SPRAY POLYURETHANE FOAM ALLIANCE

SPFA-111

Spray Polyurethane Foam Systems for Cold Storage Facilities Operating Between - 40°C and + 10°C (- 40°F and + 50°F)

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ABOUT SPRAY POLYURETHANE FOAM ALLIANCE (SPFA)

Founded in 1987, the Spray Polyurethane Foam Alliance (SPFA) is the voice, and educational and technical resource, for the spray polyurethane foam industry. A 501(c)6 trade association, the alliance is composed of contractors, manufacturers, and distributors of polyurethane foam, related equipment, and protective coatings; and who provide inspections, surface preparations, and other services. The organization supports the best practices and the growth of the industry through a number of core initiatives, which include educational programs and events, the SPFA Professional Installer Certification Program, technical literature and guidelines, legislative advocacy, research, and networking opportunities. For more information, please use the contact information and links provided in this document.

DISCLAIMER

This document was developed to aid building construction and design professionals in choosing spray-applied polyurethane foam systems. The information provided herein, based on current customs and practices of the trade, is offered in good faith and believed to be true to the best of SPFA's knowledge and belief.

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DOCUMENT HISTORY

Date	Sections Modified	Description of Changes
2004		
August 2015	All	Administrative changes
January 2021	Cover and header	New SPFA Logo

TECHNICAL OVERSIGHT COMMITTEE

Mission Statement

The mission of the Technical Committee is to provide a wide range of technical service to the SPF (spray polyurethane foam) industry such as, but not limited to:

(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 the SPF 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 to the SPF industry.

Participating Members	
Roger Morrison, Chairman NCFI	Bruce Schenke BASF
Mary Bogdan Honeywell	Irene Schwechler Gaco Western, Inc.
Bob Braun Dow Chemical	Chuck Skalski Gaco Western, Inc.
John Courier Equipment & Coatings Technologies	Larry Smiley Poly-Tek
John Hatfield Penta Engineering Group, Inc.	Robert Smith Invista
Dan Hensley Hensley Coating Inc.	John Stahl Preferred Solutions, Inc.
Tim Leonard ERSystems	Jay Zhang Convenience Products
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Jack Moore West Roofing Systems, Inc.	Scott Brown BaySystems North America LLC

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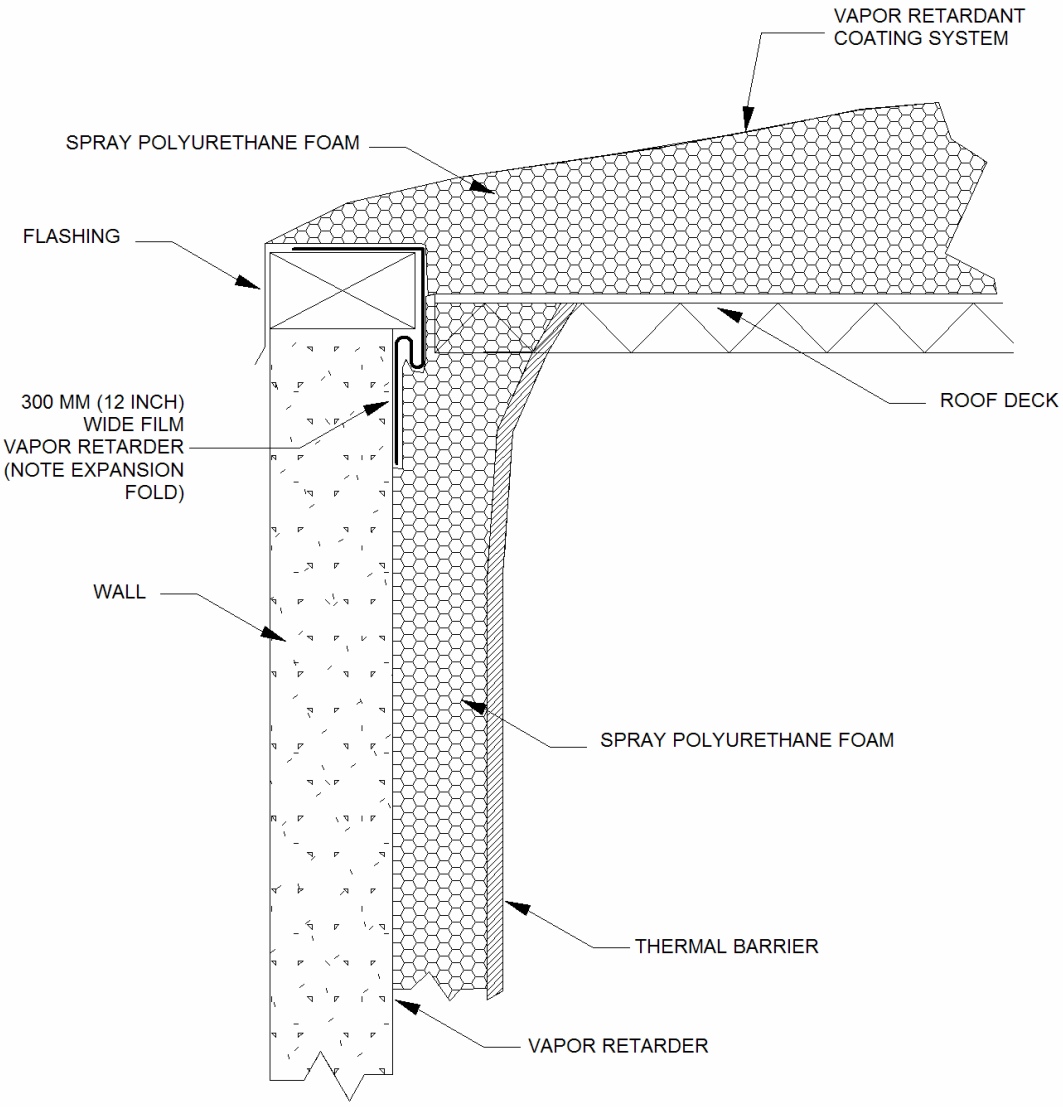
COLD STORAGE FACILITY
ROOF/WALL JUNCTION



