

Manual of Petroleum Measurement Standards Chapter 19.3—Evaporative Loss Measurement

Part D—Fugitive Emission Test Method for the Measurement of Deck-Seam Loss Factors for Internal Floating-Roof Tanks

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FOREWORD

This standard provides rules for testing the deck seams or deck joints of internal floating roofs under laboratory conditions to provide evaporative deck-seam loss factors or deck-joint loss factors. It was prepared by Task Group II of the API Committee on Evaporative Loss Estimation (CELE).

A testing program was conducted in 1982 that used the pilot tank test method for measuring the deck-seam loss factors of mechanically-joined, contact and non-contact internal floating roofs. The deck-seam loss factor that is published in API Publication 2519, *Evaporative Loss From Internal Floating-Roof Tanks*, and in *API Manual of Petroleum Measurement Standards*, Chapter 19.2, “Evaporative Loss From Floating-Roof Tanks,” is based on these tests. This deck-seam loss factor and the test method that was used to develop it have been widely accepted by oil companies, manufacturers, industry groups, regulatory agencies, and general interest groups. API has not, however, tested or developed deck-seam loss factors for proprietary designs of individual manufacturers.

A second testing program was conducted in the period from 1994 through 1996 that used the weight loss test method for measuring deck-seam loss factors. These tests were directed at developing a test protocol that would eventually be published in the *API Manual of Petroleum Measurement Standards*, Chapter 19.3, Part C, “Weight Loss Test Method for the Measurement of Deck-Seam Loss Factors for Internal Floating-Roof Tanks.” The first edition of this publication is still under development.

A third testing program was conducted in 1999 that used the fugitive emission test method for measuring deck-seam loss factors. These tests were directed at developing the test protocol that is described in this publication.

By publishing this fugitive emission test method, the API is making this test method available to interested parties who wish to test particular deck seams or deck joints under the auspices of the API.

API certification of an evaporative loss factor developed through this program is subject to the following three-step process:

- a. The testing shall be performed in laboratories licensed by the API. The requirements to qualify for licensure are presented in the *API Manual of Petroleum Measurement Standards*, Chapter 19.3, Part G, “Certified Loss Factor Testing Laboratory Registration;”
- b. Testing and determination of test results shall be performed as specified herein; and
- c. The evaluation of these test results and the certification of an evaporative loss factor for the item tested shall be conducted in accordance with the *API Manual of Petroleum Measurement Standards*, Chapter 19.3, Part F, “Evaporative Loss Factor for Storage Tanks Certification Program.”

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Suggested revisions are invited and should be submitted to the standardization manager, American Petroleum Institute, 200 Massachusetts Avenue, NW, Washington, DC 20001.

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Chapter 19.3—Evaporative Loss Measurement

Part D—Fugitive Emission Test Method for the Measurement of Deck-Seam Loss Factors for Internal Floating-Roof Tanks

0 Introduction

The purpose of this standard is to establish a uniform method for measuring evaporative deck-seam loss factors and deck-joint loss factors of mechanically-joined deck seams that are used on internal floating-roof tanks. These deck-seam loss factors and deck-joint loss factors are to be determined in terms of their loss rate at specified pressure differences across the deck seam or deck joint for certification purposes.

It is not the purpose of this standard to specify procedures to be used in the design, manufacture, or field installation of deck seams or deck joints. Furthermore, equipment should not be selected for use solely on the basis of evaporative-loss considerations. Many other factors, such as tank operation, maintenance, and safety, are important in designing and selecting tank equipment for a given application.

1 Scope

This test method may be used to establish evaporative deck-seam loss factors and deck-joint loss factors for mechanically-joined deck seams that are used on internal floating-roof tanks. The test method involves passing a controlled flow rate of air through a test enclosure that is sealed to the top deck of a test pan. The test pan incorporates the test deck seam or test deck joint and contains a test liquid. The total hydrocarbon concentration in the air streams entering and leaving the test enclosure are measured over a range of pressure differences across the test deck seam.

This standard specifies the test apparatus, the instruments, the test procedure, and the calculation procedures to be used. The variables that are to be measured are defined, and quality provisions are stipulated. The format for reporting the values of both the test results and their associated uncertainty are also specified.

