



Standard Practice for Sealing Rigid Wall Tactical Shelters with Polysulfide Based Sealants¹

This standard is issued under the fixed designation E 1773; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice establishes the recommended procedures for sealing rigid wall tactical shelters. It outlines the recommended techniques for the storage, mixing, handling, and application of polysulfide based sealants.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

D 907 Terminology of Adhesives²

E 1749 Terminology Relating to Rigid Wall Relocatable Shelters³

2.2 Military Specification:

MIL-S-8802 Sealing Compound, Temperature-Resistant, Intergal Fuel Tank and Fuel Cell Cavities, High Adhesion⁴

2.3 Other Document:

AMS 3819 Cleaning Cloths⁵

3. Terminology

3.1 *Definitions*—See Terminology E 1749 for definitions of general terms used in this practice.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *accelerator*—the term *accelerator* is used by sealant formulators to denote an ingredient included in the formulation to accelerate the rate of cure. It is also used separately in a mixture to accelerate surface curing only of applied polysulfide sealant, that is, tack free time accelerator.

3.2.2 *adhesion*—see Terminology D 907.

3.2.3 *application time (sealants)*—the time available for sealant application after mixing or time available after thawing a premixed and frozen cartridge of sealant.

3.2.3.1 *Discussion*—Acceptability limits for Class B extrudable sealants are expressed in terms of the extrusion rate of a sealant from a 6 fl oz (180 mL) cartridge through a nozzle with a 0.125 in. (3.2 mm) diameter orifice, using air pressure of 90 ± 5 psi (620 ± 34 kPa) in a pneumatic sealant gun. The extrusion rate is expressed in grams per minute or on cc per minute. A minimum extrusion rate after the stated application time is given as the acceptable limit. Sealant applied after the application time is exceeded tends not to wet the surface well and thus not to form a good bond. This term should not be used interchangeably with work life.

3.2.4 *assembly time*—the amount of time available after a two-part sealant is mixed, before the faying surfaces, to which sealant is applied, shall be assembled and the sealant squeezed out.

3.2.4.1 *Discussion*—If the assembly time is exceeded, the cure will have progressed too far to permit most of the sealant to be squeezed out for the desired surface to surface contact. The term assembly time is used in reference to faying-surface sealants. Also called work life and open time.

3.2.5 *base compound*—the major component of a two-part curing sealant that contains the polysulfide polymer.

3.2.6 *bridging*—see Terminology E 1749.

3.2.7 *cartridge*—a plastic container which contains an integral plunger.

3.2.7.1 *Discussion*—The cartridge is used to contain either a frozen quantity of premixed base compound and curing compound or simply the base compound in unmixed injection kits.

3.2.8 *cohesion strength (sealant)*—the internal forces holding a cured sealant together.

3.2.9 *contaminant*—any foreign substance that degrades the performance of the sealant.

3.2.10 *cure rate*—the rate at which a sealant polymerizes or crosslinks (that is, solidifies), a measure of which is the hardness of a sealant at a specified cure time.

3.2.11 *cure time (sealants)*—the time required for a sealant to polymerize and develop its full physical/mechanical properties.

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² *Annual Book of ASTM Standards*, Vol 15.06.

³ *Annual Book of ASTM Standards*, Vol 04.11.

⁴ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

⁵ Available from SAE, 400 Commonwealth Dr., Warrendale, PA 15096.

3.2.11.1 *Discussion*—In practice, however, it is the time required to reach a designated hardness.

3.2.12 *curing compound*—the crosslinking agent for the base compound.

3.2.13 *hardness*—see **Shore A hardness** and **REX Hardness** in Terminology E 1749.

3.2.14 *interference seal*—a seal produced between a given diameter mechanical fastener and a smaller diameter hole in a member into which it is inserted.

3.2.14.1 *Discussion*—An interference seal is also produced when a fastener shank is expanded by the installation process.

3.2.15 *primary seal*—a seal which, in combination with the structure and optional brush coat or secondary seal, forms a continuous, durable seal in the sealing plane and requires no additional seals.

3.2.16 *self-sealing fastener*—a fastener that provides a tight seal without the need for sealant materials or the use of a mechanical seal.

