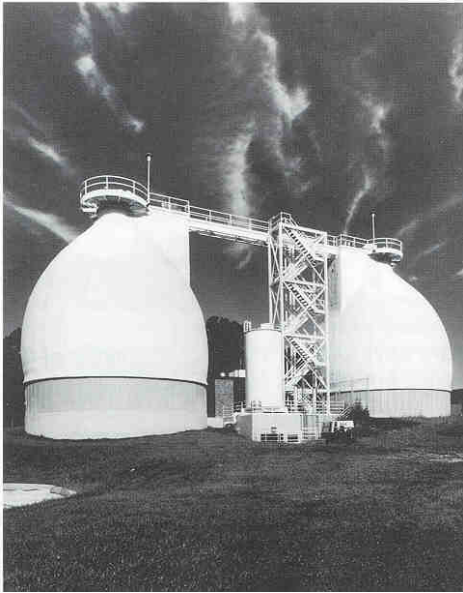


**Spray Polyurethane
Foam Insulation Systems
For
Metal Service Vessels
Operating Between
-35 °C (-30 °F) and 93 °C (200 °F)**



*Recommended Design
Considerations and
Guide Specifications*



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1. Review existing documents and serve as a clearing house to ensure the “Continuity of Value” of technical information published by SPFA and others concerning the products and services to our industry;
2. Review, research, develop and issue documents concerning new products, systems and services AND
3. To identify, explore, develop and communicate an understanding of technical issues facing our industry.

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Guide Specification for Polyurethane Foam Insulation Systems to Metal Service Vessels Operating Between -35 °C (-30 °F) and 93 °C (200 °F)

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DESIGN CONSIDERATIONS

GENERAL CONSIDERATIONS

The performance of a spray applied polyurethane foam insulation system can be affected by all the component parts of a vessel, as well as the conditions inside and outside the vessel.

Proper structural design, specification review, contractor and material selection, coupled with the compatibility and positioning of the various components of the insulation system are a necessity to produce a successful insulation system.

Consult with the respective material suppliers and the successful contractor to receive written confirmation of their agreement to all facets of the insulation system, including, but not limited to, material selection, surface preparation, metal primer, coating, design details, etc.

SURFACE PREPARATION, PROCEDURES AND CONSIDERATIONS

The following general practices must be observed on all metal surfaces which are to receive spray polyurethane foam:

1. General Surface Preparation Procedures

- A. Prior to the application of primer or polyurethane foam, the substrate shall be dry and free of any contaminants that may interfere with proper adhesion of any of the respective components.
- B. Surface contaminants, depending on their severity and quantity, may be removed by use of air pressure, vacuum equipment, hand power broom, chemical solvents, gritblasting, manual scraping, etc.
- C. Rough welds and other sharp projections shall be ground smooth. All flux, slag, or other lamination left from welding must be chipped or ground off and spot striped or primed.
- D. Name plates, valve stems, rotating equipment, etc. shall be protected from gritblasting and overspray by suitable masking materials.
- E. Gritblasted surfaces shall be coated before visible rusting occurs. In all cases the metal will be primed or coated the same day it is gritblasted.

2. Painted Iron and Steel Surfaces

- A. If a significant amount of the existing coating, paint, or primer has failed, can be easily scraped off, or exhibits extreme chalking, the entire coating, paint or primer shall be completely removed. Gritblasting is recommended. All items listed under "Recommended Gritblasting Procedures" should be followed.

- B. Gritblasting is not required on surfaces where the existing coating, paint or primer exhibits sound physical properties, good adhesion and is compatible with the proposed polyurethane foam insulation system. Follow manufacturer's recommendations

3. Ferrous Metal Surfaces

- A. All surfaces shall be gritblasted in accordance with SSPC SP-6, Commercial Blast Cleaning (Surface Preparation Specifications Steel Structures Painting Council SSPC Publication No. 91-08.)
- B. Prime and/or coat gritblasted surfaces in accordance with polyurethane foam and/or primer/coating manufacturers' instructions and recommendations.

4. Other Metal Surfaces

- A. Clean galvanized metal, aluminum, copper and stainless steel surfaces as recommended by the polyurethane foam and/or primer/coating manufacturer. Abrasive blasting may be necessary to achieve adequate primer/coating adhesion.
- B. Prime galvanized metal, aluminum, copper and stainless steel surfaces as recommended by the polyurethane foam and/or primer/coating manufacturer.
- C. Contact polyurethane foam and/or primer/coating manufacturer for recommendations to prepare other metal surfaces.

SELECTION OF METAL PRIMER AND/OR COATING SYSTEM

The following items should be considered when choosing a metal primer and/or coating system.

- A. Surface preparation required.
- B. Adhesion to substrate.
- C. Adhesion to polyurethane foam.
- D. Maximum and minimum vessel temperatures.
- E. Corrosion resistance to vessel contents or vapors.
- F. Polyurethane foam and/or primer/coating manufacturer's recommendation.

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SELECTION OF THE POLYURETHANE FOAM SYSTEM

The contractor, in the case of spray polyurethane foam applications, is fabricating the product on site in accordance with the manufacturers' instructions.

A wide range of polyurethane foam systems are available in various performance properties, each exhibiting different temperature limitations, combustibility characteristics, etc. The use of these systems in combination with each other or with other conventional insulation products offer a wide range of economical installations.

Most published data is run on laboratory produced samples. The thickness of polyurethane foam sprayed, number of passes, temperatures of substrate, ambient temperatures, etc. have a pronounced effect on all properties.

From a fire safety standpoint, polyurethane foams can be used safely. It is important, however, that all persons associated with the design, fabrication, storage and installation understand the material and environments involved.

Polyurethane foam insulation is combustible and should be treated as such. Flame spread ratings provided for polyurethane products using small scale tests are not intended to reflect the hazards presented by this or any other materials under actual fire conditions.

This specification is not applicable where severe thermal shock is possible. Discuss with your contractor and systems manufacturer the heat-up and/or cool down procedures, including expansion or contraction details, etc., to be used on each vessel.

SELECTION OF A PROTECTIVE COATING

A protective coating system must be applied to the polyurethane foam as an integral part of the vessel insulation system.

The protective coating shall be a system which will cure to form a water resistant protective membrane. The dry film thickness (DFT) of the protective coating shall be in compliance with the coating manufacturer's specification.

On many vessels, or portions thereof, fireproofing over the insulation system may be required. If fireproofing is required, consult your selected contractor for the recommended procedure to accomplish the same.

Consider the following items in the selection of the coating materials:

1. Physical Characteristics

- A. Chemical resistance.
- B. Water vapor permeance.
- C. Tensile and elongation properties.
- D. Retention of physical properties upon aging.
- E. UV resistance.

2. Performance Characteristics

- A. Environment in which to be used (abrasion and impact).
- B. Life Expectancy.
- C. Ease of maintenance.
- D. History of similar applications or laboratory data relating to the application in question.
- E. Adhesion to the polyurethane foam.
- F. Combustibility characteristics, individually and in combination with the selected polyurethane foam systems.
- G. Aesthetic qualities.

