Recommended Practice for Inspecting Buried Lined Steel Tanks Using a Video Camera

First Edition

Prepared by:
Ken Wilcox Associates, Inc.

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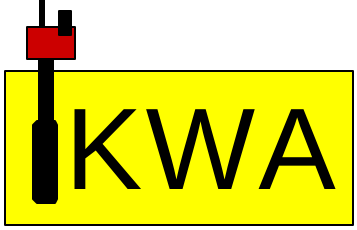
1125 Valley Ridge Drive, Grain Valley, MO 64029, USA
Voice (816) 443-2494, Fax (816) 443-2495
E-mail info@kwaleak.com, Web http://www.kwaleak.com



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INTRODUCTION

The purpose of this practice is to provide methods for inspecting and assessing buried lined steel tank(s). There are three purposes for this inspection: (1) to ensure the lining is still performing in accordance with original design specifications; (2) to determine if a lined tank is structurally sound; and (3) to determine the suitability of these lined tanks for upgrading by the application of cathodic protection.

1. Scope

1.1 This practice describes procedures for inspecting buried lined steel tanks to determine if the lining is still performing in accordance with original design specifications and if the tank is structurally sound. The practice also includes procedures for evaluating buried lined steel tanks for determining the suitability of a lined steel tank for the addition of cathodic protection. The installation of cathodic protection must be completed within the time frame established by the assessment procedure but not later than six months following the performance of the evaluation procedure on the UST site in order to assure that the data used in the evaluation are applicable.

1.2 Four Procedures are described and identified as Methods A, B, C, and D.

1.2.1 *Method A*—Permanently recorded internal video camera inspection for determining the condition of the tank lining.

1.2.2 *Method B*—Permanently recorded internal video camera inspection for determining the condition of bare steel (if found).

1.2.3 *Method C*—Non-invasive external assessment for predicted structural integrity of the tank.

1.2.4 *Method D*—Site assessment for suitability for application of cathodic protection.

Method A is used to assess the condition of the tank lining. Methods A and C when combined are used to meet the periodic inspection requirement for lined tanks under 40 CFR 280.21.

Method D is used if consideration is being given to adding cathodic protection to the tank. Method B is used only in the event that a considerable area of bare steel was found when inspecting the lined tank.

1.3 This practice does not purport to address the safety concerns associated with its use. It is the responsibility of the user of this practice to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. Referenced Documents

2.1 The most recent version of the following documents should be consulted as references by those using this practice:

2.1.1 ASTM Standards:

E 1526 Standard Practice for Evaluating the Performance of Leak Detection Devices for Underground Storage Tank Systems

E 1323 Guide for Evaluating Laboratory Measurement Practices and the Statistical Analysis of the Resulting Data

G-51-92 pH of Soil for Use in Corrosion Testing

G-57-95 A Test Methods for Field Measurement of Soil Resistivity using the Wenner 4-Electrode Method.

D-22-16 Dry Weight Moisture Content of Soils.

G 158-98 Standard Guide for Three Methods of Assessing Buried Steel Tanks.

2.1.2 Standard EPA Methods

EPA SW 846 Test Methods for Evaluating Solid Waste, specifically:

Sulfide Methods

Method 9030B: Acid-Soluble and Acid-Insoluble Sulfides: Distillation

Method 9031: Extractable Sulfides

Method 9034: Titrimetric Procedure for Acid-Soluble and Acid-Insoluble Sulfides

Method 9215: Potentiaometric Determination of Sulfide in Aqueous Samples and Distillates with Ion-Selective Electrode

Method 9215: Test Method to Determine Hydrogen Sulfide Released from Wastes

Chapter Seven 7.3 Test Method to Determine Hydrogen Sulfide Released from Wastes Chloride Methods

Method 5050: Bomb Preparation Method for Solid Waste

Method 9056: Determination of Inorganic Anions by Ion Chromatography

Method 9057: Determine of Chloride from HCL/CL2 Emission Sampling Train (Methods 0050 and 0051) by Anion Chromatography

Method 9250: Chloride (Colorimetric, Automated Ferricyanide AAI)