3.2.16.1 *Discussion*—An interference fit fastener is an example.

3.2.17 *tack free time*—the time required for a curing sealant to lose its surface tackiness to polyethylene.

3.2.17.1 *Discussion*—Refer to MIL-S-8802.

3.2.18 *tooled fillet*—a fillet formed by working an applied bead of sealant to a feathered edge using a shaped tool.

3.2.18.1 *Discussion*—The goal is to ensure good surface contact at the feathered edges, to eliminate voids, trapped air and reentrant edges, and to produce a contour of the correct thickness and shape over the area being sealed.

3.2.19 *two-component sealant injection kit*—a kit designed for the mixing and application of a two part sealant. The kit consists of a plastic (usually polyethylene) cartridge filled with base compound, a hollow dasher rod containing curing compound, and a plunger. The dasher rod extends into one end of the cartridge; at the end of the dasher rod inside the cartridge, a multi-armed agitator is attached. The plunger caps the other end of the cartridge.

3.2.19.1 *Discussion*—To use, a ram rod is inserted into the dasher rod and the curing compound is forced into the base compound. The dasher rod is then pulled back and forth at a specified rate with periodic rotation to add to the efficiency of the agitator. When the sealant is mixed thoroughly, the dasher rod is unscrewed from the agitator and removed. A nozzle is screwed onto the cartridge and the unit inserted into a sealant gun. Sealant is dispensed as the plunger is pushed further into the cartridge.

3.2.20 *wet installed fasteners*—fasteners that are coated on the shank and under the head with a curing-type sealant to provide a corrosion barrier and a secondary seal.

4. Significance and Use

4.1 This recommended practice is intended to provide information on the storage, mixing, handling and application of polysulfide based sealants. Tooling and equipment requirements for the satisfactory application of the sealants to joints in tactical shelters are also provided.

5. Hazards

5.1 *Materials*—The precautions outlined in the manufacturers' material safety data sheets (MSDS) for the materials being used shall become a part of this practice.

5.2 *Work Place*:

5.2.1 All lights and other electrical equipment used for the sealant application within an enclosed shelter shall be explosion proof. Extension cords shall be long enough to make electrical connections outside the shelter.

5.2.2 When use of compressed air is required, proper safety equipment shall be provided and used.

6. Storage

6.1 *Premixed and Frozen Sealant*—Sealants that are supplied premixed and frozen shall be stored in a cold box or a room maintained at $-40 \pm 5^{\circ}\text{F}$ ($-40 \pm 2.8^{\circ}\text{C}$).

6.2 *Two-Component Sealant Kits*—Two-component sealants supplied as either injection kits or bulk sealant kits shall be stored in areas maintained at a temperature not to exceed 80°F (27°C).

7. Labeling

7.1 Sealant containers shall have attached labels which clearly identify the product, manufacturer, matched base and curing compounds (if applicable), batch and lot numbers, date of manufacture, recommended mix ratio (if applicable), and expiration date under specified storage conditions.

8. Material Handling

8.1 *Premixed and Frozen*—Sealants are supplied premixed and frozen, used prior to the manufacturer's expiration date on the label, and shall be ready for immediate use following thawing of the contents. With the addition of a nozzle, the material is dispensed directly from the cartridge.

8.2 *Two-Component Sealant Injection Kits*—Sealants supplied in this form shall be mixed according to the manufacturer's instructions and used before the expiration date provided on the label and within the application time determined for that sealant.

8.3 *Bulk Sealant*—Two-part sealants are supplied in a wide range of kit sizes from $\frac{1}{2}$ pt to 50 gal drums plus 5 gal pail of curing compound. In every case there is a small percentage of extra curing compound included, ranging from 2 to 10 % to compensate for losses in the transfer of the curing compound. Although kit sizes are generally quoted in terms of volume, the base and curing compound are matched on basis of weight ratio. Both weight and volume ratio are usually included on the label.