This standard may involve the use of hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

2 References

The following standards contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All

standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

2.1 API REFERENCES

Manual of Petroleum Measurement Standards:

- | | |
|----------------------|---|
| Chapter 15 | “Guidelines for the Use of the International System of Units (SI) in the Petroleum and Allied Industries,” Second Edition, December 1980. |
| Chapter 19.2 | “Evaporative Loss From Floating Roof Tanks,” First Edition, April 1997. |
| Chapter 19.3, Part F | “Evaporative Loss Factor for Storage Tanks Certification Program,” First Edition, May 1997. |
| Chapter 19.3, Part G | “Certified Loss Factor Testing Laboratory Registration,” First Edition, March 1997. |
| Chapter 19.3, Part H | “Tank Seals and Fittings Certification Administration,” First Edition, March 1998. |

Standards and Publications:

- Standard 650 *Welded Steel Tanks for Oil Storage*, Tenth Edition, November 1998.

2.2 ASTM¹ REFERENCES

Standards:

- | | |
|-------|---|
| D323 | <i>Test Method for Vapor Pressure of Petroleum Products (Reid Method).</i> |
| D3195 | <i>Standard Practice for Rotameter Calibration.</i> |
| E220 | <i>Method for Calibration of Thermocouples by Comparison Techniques.</i> |
| E230 | <i>Temperature—Electromotive Force (EMF) Tables for Standardized Thermocouples.</i> |

¹ASTM International, 100 Bar Harbor Drive, West Conshohocken, Pennsylvania 19428.

3 Terminology

3.1 DEFINITIONS

3.1.1 Covered Floating Roof

A floating roof that results from covering an external floating roof with a fixed roof at the top of the tank shell. This effectively converts the external floating roof to an internal floating roof, while retaining the external-type of floating-roof design. These floating roofs are typically designed in accordance with Appendix C of the API Standard 650, *Welded Steel Tanks for Oil Storage*.

3.1.2 Data Acquisition System (DAS)

The equipment used and process of receiving signals from sensors, determining the values corresponding to the signals, and recording the results.

3.1.3 Deck

That part of a floating roof that provides buoyancy and structure, and which covers the majority of the liquid surface in a bulk liquid storage tank. The deck has an annular space around its perimeter to allow it to rise and descend (as the tank is filled and emptied) without binding against the tank shell. This annular space is closed by a flexible device called a rim seal. The deck may also have penetrations, closed by deck fittings, that accommodate some functional or operational feature of the tank.

3.1.4 Deck Fitting

The device that substantially closes a penetration in the deck of a floating roof in a bulk liquid storage tank. Such penetrations are typically for the purpose of accommodating some functional or operational feature of the tank.

3.1.5 Deck Seam

The construction feature of a floating roof pertaining to the joint between adjacent deck sheets or deck panels. Certain types of internal floating roofs are constructed of deck sheets or deck panels that are joined by mechanical means at deck seams. Such mechanically-joined deck seams have an associated deck seam loss. Other types of internal or external floating roofs are constructed of metal sheets that are joined by welding. Such deck seams do not have an associated deck seam loss.

3.1.6 Deck Joint

The construction feature of a floating roof pertaining to the intersection of one deck seam with another deck seam or pertaining to the intersection of a deck seam with the rim of the floating roof. Mechanically-joined deck seams typically incorporate deck joints at locations where the deck seams

intersect each other or intersect the rim of the floating roof. These deck joint locations have an associated deck joint loss that is separate from the deck seam loss.

3.1.7 Evaporative Loss Factor

An expression used to describe the evaporative loss rate characteristics of a given floating-roof device. In order to obtain the standing storage evaporative loss rate for a bulk liquid storage tank equipped with a floating roof, the evaporative loss factor for each evaporative loss contributing device is modified by certain characteristics of both the climatic conditions and the stored liquid. The characteristics of the stored liquid are expressed as a vapor pressure function, a vapor molecular weight, and a product factor.

3.1.8 External Floating Roof

A floating roof that is exposed to ambient environmental conditions by virtue of being in a bulk liquid storage tank that does not have a fixed roof at the top of the tank shell. External floating roofs are thus distinguished from internal floating roofs, which are located in tanks that do have a fixed roof to protect the floating roof from environmental exposure. External floating roofs are typically designed in accordance with Appendix C of the API Standard 650, *Welded Steel Tanks for Oil Storage*.

