Designation: E 2256 – 03

Standard Guide for Hydraulic Integrity of New, Repaired, or Reconstructed Aboveground Storage Tank Bottoms for Petroleum Service[1]

This standard is issued under the fixed designation E 2256; 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 guide is intended to provide the reader with a knowledge of construction examination procedures and current technologies that can be used to give an owner or operator of an aboveground storage tank (AST) in petroleum service, relevant information on the hydraulic integrity of a new, repaired, or reconstructed tank bottom prior to return to service. This guide does not pertain to horizontal ASTs, manufacture of tanks using UL 142, or to tanks constructed of concrete or other non-ferrous materials.

1.2 The adoption of the mathods and technologies presented in this guide are not mandatory, rather they represent options that may be selected to identify the likelihood of product leaking through a new, repaired, or reconstructed tank bottom.

1.3 This guide is not intended to suggest or treat any technology in a preferential manner.

1.4 The person responsible for applying this guide should be a knowledgeable individual with experience in the design, inspection, construction, or combination thereof, of aboveground storage tanks for use in petroleum service, and should also be certified under the requirements of API 653 when use is related to tank bottom repair.

1.5 This guide is written in metric measure units (SI Units) in accordance with requirements of Practice E 621. English measure equivalents are in parentheses.

1.6 The applicability of this guide to the proposed tank configuration and service conditions should be established prior to use.

1.7 This guide complies with ASTM policy for development and subsequent use of a standard.

1.8 This guide is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this guide or for additional standards and should be addressed to ASTM International, 100 Barr Harbor Drive, W. Conshohocken, PA 19428.

1.9 This guide is not intended for use as a model code, ordinance or regulation.

1.10 *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 requirements prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:* [2]

A 6 Specification for General Requirements for Rolled Steel Plate, Shapes, Sheet Piling, Bars for Structural Use

A 20/A 20M Specification for General Requirements for Steel Plates for Pressure Vessels

A 36/A 36M Specification for Carbon Structural Steel

A 53/A 53M Specification for Pipe, Steel, Black and Hot-Dipped Zinc-Coated, Welded and Seamless

A 106/A 106M Specification for Seamless Carbon Steel Pipe for High Temperature Service

A 333/A 333M Specification for Seamless and Welded Steel Pipe for Low-Temperature Service

D 3282 Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes

E 165 Test Method for Liquid Penetrant Examination

E 621 Practice for the Use of Metric (SI) Units in Building Design and Construction

E 709 Guide for Magnetic Particle Examination

E 1209 Test Method for Fluorescent Liquid Penetrant Examination Using the Water-Washable Process

E 1219 Test Method for Fluorescent Liquid Penetrant Examination Using the Solvent-Removable Process

E 1220 Test Method for Visible Liquid Penetrant Examination Using the Solvent-Removable Process

2.2 *Other Documents:*

ASME Section V and IX Boiler and Pressure Vessel Code[3]

[1] This guide is under the jurisdiction of ASTM Committee E50 on Environmental Assessment and is the direct responsibility of Subcommittee E50.01 on Storage Tanks.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016–5990.

SNT TC-1A Society for Nondestructive Testing Recommended Practice[4]
AWS B1.10 Guide for the Nondestructive Inspection of Welds[5]
AWS QC1-96 Standard for AWS Certification of Welding Inspectors[5]
API 322 An Engineering Evaluation of Acoustic Methods of Leak Detection in Aboveground Storage Tanks, Jan. 1994[6]
API PB 334 A Guide to Leak Detection for Aboveground Storage Tanks, Mar. 1996[6]
API 575 Inspection of Atmospheric and Low-Pressure Storage Tanks[6]
API 581 Base Resource Document-Risk-Based Inspection[6]
API 650 Welded Steel Tanks for Oil Storage[6]
API 653 Tank Inspection, Alteration, and Reconstruction[6]

3. Terminology

3.1 The following terms as used in this guide may differ from the more commonly accepted definitions elsewhere.

3.1.1 *aboveground storage tank (AST)*, *n*—a vertically oriented tank (normally cylindrical), whose bottom is in contact with the soil or other solid material and whose shell to bottom joint is designed to be at the plane of grade. See Fig. 1.