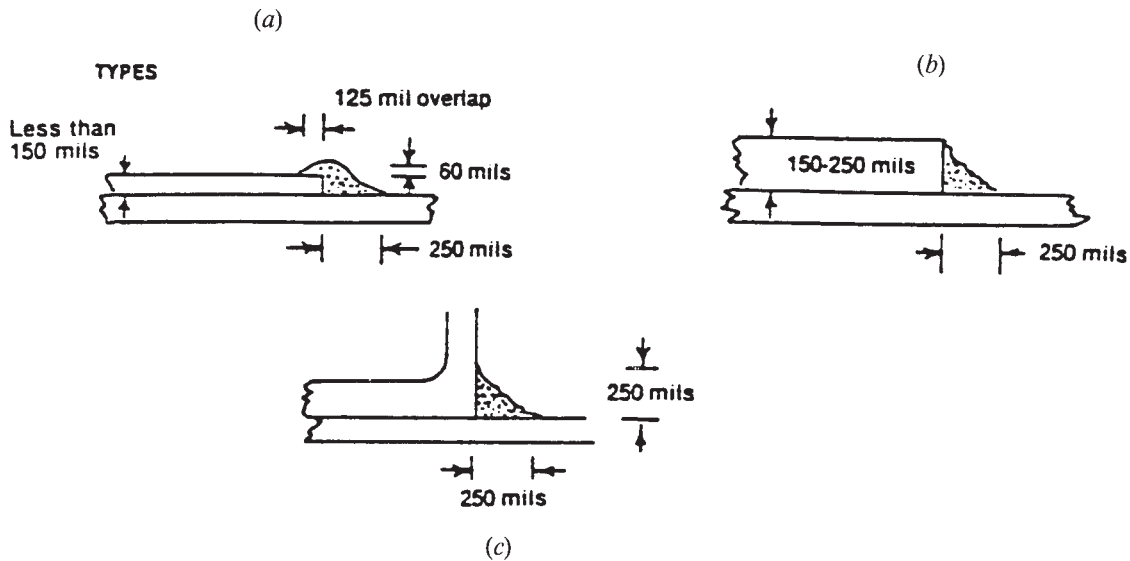
8.3.1 *Mixing*:

8.3.1.1 *Hand Mixing*—Kits under 5 gal are packaged such that the base compound container will permit the addition and mixing of the curing compound. Mix the entire kit at one time and use ALL the curing compound. By mixing and using the entire kit at once, the user is assured that the correct amounts have been used and the resultant sealant properties will be those expected. Some of the pitfalls of attempting to use partial kits include: (1) the possible use of incorrect ratio; (2) incorrect weighing; (3) failure to thoroughly stir the curing compound

in the container before removing the desired quantity; (4) incomplete transfer of base or curing compound, or both; and (5) compromising the remaining material by failure to supply an inert atmosphere or failure to set the can lid completely.

(a) (a) Stir the 5 gal pail of catalyst thoroughly with a mechanical agitator, being careful not to whip air into the curing compound or excessively heat the material.

(b) (b) Scrape down the walls of the pail.



NOTE 1—60 mils = 0.060 in (1.5 mm)
 125 mils = 0.125 in (3.2 mm)
 250 mils = 0.25 in (6.4 mm)

FIG. 1 Illustration of Three Typical Type Faired Seals

NOTE 1—In all cases it is of paramount importance that the batch of base be catalyzed only with the batch of curing compound to which it was matched. (Batch number of batch of matched base and curing compound should be given on each label.) Hand mix thoroughly by folding the material over itself. Frequently scrape down the walls of the container to ensure complete mixing. Avoid whipping the material as this will incorporate air into the mixture and result in void formation. High mixing speeds may also cause excessive heat which will advance the cure of the sealant, shortening the application and assembly time. If the storage area temperature is greatly different from normal (standard) temperature, the kits should be preconditioned to standard temperature [77°F (25°C)]; also, local humidity shall be on the order of 55 % RH if data sheet performance is expected. If the surface to which the sealant is to be applied is decidedly different from 77°F (25°C), the cure rate will vary accordingly. For example, a MIL-S-8802 B-2 system at 50 % RH will have a work life of 3 h at 60°F (16°C), 2 h at 80°F (27°C), but only 1 h at 100°F (37.8°C). While if the temperature is held at 80°F (27°C), the work life will be 3 h at 35 % RH, 2 h at 50 % RH, and at 65 % RH the work life is only 1 h.