DESIGN CONSIDERATIONS

GENERAL CONSIDERATIONS

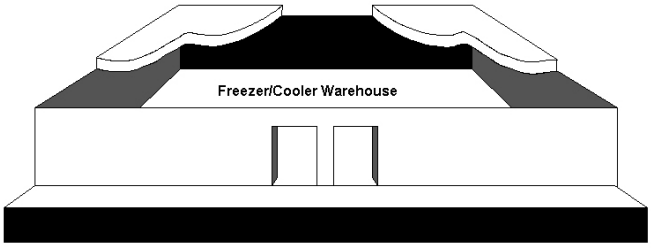
The performance of a spray-applied polyurethane foam insulation (SPF) system for cold storage facilities can be affected by all the component parts of the building structure, as well as the atmospheric conditions inside and outside the structure.

Proper structural design, specifications review, and contractor and material selection, coupled with the compatibility and positioning of the various components of the building are a necessity to produce a successful cold storage facility.

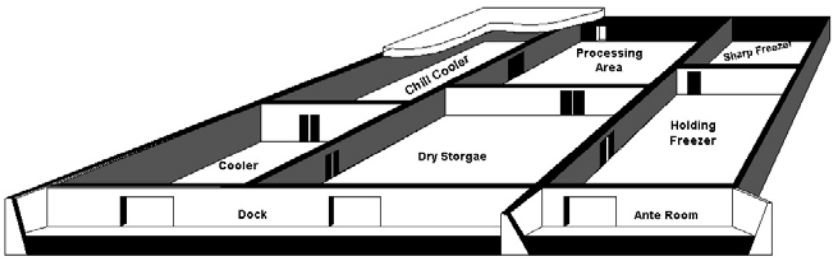
Consult with the designer/specifier and the successful contractor to receive written confirmation of their agreement with all facets of the cold storage project, including, but not limited to, material selection, moisture vapor transmission, load design, expansion joints, refrigeration requirements, flashing details, and floor, wall, ceiling and preparation, and pull-down schedule. (See Appendix.)

TYPES OF COLD STORAGE FACILITIES

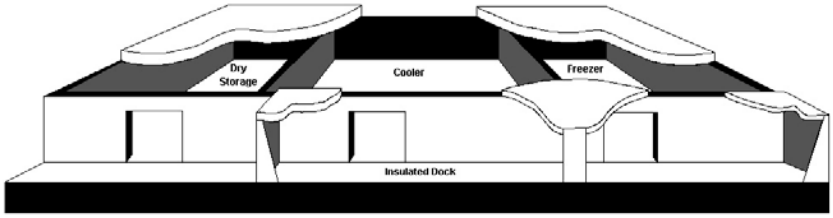
(1) **Refrigerated warehouses** generally have the single function of storing previously processed or frozen food at a constant temperature between -40°C (-40°F) and 10°C (50°F). They are often one-room buildings. Packaged goods are stored on pallets or food racks.



(2) **Processing plants** for meats, poultry, dairy, or other food products are multi-functional type structures which are quite complex. They typically consist of many rooms, each with a certain function, operating temperature, and humidity condition.