ADDITIONAL DESIGN CONSIDERATIONS

1. Before applying polyurethane foam and protective coatings, protect individuals and areas from the application of material by masking and sealing of air intakes into buildings that may be affected. Take pre-cautions to avoid concentrations of fumes in occupied areas.
2. Best results will be obtained when polyurethane foam is applied to a warm substrate (40 °C to 60 °C [100 °F to 140 °F]). Consult your manufacturer for specific recommendations.
3. Temperature sensing indicators can be installed to help monitor maximum tank temperature.
4. Use the following pull down schedule for insulated vessels operating at temperatures under 0 °C (32 °F):

COLD VESSEL PULL DOWN SCHEDULE

Materials used to construct and insulate cold storage vessels are affected by temperature changes. Gradual lowering of the temperature is designed to eliminate problems stemming from these temperature changes.

Reduce temperature 6 °C (10 °F) every 24 hours until the operating temperature is reached.

MAINTENANCE PROCEDURES

It is strongly recommended that maintenance procedures, including annual inspections, be established with your selected contractor for any insulation system to yield its full value.

CONTACT THE RESPECTIVE MANUFACTURERS/SUPPLIERS AND CONTRACTORS FOR THEIR RECOMMENDED MAINTENANCE PROCEDURES.

**GUIDE SPECIFICATION FOR POLYURETHANE FOAM
INSULATION SYSTEMS TO METAL SERVICE VESSELS OPERATING
BETWEEN -35 °C (-30 °F) AND 93 °C (200 °F)**

NOTE: This guide is designed to help the specifier achieve a successful polyurethane foam insulation system. It is the responsibility of the specifier to consult with manufacturer of material specified as to the manufacturer's specific recommendations.

PART I - GENERAL

This guide discusses the application of a seamless spray polyurethane foam with a protective coating for use as an insulation system for metal service vessels. Your contractor, selected systems manufacturer and regulatory agencies can assist you, as each project must be assessed individually.

1.01 SCOPE OF WORK

Furnish all labor, material, tools and equipment necessary for the application of a polyurethane foam insulation system, including accessory items, subject to the general provisions of the contract.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Metals-Metal Fabrications	Section 05500
B. Vapor and Air Retarders	Section 07190
C. Insulation	Section 07200
D. Fireproofing	Section 07250
E. Special Coatings	Section 09800
F. Special Construction-Liquid and Gas Storage Tanks	Section 13200

1.03 QUALITY ASSURANCE

- A. Contractor Qualifications: The contractor should provide information concerning projects similar in nature to the one proposed including location and person to be contacted. SPFA accredited companies are recommended. Some manufacturers of spray polyurethane foam systems and/or protective coatings have approval programs.
- B. Manufacturer Qualifications: Polyurethane foam and protective coating manufacturers shall show evidence of sufficient financial resources and manufacturing facilities to furnish materials on this project. References shall be required, sufficient project lists and warranties shall be submitted for verification.
- C. Inspections: An inspection of the finished insulation system by the polyurethane foam and/or protective coating manufacturer, or third party inspector is recommended.

1.04 SUBMITTALS

- A. Manufacturers published data sheets or letter of certification that their products comply with the materials specified. This is to include primers, metal coating systems, polyurethane foam, thermal barriers and protective coatings.
- B. Shop drawings on accessories, design details, and fabricated items.
- C. Manufacturers' application or installation instructions.
- D. Evidence of contractor/applicator qualification and experience.
- E. A specimen copy of the applicable warranty for the project.
- F. Safety and handling instructions for storage, handling, and use of the materials to include appropriate Materials Safety Data Sheets (MSDS).

1.05 MATERIALS, DELIVERY AND STORAGE

- A. Material shall be delivered in the manufacturer's original, tightly sealed containers or unopened packages, all clearly labelled with the manufacturer's name, product identification, safety information, and batch or lot numbers where appropriate.
- B. Containers shall be stored out of the weather and direct sun where the temperatures are within the limits specified by the manufacturer.
- C. All materials shall be stored in compliance with local fire and safety requirements.

1.06 ENVIRONMENTAL CONDITIONS

- A. The polyurethane foam applications shall not proceed during periods of inclement weather. Do not apply the polyurethane foam below the temperature and/or above humidity specified by the manufacturer for ambient air and substrate.
- B. Do not apply protective coatings when there is ice, frost, surface moisture or visible dampness present on the surface to be coated. Prior to applying the coatings, check the polyurethane foam to insure that the surface is dry. Apply protective coatings in accordance with the coating manufacturer's application instructions.
- C. Wind barriers may be used if wind conditions could affect the quality of the polyurethane foam or protective coating installation.

1.07 SEQUENCING AND SCHEDULING

In vessel insulation projects the spray polyurethane foam is installed when all welding is complete, and the metal surface is prepared according to specification. There should not be any other trades-people working on the vessel when the spray polyurethane foam and coating are being installed.

1.08 WARRANTY

Warranty agreements vary in duration and content. If a warranty is desired, it is suggested that parameters be established as a prerequisite to the execution of a contract.

1.09 SAFETY REQUIREMENTS

- A. See API Bulletin AX-119, "MDI-Based Polyurethane Foam Systems: Guidelines for Safe Handling and Disposal."
- B. Refer to appropriate Materials Safety Data Sheets (MSDS).
- C. Take precautions to avoid concentrations of fumes in occupied areas.

PART 2 – PRODUCTS

2.01 POLYURETHANE FOAM

- A. The polyurethane foam shall be a two component system made by combining an isocyanate (A) component with a polyol (B) component and shall possess the following physical characteristics.

PROPERTIES (Sprayed-in-Place)	ASTM Test	Metric (SI)		Traditional U.S.	
		Value	Units	Value	Units
Density	D-1622	40-55	kg/m ³	2.5-3.5	lb/ft ³
Compressive Strength	D-1621	240 min	kPa	35 min	lb/in ²
Closed Cell Content	D-2856	90% min	% value	90% min	% value
R-Value*	C-177 or C-518	1.1	m ² •K/W	6.0 aged	(ft ² •hr•°F)/Btu
Flammability**	E-84	75 max		75 max	

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* Refer to API Bulletin AX-113, "An Assessment of the Thermal Performance of Rigid Polyurethane and Polyisocyanurate Foam Insulation for Use in Building Construction."

** This standard is used solely to measure and describe properties of products in response to heat and flame under controlled laboratory conditions. This numerical flame spread rating is not intended to reflect hazards presented by this or any other material under actual fire conditions.

- B. Fire Safety Requirements: See API Bulletin AX- 119, "MDI-Based Polyurethane Foam Systems: Guidelines for Safe Handling and Disposal," Alliance for the Polyurethanes Industry, 1300 Wilson Blvd., Arlington, VA 22209.

2.02 PROTECTIVE COATING

- A. The Elastomeric Coating System may be one or more of following types:
1. Acrylic
 2. Butyl Rubber
 3. Hypalon
 4. Neoprene
 5. Silicone
 6. Polyurethane Elastomer
 7. Modified Asphalt
- B. Physical Properties: The Elastomeric Coating System shall possess the following physical characteristics. (NOTE: Specifier shall list physical properties of chosen Elastomeric Coating System):

PROPERTIES	ASTM TEST	VALUE
Tensile Strength	D-412	_____
Elongation	D-412	_____
Hardness Shore A	D-2240	_____
Tear Resistance	D-624	_____
UltraViolet Exposure	G-53	_____
Moisture Vapor Transmission	E-96 Procedure E	_____
Chemical Resistance	D-1308	_____

- C. General: It is recommended that the coating systems be elastomeric in nature (at least 100% elongation.) Within these generic coatings are both vapor retarder and non vapor retarder systems.