8.3.1.2 *Machine Mixing*—Meter/mix machines are used when large quantities of mixed sealant are required. Separate pumps force base compound and curing compound through a metering system which measures the proper ratio of the components. The two streams are then fed into a mixing head where a uniform mixture is produced. The sealant is then usually dispensed into low density polyethylene cartridges ranging in size from 2.5 to 12 oz (74–355 mL) for immediate use or quick frozen (see 8.5) for future use. The mixed sealant should exhibit no visible streaks or evidence of entrapped air (bubbles or voids) during the dispensing operation. When using meter mix machines the following steps should be made a part of the standard operating procedure:

(c) (c) If the curing compound sits for 48 h after stirring, stir again.

(d) (d) Start with clean lines and an empty meter/mix machine or purge the lines and machine with at least 2 gal of base and the equivalent catalyst.

(e) (e) Calibrate a variable ratio machine frequently. (At the start of each shift or the change of containers, or both).

(f) (f) If a static mix head is used, clean it if the flow rate decreases substantially. Purging of the static mix head is essential if the material has set for one quarter of the application life.

(g) (g) Air pressure to the meter mix equipment should be of sufficient volume as well as pressure.

(h) (h) *Quality Control*—A visual inspection should be conducted to ensure that no streaks or excessive air is incorporated into the mixed material.

8.4 *Freezing*—Once the base compound and curing compound are mixed, the application time will decrease rapidly. Therefore, unless mixed sealants are to be used immediately, they should be quick frozen [–40°F (–40°C) or below]. This can be accomplished by placing the filled cartridges in a cold bath of methanol and dry ice for at least 30 min [–100°F (–73.3°C)]. Another approved method of quick freezing is to place the freshly filled tube of sealant into a liquid nitrogen chamber for approximately 2 min. Place the frozen tubes in a cold box or room at –40°F (–40°C). Frozen tubes of polysulfide sealants should not be kept for more than 1 month.

8.5 *Thawing*—Frozen cartridges of mixed sealant may be thawed by three methods:

(1) Normal temperature air, 8.5.1,

- (2) Enclosed heating bath, 8.5.2, and
- (3) Microwave oven, 8.5.3.

In all methods of thawing, less application life per tube will be available than in freshly mixed material. It is estimated that approximately 25 % of the work life is lost by freezing and thawing.

8.5.1 *Normal Temperature Air*—The frozen cartridges are placed on a bench or table and allowed to warm at normal temperature. The rate of warm up is variable depending upon the size of cartridge, temperature of the room and that of the cartridge, the closeness of one tube to the next, and whether it is standing vertically or lying horizontally. Normal temperature thaw usually takes approximately 30 min for a 6 oz tube.

8.5.2 *Enclosed Heating Baths*—The cartridges are inserted in metal sleeves in a water bath at 120°F (49°C) for 10 min. The metal sleeves are made to fit snugly to the cartridge providing good heat transfer and a dry condition. The sealant at the core of the cartridge should reach 65°F (18°C) before application is started.

8.5.3 *Microwave Oven*—A carousel microwave oven, 600 watts, with automated interrupt defrost cycle of 20 s heat, 20 s soak will thaw a 6 oz cartridge in approximately 2 min. This method is fairly reproducible if the same number and size of cartridge are used each time. The oven wattage, heat/soak cycle is directly related to the time required. The carousel feature is used to produce uniform radiation and to avoid hot spots.

8.6 *Surface Preparation*—Sealant adhesion is crucial for achieving a functional seal. Absence of a good bond or a partial failure of the bond can result in lack of the formation of a seal to isolate the environment. It is recognized that many sealing requirements encountered do not involve “virgin surfaces” but require adhesion to surfaces that have been subjected to various production steps since the surfaces have been previously cleaned. An adhesion promoter recommended by the sealant manufacturer may be applied, “brushed,” to these areas to enhance sealant bond to these surfaces. All surfaces prior to application of any promoter or sealant must be cleaned with a suitable (non-ozone-depleting) solvent to remove dirt, grease, and other foreign materials that may have accumulated during prior processing. Just prior to sealant application the surface should be cleaned with solvent using non-contaminated solvent and cleaning cloths which are either woven or non-woven meeting the requirements of AMS-3819. A progressive cleaning procedure should be used. Wash one small area at a time, then dry with a clean cloth before the solvent evaporates. Clean from the top down or from the inside out to prevent recontamination of the surface. To maintain a clean solvent supply, always pour the solvent on the washing cloth.