(3) **Distribution centers** are multi-room buildings for packaged dry goods, frozen foods, fresh produce, baked goods, and dairy products. In addition to the foregoing, these centers may contain specialty rooms such as banana rooms, or ice cream holding rooms.



(4) **Existing facilities** may be converted to another use (i.e., a cooler may be converted to a freezer), or a new room may be added within an existing structure.

STRUCTURE PREPARATION, PROCEDURES, AND CONSIDERATIONS

(1) **Freezer Floors**

a. The ultimate load capacity of the SPF insulated floor is dependent on the thickness and compressive strength of the insulation and the strength of the concrete wearing slab. The concrete wearing slab is placed directly on the SPF and slip sheet.

b. All freezer floors are to be vented or heated. This may be in the form of ducts to circulate warm air, pipes for warm fluid, or electric heating cables. The capacity of the heat supply should be sufficient to prevent freezing of the subfloor soil. Thermocouples should be installed to allow monitoring of under-floor temperature during operation of the facility. The design of the sub-grade heating system will be based on local soil conditions and the thermal conductivity of the SPF insulation system.

c. Sequence of floor construction:

i. Apply the vapor retarder and SPF insulation to base columns.

ii. Install the heated mechanical equipment and vent pipes. Pour the base slab (recess to allow for thickness of insulation). Allow new concrete to cure a minimum of 28 days before applying the vapor retarder.

iii. Apply the vapor retarder and SPF insulation.

iv. Secure the slip sheet and pour the concrete wearing slab.

(2) **Cooler floors** may not need to be insulated.

(3) **Walls and Ceilings**

a. Conduits, pipes less than 50 mm (2 in.) in diameter, and hanger rods that project through the insulation should be insulated a distance of four times the regular wall insulation thickness. Insulate columns and pipes larger than 50 mm (2 in.) in diameter a distance of 1.2 m (4 ft.) from the wall, ceiling, or floor.

b. Suspended ceilings should have sufficient working space above the ceiling and should be vented.

c. Hanger rods should be insulated and spaced to provide safe support for anticipated loads.
d. All penetrations should be made before the vapor retarder and SPF are applied.
e. Hollow walls between two freezers are not recommended.
f. Walls that separate a low-temperature space from a heated space require more insulation than would be used on walls that separate cold spaces from each other.

(4) **Roof Decks**
a. Metal decking or other conductive material should not be continuous between rooms of varying temperatures.
b. SPF should not be applied directly over a lightweight concrete fill deck.

(5) **Other Design Considerations**
a. When a vapor retardant material is used on the cold side of the insulation in a cold storage facility, such as in panels of metal roof decks, breaks in the exterior vapor retarder will result in the build-up of ice or moisture within the insulation. Routine maintenance inspections should be done to repair vapor retarder breaks before this occurs.

SURFACE PREPARATION

(1) The surface to be insulated should be securely fastened and conform to the load limits of good engineering practices.
(2) Priming should be done in accordance with the recommendations of the SPF, primer, and/or vapor retarder manufacturers.

SELECTION OF A VAPOR RETARDER

The following items should be considered when choosing a vapor retarder:

(1) Permeance required
(2) Surface preparation required
(3) Adhesion of all system components
(4) Manufacturer's recommendations
(5) Environment in which it is to be used

SELECTION OF THE SPRAY POLYURE- THANE FOAM (SPF) SYSTEM

Many different SPF systems are available, each exhibiting different temperature limitations, combustibility characteristics, and physical properties. Most published data are run on laboratory samples. The thickness of polyurethane foam sprayed, number of lifts, temperature of substrate, ambient temperature, etc., may have an effect on all polyurethane foam 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 materials and environments involved. Special care is recommended to prevent accidental ignition during construction.

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. Care must be taken to ensure that the foam is not exposed to heat or flame.

SELECTION OF A THERMAL BARRIER

Many types of thermal barriers are available, including, but not limited to:

(1) Gypsum wallboard
(2) Spray-applied cementitious materials
(3) Spray-applied cellulose materials
(4) Portland cement plaster
(5) Various proprietary materials

The thermal barrier should have a valid building code certification that lists a report number and date. In some cases, a local building code official will allow the use of a thermal barrier that has been tested to the satisfaction of the official, but is not yet certified by a code agency.

Generally accepted tests for thermal barriers include:

- UL 1715 Fire Test of Interior Finish Material
- UL 1040 Insulated Wall Construction
- FM 4880 Building Corner Fire Test
- UBC Standard 26-2 Test Method for the Evaluation of Thermal Barriers

Caution: Materials advertised as thermal barriers may not have been approved by a code agency or a local code official. Ask for test data and code body approvals, listings, or other written indications of acceptance under code to be sure that the product selected offers the fire protection that the code demands.

