NACE INTERNATIONAL
THE CORROSION SOCIETY

NACE Standard RP0181-94
Item No. 21025

Standard
Recommended Practice

Liquid-Applied Internal Protective Coatings for Oilfield Production Equipment

NACE International
P.O. Box 218340
Houston, TX 77218-8340
+1 281/228-6200

Foreword

This standard (recommended practice) provides guidelines for obtaining an effective internal coating or corrosion barrier to protect against general or pitting corrosion of production equipment commonly used in oilfield operations at atmospheric and elevated pressures. This document is not applicable to the internal or external coating of tubing, casing, line pipe, or other tubular goods.

This standard details various factors required to obtain a satisfactory coating, including production equipment design and fabrication considerations, surface preparation, coating application, and inspection.

Determination of the need for coating, selection of portions of the production equipment to be coated, and selection of a coating are outside the scope of this standard. These decisions must be based on the user's experience, knowledge of the system conditions, project economics, and environmental and safety considerations. Because numerous excellent coatings are available, no attempt was made to list all of the coatings suitable for this service.

This standard is a revision to NACE Standard RP0181-81 and replaces former NACE Standard RP0372-81, "Method for Lining Lease Production Tanks with Coal Tar Epoxy." This NACE standard, prepared by Task Group T-1G-20 of Unit Committee T-1G on Protective Coatings and Nonmetallic Materials for Oilfield Use, is issued by NACE under the auspices of Group Committee T-1 on Corrosion Control in Petroleum Production.

NACE International
Standard
Recommended Practice

Liquid-Applied Internal Protective Coatings for Oilfield Production Equipment

Contents

Section 1: General

1.1 Introduction

1.1.1 This standard presents procedures for applying liquid coatings to the interior of various types of oilfield production equipment used primarily for the processing and storage of corrosive fluids in oilfield operations.

1.1.2 The area of production equipment to be coated may either be the entire interior surface area or only those areas where corrosion is a concern.

1.1.3 Various phases of the coating process are explained within the following sections:

Section 2:	Definitions
Section 3:	Production Equipment Design and Fabrication
Section 4:	Coating Types
Section 5:	Surface Preparation
Section 6:	Application
Section 7:	Inspection
Section 8:	Cathodic Protection
Section 9:	Laboratory and Field Testing
Section 10:	Monitoring, Records, and Maintenance
Section 11:	Safety Guidelines
Appendixes A, B, C, and D	

NOTE: The appendixes are not considered a mandatory part of this standard but are included for informational purposes.

Section 2: Definitions

Production Equipment: All atmospheric and pressurized metal tanks and vessels used in oilfield operations, including, but not limited to, oil and water storage tanks, separators/treaters, and deaeration towers. This does not include tubing, casing, pipelines, or other tubular goods.

Corrosive Fluids and/or Vapors: Corrosive fluids are normally considered to consist of produced and/or condensed fluids containing water and some, or possibly all, of the following corrosives: chlorides, carbon dioxide, hydrogen sulfide, oxygen, acidizing fluids, naturally occurring organic acids, and bacteria.

Coating: A barrier applied to the metal as a liquid and cured on the inside surface of the production equipment to protect it from the corrosive action of the liquids and/or vapors.

Section 3: Production Equipment Design and Fabrication

3.1 Welded tanks are preferred over bolted tanks because complete coating coverage is easier to obtain on welded joints than on bolted channels and gasketed joints.

3.2 Production equipment should be designed and fabricated to allow easy access for surface preparation and coating of internal surfaces that require a coating for corrosion protection.[1-5] It is essential that these surfaces receive the required surface preparation and uniform coating.

(1) NACE Standard RP0178 (latest revision), "Fabrication Details, Surface Finish Requirements, and Proper Design Considerations for Tanks and Vessels to Be Lined for Immersion Service" (Houston, TX: NACE International).
(2) API Spec 12B (latest revision), "Specification for Bolted Tanks for Storage of Production Liquids" (Washington, DC: American Petroleum Institute).
(3) API Standard 620 (latest revision), "Design and Construction of Large, Welded, Low-Pressure Storage Tanks" (Washington, DC: API).
(4) API Standard 650 (latest revision), "Welded Steel Tanks for Oil Storage" (Washington, DC: API).
(5) API RP 652 (latest revision), "Lining of Aboveground Petroleum Storage Tank Bottoms" (Washington, DC: API).