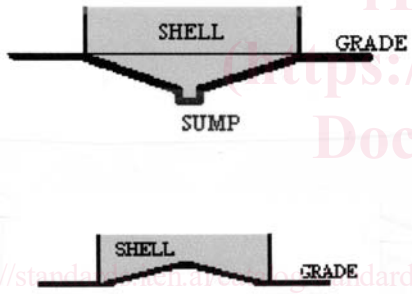

FIG. 1 Examples of ASTs per this Guide

3.1.2 *conditions and limitations*, *n*—the environmental and physical effects that restrict the collection of data.

3.1.3 *cut and cover or bunkered tank*, *n*—a field-constructed aboveground storage tank that has been cut into the soil and covered to protect it from damage either by accident or hostile intent of war.

3.1.4 *developing technology*, *n*—a procedure or testing method that may be used to provide additional information on a potential leak path.

3.1.5 *for petroleum service*, *n*—an AST that is designated for or expected to be used for petroleum product storage to include crude oil, residual, and refined petroleum products.

3.1.6 *hydraulic integrity*, *n*—the actual ability of a tank bottom to prevent passage of a stored product to the external environment.

3.1.7 *leak path*, *n*—the route or opening through which the tank contents are released through to the exterior environment.

3.1.8 *tank*, *n*—a field-erected steel structure constructed of welded or riveted steel and designed for petroleum service.

3.1.9 *tank bottom*, *n*—the floor of a vertically oriented tank, including the shell to bottom weld, connected piping supports, column base plates, sumps, floor plates, and floor welds, but not interior or exterior coatings or cathodic protection.

3.1.10 *tank owner or operator*, *n*—an individual or entity that owns or operates an aboveground storage tank in accordance with and definitions of The U.S. Environmental Protection Agency Regulation 40 CFR 112.

3.1.11 *technologies*, *n*—systems or services that provide information that can be used to evaluate the hydraulic integrity of a tank bottom.

3.2 *Abbreviations:*

3.2.1 *cm*—centimetre

3.2.2 *mm*—millimetre

3.3 *Acronyms:*

3.3.1 *ANSI*—American National Standards Institute

3.3.2 *API*—American Petroleum Institute

3.3.3 *ASM*—American Society for Metals

3.3.4 *ASME*—American Society of Mechanical Engineers

3.3.5 *ASNT*—Society for Nondestructive Testing

3.3.6 *AST*—aboveground storage tank

3.3.7 *AWS*—American Welding Society

3.3.8 *ERW*—electric resistance weld

3.3.9 *NDE*—non-destructive evaluation

3.3.10 *OSHA*—United States Occupational, Safety and Health Administration

3.3.11 *UL*—Underwriters Laboratory

3.3.12 *UST*—underground storage tank

3.4 *Measurement Units*—This guide is written in metric measure units (SI Units) in accordance with requirements of Practice E 621. English measure equivalents are in parentheses.

4. Summary of Guide

4.1 This guide establishes a process and provides guidance about practices and procedures that are called for in API 650 and API 653, or available as optional selections and which will lead to a better understanding about the hydraulic integrity of an AST's bottom. The information contained in the guide is set out in three formats: a flowchart of the procedures and the appropriate point for employment in order to gather the most useful information; a table of the procedures briefly describing what and how they should be used in order to gather the most useful information; and an expanded listing of the procedures to provide the guide user with procedure background and expected results in order to determine the type and validity of the information gathered.

5. Significance and Use

5.1 Inspection, repair, and construction of ASTs in petroleum service should follow at a minimum the requirements of API 650 and API 653. These standards describe methods for testing the weld quality and structural and hydraulic integrity of new or repaired ASTs. With increasing emphasis on protecting the environment and with environmental issues related to

[4] American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlingate Lane, Columbus, OH 43228–0518.
[5] American Welding Society (AWS,) 550 NW Le Jeune Rd., NW, Miami, FL 33126.
[6] American Petroleum Institute (API), 1220 L. St., NW, Washington, CD 20005.

the storing of petroleum materials in ASTs, owners and operators of such tanks may want or need a guide devoted to existing and enhanced methods for evaluating the hydraulic integrity of new or repaired tank bottoms.