Consider the following items in the selection of a thermal barrier:

(1) USDA and building code requirements
(2) Adhesion to the SPF
(3) Environment in which it is to be used
(4) Aesthetic qualities
(5) Ease of maintenance

PULL-DOWN SCHEDULE

The gradual lowering of the facility's temperature allows for the construction materials to adjust to dimensional changes, reduces stress from sudden moisture changes, and allows for more accurate monitoring of the performance of the vapor retarder and mechanical equipment. (See Appendix I for more detailed information.)

MAINTENANCE PROCEDURES

It is recommended that maintenance procedures, including annual inspections, be established with your selected contractor for any insulation system requiring periodic maintenance.

Contact the respective manufacturer, supplier, and contractors for recommended maintenance procedures.

RECOMMENDED GUIDE SPECIFICATION FOR INSULATION OF COLD STORAGE FACILITIES

NOTE: This guide is designed to help the specifier insulate a cold storage facility. It is the responsibility of the specifier to consult the chosen manufacturers of the materials specified about their recommendations.

PART 1 – GENERAL

This guide discusses the application of a vapor retarder and SPF with a protective thermal barrier for use as an insulation system in cold storage facilities. Your contractor, systems manufacturer, and local code agencies can assist you, as each project must be assessed individually.

1.01 SCOPE OF WORK

Furnish all labor, materials, tools, and equipment necessary for the application of a SPF insulation system to a cold storage facility, including accessory items, subject to the general provisions of the contract.

1.02 RELATED WORK SPECIFIED ELSEWHERE

(1) Cast-in-place Concrete	Section 03300
(2) Metal	Section 05300
(3) Rough Carpentry	Section 06100
(4) Insulation	Section 07200
(5) Membrane Roofing	Section 07500
(6) Flashing and Sheet Metal	Section 07600
(7) Roof Specialties and Accessories	Section 07700
(8) Mechanical	Division 15
(9) Electrical	Division 16

1.03 QUALITY ASSURANCE

(1) Contractor Qualifications: The proposed contractor will provide information concerning projects that are similar in nature to the one proposed, including the location and person to be contacted. Some manufacturers of SPF systems and thermal barriers have approval programs and/or licensing methods that could be required.

(2) Manufacturer Qualifications: Polyurethane foam, primer, thermal barrier, and vapor retarder manufacturers shall show evidence of sufficient financial resources and manufacturing facilities to furnish the materials for this project. References shall be required, and sufficient project lists and building code approvals shall be submitted for verification.
(3) Inspections: The polyurethane foam and thermal barrier manufacturers may provide qualified representatives to monitor and inspect the installation of their products.

1.04 SUBMITTALS

(1) Manufacturers are to provide published data sheets or letters of certification that their products comply with the materials specified. This is to include primers (if required), SPF, vapor retarders, and thermal barriers.
(2) Shop drawings on sheet metal, accessories, or other fabricated items.
(3) Manufacturer's application or installation instructions.
(4) Contractor/applicator certification from the polyurethane foam and/or thermal barrier manufacturers and evidence of the contractor/applicator qualification and experience. (See Section 1.03.)
(5) Approval and information guides for applicable building codes.
(6) Safety and handling instructions for storage, handling, and the use of the materials including the appropriate Materials Safety Data Sheets (MSDS).
(7) Field Quality Control Procedures are to be utilized by the contractor/applicator to ensure proper preparation and installation of SPF, primers, vapor retarders, thermal barriers, detail work, and follow-up inspection.

1.05 MATERIALS, DELIVERY AND STORAGE

(1) Material shall be delivered in the manufacturers' original, tightly sealed containers, or unopened packages, all clearly labeled with the manufacturers' name, product identification, safety information, and batch or lot numbers where appropriate. Where materials are covered by a referenced specification, the labels shall bear the specification number, type, and class, as applicable.
(2) Containers shall be stored out of the weather and direct sunshine where temperatures are within the limits specified by the manufacturer.
(3) All materials shall be stored in compliance with fire and safety requirements.

1.06 ENVIRONMENTAL CONDITIONS

(1) Do not apply the SPF below the temperature and/or above the humidity specified for ambient air and substrate by the manufacturer.
(2) Apply primers, vapor retarder, and thermal barrier in accordance with the material manufacturers' application instructions.

1.07 SEQUENCING AND SCHEDULING

New construction requires that the contractor/applicator must apply the vapor retarder and the SPF insulation systems at different times during the construction project.

1st Phase	Floors and Columns (see Design Considerations)
2nd Phase	Roof
3rd Phase	Walls and Ceiling
4th Phase	Doors

Penetrations must be in place before the application of primer, vapor retarder, and SPF insulation.