3.2.1 The shell of production equipment shall be designed to facilitate grinding, blasting, and coating. All inlet deflector plates, agitators, anti-swirl baffles, gauging devices, internal piping, and other internal surfaces as specified by the purchaser shall be removable and/or designed to facilitate grinding, blasting, and coating. All internal carbon steel pipe should be removable and designed for cleaning and coating.

3.2.2 Manways shall be installed to provide adequate ventilation and access to all interior areas for grinding, blasting, and coating. For easy access, manways should be 500 mm (20 in.) in diameter or larger.

3.2.3 To prevent galvanic corrosion of carbon steel equipment, any stainless steel or corrosion-resistant alloy internals (e.g., trays, mist extractors, and baffle plates) should be electrically isolated from the carbon steel. In areas where dissimilar metals are joined by welding and galvanic corrosion is a concern, accelerated corrosion of the carbon steel may be eliminated by coating the carbon steel and the adjacent few centimeters (inches) of the more noble metal, e.g., stainless steel.

3.2.4 All attachments to the internal surface of the production equipment shall be continuously welded to prevent any voids or appendages that cannot be properly cleaned and coated. All surfaces to be coated must be accessible to applicator and equipment.

3.2.5 For coatings with a thickness of 250 µm (10 mils) or less, welds shall be ground to a smooth contour, with all defects repaired or removed per NACE Standard RP0178 Weld Preparation Designation C or better.(1) Sharp wave crests, slag pits, and slag shall be ground away, leaving a smooth, rounded base for the coating; this does not require grinding flush to the plate.

3.2.6 For coatings with greater than 250 µm (10 mils) but not exceeding 1000 µm (40 mils) thickness, welds shall be ground smooth and blended per NACE Standard RP0178 Weld Preparation Designation D or better.(1) Weld splatter shall be removed and welds shall be ground smooth and blended into the plate surfaces.

3.2.7 For coatings with a thickness greater than 1000 µm (40 mils), welds shall be minimally ground per NACE Standard RP0178 Weld Preparation Designation E or better.(1) Sharp projections on the weld bead, slag, and weld splatter shall be removed.

3.2.8 All sharp edges that are to be coated, including those on bolt holes, shall be rounded by grinding to a smooth contour radius. Edges or projections shall not be hammered.

3.3 Welded tanks should be inspected to ensure they meet the design criteria of Paragraph 3.2.

3.4 Hydrotesting and stress relieving, if required, should be done prior to the application of any coating.

Section 4: Coating Types

4.1 Many coatings are currently available in the industry and new coatings are continually being introduced.(6) Selection of a coating system for a specific application is beyond the scope of this document. However, for proper coating selection the following parameters should be considered by the user.

a) Fluid composition and concentration of gas, oil, water, and additives such as biocides should be considered;

b) Intended service life and service operating conditions, temperature, pressure, and velocity should be considered. Maximum, minimum, and cycling temperatures and pressures the vessel will be subjected to during service life should be considered;

c) Cathodic protection should be considered in conjunction with coatings. However, applying excessive voltage can cause loss of coating adhesion to steel;

(6) NACE TPC Publication #2 (TPC #2), "Coatings and Linings for Immersion Service" (Houston, TX: NACE International, 1972).

d) Metallurgy of the production equipment or internal components such as galvanizing, zinc, or stainless steel should be considered;
e) Ambient temperature and humidity at the time the coating will be applied should be considered;
f) Environment and handling of the equipment during shipping and/or storage to prevent coating damage should be considered;
g) The selected primer should be compatible with subsequent coats. Each coat of the coating system should be compatible with the previous coat; and
h) Physical abuse, e.g., manual cleaning or inspection of the tank during service life, etc., should be considered.

4.2 Some coatings in use for corrosion control in oil and gas production are listed in Table 1. Since no one coating is suitable for all environments, coating selection should be based on laboratory data and past field performance.

