carcinogenic by ACGIH or IARC, not regulated as carcinogens by OSHA, and not listed as carcinogens by NTP.
Mutagenicity: There is no substantial evidence of mutagenic potential.

Reproductive Effects: No adverse reproductive effects are anticipated.

Teratogenicity and Fetotoxicity: No birth defects were seen in two independent animal studies.

Section XII – Shipping Information

Technical Shipping Name: 4,4’ Diphenylmethane Diisocyanate
DOT (Domestic Surface) Hazard Classification: NOT REGULATED (in pails, drums or totes).

IMO (Ocean): NOT REGULATED
IATA/ICAO (Air): NOT REGULATED
Transportation Emergency Telephone Number: 1-800-424-9300 (Chemtrec)

Section XIII – Regulatory Information

OSHA Status: This product is classified as hazardous under the criteria of the Federal OSHA Hazard Communications Standard 29 CFR 1910.1200.

TSCA Status: On the TSCA Inventory.

CERCLA Reportable Quantity: 4,4’ Diphenylmethane Diisocyanate = 5,000 lbs.

RCRA Status: MDI is not a hazardous waste. However, under RCRA, it is the responsibility of the user of products to determine, at any time of disposal, whether a product meets any of the criteria for hazardous waste.

This product does not contain, nor is it manufactured with ozone depleting substances.


We believe the statements, technical information and recommendations contained herein are reliable, but they are given without warranty or guarantee of any kind, expressed or implied, and we assume no responsibility for any loss damage, or expense, direct or indirect or consequential, arising out of their use.

Green Mountain International LLC.

235 Pigeon Street, Waynesville, NC 28786
Ph: 800-942-5151 Fx: 888-632-5360