Method 9251: Chloride (Colorimetric, Automated Ferricyanide AAII)

Method 9253: Chloride (Titrimetric, Silver Nitrate)

2.1.3 US Code of Federal Regulations:

40 CFR Part 280, Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (UST)

2.1.4 National Association of Corrosion Engineers (NACE) International Standards:

RP-0169 Standard Recommended Practice-Control on External Corrosion on Underground or Submerged Metallic Piping Systems

RP-0285 Standard Recommended Practice-Control of External Corrosion on Metallic Buried, Partially Buried, or Submerged Liquid Storage Systems

2.1.5 National Leak Prevention Association

NLPA 631 (Chapter B Sections B5 and B6)

2.1.6 Department of the Navy, Techdata Sheet 82-08, “Paint Failures-Causes & Remedies,” June 1982.

2.1.7 Test Procedures for Evaluating Video Camera Inspection of Lined Tanks, Ken Wilcox Associates, Inc., 1999.

3. Terminology

3.1 Descriptions of Terms Specific to This Guideline*:*

3.1.1 **buried**—to be placed in the ground and covered with earth.

3.1.2 **lined ¾**to have coating applied to the internal surface.

3.1.3 **cathodic protection**—an applied technique to prevent further corrosion of a metal surface by making that surface the cathode of an electrochemical cell. For example, a tank system can be cathodically protected through the application of either galvanic anodes or impressed current.

3.1.4 **corrosion specialist/cathodic protection specialist**—a competent person who by reason of knowledge of the physical sciences and the principles of engineering and mathematics, acquired by education and related practical experience, is qualified to engage in the practice of corrosion control on buried or submerged metallic piping systems and metallic tanks. Such persons may be registered professional engineers or persons recognized as corrosion specialists or cathodic protection specialists by NACE, if their professional activities include suitable experiences in external corrosion control on buried or submerged metallic structures.

3.1.5 **corrosion technician**—a person possessing basic knowledge of corrosion and corrosion control, who is capable of performing routine, well defined work under the direct supervision of the corrosion specialist/cathodic protection specialist.

3.1.6 **lining/coatings specialist**—a competent person who by reason of knowledge of the physical sciences and the principles of engineering and mathematics, acquired by education and related practical experience, is qualified to evaluate linings on buried steel tanks. Such persons may be recognized as lining or coating specialists by NACE, SSPC, or other relevant associations if their professional activities include suitable experience in lining or coatings.

3.1.7 **invasive**—for the purpose of this standard, requiring manned entry.

3.1.8 **non-invasive**—for the purpose of this standard, not requiring manned entry into the tank.

3.1.9 **pH**—the numerical value of the negative logarithm of the hydrogen ion concentration in moles per liter in an electrolyte.

3.1.10 **tank(s)**—buried steel vessel(s) designed to contain an accumulation of liquid substances.

3.1.11 **underground storage tank (UST)**—any one or combination of tanks (including underground pipes connected thereto) that is used to contain an accumulation of liquid substances, and the volume of which (including underground pipes connected thereto) is 10 % or more beneath the surface of the ground.

3.1.12 **UST**—see underground storage tank (see 3.1.11).

3.1.13 **specialist**—for the purpose of this practice, it identifies the corrosion/cathodic protection or coating/lining specialist.

3.1.14 **ullage**—the part of the UST above the top level of liquid product.

3.1.15 **wetted area**—the surface of the tank shell normally in contact with the liquid product.

3.1.16 **technician**—a properly trained person who operates the video equipment.

3.1.17 **disqualifying flaw**—for lining, one of the items detailed in Section 10.2.1-10.2.10; for bare steel, one of the items detailed in Section 11.2.

4. Significance and Use

4.1 This practice provides a method for determining the condition of the lining of a buried lined steel tank (Method A).

4.2 This practice also provides a method for determining the structural integrity of a buried lined steel tank (Method C).

4.3 When methods A and C are combined, this practice provides minimum periodic inspection requirements for internally lined tanks.