4.3 There are several shop-applied powder coatings that can also be used in production equipment.

TABLE 1
PARTIAL LISTING OF COATINGS USED IN OIL AND GAS PRODUCTION EQUIPMENT

Coating Material Generic Type	Total Dry Film Thickness Range
Fluoropolymers	50-125 µm (2-5 mils)
Baked Epoxy-Modified Phenolics	125-200 µm (5-8 mils)
Baked Thin-Film Phenolics	125-200 µm (5-8 mils)
Catalyzed/Baked Urethanes	125-225 µm (5-9 mils)
Epoxy Amines	250-375 µm (10-15 mils)
Catalyzed Epoxy-Modified Phenolics	250-375 µm (10-15 mils)
Epoxy Polyamide	250-375 µm (10-15 mils)
Coal Tar Epoxy	250-500 µm (10-20 mils)
Flake-Filled Epoxies	750-1,000 µm (30-40 mils)
Flake-Filled Polyesters	750-1,000 µm (30-40 mils)
Flake-Filled Vinyl Esters	750-1,000 µm (30-40 mils)
Fiberglass-Reinforced Epoxies	1,000-3,000 µm (40-120 mils)
Fiberglass-Reinforced Polyesters	1,000-3,000 µm (40-120 mils)
Fiberglass-Reinforced Vinyl Esters	1,000-3,000 µm (40-120 mils)
Polyvinylidene Fluorides	500-1,500 µm (20-60 mils)

Section 5: Surface Preparation

5.1 Prior to surface preparation and if design allows, newly bolted storage tanks that will be coated before being placed in service should be filled with fresh water to check for leaks and expand all chimes (bottom-to-shell corner) to final position. Necessary repairs shall be completed and the tank dried before surface preparation begins.

5.2 Production equipment previously used in hydrogen sulfide (H_2S) service can be difficult to coat because of sulfide contamination. Wet or dry abrasive blasting removes most corrosion products, including sulfides; however, sulfide corrosion of carbon steel often occurs as pitting. Dry abrasive blasting may not remove all of the sulfide from the bottom of corrosion pits. Wet abrasive blasting is more effective than dry abrasive blasting but complete removal of sulfide may not be achieved. After blast cleaning, contaminated surfaces may be washed with dilute acid to remove sulfide. Acid treatment removes sulfide from the surface by volatilization to H_2S gas. SAFETY NOTE: Follow precautions when H_2S is liberated. Sulfide removal methods that have proven useful include:

a) Blast cleaning followed by a 10 to 15% hydrochloric-acid wash, fresh-water rinse until neutral pH is achieved, dry, and a final dry-blast cleaning. Other acids, such as acetic, citric, and phosphoric acids, have been used in place of hydrochloric acid;

b) Water-abrasive blasting (abrasive plus water), dry, and a final dry-blast cleaning;

c) Steam cleaning (for up to several days) with venting, fresh-water wash, dry, and a final dry-blast cleaning.

5.3 Before blasting, oil, tar, grease, etc., shall be removed from the area to be coated. Any surface to be coated should be checked with ultraviolet light to determine whether the oils, tars, and greases have been removed. Washing with high-pressure detergent water and steam cleaning are the most effective methods of accomplishing complete hydrocarbon removal in the field. In some cases, solvent cleaning can be used effectively.[(7,8)] Prior to application of shop-applied coatings, baking at 400 ±25°C (750 ±50°F) for 4 to 8 hours may be an effective method of hydrocarbon removal. Some alloy steels are embrittled by this oil-removal technique, including ferritic and duplex stainless steels and certain high-strength low-alloy carbon steels, if used in the quenched and tempered condition.

5.4 If necessary, weld areas and edges shall be treated as described in Paragraphs 3.2.5, 3.2.6, and 3.2.7 prior to blasting to provide a suitable surface for coating.

5.5 Surface irregularities that cannot be adequately ground shall be corrected by either welding or caulking. When welding can be used, it is preferred over caulking. Such surface irregularities include the bottom-to-shell corner (chime), large projections, thick plate edges, etc. The area to be caulked shall be filled and shaped with compatible caulk, putty, or filler that will bond to steel and provide a suitable surface for the coating. The putty shall be compatible with the coating material and fluid the vessel is to contain. The use of caulk, putty, or filler shall be kept to the minimum amount required to obtain an acceptable contour (see Appendix A). If the caulk is applied too thick, it can cause the coating to crack or spall off the substrate. Caulking is not recommended for high-bake coating systems.

5.6 Surfaces to be coated shall be dry prior to abrasive blasting. Abrasive blasting shall not be performed when the metal surface temperature is less than 3°C (5°F) above the dew point. The applicator shall measure the metal surface temperature, relative humidity, and determine the dew point a minimum of once every 4 hours. When the relative humidity in the blast area is greater than 85%, the applicator shall measure the metal surface temperature, relative humidity, and determine the dew point a minimum of once every hour. During periods of high humidity or low ambient temperature, the environment inside the production equipment can be controlled with heaters and dehumidification equipment.