1.08 SAFETY REQUIREMENTS

(1) See:
   a. API Bulletin AX-151, "Guide for the Safe Handling and Use of Polyurethane and Polyisocyanurate Foam Systems," Alliance for the Polyurethane Industry, 1300 Wilson Boulevard, Arlington, VA 22209.
   b. "Six Steps for Fire Safety During Construction," Alliance for the Polyurethane Industry, 1300 Wilson Boulevard, Arlington, VA 22209.

(2) Refer to the Material Safety Data Sheets (MSDS) for additional safety information.

PART 2 – PRODUCTS

2.01 SPRAY POLYURETHANE FOAM (SPF)

The cured SPF shall possess the following physical characteristics:

PROPERTIES	ASTM TEST	METRIC UNITS	U.S. UNITS
Density (sprayed in place)*	D-1622	32-48 kg/m^3	2.0-3.0 lbs/ft^3
Compressive Strength	D-1621	140 kPa min	20 psi min
Closed Cell Content	D-2856	90% min	90% min
R-Value	C- 177 or C-518	As reported	As reported
Flammability **	E-84	#75 or as required by applicable building code	
Smoke Developed	E-84	#450	

*In freezer applications, the specified SPF density should generally be increased with decreasing freezer temperatures. Consult the SPF manufacturer for specific recommendations.

**This standard is used solely to measure and describe the 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.

2.02 VAPOR RETARDER

Physical properties: The vapor retarder will be chosen for its compatibility to the substrate and SPF.

Moisture Vapor Transmission: As tested by ASTM E-96 Method E shall be 0.01 perm or less. Refer to SPFA-118, “Moisture Vapor Transmission.”

2.03 THERMAL BARRIER

If required, the thermal barrier must meet applicable building codes. Refer to SPFA-126, “Thermal Barriers for the Spray Polyurethane Foam Industry.”

2.04 PRIMER

If required, the primer used shall be as recommended by manufacturer.

2.05 ACCESSORIES AND MISCELLANEOUS MATERIALS

(1) Flashings and waterproof coverings for expansion joints shall be compatible with the specified vapor retarder and SPF system, and shall be as recommended by the manufacturers of the systems used.
(2) Miscellaneous materials such as adhesives, elastomeric caulking compounds, metal, vents, and drains shall be a composite part of the cold storage facility and shall be those recommended by the system's manufacturer.
(3) Insulation Boards: If insulation boards are required over floors or roof decks, follow the manufacturer's instructions for fastening and/or other design requirements. Multiple layers should have staggered seams.

PART 3 – EXECUTION

3.01 SURFACE PREPARATION AND PRIMING

(1) Metal Deck
    a. The metal roof deck shall be constructed of minimum 22-gauge steel. Construction shall conform to local building codes.
    b. Ferrous Metal: Remove sandblast iron and steel surfaces that are not primed, shop-painted, or otherwise protected in accordance with SSPC SP-6, "Commercial Blast Cleaning." Remove loose rust and unsound primer from shop-primed iron and steel surfaces by scraping or wire brushing.
    c. Non-ferrous Metal: Clean galvanized metal, aluminum, and stainless steel surfaces as recommended by the manufacturer issuing the warranty.
    d. If the metal surface is free of loose scale, rust, weathered, or chalking paint, the surface can be cleaned using a compressed air jet, vacuum equipment, and a hand or power broom to remove loose dirt. Grease, oil, or other contaminants shall be removed with proper cleaning solutions.
    e. Fluted metal decks require a suitable method of covering or filling the flutes prior to polyurethane foam application. Flutes may be covered with mechanically fastened boardstock, open-weave mesh fabric, or filled with precut board-stock or SPF.
(2) Concrete
    a. Remove loose dirt, dust, and debris by using a compressed air jet, vacuum equipment, or brooming. Oil, grease, form release agents, or other contaminants shall be removed with proper cleaning solutions.
    b. All joint openings in concrete decks that exceed 6 mm (1/4 in.) shall be grouted or caulked prior to the application of polyurethane foam.
    c. Priming is required on concrete surfaces, and the recommended cure time for poured concrete decks is 28 days prior to the application of primer or SPF.
    d. SPF is not recommended for lightweight or insulating concretes unless tests have been made to determine that adequate adhesion can be obtained or an overpavement is installed.