5.2 The consequences of a tank bottom failure include the economic loss of product, cost of repair or replacing the tank bottom, and exposure to the cost of environmental remediation and potential damage or harm to adjacent lands that may give rise to adverse public relations or regulatory action. In addition, releases of petroleum products introduce potential fire or explosive conditions.

5.3 Owners and operators of ASTs or their agents can use this guide to help choose methods of evaluating the hydraulic integrity of their repaired or new tank bottoms. Selection of the methods should be based on regulatory and economic criteria that include operational and cost/benefit considerations.

5.4 This guide is intended for use by an individual experienced in repair and construction of ASTs in petroleum service.

5.5 This guide is intended for use when repairing or building ASTs and not intended for use beyond the construction process. This guide does not address suitability for use or imply useful life of an AST bottom.

5.6 This guide is intended to be used in conjunction with and as a supplement to standards provided for hydraulic integrity in API 650 and API 653.

5.7 Procedures or methods included here may be supported by a previously completed and documented performance evaluation(s) that may lend itself as valuable results validation.

6. Procedures

6.1 This section provides information on established practices described in API 650 and API 653. This section provides information on other practices listed in this guide as optional during a hydrostatic test, and which may be used to assess the hydraulic integrity of the tank bottom. Also identified in this section are developing technologies that may be used in conjunction with a hydro-test, and may produce supplemental information about the hydraulic integrity of the completed tank bottom construction. Some of the procedures identified here are recognized to be voluntary when used for attaining an enhanced confidence in the hydraulic integrity for a repaired or newly constructed tank bottom. For those owners and operators that already have procedures for determining the suitability of the tank bottom, this guide may serve as a reference when policy warrants a change in their methods.

6.2 Table 2 identifies tests and procedures, and notes when application of those tests or procedures will provide the most useful information for assessing the hydraulic integrity of tank bottom.

6.3 Table 1 supplements the flow chart by listing the accepted tests and procedures from API 650 and API 653, as a readily available reference, and also the developing technologies. These API procedures, although established chiefly to assess tank structural soundness, are also useful for determining the hydraulic soundness of tank bottom construction when it has been repaired or newly constructed. Information relating to the developing technologies may be employed by an owner and operator in order to obtain hydraulic integrity and other supplementary information during a hydrostatic test.

6.4 When using information provided in this section, considerations for schedule, operational, economic, and environmental characterizations should be reviewed. An owner and operator or the owners' and operators' representative should be familiar with conditions under which the tests and procedures can be used and in the case of the developing technologies, API 334 should be consulted.

7. Evaluation Methods

7.1 *Procedures Prior to Filling and After Filling the Tank*:

7.1.1 The owner and operator of a tank, included by definition in this guide, will find that there are numerous procedures associated with the determination of the hydraulic integrity of a tank bottom. Of this total number of procedures there can be at least nine that are conducted prior to filling the tank and can be at least another four procedures that are applied with the tank either partially or completely filled to its safe fill height.

7.2 *Evaluation of Floor Plate, Weld Construction Practices*:

7.2.1 Factors or conditions that contribute to tank bottom failure are:

7.2.1.1 Imperfections that may be included in steel plate during manufacture.

7.2.1.2 Gouging and tearing in steel plate can occur during shipment and storage, and in moving the plates into final position for welding. Such damage can be the result of improper use of equipment for moving the plate or the dragging of the plates across one another or other construction materials and rocks. The gouges and tears can compromise the structural integrity and intended service life of the tank.

7.2.1.3 Irregular surface continuities or voids in the structural fill or concrete foundation can be a significant condition causing a bottom to fail and leak. The voids and projections created by the sub-floor structural system irregularities will cause uneven stressing of the floor plates, seam welds, floor to shell weld, and sumps located in the bottom. The stress can lead to early failure of the bottom when the tank is placed back in service and under load from the stored product or the columns and legs of floating pans or roofs.

7.2.1.4 The use of incorrect welding procedures or unqualified welders can result in sub-standard welds that are more likely to fail.

7.2.1.5 Service conditions that might include the presence of hydrogen sulfide or conditions that may cause weld or plate cracking require the appropriate selection of materials, and quality control for manufacture and fabrication.