5.7 The surfaces of bolted tanks shall be cleaned and blasted as specified in Appendix B.

5.8 Compressed air used for blasting shall be free of water and oil contamination. The applicator shall check the air system for contaminants with a clean white cloth or blotter a minimum of once every 4 hours.

[(7)] SSPC-SP 1 (latest revision), "Solvent Cleaning" (Pittsburgh, PA: Steel Structures Painting Council).
[(8)] API Standard 2015 (latest revision), "Safe Entry and Cleaning of Petroleum Storage Tanks" (Washington, DC: API).

5.9 Abrasive should be checked for oil contamination.

5.10 The coating manufacturer's recommendations for surface preparation and anchor pattern must be followed. Unless specified otherwise, white metal blast cleaning to NACE No. 1 per NACE Standard TM0170 (latest revision)[9] or SSPC-SP5[10] is required. Appropriately graded abrasive materials that will produce the necessary anchor pattern for the coating material to be applied shall be used. The anchor pattern required for coatings generally increases with coating thickness. Table 2 should be used as a guide for determining the anchor pattern on mild steel if it is not specified by the coating manufacturer. For high-temperature service or when coating is used in conjunction with cathodic protection, a higher anchor profile may be beneficial.

TABLE 2
RELATIONSHIP BETWEEN COATING THICKNESS AND ANCHOR PATTERN

Dry Film Coating Thickness	Anchor Pattern
125-200 µm (5-8 mils)	25-50 µm (1-2 mils)
200-500 µm (8-20 mils)	50-75 µm (2-3 mils)
500 µm or more (20 mils or more)	75-125 µm (3-5 mils)

5.11 When water or water-abrasive blasting is used, it shall be followed by dry blasting.

5.12 If any discoloration of the metal occurs prior to the coating application, the surface shall be reblasted to achieve the specified degree of surface preparation.

5.13 All abrasives, dust, etc., shall be removed from surfaces by brushing, blowing off with clean dry air, or vacuuming prior to coating application. A cloth should not be used to wipe blasted surfaces because of the possibility of depositing lint on an otherwise clean surface.

5.14 Inspection of the Blasted Surface

5.14.1 The surface to be coated shall be examined to ensure that it is clean and free of contamination (foreign matter) such as oil, grease, tar, blast abrasive, etc., as specified. The surface should be checked by the applicator every 4 hours for soluble salts with an accepted test kit with acceptable amounts of soluble salt contamination to be agreed on by user, applicator, and coating manufacturer.

5.14.2 The surface to be coated shall be inspected by the applicator to verify that the specified surface preparation has been achieved. Visual comparators, such as NACE Standard TM0170 or SSPC-VIS 1[11] visual standard for blast-cleaned steel may be used to make this determination. The anchor pattern shall be verified by the applicator every 20 m^2 (200 ft^2) using appropriate visual comparators or by the replica tape method.[12]

5.14.3 The metal surface to be coated shall be visually inspected by the applicator to ensure that all discontinuities, including metal defects (slivers, laps, etc.) detrimental to coating performance have been removed and that all surface irregularities have been ground smooth or properly caulked. Welds shall be inspected by the applicator to ensure that they meet the design criteria of Paragraphs 3.2.5, 3.2.6, and 3.2.7.

[9] NACE Standard TM0170 (latest revision), "Visual Standard for Surfaces of New Steel Airblast Cleaned with Sand Abrasive" (Houston, TX: NACE International).
[10] SSPC-SP 5 (latest revision), "White Metal Blast Cleaning" (Pittsburgh, PA: SSPC).
[11] SSPC-VIS 1 (latest revision), "Visual Standard for Abrasive Blast Cleaned Steel" (Pittsburgh, PA: SSPC).
[12] NACE Standard RP0287 (latest revision), "Field Measurement of Surface Profile of Abrasive Blast Cleaned Steel Surfaces Using a Replica Tape" (Houston, TX: NACE International).

5.15 Safety Precautions during Blasting

5.15.1 When blasting in a confined area, all blast nozzles shall be equipped with remote ("deadman") controls for automatic shutoff in case the operator drops the nozzle.