(3) Wood
   a. Plywood shall be exterior grade not less than 13 mm (1/2 in.) thick, nailed firmly in place. The attachment must meet building code requirements for resistance to wind uplift.
   b. Plywood shall contain no more than 18% water, as measured in accordance with ASTM D 4444 or ASTM D 4442.
   c. All untreated and unpainted surfaces shall be primed with an exterior grade primer. Priming is required to minimize moisture absorption and eliminate potential polyurethane foam adhesion problems.
   d. Plywood joints in excess of 6 mm (1/4 in.) shall be taped or filled with a suitable sealant material.
   e. The deck shall be free of loose dirt, grease, oil, or other contaminants prior to priming or foam application. Remove loose dirt or debris by use of a compressed air jet, vacuum equipment, or brooming. No washing shall be permitted.
   f. Tongue and Groove, Sheathing, and Planking: Due to the frequency of joints, the possibility of variable openings, and the effects of aging and shrinking, these surfaces must be overlaid with a minimum of 6 mm (1/4 in.) thick exterior grade plywood or suitable covering.

(4) Other Surfaces (e.g., Gypsum Board, Isocyanurate Board)
   a. These materials are generally used over fluted metal decks and must be fastened to achieve necessary wind uplift requirements.
   b. Boards shall be firmly butted together along all edges without gaps or openings. Joints exceeding 6 mm (1/4 in.) shall be caulked with a suitable sealant material.
   c. Special care must be taken to prevent these materials from getting wet in storage on the job site and after installation prior to being protected by polyurethane foam. Moisture exposure will damage these materials and may be a cause for replacement.
   d. Remove loose dirt and debris by using a compressed air jet, vacuum equipment, or light brooming. No power brooming is permitted due to possibility of damage.
   e. The installed materials shall be protected from spills of contaminants such as oil, grease, solvents, etc., as these materials cause soiling that cannot be readily removed from the board surfaces.

3.02 VAPOR RETARDER APPLICATION

(1) Interior Application
   a. The vapor retarder shall be applied in accordance with the manufacturer's specifications and instructions.
   b. The vapor retarder shall be applied to all surfaces to be insulated and extend 150 mm (6 in.) beyond where the insulation will end. Metal surfaces do not require vapor retarders. However, seams and/or penetrations must be sealed.
   c. The vapor retarder shall be cured before the SPF insulation is applied.
   d. The vapor retarder shall be a continuous film; floor to wall to ceiling or roof. (See Design Consideration.)

e. Any damage or defects to the vapor retarder film shall be repaired prior to the application of SPF insulation.
f. The vapor retarder film shall be free of moisture, frost, debris, or contaminants that will impair the adhesion of the SPF insulation to the vapor retarder and substrate.

(2) Exterior Application
a. The vapor retarder shall be applied in accordance with the manufacturer's specifications and instructions.
b. The vapor retarder shall be applied as a continuous membrane to a clean, dry SPF surface.
c. The vapor retarder shall be without voids or holidays and shall extend 100 mm (4 in.) beyond the termination of the polyurethane foam at projections and wall terminations.

See SPFA-118, "Moisture Vapor Transmission."

3.03 SPRAY POLYURETHANE FOAM APPLICATION

(1) Application
a. The applicator shall not apply SPF insulation below the surface temperature and/or above the humidity for ambient air and substrate specified by the manufacturer.
b. The SPF insulation should be applied in a minimal lift thickness of 13 mm (1/2 in.), with a maximum thickness per lift as recommended by the SPF manufacturer.
c. The SPF insulation shall be applied uniformly to the minimum specified thickness over the entire surface.
d. SPF insulation thickness shall be determined by the specifier and shall be sufficient to provide the R- value required, and to prevent condensation. Factors such as exterior temperature, facility temperature, and humidity, should be considered to determine the final thickness of the SPF insulation.
e. The SPF insulation shall be allowed to cure. If the full thickness of the SPF insulation is not completed prior to the end of the day, the foam surface shall be prepared in conformity with the recommendations of the manufacturer.

(2) Surface Finish
a. The finished surface shall be acceptable for the application of the thermal barrier.
b. Any damage or defects to the SPF insulation surface shall be repaired as necessary prior to the thermal barrier application.

3.04 THERMAL BARRIER APPLICATION

(1) The thermal barrier shall be installed at the thickness required by the manufacturer to comply with applicable building codes.
(2) Sprayed or troweled thermal barriers shall be allowed to cure. The thermal barrier should be inspected for uncured areas or defects. Any defects shall be repaired prior to subsequent applications or temperature pull-down.
(3) Refer to API document, "Six Steps for Fire Safety During Construction," Alliance for the Polyurethane Industry, 1300 Wilson Boulevard, Arlington, VA 22209.

3.05 ROOFS

Refer to SPFA-104, “Spray Polyurethane Foam Systems for New and Remedial Roofing, Design Considerations and Guide Specifications.”

APPENDIX I

COLD STORAGE FACILITY – PULL DOWN SCHEDULE

Materials used to construct refrigerated rooms, like all materials used in building structures (i.e., steel frames, metal decks, etc.), are affected by temperature changes.