Cold tanks require a vapor retarder coating. For further information regarding perm ratings and coating selection see "Moisture Vapor Transmission" paper. [SPFA Stock number AY-118]

For further information concerning protective coatings refer to "A Guide for Selection of Protective Coatings Over Sprayed Polyurethane Foam Roofing Systems." [SPFA Stock number AY-102]

2.03 RELATED PRODUCTS

- A. Flashings and waterproof coverings for flexible joints shall be compatible with specified polyurethane foam and elastomeric coating system and shall be as recommended by the manufacturers of the systems used.
- B. Miscellaneous materials such as adhesives, elastomeric caulking compounds, metal, insulation blankets etc. shall be a composite part of the insulation system and shall be those recommended by the systems manufacturer.
- C. Primers, metal coatings and thermal barriers shall be as recommended by the respective manufacturers.

PART 3 - EXECUTION

3.01 SURFACE PREPARATION, METAL PRIMING AND COATING

- A. Ferrous Metal:
1. Gritblast iron and steel surfaces which are not primed, painted, or otherwise protected in accordance with SSPC SP-6, Commercial Blast Cleaning. This includes stairs, tank connecting nozzles, and other items that are a part of the vessel and will have the polyurethane foam insulation system applied to portions of it.

2. Remove contaminants from metal surfaces.
3. Apply primer before surface rust develops. if surface rust develops, gritblast surface again.
4. All bolts, welds, sharp edges and difficult access areas shall receive a primer spot-coat prior to metal primer/coating system.
5. Apply metal primer/coating system according to manufacturer's instructions.

B. Aluminum, Stainless Steel, Galvanized Metal

Clean surface in accordance with SSPC-1, Solvent Cleaning or Steam Cleaning. If polyurethane foam and/or metal primer/coating manufacturer recommends gritblasting, clean surface in accordance with SSPC-7, Brush-Off Blast Cleaning.

3.02 PRIMER AND METAL COATING APPLICATION

A. Inspection

1. Prior to the application of the metal primer/coating system, the surface shall be inspected to insure that conditions required by Section 3.01 have been met.
2. The metal primer/coating system application shall not proceed during periods of inclement weather. The applicator shall not apply the coatings below the temperature and/or humidity specified by the manufacturer for ambient air and substrate.

B. Application

1. The metal primer/coating system shall be applied in accordance with the manufacturer's specification and instructions.
2. The metal primer/coating shall be allowed to cure sufficiently before subsequent coats or polyurethane foam is applied and will be within the recoat schedule recommended by the respective manufacturers.
3. Inspect the metal primer/coating system for holidays and adequate dry film thickness before subsequent coats are applied. Any damage or defects to the metal primer/coating system shall be repaired before the polyurethane foam application.
4. The metal primer/coating system shall be free of contaminants and holidays before the application of polyurethane foam.

3.03 POLYURETHANE FOAM APPLICATION

A. Inspection

1. Prior to the application of the polyurethane foam, the surface shall be inspected to insure that conditions required by Section 3.02 have been met.
2. The polyurethane foam application shall not proceed during periods of inclement weather. The applicator shall apply the polyurethane foam within the temperature and/or humidity limits specified by the manufacturer for ambient air and substrate. Wind barriers should be used if wind conditions could affect the quality of installation.

B. Application

1. Prior to spray application, all surfaces not be insulated should be protected from overspray.
2. The spray polyurethane foam shall be applied in accordance with the manufacturer's specification and instructions.

3. The spray polyurethane foam shall be applied in minimal pass thicknesses of 13 mm (1/2 inch).
4. Spray polyurethane foam thickness shall be a minimum of 25 mm (1 inch) or more if specified. The polyurethane foam shall be applied uniformly over the entire surface with a tolerance of plus 6 mm per 25 mm (1/4 inch per inch) of thickness minus 0 mm (0 inches) except where variations are required to insure proper drainage or to complete a feathered edge.
5. The polyurethane foam shall be uniformly terminated 100 mm (4 inches) beyond all projections, nozzles, pipes, flanges, etc.
6. The polyurethane foam shall be applied over vessel roofs in a manner to provide drainage and prevent standing water.
7. When equipment is supported by structural members, the polyurethane foam shall extend at least 4 times the specified insulation thickness in each direction, measured from junction of equipment with insulated support lug. Thickness of polyurethane foam on steel supports shall be 1/2 of that specified for the body of the equipment. Thickness of polyurethane foam over support lugs will be the same as specified for the body of the equipment. (See Details #4, #6)
8. Skirts supporting vertical equipment shall be insulated inside and outside as part of the equipment area. Polyurethane foam is to extend from the junction at the inside of the skirt down at least one foot. (See Detail # 7)
9. Heads, manholes, blind flanges, etc., that must be removed occasionally should be insulated so that they can be removed without damage to the insulation. (See Detail # 8)
10. Where temperatures exceed 93 °C (200° F), a high temperature insulation blanket shall be installed prior to the polyurethane foam application.
11. The full thickness of polyurethane foam in any area shall be completed prior to the end of each day. If more than 24 hours elapse between the polyurethane foam lifts, the polyurethane foam shall be examined for UV degradation, oxidation, or contamination. The surface shall be prepared according to the manufacturer's recommendations.

C. Surface Finish

1. The final spray polyurethane foam surface shall be "smooth, orange peel, coarse orange peel, or verge of popcorn" Polyurethane foam surfaces termed "popcorn" or "treebark" are not acceptable and should be corrected. (See surface texture photos)
2. Any damage or defects to the polyurethane foam shall be repaired prior to the protective coating application.
3. The polyurethane foam surface shall be free of contaminants that will impair adhesion of the protective coating system.

3.04 PROTECTIVE COATING APPLICATION

A. Inspection

Prior to the application of the protective coatings, the polyurethane foam shall be inspected to insure that conditions required by Section 3.03 have been met.

B. Application

1. Base Coat

- a. The base coat shall be applied the same day as the polyurethane foam when possible. If more than 24 hours elapse prior to the application of the base coat, the polyurethane foam shall be inspected for UV degradation, oxidation, and contaminants. The manufacturer's recommendations shall be followed to prepare the foam surface before coating applications.

- b. The base coat shall be applied at a uniform thickness with the rate of application governed by the polyurethane surface texture. Coatings shall be applied at a rate to achieve the minimum dry film thickness specified by the protective coating manufacturer.
 - c. The coating shall be allowed to cure and be inspected for pinholes, thinly coated areas, uncured areas or other defects. Defects shall be repaired prior to subsequent applications.
 - d. Coating will be reinforced in accordance with manufacturer's instructions around protrusions, stairs, etc.
 - e. The coating application shall not proceed during periods of inclement weather. The applicator shall apply the protective coating within the temperature and the humidity specified by the manufacturer for ambient air and substrate. Wind barriers should be used if wind conditions could affect the quality of installation.
2. Top Coat and/or Subsequent Coat
- a. Inspect the base coating for defects and thin coating. Make repairs before applying subsequent coats.
 - b. Subsequent coating should be applied in a timely manner to insure proper adhesion between coats.
 - c. Final coat shall be inspected for defects and thin coating. Make repairs in accordance with manufacturer's instructions.