5.15.2 Positive pressure helmets and goggles shall be worn by blasters during blasting of production equipment.

5.15.3 Forced-air ventilation shall be provided inside the production equipment to prevent oxygen depletion.

5.15.4 All applicable federal, state, and local regulations shall be followed.

Section 6: Application

6.1 All surfaces to be coated must be free of moisture, oil, or solvent residues. Blasted surfaces shall be coated on the same day (typically within 8 hours) and prior to surface discoloration.

6.2 The temperature of the steel surface to be coated should conform to the manufacturer's application and curing temperature recommendations. Typical minimum conditions for coating application are as follows: The steel temperature must be more than 3°C (5°F) above the dew point. Recommendations of the coating manufacturer for minimum application temperature should be followed.

6.3 Welds should be brush-coated with solvent-reduced coating using manufacturer's recommendations for dilution in accordance with the following:

a) For welds ground to Designation C (see Paragraph 3.2.5), brush-coating is not required unless recommended by the coating manufacturer;
b) For welds ground to Designations D and E (see Paragraphs 3.2.6 and 3.2.7), they should be brush-coated if the coating thickness is 1000 µm (40 mils) or less;
c) Brush-coating is not required for a coating thickness of more than 1000 µm (40 mils).

6.4 Proper storage, mixing, application, and curing of the coating are essential procedures. The coating manufacturer's recommendations should be followed.

6.5 The repair of damaged or faulty coatings before or after final cure may be difficult. The coating manufacturer's recommended repair procedures shall be followed (see Paragraph 10.3). Also see NACE Standard RP0184.[13]

Section 7: Inspection

7.1 Inspection shall be conducted by the applicator. A user or user's representative has the right to inspect and reject work per the contract or by prior agreement.

7.2 Inspection check points should be established as follows:

a) Pre-blast cleaning inspection;
b) After blast cleaning;
c) After each coat is applied;
d) After final cure; and
e) Final completion inspection including damage inspection after the scaffolds have been removed.

[13] NACE Standard RP0184 (latest revision), "Repair of Lining Systems" (Houston, TX: NACE International).

7.3 The inspection should verify that:

a) Production equipment cleaning, weld and edge grinding, masking and protection of non-coated items, such as threads, metal-to-metal seals, etc., was adequate;[14]
b) Requirements of Paragraphs 5.7, 5.9, 5.10, and 5.11 have been met after blast cleaning;
c) The coating is the proper material and within its expiration date prior to mixing. The manufacturer can explain the date code;
d) The mixing operation meets the manufacturer's recommendations;
e) Requirements of Paragraphs 6.1, 6.2, and 6.3 have been met prior to application of the coating;
f) The proper coating thickness range for each coat is obtained by checking it with wet and dry film thickness gauges.[14] The applicator shall check every 10 m^2 (100 ft^2) or per SSPC-PA 2[15] requirements;
g) There is adequate lighting for visual inspection of the coating; and
h) Holiday detection tests are done on the cured coating system to detect discontinuities.

7.4 Holiday Detection Tests

7.4.1 The entire coating surface shall be holiday tested. The type of holiday detection device used can vary based on customer preference, available equipment, total coating thickness, and type of coating used. The type of holiday test and voltage recommended by the coating manufacturer should always be used. See Table 3 for suggested voltages for high-voltage spark testing if the coating manufacturer's information is not available.

7.4.2 There are two basic types of holiday detection tests.[16]

a) Low-voltage wet sponge test.
b) High-voltage spark test, the voltage specified for wet or dry high-voltage spark test is generally based on a spark length capable of bridging an air gap (at prevailing humidity conditions) of two times the coating thickness.

NOTE: Excessive voltage may produce a holiday in the coating film. Unless carefully calibrated, some high-voltage testers "burn through" the coating and require repair. All holiday-testing equipment should be recalibrated every 4 hours if equipped for calibration.

7.4.3 The low-voltage holiday test should be used on thin-film coatings up to 500 µm (20 mils). A wetting agent is required when testing in the 250 to 500 µm (10 to 20 mil) range.

7.4.4 One method of calibrating or checking a high-voltage holiday detector for "burn through" on a coating that can be repaired is as follows:

A pinhole should be made in the coating and the high-voltage detector should be passed over the holiday starting at the lowest acceptable voltage. The voltage should be increased until the detector rings consistently over the holiday.

CAUTION: This type of calibration should not be used on a coating that cannot be repaired properly for immersion service, i.e., high-baked coating or a fully chemically reacted coating.