8.7 *Sealant Application*—In all methods of sealant application it is important that complete contact be made with no bridging or absence of sealant.

8.7.1 *Extrudable Sealant*—The extrudable or type “B” sealants are also called trowelable or “gunnable” sealants. They are used for filleting over joints, splices, and seams, injecting slots and joggles, filling corner closeouts, and are also used to overcoat and crown fastener heads. They are also used for hole filling and, in some cases, for faying surface applications. The MIL-S-8802 type “B” sealants are distinguished by their

“non-sag” or low block flow characteristics and by their thixotropic nature which permits the easy extrusion of very viscous material. The mixed sealant is applied from a cartridge contained in a sealant gun powered by plant air at a suggested maximum of 90 psig. Use of greater pressure may cause a high incidence of flipping (overturning) of the plunger, resulting in air being blown directly through the tube of sealant. It is important to note that the initial extrusion rate of freshly mixed material is on the order of 30 to 100 g/min. This rate drops continuously to 15 g/min at the end of designated application time.

8.7.2 *Brushable Sealant*—The brushable or MIL-S-8802 type “A” sealants may be used as a base coat over which an extrudable or trowelable (type “B”) sealant is applied, or as a topcoat to a type “B” sealant, or both. As a base coat for a primary seal, the type “A” brushable sealant is applied with a short, stiff brush and scrubbed thoroughly into the joints, crevices, seams, around the edges, and over the top of fasteners and bolts, producing intimate contact with all surfaces around a potential leak source. The sealant surface should be allowed to become tack free before the primary “B” type sealant is applied. This also allows time for the solvent to evaporate.

8.7.3 *Brushable Sealant, Other Applications*—The brushable or MIL-S-8802 “A” sealant may be applied over welded seams of structural assemblies as a finish coat to form contact weld joints and panel edges to eliminate potential environmental leak sources.

8.8 *Sealing Guidelines:*

8.8.1 *Sealing Joints*—The preferred technique is to hold the gun about 20 to 30 degrees of the vertical pointing the nozzle in the direction of travel as the fillet is laid in the joint or seam. This forces sealant into the crevice and minimizes the possibility of air entrapment. DO NOT apply sealant with the tip pointing opposite the direction of travel (dragging the sealant). The principal goal in applying the appropriate thickness and contour of sealant at any potential leak source is to use a thickness in relationship to sealant elongation that will allow joint movement under operational conditions without tearing the sealant. After the bead of sealant is applied, the sealant is tooled to produce a faired configuration. Fig. 1a shows a thin plate (less than 150 mils) overlapping a thicker plate. The edge is sealed by a fillet which overlaps the top of the upper plate with the dimensions shown. Fig. 1b shows the application of a standard fillet when the upper plate is more than 0.15 in (3.2 mm) thick. Fig. 1c defines the height to carry the fillet when a vertical member is being sealed to a horizontal member.

NOTE 2—In all three cases the sealant is feathered (or faired) to approximately 250 mils from the potential leak source. Special fairing tools are available to perform this task.

8.8.1.1 Fig. 2 shows examples of some poor or unsatisfactory seals as 2a unfaired versus faired, 2b unfaired, reentrant edge and 2c unfaired, overlap.

8.8.1.2 Two major factors govern the sealant contour: (1) the sealant should extend at least 0.25 in (6.4 mm) from the potential leak source, and (2) the diagonal thickness from the leak source should be at least 0.15 in (3.2 mm). Extreme care shall be taken when a butt joint is sealed to assure that the butt gaps are not bridged over rather than filled. When a butt gap is