3.05 SAFETY REQUIREMENTS

- A. See API Bulletin AX-119, "MDI-Based Polyurethane Foam Systems: "Guidelines for Safe Handling and Disposal."
- B. Refer to appropriate Materials Safety Data Sheets (MSDS) for additional safety information.
- C. Before applying polyurethane foam and protective coatings, protect adjacent areas and personnel from overspray. Take precautions to avoid concentration of fumes in occupied areas.

APPENDIX 1

GUIDE SPECIFICATIONS FOR THE REPAIR OF A POLYURETHANE FOAM INSULATION SYSTEM FOR METAL STORAGE VESSELS

1.0 SCOPE OF WORK

This guide specification covers the repair of spray applied polyurethane foam insulation applied to metal vessels.

2.0 SURFACE PREPARATION

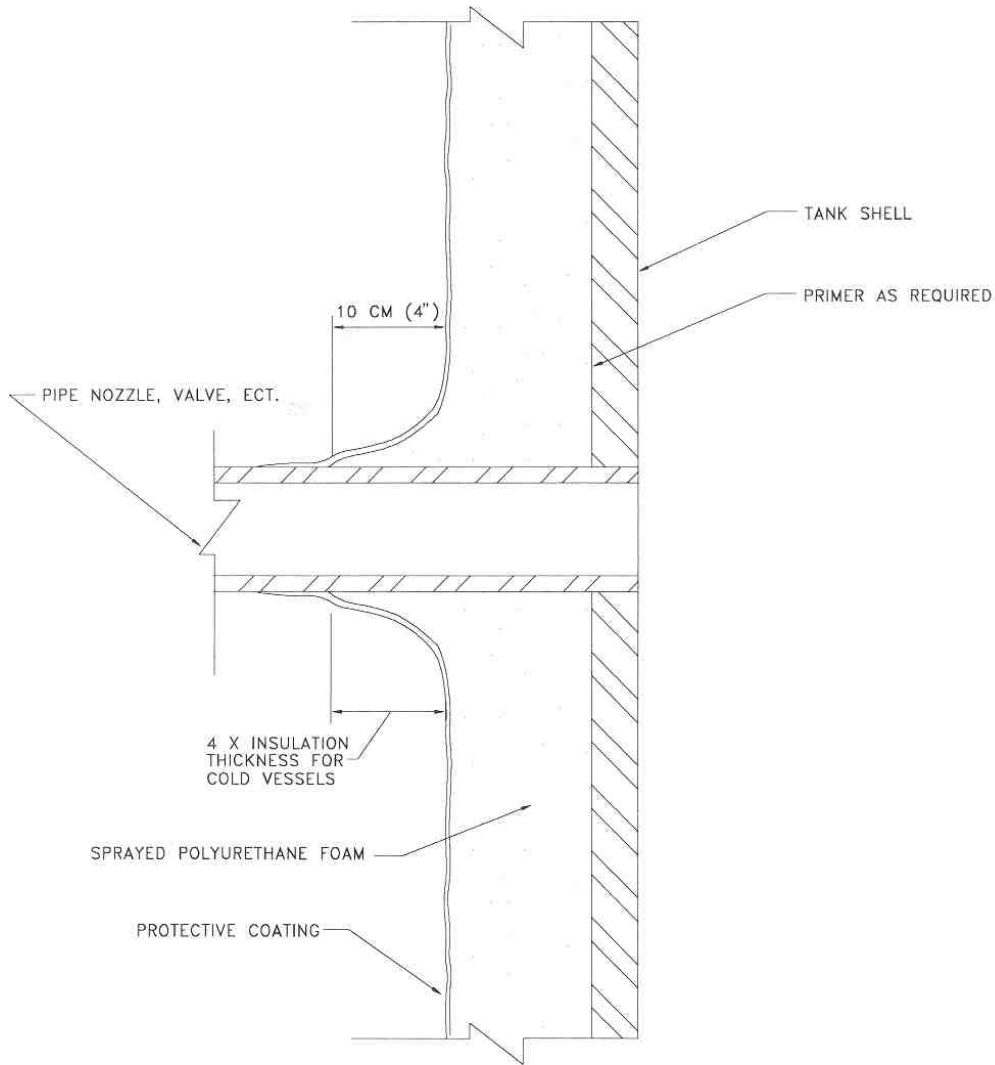
- A. Defective polyurethane foam shall be removed at a 45 degree angle in all directions to dry, solidly adhered polyurethane foam.
- B. If existing metal primer/coating is damaged, it shall be wire brushed and recoated according to manufacturer's instructions.
- C. Protect surrounding area from overspray.
- D. Vessels in operation may have condensation or ice on the metal substrate. Contact polyurethane foam manufacturer for instructions if unit cannot be shut down.

3.0 REPAIR PROCEDURE

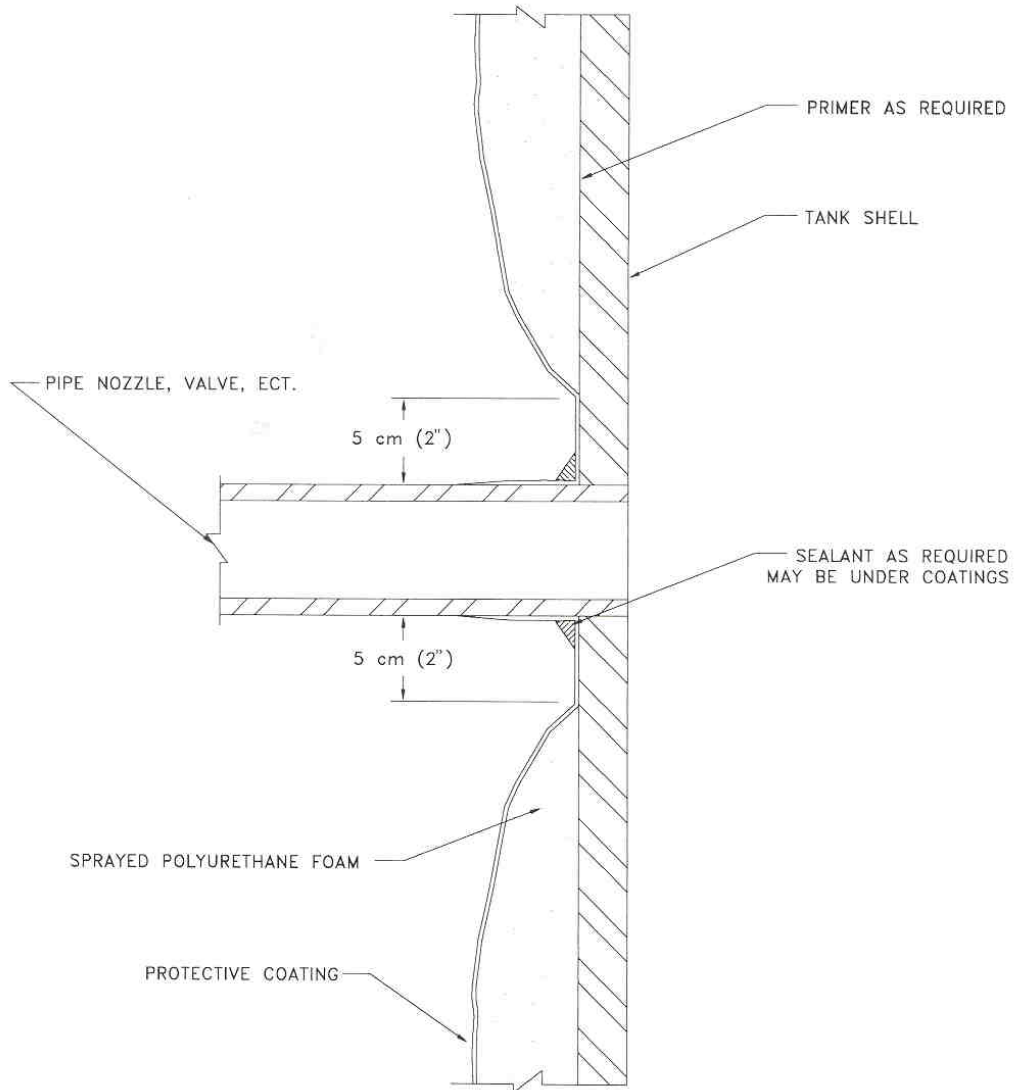
- A. Apply polyurethane foam in the prepared area according to procedure outlined in Section 3.03 so that it conforms to the existing configuration of the vessel.
- B. Apply subsequent coating according to procedures outlined in Section 3.04. A reinforcing fabric may be installed with the base coat if desired.
- C. All areas shall be repaired in a manner to prevent standing water and promote drainage.
- D. All prepared areas shall be repaired the same day or adequately protected against moisture or other contaminants.