7.5 Coating that does not pass all inspections shall be repaired or recoated in accordance with this standard (see Paragraph 6.5).

[14] NACE Standard RP0288 (latest revision), "Inspection of Linings on Steel and Concrete" (Houston, TX: NACE International).
[15] SSPC-PA 2 (latest revision), "Measurement of Dry Paint Thickness with Magnetic Gages" (Pittsburgh, PA: SSPC).
[16] NACE Standard RP0188 (latest revision), "Discontinuity (Holiday) Testing of Protective Coatings" (Houston, TX: NACE International).

TABLE 3
SUGGESTED VOLTAGES FOR HIGH-VOLTAGE SPARK TESTING

Total Dry Film Thickness		Suggested Inspection (voltage)
(µm)	(mils)	(V)
500-1,000	20-40	3,000
1,000-1,400	40-55	4,000
1,400-2,000	55-80	6,000
2,000-3,200	80-125	10,000
3,200-3,400	125-135	15,000

Section 8: Cathodic Protection

8.1 Cathodic protection can be employed to protect the bare steel inside production equipment that is continuously immersed in an aqueous phase. Cathodic protection may be achieved with galvanic anodes or with rectifier-driven impressed current anodes. Anode type and location in production equipment are important considerations.(17,18) Cathodic protection is not effective in vapor or bulk hydrocarbon exposures.

8.2 When production equipment is internally coated, cathodic protection should be considered to supplement the protection afforded by the coating. Cathodic protection can prevent corrosion of any steel that is exposed at holidays in the coating unless the holidays are shielded in some manner. When internal cathodic protection is to be employed, coatings that are compatible with cathodic protection should be used.

Section 9: Laboratory and Field Testing

9.1 Standard screening tests may be used to evaluate the performance of a large number of coatings.(19)

9.2 The better-performing coatings' laboratory results should be verified by comparison with the field test results.

9.3 Selection of coating materials for specialized service should be based on laboratory tests duplicating the service environment as closely as possible.

Section 10: Monitoring, Records, and Maintenance

10.1 Coating performance should be monitored to determine which coatings are giving the most satisfactory service. This monitoring should include: (1) an initial inspection, (2) inspections every time the production equipment is opened, and (3) coating failure history.

(17) NACE Standard RP0575 (latest revision), "Design, Installation, Operation, and Maintenance of Internal Cathodic Protection Systems in Oil Treating Vessels" (Houston, TX: NACE International).
(18) NACE Standard RP0388 (latest revision), "Impressed Current Cathodic Protection of Internal Submerged Surfaces of Steel Water Storage Tanks" (Houston, TX: NACE International).
(19) NACE Standard TM0174 (latest revision), "Laboratory Methods for the Evaluation of Protective Coatings Used as Lining Materials in Immersion Service" (Houston, TX: NACE International).

10.2 A detailed record of the coating used on all production equipment should be kept, if possible. If this is not feasible, detailed records of the coating should be kept on a representative sampling of production equipment for evaluation of the systems.

10.2.1 This detailed record should include:

a) Production equipment location and serial number or other designation;
b) Description of fluids, vapors, and solids contained in the production equipment;
c) Working temperature and pressure, depressurization cycle, and any modification to the system or production equipment;
d) Coating system used and date applied;
e) Coating applicator and any written guarantees;
f) Complete details of inspection reports including observations on cleaning, blasting, coating application (thickness of coating and general appearance), and, if possible, applicator's foreman or representative on the coating job; and
g) Inspection forms (samples included as Appendixes C and D).

10.2.2 When feasible, the following identification shall be included on the production equipment exterior: (1) no welding or hot work, internal coating, (2) the coating application date, (3) the coating system used, and (4) the application contractor. This aids in production equipment maintenance.

10.3 To extend the coating and production equipment service life, the coating should be inspected, touched up, or repaired as needed when the production equipment is opened for cleaning.

10.3.1 The touch-up or repair of the coating should be in accordance with the coating manufacturer's recommendations and must be compatible with the original coating.

10.3.2 To obtain good adhesion between the existing coat and the repair coat, it is essential that the surface of the damaged coating be thoroughly cleaned prior to touch-up or repair. The manufacturer should be consulted for an appropriate repair procedure.

10.3.3 Repaired and touched-up coating areas shall be inspected per Section 7.

Section 11: Safety Guidelines

11.1 The importance of safe working practices cannot be overemphasized. The applicator must be informed about the liquids and vapors that were contained in the production equipment to be coated. The applicator must use the cleaning and coating equipment properly and store and handle the coating materials properly.