7.2.2 *Summary of Test Parameters*:

7.2.2.1 The user will need to ensure good practices, procedures and record keeping, are used throughout the process to avoid or intercept the foregoing conditions or factors that contribute to tank bottom failure. Specification A 36/A 36M or other steels for use accepted by API 650 provide guidance on oversights by the owner or operator during the manufacturing process that can be used to establish the quality of the steel plate.

7.2.2.2 This control is accomplished on the steel floor plate, floor plate welds, floor plate to shell welds, internal piping supports connected to the floor plates, tank sumps, gaging well

wear plates, and steel used as wear plates for roof or pan legs, and all exposed plate surfaces.

7.2.3 Evaluating the quality of construction and material is dependent on the schedule, integrity, skill, and experience of the manufacturing process, the individuals directing and performing the installation, and the individual inspecting and reviewing records required under this procedure. Tight construction schedules may impact construction quality. The quality of workmanship is a subjective measure and the experience of an inspector determines the ability to detect defects in the materials and workmanship.

7.2.4 *Records*:

7.2.4.1 The tank owner and operator or the owner and operator's representative should request reports, as recommended by Specification A 6, Specification A 20, API 650, and API 653. Rejected conditions require replacement or repair of the affected material until such meet materials and construction requirements.

7.2.5 *Hazards (Cautionary and Generic)*—None.

7.3 *Evaluation of Connected Under-Floor Piping*:

7.3.1 Connected under-floor piping and associated sumps used for water draw or stripping petroleum product from the bottom of the tank can be sources of a leak, and should be tested prior to burying. Such piping that is connected may be: (*1*) Water draw offs, (*2*) Drain dry piping, and (*3*) Sump systems.

7.3.2 *Summary of Test Parameters*:

7.3.2.1 Piping should be manufactured under API accepted standards for construction and monitored for possible leaks during hydrostatic testing. Additional requirements for Electric Resistance Welded (ERW) piping may be necessary.

7.3.2.2 Preparation of the bedding or the foundation that the piping rests on is very important, as piping and sumps that are not adequately supported will be stressed, causing potential for collapse or failure of welds.

7.3.2.3 The quality of the welds completed on site can be maintained by establishing welding procedures, certifying the capability of the welders who will perform the work, and inspection of the completed work by certified inspectors.

7.3.3 *Application to Portion of the Tank Floor*:

7.3.3.1 This control is performed on the tank piping that is beneath the sub floor and floor plates of a tank bottom, including the sump, bedding material, piping welds and sump welds that are related to the connected piping to the bottom.

7.3.4 *Limitations*:

7.3.4.1 The procedure for evaluating the quality of construction and material is dependent on the schedule, integrity, skill, and experience of the manufacturing process, the individuals directing and performing the installation, and the individual inspecting and reviewing records required under this procedure. The structural integrity and service life are subject to compromise as installation schedules become tighter. The quality of workmanship is a subjective measure under this procedure and the experience of an inspector determines the ability to detect defects in the materials and workmanship.

7.3.5 *Hazards (Cautionary and Generic)*—None.

7.4 *Evaluation by Visual Examination of the Tank Floor*:

7.4.1 *Background and History*:

7.4.2 *General Description*—Visual test may be direct type when the tank bottom or steel plate surface is readily accessible to place the eye within 60.9 cm (24 in.) of the surface at an angle of not less than 30°. The minimum illumination is 15 footcandles for general viewing and 50 footcandles for viewing of small anomalies. Visual test may be remote by using mirrors, cameras, or other suitable instruments. The test would detect surface defects such as cracking, weld undercut, corrosion, dents, gouges, weld scars, incomplete welds, and so forth.

7.4.3 *Summary of Test Parameters*—Visual-direct type requires accessibility of the eye to within 60.9 cm (24 in.) of object at an angle of not less than 30° and 15 to 50 footcandles of illumination. Remote type requires instruments.

7.4.4 *Application to Portions of Tank Floor*—All welded floor seams whether lapped or butt type.

7.4.5 *Limitations*—Accessibility to viewing, cleanliness of weld (slag removal, dirt, and so forth). Surface defects only.