DETAIL ILLUSTRATION

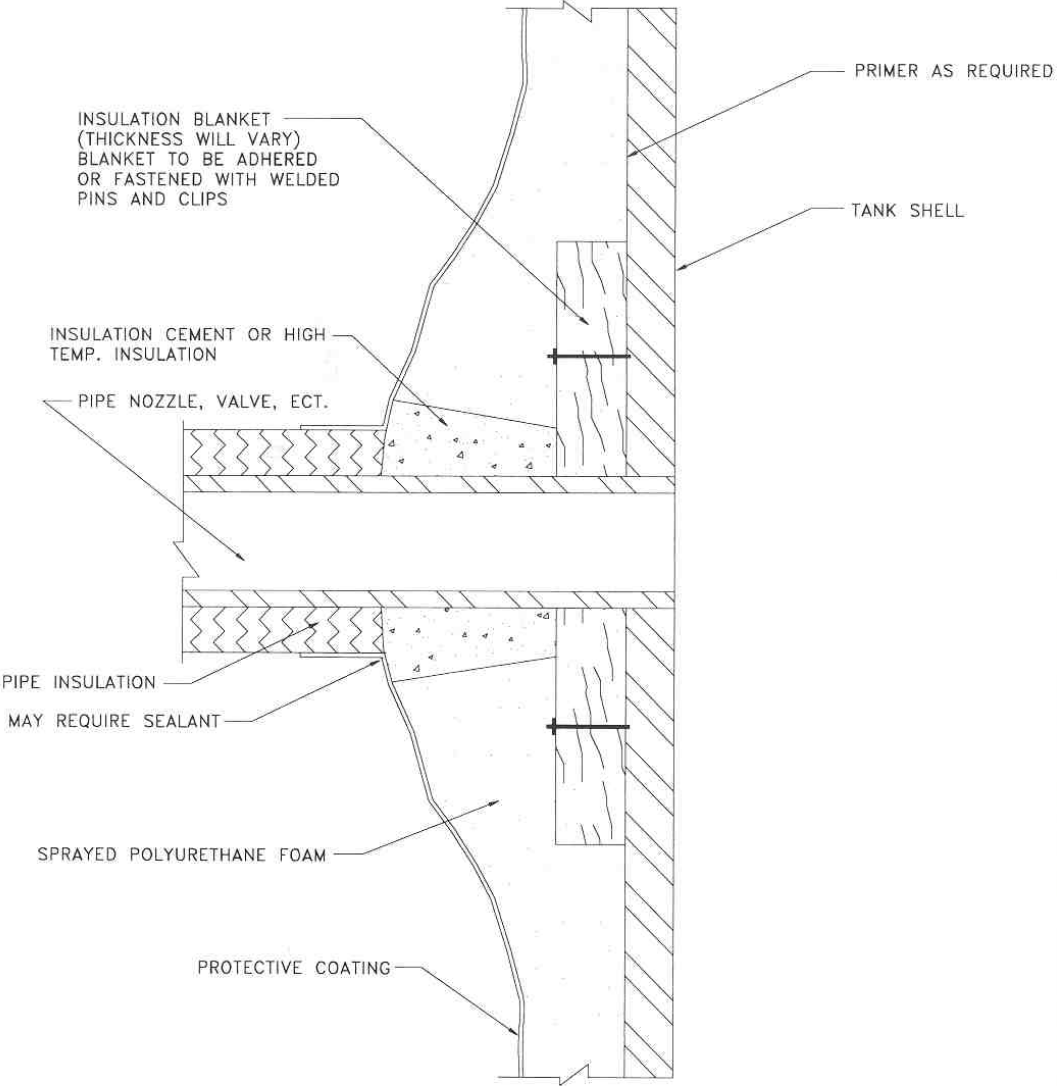
DETAIL 1 - STANDARD PROTRUSION DETAIL



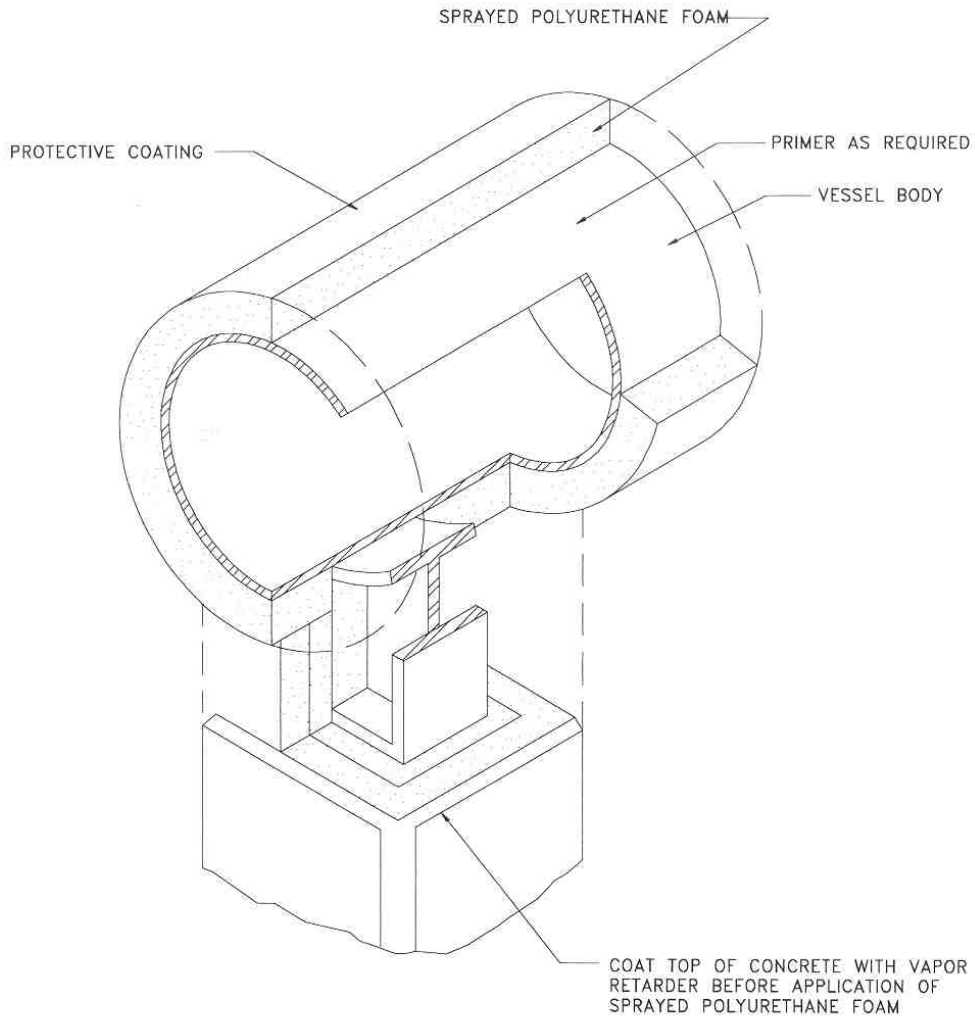
DETAIL 2 - VERTICAL WALL PROTRUSION DETAIL
FOR ABOVE AMBIENT AND BELOW 93°C (200°F)
WHERE SERVICE ACCESS IS REQUIRED