4.4 In addition this practice may be used to determine the suitability of the lined tank to be upgraded with cathodic protection (Method D). The timely application and maintenance of cathodic protection will provide the needed corrosion mitigation and will protect the outside surfaces from external corrosion.

4.5 This practice is equally applicable to those USTs that are neither regulated nor cathodically protected.

5. Permits, Plans and Tank Leak Testing

5.1 Prior to engaging in any activities relating to the alteration, repair, or upgrade of any UST system, consult all necessary authorities to obtain any required permits.

5.2 If lined tanks are being evaluated for the addition of cathodic protection, tanks shall be tightness tested in accordance with 40 CFR 280.43 (c) to establish that the tanks are not leaking. This testing shall be accomplished within 6 months prior to and within 6 months after performing any of these assessment procedures. If a tank fails a tightness test, manned entry is required to inspect the tank to determine if it can be repaired prior to adding cathodic protection.

6. Required Approvals and Certifications

6.1 All phases of work carried out under this practice shall be performed under the supervision and responsibility of a lining/coating specialist, as defined in 3.1.4 and 3.1.6. when inspecting the lining and of a corrosion specialist/cathodic protection specialist when assessing the tank for addition of cathodic protection.

6.2 The specialist shall certify to the tank owner or operator that the personnel performing the assessment work on the tank are knowledgeable of all the applicable procedures in this practice.

6.3 The specialist shall certify to the tank owner or operator that all work was performed in strict accordance with this practice.

7. General Safety Requirements

7.1 All personnel shall comply with applicable federal, state, and local health and safety codes and regulations.

8. Preliminary Site Survey

Preliminary Evaluation—Prior to assessing the tank, a preliminary site survey must be performed pursuant to Section 8. To establish that tanks are not leaking prior to assessment, they shall be tank tightness tested in accordance with 40 CFR 280.43(c). If a tank fails the tightness test, human entry is required to determine whether the tank can be repaired. Some of the items listed may be unknown or unavailable. The best available data are obtained for the

items listed to aid in the assessment of the tank.

8.1 The technician, under the supervision of the specialist shall obtain the following site-specific information (as available) for all methods:

8.1.1 Address or location,

8.1.2 Name and telephone number of owner and operator contact personnel,

8.1.3 Number and capacity of tanks,

8.1.4 Location and dimensions,

8.1.5 Age(s) of tank(s) and pipe(s).

8.2 The technician under the supervision of the specialist shall obtain the following site-specific information for Method A or B:

8.2.1 Lining material,

8.2.2 Age of lining,

8.2.3 Contractor performing lining work,

8.2.4 Product stored.

8.3 When using Method C the technician, under the supervision of the specialist, shall obtain the following site-specific information in addition to that in Section 8.2:

8.3.1 Leak history,

8.3.2 Repair history.

8.4 When using Method D, the technician, under the supervision of the specialist, shall obtain the following site-specific information in addition to that specified in Sections 8.2 and 8.3:

8.4.1 Backfill material,

8.4.2 Electrical isolation of tanks and pipes,

8.4.3 Presence of exterior coating,

8.4.4 Material of exterior coating,

8.4.5 Stray d-c current sources,

8.4.6 Existing cathodic protection systems,

8.4.7 Steel product and vent piping and fittings, and

8.4.8 Adjacent subsurface metallic/steel-reinforced concrete structures.

9. **Permanently Recorded Internal Video Inspection:**

9.1. This subsection provides the general procedure for internal visual inspecting, recording and archiving the inspection results inspection of internally lined tanks without manned physical entry into the tanks.

9.1.1. If the tank is being evaluated for the condition of the lining for warranty purposes, the visual inspection is part of a total assessment procedure that includes testing of the lining material for hardness in accordance with 10.3.1 and thickness in accordance with 10.3.2.

9.1.2 If the tank is being evaluated for the condition of the lining and structural integrity for required periodic inspections of lined tanks, the visual inspection is part of a total assessment procedure that includes tightness testing in accordance with Section 8, testing of the lining material in accordance with 10.3.1 and 10.3.2, and external corrosion evaluation as outlined in Section 12.