11.2 All needed safety checks shall be performed to ensure that the production equipment is gas-free prior to entry.

11.3 All equipment used inside the production equipment shall be spark-proof and explosion-proof. All electrical equipment shall be properly grounded.

11.4 All flammable solvents shall be removed from the production equipment and evaporated out of the coating system before holiday tests are conducted.

11.5 Forced-air ventilation is required to prevent oxygen depletion inside production equipment during all phases of internal protective coating application. The air supply shall be sufficient to keep the vapor contents inside the production equipment below the explosive limits.

11.6 Chapter 1 of "Coatings and Linings for Immersion Service" (TPC #2, NACE) furnishes an excellent list of guidelines to follow for the safe application and inspection of enclosed equipment. Detailed safety information for coating application is also found here.

11.7 For proper handling procedures, the coating manufacturer's guidance provided on the Material Safety Data Sheet (MSDS) shall be followed.

11.8 All applicable company and government regulations and coating manufacturer's recommendations shall be followed.

11.9 Safety References

11.9.1 SSPC-PA 3 (latest revision), "A Guide to Safety in Paint Application," Pittsburgh, PA: SSPC.

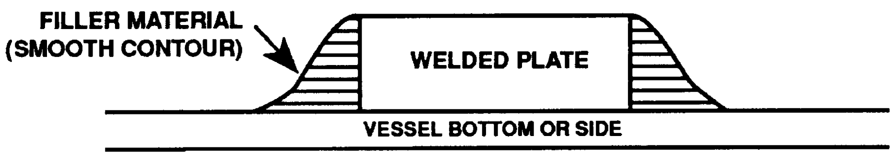
11.9.2 NACE Publication 6F264, "Recommended Safety Inspection Check List for Application of Interior Linings," Houston, TX: NACE International, 1964.

11.9.3 Federal Regulation, Occupational Safety and Health Administration (OSHA) Code Title 29.

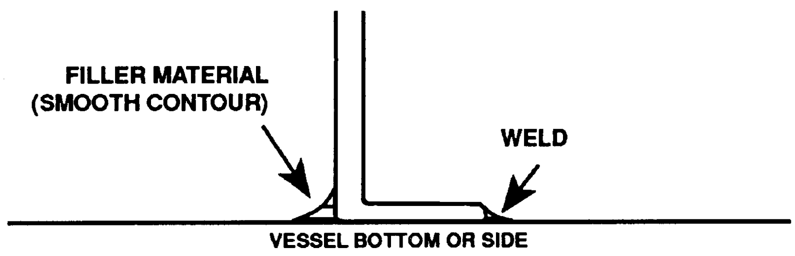
11.9.4 API Publication 2217A (latest revision), "Guidelines for Work in Inert Confined Spaces in the Petroleum Industry" (Washington, DC: API).

APPENDIX A
PLACING CAULKING, PUTTY, OR FILLER

NOTE: The filler material must be compatible with the coating to be applied.



FILLER MATERIAL USE ON
SHARP-EDGED AREAS



FILLER MATERIAL USE ON
AREAS INACCESSIBLE TO COATING

CAUTION: The use of caulk should be kept to a minimum.

APPENDIX B
SPECIAL SURFACE PREPARATION FOR BOLTED TANKS

Clean and blast the surfaces of bolted tanks as specified.

Undercut all seam and chime gaskets as shown in Figure B-1. After cutting, abrasive blast the seams and chimes to clean the new surface exposed by undercutting.

Caulk all chimes and seams after blasting, as shown in Figure B-2, with a caulking compound that is compatible with the coating to be applied.