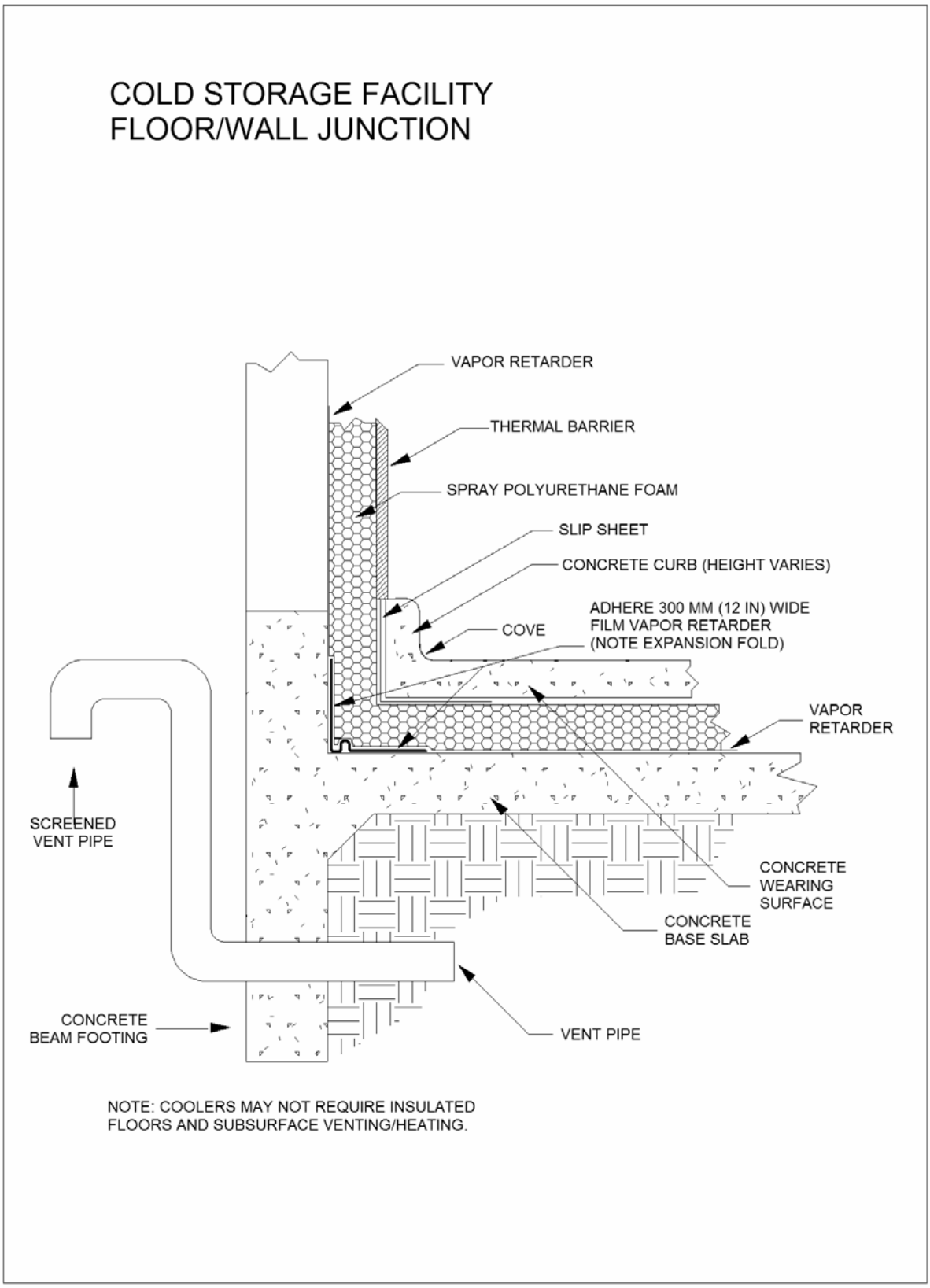
The gradual lowering of the facility's temperature allows for the construction materials to adjust to dimensional changes, reduces stress from sudden moisture changes, and allows for more accurate monitoring of vapor retarder and mechanical equipment performance.