7.4.6 *Qualifications of Individuals Performing Test*—Natural or corrected near distance acuity as measured by reading standard J-1 letters of a standard Jaeger chart.

7.4.7 *Reference to Other Test Procedures*—ASME BPVC, Section V, Art. 9.

7.4.8 *Test Reports*—Test reports should be written and traceable and include the following pertinent information: date, name of inspector, type of test, equipment used, defects, and locations.

7.4.9 *Hazards (Cautionary and Generic)*—Confined space requirements apply.

7.5 *Evaluation by Radiography Procedure*:

7.5.1 *General Description*:

7.5.1.1 Radiography is a non-destructive method for inspecting welds that provides information about the internal condition, utilizing radiation. The radiation that is directed at the weld is either absorbed, penetrated, or scattered and then recorded by a device. There are two accepted methods of radiography inspection: Film/Paper Radiography, and Radioscopy. The most traditional manner for recording is on photographic film or paper. The amount of radiation transmitted to the film is a factor of absorption over the length of the weld and is dependent on the mass of various areas and intensity of the beam applied. Interpretation of radiography should be conducted in a room with low levels of light. This permits the observation of the image created in variations of light and dark on the film. The dark areas represent points where greater degrees of penetration and hence an area of lower density. The lighter areas represent impeded or more difficult areas to penetrate and higher density. Absorption rates that differ by more than 1 % are generally detectable when compared to surrounding material areas.

7.5.2 Both making of the exposure and the interpretation of the exposure require the skills of individuals with experience in their respective areas.

7.5.3 *Limitations*:

7.5.3.1 The surface to be examined needs to be accessible (no obstruction to equipment or file placement) from both sides. Discrepancies must be suitably aligned with the radiation beam in order to be reliably detected.

7.5.3.2 It is a relatively expensive testing method.

7.5.4 *Qualifications of Individuals Making and Interpreting Exposure*—Individuals performing this test should be skilled, capable, and familiar with the techniques and procedures recommended by ASM Committee document on Radiographic Inspection and ANSI/AWS B1.10.

7.5.5 *Hazards (Cautionary and Generic)*:

7.5.5.1 Radiation exposure to individuals is a hazard and these individuals must be included in a medical monitoring program as established by OSHA.

7.5.5.2 Confined space requirements apply as required by OSHA.

7.6 *Evaluation by Wicking Examination of Corner Weld*:

7.6.1 *Background and History*:

7.6.1.1 This test is a practical test because it provides information regarding the actual hydraulic integrity of the weld with a product less viscous than the product being stored. A leak could be easily located and repaired.

7.6.2 *General Description*:

7.6.2.1 Wicking test of corner weld (shell to bottom weld) is the process of applying a highly penetrating oil or dye penetrant to one side of a weld, then letting it stand for at least four (4) h (12 is preferred) and observing if it penetrates to the other side of the weld.

7.6.3 *Summary of Test Parameters*—Requires proper oil type and minimum visual acuity.

7.6.4 *Application to Portions of Tank Floor*—Corner joint (shell to bottom weld).

7.6.5 *Limitations*—Accessibility to viewing, cleanliness of weld (slag removal, dirt, and so forth). Dry conditions are necessary for reliable test results. Ambient air temperature must be high enough to allow the oil or penetrant to flow freely.

7.6.6 *Qualifications of Individuals Performing Test*—Same as for visual.

7.6.7 *Reference to Other Test Procedures*—API 650 Section 5.3.6b; API 653 Section 10.1.6.

7.6.8 *Reports*—Test reports should be written and provide the following information: date, name of inspector, type of test, equipment used, defects, and locations.

7.6.9 *Hazards (Cautionary and Generic)*—Confined space requirements apply.

7.7 *Evaluation by Bubble Test Examination-Pressure*:

7.7.1 *Background and History*:

7.7.1.1 This method has its roots in the pressure vessel industry and has been an elemental test for these tanks. The current API Standard 650 includes this type of test for closed top tanks in Section 5.3.6b.

7.7.2 *General Description*:

7.7.2.1 Pressure method locates leaks in a pressurized component by the application of a solution or immersion in liquid that will form bubbles as leakage gas passes through it.