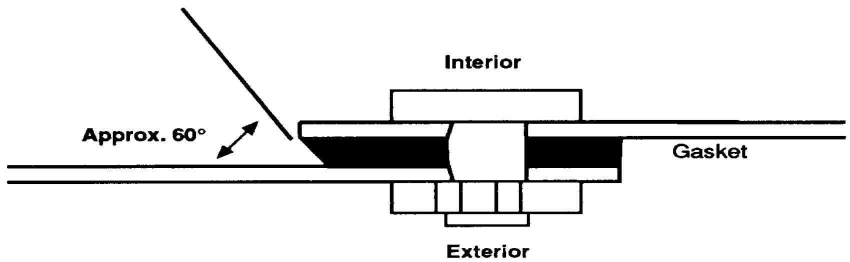


FIGURE 1- Undercutting gaskets

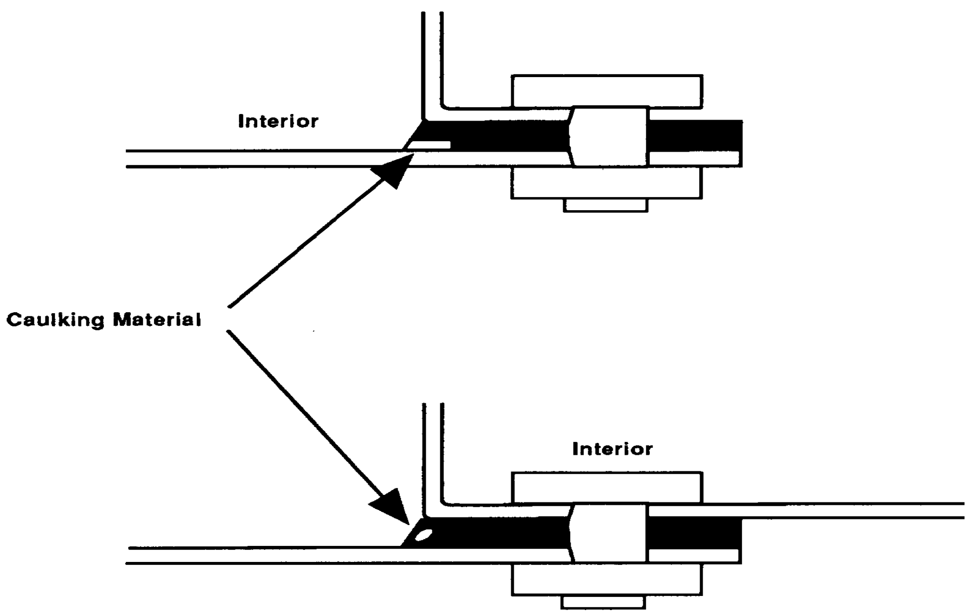


FIGURE 2- Caulking seams and chimes

CAUTION: The use of caulk should be kept to a minimum.

APPENDIX C
INITIAL INSPECTION REPORT ON PRODUCTION EQUIPMENT

File____________________

LEASE OR BATTERY ____________________**EQUIPMENT NO.** ______________________**SIZE** ________
SERVICE: Former __________________________________New __________________________________
EQUIPMENT MFR ____Yr.Built __________
ORIGINAL THICKNESS: Bottom ______________________Shell ____________________Top _________
REPAIRS BEFORE COATING:

____
____

CORROSION ____
____
Surface Contamination (sulfides, oil/greases/tar, and soluble salts)__________________________
____

BLASTING:
Material (size, brand, etc.)

____

Date & Time Started ____________________________ Date Completed _________________________ Inspected By _________________
Type Finish ____
Remarks ____

COATING MFR_____________________________**APPLICATOR** _______________________________

COATING APPLIED________ APPLICATION

(By Coats)	DATE	WEATHER	TEMPERATURE

Tests: Final Thickness Range

Bottom________________________Shell________________________Top___________________________

Holidays ____
____
Remarks ____
____
____

APPROXIMATE CURING TIME____
AVERAGE CURING TIME____
DATE READY FOR SERVICE_________________________**DATE PLACED IN SERVICE**_________________

APPENDIX D
REINSPECTION REPORT
INTERNAL COATING ON PRODUCTION EQUIPMENT
(After Period of Service)

LEASE OR BATTERY___________________________**EQUIPMENT NO**.________________________________

EXPOSURE OF COATING:

Type of service____

Length of time in service____

Other service during period of exposure____

____

DATE OF COATING_________________________ TYPE OF COATING_________________________ AVERAGE THICKNESS________________

CONDITION OF COATING AT TIME OF THIS INSPECTION:

Cleaning done before equipment inspected (type)____

____

____

Type, location, and extent of failure ____

____

____

____

Film thickness adjacent to failed areas at time of inspection __________________________________

____

____

APPARENT REASON FOR THE FAILURE

____

____

____

____

OTHER COMMENTS OR SUGGESTIONS THAT ARE APPARENT FROM THIS INSPECTION

Coating repairs required ______________________________yes_____________________________________no

Inspected by________________________________Dept. _______________________Date ________________