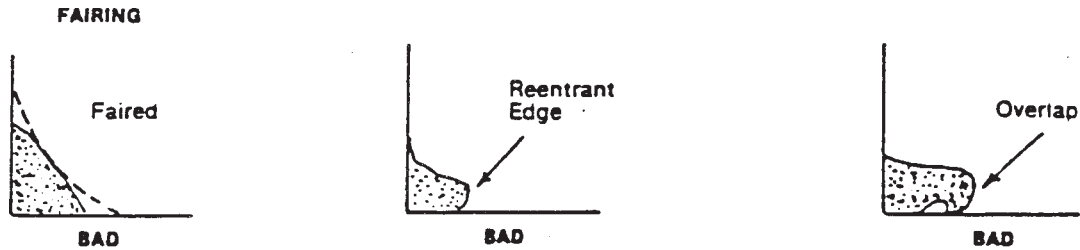
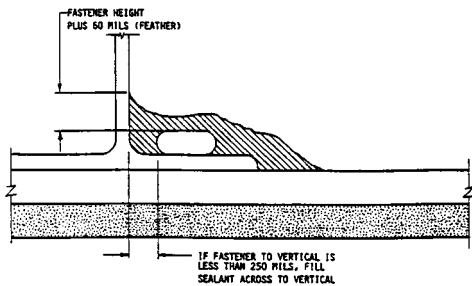
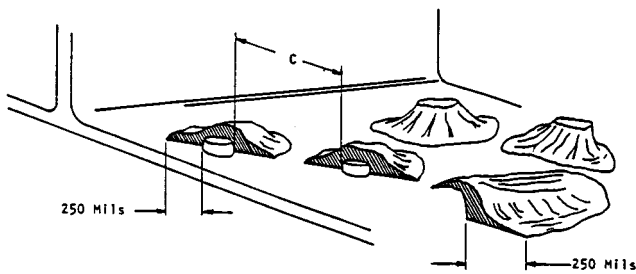


FIG. 2 Examples of Unsatisfactory Fillets



Note: 60 mils = 0.060 in (1.5 mm)
250 mils = 0.250 in (6.4 mm)

Sealing Fastener Near a Vertical Surface
SEALING INDIVIDUAL FASTENERS



IF "c" IS GREATER THAN 500 MILS
FASTENERS CAN BE INDIVIDUALLY SEALED.

Note: 250 mils = 0.250 in (6.4 mm)
500 mils = 0.500 in (13 mm)

FIG. 3 Sealing Individual Fasteners

greater than 500 mils, two separate fillets can be laid, each extending 250 mils from its potential leak path.

8.8.2 *Sealing Holes and Slots*—Holes and slots may be sealed with extrudable sealant alone if the opening is less than 125 mils. If the opening is between 125 mils and 500 mils, it can be sealed with a combination of sealant plug and sealant,

or a combination of annealed aluminum wire screen and sealant. When wire screen is used, it shall be trimmed to overlap the hole or slot by approximately 250 mils. A thin layer [0.16 cm (1/16 in.)] of sealant is applied around the opening first. The screen is then embedded in the sealant and the hole is filled with sealant from the opposite side. A second piece of screen of similar size is then positioned in the sealant over the opposite side. Apply sealant around the hole as was done on the first side. Impregnate the screens with sealer, completely crowning on both sides and fairing the sealant edges approximately 100 mils beyond the edge of the screen, completing the seal.

8.8.3 *Sealing Fasteners*—All fasteners penetrating the structure boundary line shall be wet installed. Sealant shall be applied into the hole and around the surface to be under the head of the fastener. All torquing of fasteners shall be completed within the assembly time of the sealant, that is, while the sealant will still flow. Once fasteners and bolts are installed and tightened they shall be overcoated with sealant. Tools are available to help perform these tasks.

8.8.3.1 *Fastener Overcoating, Brush Method*—Starting at the base of the fastener, rotate the brush around the head and adjacent surface until it is coated and surrounded by a fillet.

8.8.3.2 *Fastener Overcoating, Beehive Method*—Start the application of sealant from the nozzle of the sealant gun at the base of the fastener head. Rotate the nozzle in a spiral motion until the head is completely covered. Tool to the proper configuration. See Fig. 3. Care should be taken to exclude air bubbles, to avoid entrapment, to avoid bridging, and to tool or shape the configuration to provide the faired edges and the thicknesses required.

9. Keywords

9.1 application; handling; mixing; polysulfide; sealant; sealing; shelter; storage

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