The following is an example of a typical pull-down schedule:

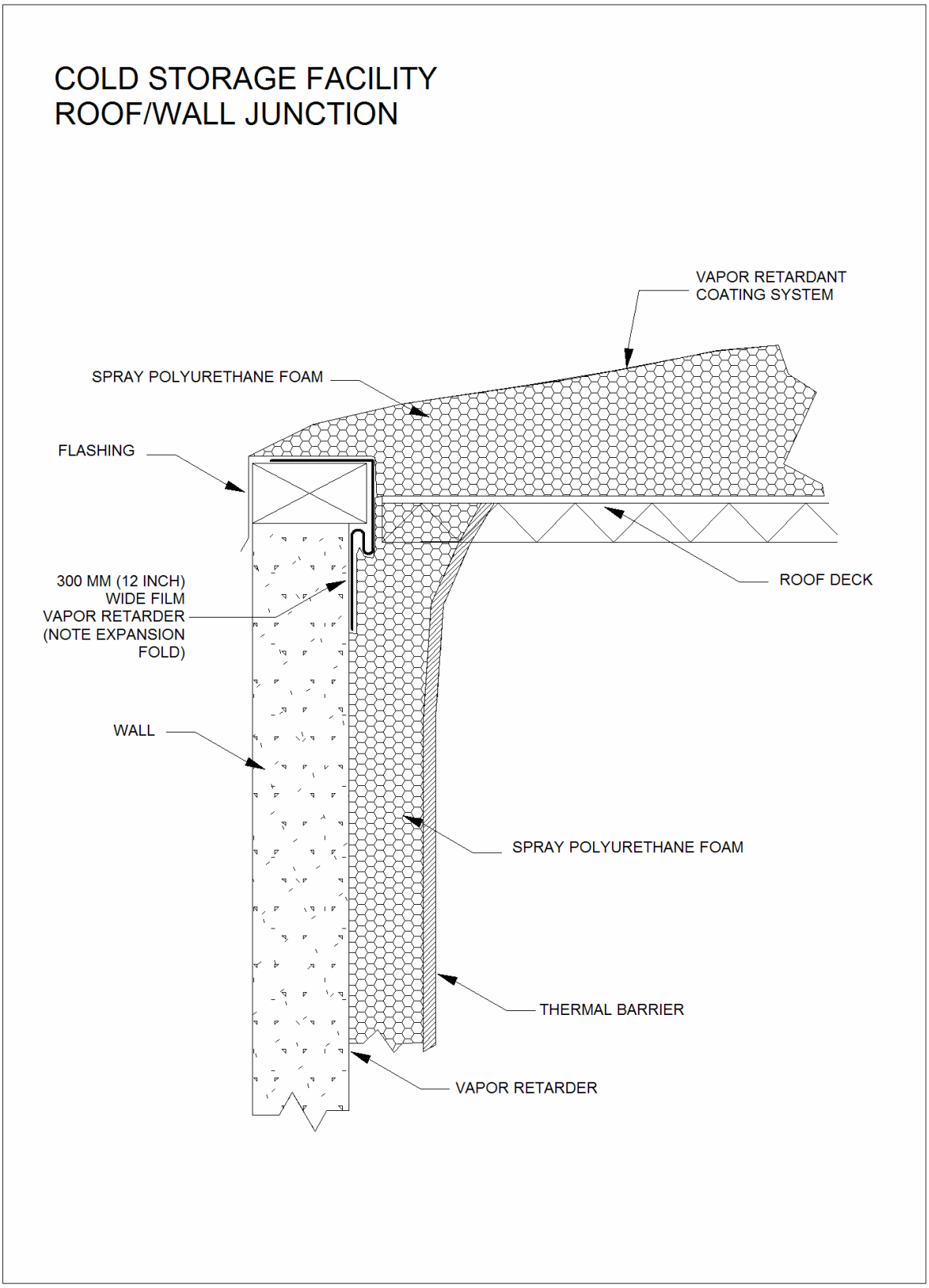
Temperature Reduction Until Room Is Dry				
Time Period	Maximum Temperature Reduction		Minimum Room Temperature	
First 24 hours	---	---	24°C	75°F
Second 24 hours	8°C	15°F	16°C	60°F
Third 24 hours	8°C	15°F	7°C	45°F
Fourth 24 hours	6°C	10°F	2°C	35°F
Until room is dry (Observe moisture on cooling coils as an indicator)	0°C	0°F	2°C	35°F

Temperature Reduction After Attaining Dry State				
Time Period	Maximum Temperature Reduction		Minimum Room Temperature	
First 24 hours	3°C	5°C	-1°C	30°F
Second 24 hours	6°C	10°F	-6°C	20°F
Third 24 hours	6°C	10°F	-12C	10°F
Fourth 24 hours	6°C	10°F	-17°C	0°F
Fifth 24 hours	6°C	10°F	-23°C	-10°F

DETAIL DRAWING 1: COLD STORAGE FACILITY FLOOR/WALL JUNCTION



DETAIL DRAWING 2: COLD STORAGE FACILITY ROOF/WALL JUNCTION



DETAIL DRAWING 3: COLD STORAGE FACILITY SUSPENDED CEILING