9.1.3 If the lined tank is being evaluated for the addition of cathodic protection, the visual inspection is part of a total assessment procedure that includes tightness testing in accordance with Section 5.2, external corrosion evaluation as outlined in Section 12, and site inspection as outlined in Section 13.

9.2 **Technical Certification**—The person performing this inspection shall be a corrosion technician operating under the supervision and direction of a corrosion or coating specialist. The coating/lining specialist will conduct the analysis of the videotape to assess the lining. The corrosion/cathodic protection specialist will conduct the analysis to determine whether the tank is suitable for upgrading with cathodic protection.

9.3 **UST Preparation**—Prior to conducting the internal visual inspection, the tank must be emptied, cleaned if necessary, and inerted. The atmosphere within the tanks must be tested to avoid air/vapor mixtures within the flammable range.

9.3.1 **Emptying Tanks**—Tanks to be inspected must be taken out of operation and all liquid product removed that would otherwise preclude accurate visual inspection of the tank,

employing applicable safety precautions and procedures.

9.3.2 **Inerting Tanks**—Prior to placing any visual inspection, recording or lighting equipment within the fill pipe or tank, the atmosphere within the tank must be inerted to avoid any combustible hydrocarbon/air vapor mixture. Inerting may be accomplished by pressure feeding a "blanket" of carbon dioxide or another inert gas into the tank until sufficient air is displaced to render the interior tank atmosphere safe.

9.3.2.1 As the tank is inerted, the atmosphere within the tank must be tested with an intrinsically safe oxygen-indicating meter capable of reading percent oxygen and approved by one or more of the following testing organizations: Factory Mutual, Mine Safety and Health Administration (MSHA), or Underwriters Laboratories. Oxygen concentration shall be less than that required to support combustion based upon information about the specific product being stored.

9.3.3 **Cleaning Tanks**—Determined by the specialist upon reviewing the visual record, the tank shall be sufficiently free (clean) of sludge, thick oxides, or other dense residual materials as to allow the internal surface of the tank to be evaluated. At least 98% of the interior surface area of the tank must be visible for inspection.

9.3.3.1 If the specialist determines the interior surfaces were not adequately clean, the specialist shall reject the tank until such time the condition has been corrected and the tank re-inspected.

9.3.3.2 If less than 98% of the interior surfaces are visible or adequately clean, but disqualifying flaws in the lining or tank surface can be documented in that portion of the tank’s interior surface that can be viewed, then the result of the inspection is that the lining has failed or that the tank is not structurally sound. In this case, a valid inspection can be conducted with less than 98% of the interior surface visible for inspection.

9.3.3.3 At least 98% of the interior surface must be visible for inspection in order to pass the tank. In some configurations this may require putting the video camera in a second opening.

9.4 **Lighting Equipment**—The "in-tank" visual recording system shall be equipped with lighting

capable of adequately illuminating the interior surfaces so that the defect sizes defined in 9.5.1 can be visually observed and permanently recorded.

9.5 **Visual Inspection Resolution:**

9.5.1 The visual inspection method must be capable of detecting the presence of pits or corrosion by-product tubercles or lining anomalies of 3/32 inch (2.3mm) or larger in size at the maximum operating distance from the camera. Multiple access points may be needed in large tanks to ensure adequate coverage.

9.5.2 The visual inspection method shall identify and permanently record the presence of all detectable pits or corrosion by-product tubercles or lining anomalies while observing and permanently recording the condition of at least 98% of the tank's interior surfaces. If disqualifying flaws are found, the inspection may be terminated with less than 98% of the tank's interior surface observed and permanently recorded, but the disqualifying flaw(s) shall be observed and permanently recorded.

9.6 **Visual Recording**—The minimum resolution of the visual recording system shall be capable of identifying the location and degree of activity as listed in 9.5.1. The system shall also permanently embed the time, structure site, UST location and date of the visual examination in the visual record. It shall also provide for permanently recording the direction and angle of the camera and observation comments of the technician conducting the inspection.