7.7.3 *Summary of Test Parameters*—Requires pressurization and application of exterior solution or immersion in liquid.

7.7.4 *Application to Portions of Tank Floor*—Entire area.

7.7.5 *Limitations*—Small tanks or potions of tanks.

7.7.6 *Qualifications of Individuals Performing Test*—Same as for visual plus training on the specific procedure used by the manufacturer or fabricator. Training to meet the requirements of SNT-TC-1A.

7.7.7 *Reference to Other Test Procedures*—ASME BPVC, Section V, Art. 10, App. I.

7.7.8 *Test Reports*—Written date, name of inspector and certification, test procedure and method, equipment used, test conditions, defects, and locations.

7.7.9 *Hazards (Cautionary and Generic)*—Confined space requirements apply.

7.8 *Evaluation by Bubble Test Examination-Vacuum*:

7.8.1 *Background and History*:

7.8.1.1 This method (vacuum box) has its roots in the pressure vessel industry and has been an elemental test for these tanks. The current API Standard 650 includes this type of test for floor lap joints in Section 5.3.3. The current API Standard 653 includes this type of test for floor lap joints and corner joint in Sections 10.1.6 and 10.1.7 and represents the industry norm.

7.8.2 *General Description*:

7.8.2.1 Vacuum method locates leaks in a pressure boundary that can not be directly pressurized. A solution is applied to a local area and a differential pressure is created which produces bubbles on the surface. This type of test is identified by API 650, Section 5.3.4 as a method for testing bottom plate lap welds and one option for shell to bottom weld.

7.8.3 *Summary of Test Parameters*—Requires application of vacuum to solution on a local area.

7.8.4 *Application to Portions of Tank Floor*—All fillet welded lapped seams and corner joint (shell to bottom weld).

7.8.5 *Limitations*—Requires minimum vertical clearance of 6 in. between the bottom and any obstruction for placement of device and accessibility to viewing the local area being examined.

7.8.6 *Qualifications of Individuals Performing Test*—Same as for visual plus training on the specific procedure used by the manufacturer or fabricator. Training to meet the requirements of SNT-TC-1A.

7.8.7 *Reference to Other Test Procedures*—ASME BPVC, Section V, Art. 10, App. II.

7.8.8 *Test Reports*—Written, date, name of inspector and certification, test procedure and method, equipment used, test conditions, defects and locations.

7.8.9 *Hazards (Cautionary and Generic)*—Confined space requirements apply.

7.9 *Evaluation by Liquid Penetrant*:

7.9.1 *General Description*:

7.9.1.1 Liquid penetrant inspection is a test method that can be used to locate weld defects such as cracks, seams, laps or porosity that are open to the surface of the weld. Liquid penetrant is applied to the weld where it will enter discontinuities in the surface, primarily by capillary action. The excess penetrant is removed using water or a cleaning agent. The weld is then allowed to dry and a developer is applied. The developer acts as a blotter to draw the penetrant out of the discontinuities back to the surface and as a contrasting background for the penetrant. The dyes are either color contrast (viewable in white light against a contrasting color developer) or fluorescent (visible under ultraviolet or a ⅓ black light). Discontinuities should show clearly as colored marks on a

contrast background (visible light type) or a glowing fluorescent mark (ultraviolet light type).

7.9.2 *Summary of Test Parameters*—The test requires liquid penetrant, liquid penetrant developer, an appropriate light source and a qualified inspector.

7.9.3 *Application to Portions of Tank Bottom*—May be used on any weld. The test may be most useful in areas where other physical weld evaluations cannot be done due to access limitations. A special examination of the bottom welds is not required by API 650 or API 653, but is listed as an option for examination of the corner weld.

7.9.4 *Acceptance Criteria*:

7.9.4.1 No recognizable indications that might indicate a through defect.

7.9.5 *Limitations*:

7.9.5.1 Limitations include:

(1) The discontinuities must extend to the surface of the weld,

(2) The weld must be in an accessible location,

(3) The weld must be clean (free of dirt, grease, lint, scale, flux, weld spatter, and so forth),

(4) The weld must not be coated, and

(5) The test checks only the welds.