DETAIL 3 - INSULATION OF FLASHING FOR HIGH TEMPERATURE PROTRUSION [(EXCESS OF 93°C (200°F)]

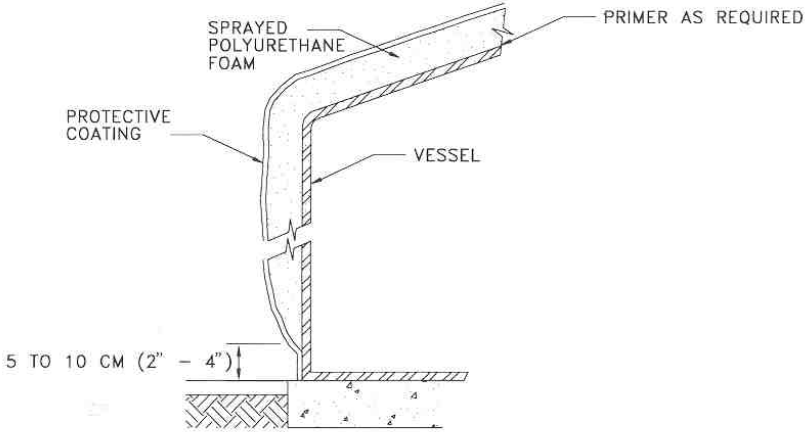


DETAIL 4 - INSULATION OF VESSEL CRADLES AND SUPPORTS

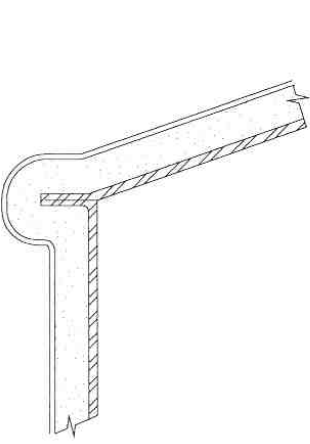


COLD VESSELS SHALL HAVE A THERMAL
BREAK (INSTALLED BY OTHERS) BETWEEN
THE VESSEL AND SUPPORT LUG

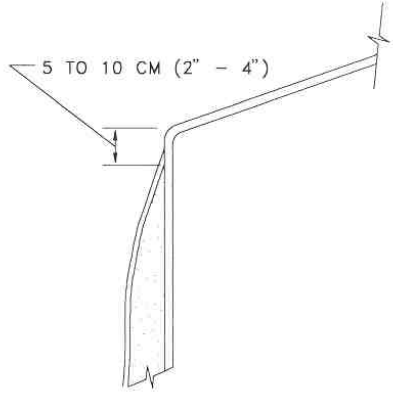