10. Method "A" –Permanently Recorded Video Inspection for Lining Evaluation.

10.1 **Lining Inspection Recording** ¾After the tank has been tested and found to be safe in accordance with Section 9.3, and the equipment is in place, the inspection shall be made by a qualified technician working under the supervision of the responsible specialist in accordance with the following minimum requirements:

10.1.1 Scan all interior tank surfaces to assess the general conditions and to ensure the tank is sufficiently clean to permit effective visual inspection.

10.1.2 At the start of the recording process, record the date, time, and all necessary tank identification data including: company name and address, project identification number, tank

size, age, product, riser entered, identification number, and corrosion technician's name.

10.1.3 Systematically perform and record the visual condition on at least 98% of the internal tank surfaces (unless disqualifying flaws are recorded before 98% of the surface is observed). Remove any drop tubes or submersible pumps prior to inspection. (Note: There are always some areas immediately above the camera that are not observable. The area not visible is limited to 2% or less. Otherwise additional access to the tank must be provided to view the additional surface area.)

10.1.4 Permanently record in the visual record all pertinent or unique observations, condition of lining, corrosion activity or damage and location relative to the internal tank surface.

10.1.5 Permanently record any summation commentary of the Technician.

10.2 Lining—The Technician shall identify any evidence of the lining problems defined below (taken from Techdata Sheet 82-08, Department of the Navy, June 1982), including:

10.2.1 Separation ¾Loss of adhesion between the lining material and the tank wall.

10.2.2 Delamination ¾Loss of adhesion between coats of lining material.

10.2.3 Blistering ¾Isolated convex formations of lining material in the form of blisters.

10.2.4 Holidays ¾Defects characterized by areas of missing coating.

10.2.5 Peeling ¾Lack of adhesion between the substrate and lining or between coats.

10.2.6 Thin areas—areas with insufficient coating thickness.

10.2.7 Surface Wrinkling or Roughing—Furrows and ridges in the lining surfaces.

10.2.8 Cracking ¾Breaks in the lining that penetrate to the substrate.

10.2.9 Pin Holes—Small visible holes in the lining that formed during application.

10.2.10 Other—Any other visible condition that indicates a problem in the opinion of the coating specialist.

10.3 Testing of Lining

10.3.1 Using a Defelsko Positector 6000-FHS2 or equivalent, the technician shall test the thickness of the lining.

10.3.1.1 A nominal thickness of 125 mils (0.125 inch) is expected; a minimum of 100 mils (as specified in NLPA-631 A12.7.1) is required to pass.

10.3.2 Using a Rex Gauge Durometer DD-3 or equivalent, the technician shall test the hardness of the lining.

10.3.2.1 A minimum of 50% of the original cured hardness at installation (as specified in NLPA-631 A4.7.1) is required for the lining material is required to pass.

10.3.3 These test readings shall be taken on the bottom of the tank below the fill riser. Additional test readings shall be taken at any other openings that prove access to the tank bottom without removing permanently installed equipment.

10.3.3.1 At each opening, a minimum of five test readings of hardness and thickness shall be taken. Beginning with a reading in line with the centerline of the tank, readings shall be taken at least every 90 degrees rotating from the initial readings. One reading shall be taken directly below the opening. The other test readings shall be taken a minimum of 10 inches offset from the centerline of the opening and they shall be outside the influence of any striker plate.

10.3.3.2 The minimum hardness reading obtained and the minimum thickness reading obtained are used to determine whether the lining passes.

10.4 Data Analysis and Report of Determination of the Condition of the Lining

10.4.1 The examining technician may record comments to aid the specialist in evaluation of the lining on the tank's internal surfaces. If no deterioration is evident, the report shall so state.

10.4.2 The coating/lining specialist shall be responsible to view the visual permanent record and make a final determination on the condition of the lining for each tank tested.

10.4.3 After review of the visual permanent record including all notations and comments, a report shall be prepared and submitted to the UST owner/operator by the specialist including the condition of the lining for each tank. This visual record and report shall be kept on file until replaced by a subsequent inspection by the UST owner/operator as part of the required documentation.

10.4.4 Any evidence of a perforation or significant deterioration of the lining, as defined in accordance with 10.2 and 10.3, confirmed by the specialist, indicates that the lining has failed the inspection. If the specialist's analysis of the condition of the lining indicates that it is not

performing according to specification, the lining has failed the inspection.