7.9.6 *Qualifications of Individuals Performing Test*:

7.9.6.1 The test should be performed in accordance with a written procedure and performed by an individual trained in the application of that procedure. The personnel performing the test should be professionally and technically qualified to perform the test. As a minimum, personnel should have:

(1) Sufficient natural or corrected near distance acuity to read a Jaeger Type 2 standard chart and the ability to distinguish between the colors used in the test, and

(2) Level II or Level III certification in accordance with SNT-TC-1A.

7.9.7 *References to Other Test Procedures*—ASME Boiler and Pressure Vessel Code, Section V, Article 6.

7.9.8 *Test Report*—The test report should be written and include the following: Owner's and operator's name, facility name, facility location, tank unique identifier, name of testing organization, test operator name and signature, date of test, equipment used, and defects identified and their locations.

7.9.9 *Hazards (Cautionary and Generic)*—None.

7.10 *Evaluation by Magnetic Particle Examination*:

7.10.1 *General Description*:

7.10.1.1 The weld area to be examined is first magnetized and then ferromagnetic particles are placed on the weld. These will form patterns on the surface of the weld where there are distortions in the magnetic field caused by such weld discontinuities as cracks, seams, laps or porosity. The patterns are most evident for discontinuities located near the surface of the weld and oriented perpendicular to the magnetic field. The test is run a second time with the direction of the new magnetic field set up perpendicular to the old one in order to pick up discontinuities oriented in the other direction. The magnetic particles are either color contrast (viewable in white light) or fluorescent (visible under ultraviolet or a black light) type. The color contrast type is either wet or dry type. Discontinuities should show clearly as colored marks (visible light type) or a glowing fluorescent mark (ultraviolet light type).

7.10.2 *Summary of Test Parameters*—The test requires equipment to magnetize the area, magnetic particles, a light source and a qualified inspector.

7.10.3 *Application to Portions of Tank Bottom*—May be used on any weld. The test may be most useful in areas where other physical weld evaluations cannot be done due to access limitations. It is not required by API 650 and API 653 as a specified examination of the bottom welds, but is listed as an option for examination of the corner weld.

7.10.4 *Acceptance Criteria*:

7.10.4.1 No recognizable indications that would indicate a through thickness defect.

7.10.5 *Limitations*:

7.10.5.1 Limitations include:

(1) The discontinuities below the surface are more difficult to detect than those at the surface,

(2) Not all discontinuities are defects,

(3) The weld must be in an accessible location,

(4) The weld must be clean (free of dirt, grease, lint, scale, flux, weld spatter, etc.),

(5) The weld will generally have to be uncoated, and

(6) The test checks only the welds.

7.10.6 *Qualifications of Individuals Performing Test*:

7.10.6.1 The test should be performed in accordance with a written procedure and performed by an individual trained in the application of that procedure. The personnel performing the test should be professionally and technically qualified to perform the test. As a minimum, personnel should have:

(1) Sufficient natural or corrected near distance acuity to read a Jaeger Type 2 standard chart and the ability to distinguish between the colors used in the test, and

(2) Level II or Level III certification in accordance with SNT-TC-1A.

7.10.7 *References to Other Test Procedures*—ASME Boiler and Pressure Vessel Code, Section V, Article 7.

7.10.8 *Test Report*—The test report should be written and include the following: Owner's and operator's name, facility name, facility location, tank unique identifier, name of testing organization, test operator name and signature, date of test, equipment used, defects identified and their locations.

7.10.9 *Hazards (Cautionary and Generic)*—None.

7.11 *Evaluation by Detectable Gas-Beneath Floor Injection*:

7.11.1 *Background and History*:

7.11.1.1 The technology has been applied to existing, replacement, and new tank floors. The tank must be emptied and cleaned prior to the testing. This test method is best suited for uncoated floors or tank floors prior to coating or lining. This method is also well suited for determining the location of leaks in tank floors having a known or suspected leak.

7.11.2 *General Description*:

7.11.2.1 Testing of tank bottoms using detectable gas beneath the tank floor is accomplished by injecting a detectable gas, which is lighter than air beneath the tank floor in adequate