DETAIL 5 - TYPICAL INSTALLATIONS - SHELL, ROOF JUNCTION AND BASE



ROOF AND WALL INSULATED

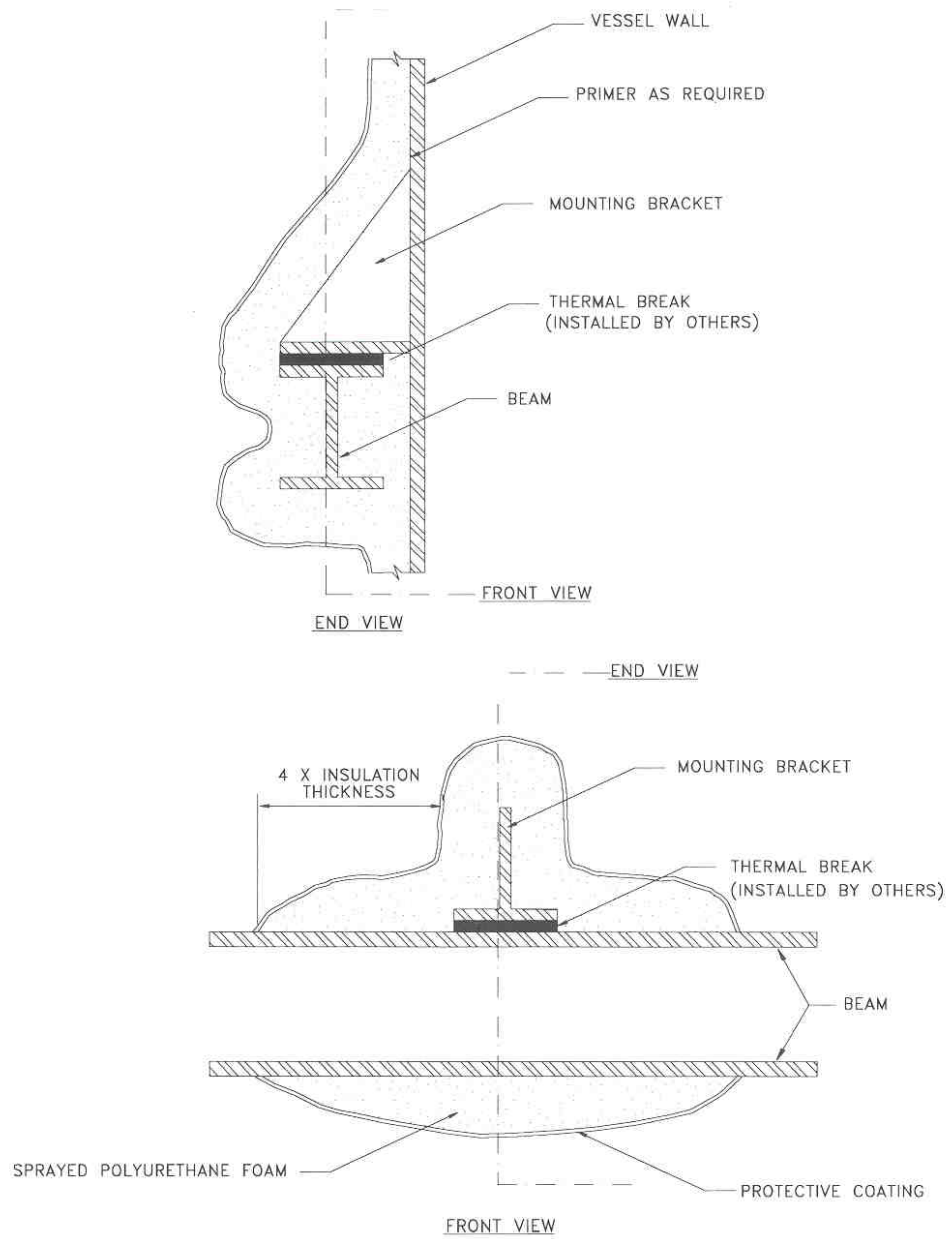


TANK WITH FLANGE AT ROOF AND WALL JUNCTURE

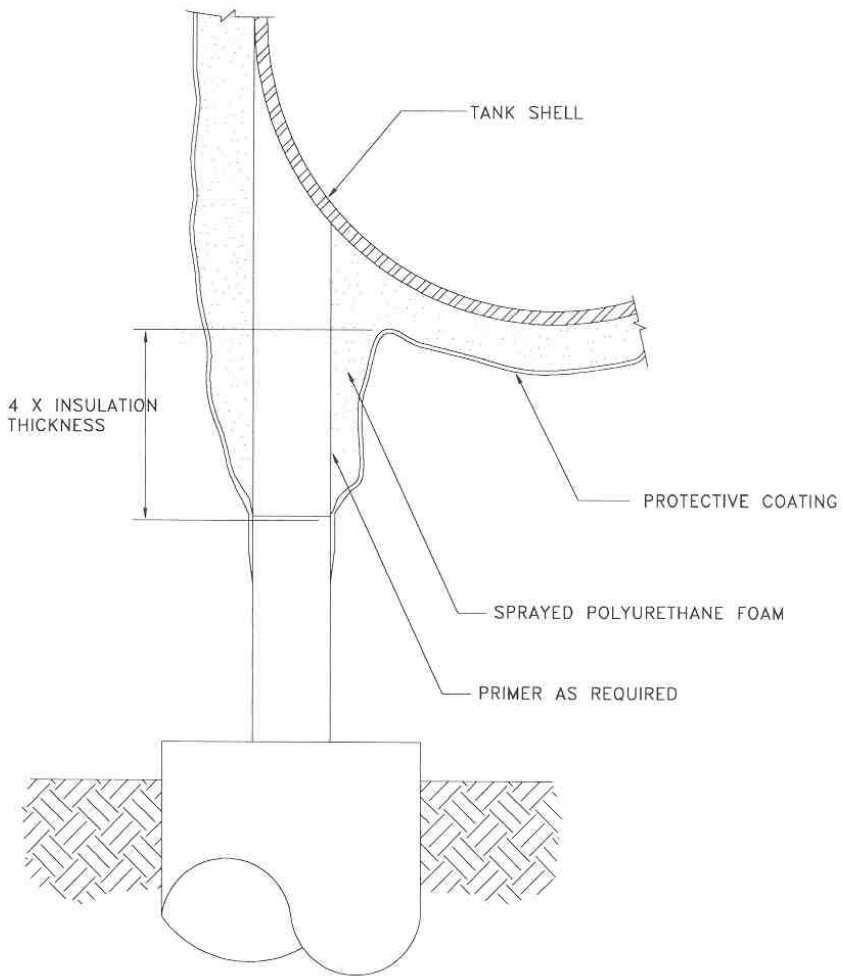


ROOF NOT INSULATED

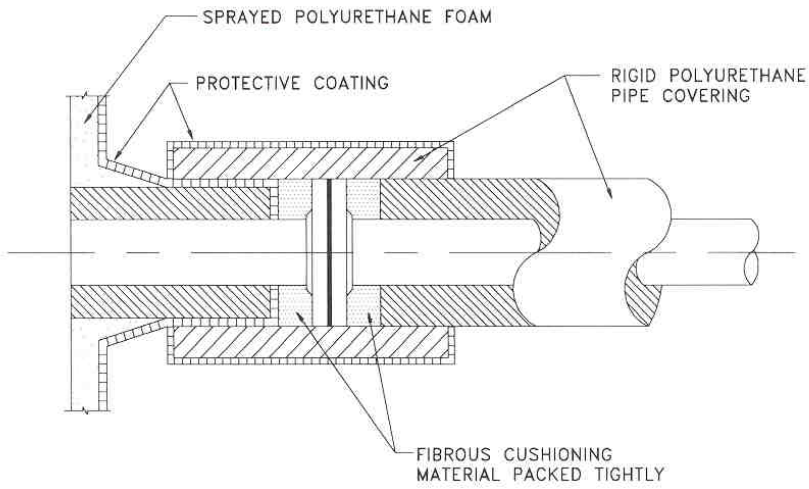
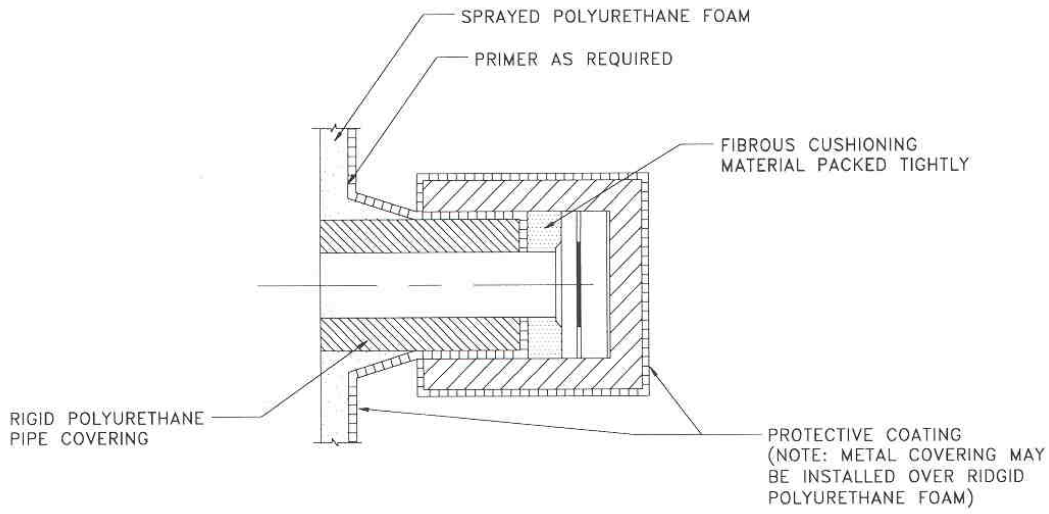
DETAIL 6 – INSULATION OF VESSEL LUGS AND SUPPORTING STEEL