10.4.4.1 In the wetted area of the tank shell, significant deterioration of the lining is evidenced by any evidence of a perforation or leak, or by any of the lining problems specified in 10.2.1-10.2.10. The minimum of the hardness readings shall be at least 50% of the original hardness requirement or the lining fails. The minimum thickness reading shall be at least 100 mils or the lining fails.

10.4.4.2 In the ullage area, small defects shall be noted, but will not fail the tank unless, in the judgment of the Specialist, they pose a significant evidence of lining deficiency or structural defects. For example, failure to coat the manway opening will be noted, but will not automatically fail the tank.

11. Method "B" –Permanently Recorded Video Inspection for Evaluation of Bare Steel Areas (if found).

Since the tank is lined, only small areas of bare steel in the top of the tank, such as an unlined manway, are allowed. Otherwise the tank fails the lining inspection. If the tank fails the lining inspection, human entry is required to effect needed repairs. When any visible areas of the interior of the lined tank that are found where the lining is not present so that bare steel is visible, the interior steel surface in those areas may be assessed according to the following provisions.

11.1 **Inspection and Recording**—After the tank has been tested and found to be safe in accordance with Section 9.3, and the equipment is in place, the inspection shall be made by a qualified technician working under the supervision of the responsible specialist in accordance with the following minimum requirements:

11.1.1 Scan all interior tank surfaces to assess the general conditions and to ensure the tank is sufficiently clean to permit effective visual inspection.

11.1.2 At the start of the recording process for each tank record the date, time, and all necessary tank identification data including: company name and address, project identification number, tank size, age, identification number, product, riser(s) entered and corrosion

technician's name.

11.1.3. Systematically perform and record the visual condition of all bare steel areas found (unless disqualifying flaws are evident after viewing a smaller proportion of the surface).

11.1.4 Permanently record in the visual record all pertinent or unique observations, condition of lining, corrosion activity or damage and location relative to the internal tank surface.

11.1.5 Permanently record any summation commentary of the technician.

11.2 Evidence of corrosion activity.

The following items (as in ASTM G158-98, Section 11.2.13) indicate the presence of active corrosion or corrosion damage. The technician shall identify any evidence of corrosion including:

11.2.1 Perforations—Water intrusion or other visual evidence.

11.2.2 Rust Tuberculation—Active dark red/maroon crust.

11.2.3 Streaks—Elongated in shape, dark red/black in color at apex.

11.2.4 Discoloration—Patches showing dark reddish/ black center, becoming lighter toward the edges, usually irregularly spaced, 3 to 9 in. (7.5 to 23 cm) in diameter.

11.2.5 Pitting—Black in center-bottom of crater, light red or bright metal near perimeter.

11.2.6 Scaling or Delaminations—Typical exfoliation, no discoloration, layered flakes in small 2 to 4-in. (5 to 11-cm) diameter irregular patches.

11.2.7 Weld Deterioration —Little discoloration, except possible black/maroon deposit beneath interface; deterioration of metal within the weld sometimes with cracks and undercuts.

11.2.8 Cracks (weld*)*—Usually no discoloration, typically near welds, openings, fittings, connections, and other stress concentration sites.

11.2.9 Passive Corrosion Films:

11.2.9.1 General Overall Rust Film—Light red, pink, or pink/beige; smooth to slightly pockmarked. This is not active corrosion, but an iron oxide film that is protective or passivating.

11.3 Any evidence of a perforation or significant corrosion as defined in accordance with 11.2.1-11.2.9 that is confirmed by the corrosion/cathodic protection specialist fails the tank. In addition, the specialist's analysis of the site corrosion data as defined in 12.1 may fail the tank.

Significant evidence of corrosion exists when the corrosion has advanced enough to compromise the integrity and useful life of the tank. (ASTM G158-98).

12. Method "C" –External Assessment for Structural Integrity of Tank.

In addition to the internal inspection described in Section 10 (and Section 11 if applicable) the following procedure shall be performed.

12.1 Prediction Model—Use a prediction model as described in ASTM G158-98, Section 11.3.5.1, to determine the probability of an individual tank leak as a result of corrosion. It shall yield the years of leak-free life remaining and the probability of a potential leak of the tank in the specific soil condition found at the site. The model shall be based on tank inspection data collected and shall include all of the site-specific parameters listed in 13.2.2 and any test(s) performed in 13.2.3. The mathematical formulation used in the prediction model shall be based on accepted physical and electrochemical characteristics of the tank corrosion process. Consider the tank structurally sound if the tank is not leaking and the results of the prediction model indicate that the age of the tank is less than the expected leak-free life and the probability of a corrosion perforation is less than 0.05.

12.2 Data Analysis and Report of Determination that the Tank is Structurally Sound and the Lining is still Performing in Accordance with Original Design Specifications

12.2.1 The examining technician may record comments to aid the specialist in evaluation of the lining and the condition of the tank's internal surfaces. If no deterioration is evident, the report shall so state.

12.2.2 The lining specialist shall be responsible to view the visual permanent record and make a final determination of the condition of the lining for each tank tested. The corrosion specialist shall also determine whether the tank is structurally sound, using the method of 12.1.

12.2.3 After review of the visual permanent record including all notations and comments and the results of 12.1 a report shall be prepared and submitted to the UST owner/operator by the specialist including the results of the inspection for each tank. This visual record and report shall be kept on file until replaced by a subsequent inspection by the UST owner/operator as

part of the required documentation that the lined tank has been inspected as required and found to be structurally sound with the lining performing in accordance with original specifications.

12.2.4 Any evidence of a perforation or significant deterioration of the lining, as defined in 12.2.4.1 and 12.2.4.2, confirmed by the specialist, or if the specialist's analysis of the condition of the lining indicates that it is not performing according to specification indicates that the tank fails the inspection.

12.2.4.1 In the wetted area of the tank shell, significant deterioration of the lining is evidenced by any evidence of a perforation or leak, or by any of the lining problems specified in 10.2.1-10.2.10.

12.2.4.2 In the ullage area, small defects shall be noted, but will not fail the tank unless, in the judgment of the Specialist, they pose a significant evidence of lining deficiency or structural defects. For example, failure to coat the manway opening will be noted, but will not automatically fail the tank.

12.2.4.3 A failing result from 12.1 indicates that the tank is not structurally sound. This result indicates that the tank is no longer suitable for use without further investigation. The tank could be replaced, or manned entry for internal inspection to determine wall thickness and condition is required to document that the tank is structurally sound.

13. Method "D" –Assessment for Addition of Cathodic Protection.

13.1 The lined tank shall be found structurally sound using the internal inspection procedures of Method "A," Method "B," and Method "C."

13.2 External corrosion assessment data gathering shall be conducted as described below:

13.2.1 Conduct the following procedures when assessing the suitability of a lined steel tank for upgrading with cathodic protection using this method.

13.2.2 Before a tank is suitable for upgrading with cathodic protection using this approach, the following site-specific tests shall be conducted for each tank excavation zone in accordance with industry recognized standard practices:

13.2.2.1 Stray Currents—Perform tests to detect the presence of stray currents at each

tank site. This test shall consist of measuring structure-to-soil potentials at right angles at a minimum of two locations within the tank facilities and observing the measurements for not less than 2 h at a time when such influences are most likely to occur. The monitor shall consist of a field data acquisition unit, with a minimum of 10-MΩ input impedance, used in conjunction with a stable reference cell(s) placed in contact with the soil in the vicinity of the tank. The instrument shall measure and store structure-to-electrolyte potential (voltage) data at least every 5 seconds throughout the entire duration of field investigation at the site or for 2 hours, whichever is greater. If variations of ±50 mV or greater are measured during the test period, make 24-h recording measurements to confirm stray current effects.

13.2.2.2 Soil resistivity in accordance with ASTM G-57. These values shall be measured in the immediate vicinity of the tank excavation zone and shall, as a minimum, be measured at depths of 5, 7½, 10, 12½, and 15 ft (1.5, 2.3, 3, 3.5, & 5 m) depths.