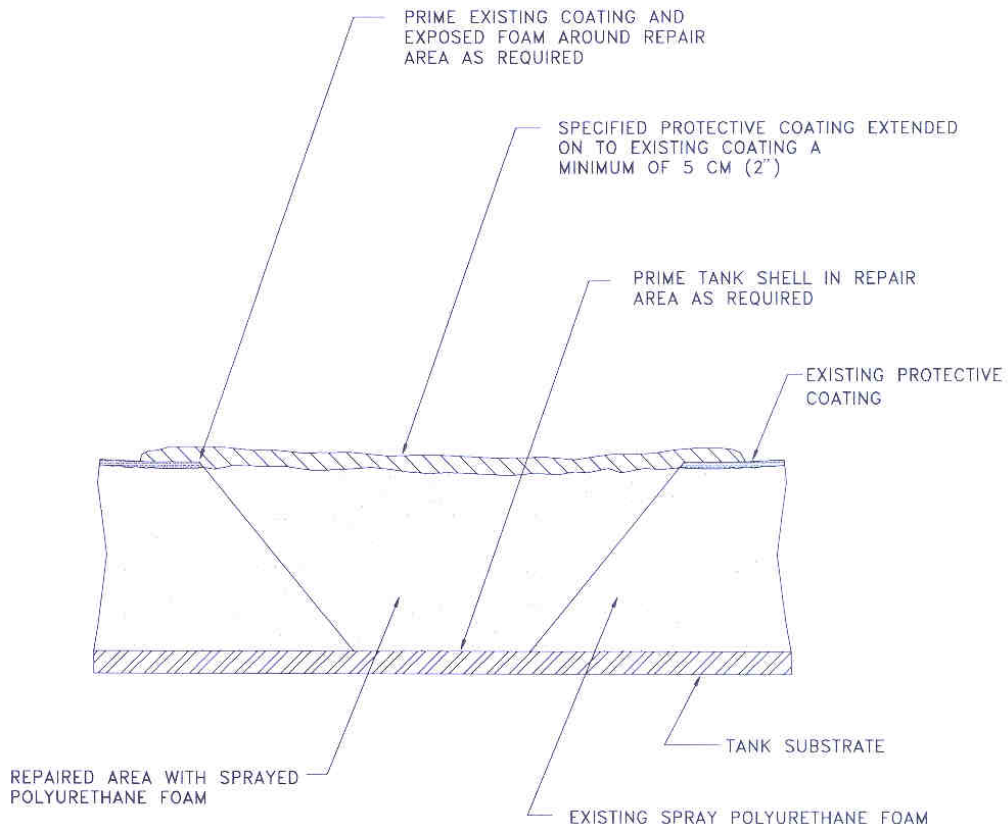
DETAIL 7 - INSULATION OF VESSEL LEG



DETAIL 8 - INSULATION OF VESSEL NOZZLES



DETAIL 9 - REPAIR WITH SPRAY APPLIED POLYURETHANE FOAM



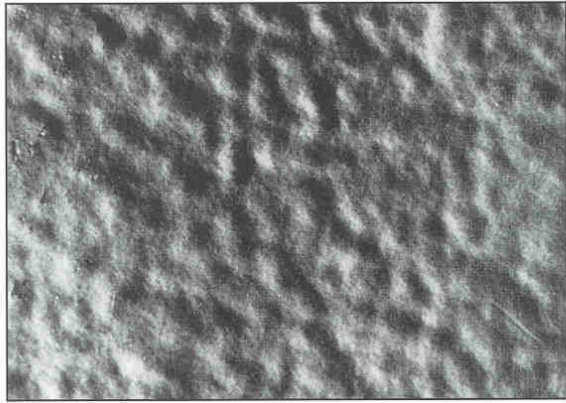


Photo 1
Polyurethane
Foam Texture
Smooth

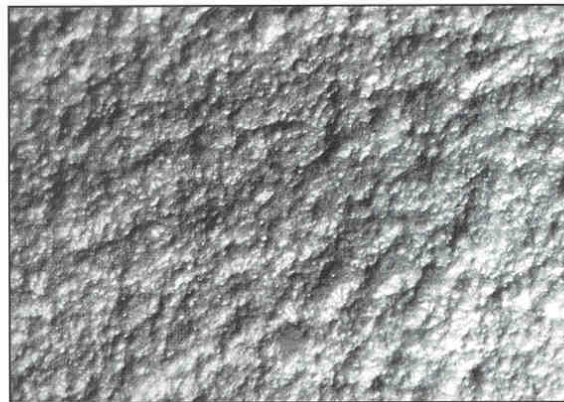


Photo 2
Polyurethane
Foam Texture
Orange Peel

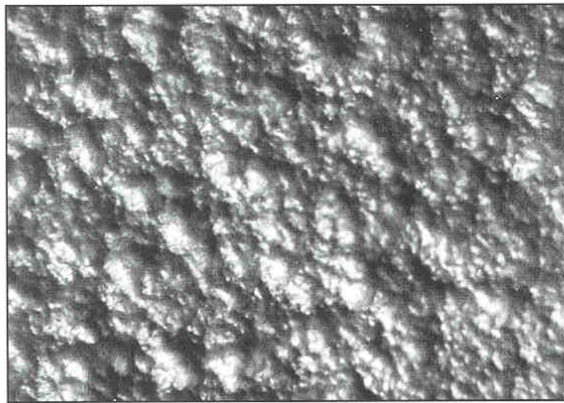


Photo 3
Polyurethane
Foam Texture
Coarse Orange Peel



Photo 4
Polyurethane
Foam Texture
Rippling – Verge
of Popcorn

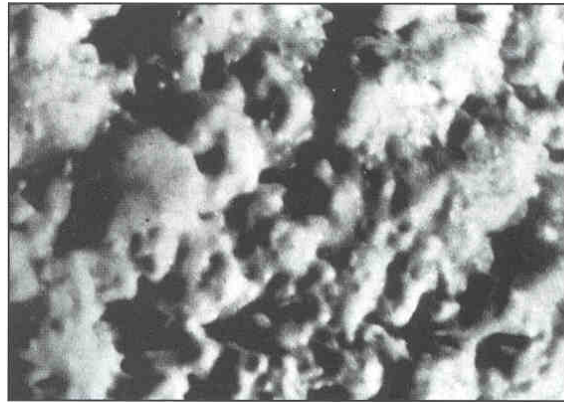


Photo 5
Polyurethane
Foam Texture
Popcorn

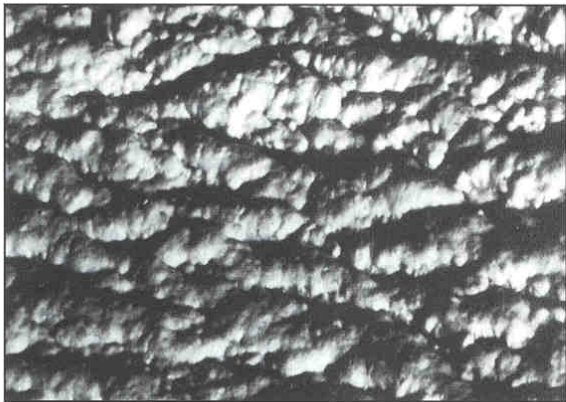


Photo 6
Polyurethane
Foam Texture
Treebark



For More Information

Spray Polyurethane Foam Alliance
4400 Fairlakes Court, Suite 105
Fairfax, VA 22033
800-523-6154