13.2.2.3 Structure-to-soil potential in accordance with NACE RP-02-85 with at least 5 such measurements spaced uniformly about each tank excavation zone.

13.2.2.4 Soil pH in accordance with ASTM G-51 and if requested by the Specialist, soil chlorides and sulfides in accordance with EPA SW 846 and Guide E 1323 uniformly gathered from three locations about each tank excavation zone.

13.2.2.5 Electrical continuity/isolation in accordance with NACE RP-0285 for each UST being evaluated.

13.2.3 The corrosion specialist/cathodic protection specialist should also consider, as a minimum but not be limited to, performing and evaluating the following tests:

13.2.3.1 REDOX potential,

13.2.3.2 Current requirement,

13.2.3.3 Coating resistance,

13.2.3.4 Coating efficiency,

13.2.3.5 Wall thickness,

13.2.3.6 Soluble Chloride ion concentration,

13.2.3.7 Sulfide ion concentration,

13.2.3.8 Sulfate ion concentration,

13.2.3.9 Any other tests deemed necessary by the specialist.

13.3 Requirements for Cathodic Protection Application

13.3.1 All of the following must be met prior to adding cathodic protection to a lined tank;

13.3.1.1 The lined tank passed the tightness test specified in Section 5.2.

13.3.1.2 The lined tank has passed inspections set forth Section 10. (If sufficient bare steel is found so that Section 11 inspections must be conducted, the tank has failed the lining inspection. The tank must be entered and the lining repaired along with any other required repairs before addition of cathodic protection is considered.)

13.3.1.3 The lined tank has passed the assessment specified in Section 12.

13.3.2 Either a tank tightness test is conducted and passed between three and six months after the tank is cathodically protected, or monthly monitoring is implemented using one of methods described in 40 CFR Part 280.43 (b) through (h) within one month after the addition of cathodic protection and shows that the tank is not leaking.

13.4 Data Analysis and Report of Determination that the Tank is Structurally Sound and the Lining is Still Performing in Accordance with Original Design Specifications

Any evidence of a perforation or significant deterioration of the lining as judged by the coating/lining specialist in accordance with Sections 10.2 and 10.3 indicates the tank has failed the lining inspection.

Any evidence of a perforation or significant corrosion deterioration of the tank's internal surface, as defined in accordance with 11.1.3 and 11.1.4, confirmed by the specialist, indicates that the tank has failed the inspection of bare steel.

Similarly, a failing result from Section 12.1 indicates that the tank is not structurally sound.

Any of these results indicates that the tank is not suitable for upgrading with cathodic protection without further inspection involving manned entry into the tank. Such inspection might indicate necessary repairs that would have to be made before adding cathodic protection.

14. Independent Third Party Evaluation

Companies performing this inspection must demonstrate their performance capability by having an independent third party evaluate their capability using the test protocol developed by KWA or an alternative protocol determined to be acceptable by KWA. This evaluation should be performed before the inspection is used as a stand-alone procedure. This video inspection can be used in conjunction with other inspections prior to its evaluation. There are two requirements in the KWA test protocol.

14.1 Evaluation of Video Equipment

The company must subject its video inspection equipment to a series of tests to document that it has the appropriate illumination and resolution and that the operator can identify a series of standard flaws in coatings.

14.2 Comparison to standard inspection

The company must provide a database of at least 50 consecutive tank inspections where the tank was initially inspected with the video camera procedure, then subsequently was inspected by the standard approach using manned entry into the tank (as described in NLPA 631). Alternatively, the evaluating organization may randomly select 50 (or more) tank inspections that include both the video camera procedure and a manned entry inspection from a larger database. The evaluating organization will compare the findings of the video inspection and manned entry inspection to demonstrate that the video inspection agrees within acceptable limits to the manned entry inspection.

15. Keywords: assessment; cathodic protection; corrosion; criteria; evaluation; inspection; model; prediction; steel; suitability; tank; underground storage tank; lining; UST; upgrade; video; ullage; wetted area; visual.