3.1.9 FET Facility

The entire facility used in the fugitive emission test (FET) method. The FET facility includes: the test pan; the test enclosure; the pressure and temperature sensors; the data acquisition system; the sample and dilution air pumps; the total hydrocarbon analyzers; the flow meters; and the associated flow tubing.

3.1.10 Floating Roof

A device that floats on the surface of the stored liquid in a bulk liquid storage tank. A floating roof substantially covers the liquid product surface, thereby reducing its potential for exposure to evaporation. Floating roofs are comprised of a deck, a rim seal, and miscellaneous deck fittings.

3.1.11 Fugitive Emission Test Method

The test method used to establish evaporative deck-seam loss factors and deck-joint loss factors for mechanically-joined deck seams that are used on internal floating-roof tanks. The fugitive emission test (FET) method involves passing a controlled flow rate of air through a test enclosure that is sealed to the top deck of a test pan over a test deck seam or over a test deck joint. The test pan contains a volatile hydrocarbon test liquid. The total hydrocarbon concentration in the air that enters and in the air that leaves the test enclosure is

measured, along with the flow rate of the air leaving the test enclosure, at specified pressure differences across the test deck seam or test deck joint.

3.1.12 Indicator

An instrument that displays or records signals received from a sensor. The indicator is typically constructed to express the signal in units that are useful to describe the observed value of measurement. For example, an electronic signal may be received by the indicator as volts, but then displayed as pounds. An indicator may be incorporated into an electronic data acquisition system. An electronic data acquisition system typically has the capability to be pre-programmed to record data at prescribed time intervals, to analyze the data that has been received, and to electronically store the results.

3.1.13 Instrument

A device used in the measurement process to sense, transmit, or record observations.

3.1.14 Internal Floating Roof

A floating roof that is not exposed to ambient environmental conditions by virtue of being in a bulk liquid storage tank that has a fixed roof at the top of the tank shell. Internal floating roofs are thus distinguished from external floating roofs by their use of a fixed roof to protect the internal floating roof from environmental exposure. Internal floating roofs are typically designed in accordance with Appendix H of the API Standard 650, *Welded Steel Tanks for Oil Storage*.

3.1.15 Product Factor

A factor that describes the evaporative loss characteristics of a given liquid product. The product factor, vapor pressure function, and vapor molecular weight are multiplied by the sum of the equipment loss factors to determine the standing storage evaporative loss rate of a bulk liquid storage tank equipped with a floating roof.

3.1.16 Rim Seal

A flexible device that spans the annular rim space between the tank shell and the perimeter of the floating roof deck. Effective rim seals close the annular rim space, accommodate irregularities between the floating roof and the tank shell, and help to center the floating roof, yet permit normal floating roof movement.

3.1.17 Sensor

An instrument that senses attribute or measurement information that is to be obtained in a measurement process. This

information is then transmitted to the indicator to be displayed or recorded.

3.1.18 Standing Storage Evaporative Loss

Loss of stored liquid product by evaporation past the floating roof during normal service conditions. This does not include evaporation of liquid that clings to the tank shell and is exposed to evaporation when the tank is being emptied (withdrawal loss); nor does it include vapor loss that may occur when the liquid level is sufficiently low so as to allow the floating roof to rest on its supports (landing loss). This does include, however, evaporative losses from the rim seal, deck seams, and deck fittings.

3.1.19 Test Enclosure

The portion of the FET facility that covers the test deck seam or test deck joint and is sealed to the top deck of the test pan.

3.1.20 Vapor Pressure Function

A dimensionless factor, used in the loss estimation procedure, that is a function of the ratio of the vapor pressure of the stored liquid to the average atmospheric pressure at the storage location. The vapor pressure function, the product vapor molecular weight, and the product factor are multiplied by the sum of the loss factors of the individual floating roof devices to determine the total standing storage evaporative loss rate of a bulk liquid storage tank equipped with a floating roof.

3.2 UNITS OF MEASUREMENT

3.2.1 System of Units

This standard employs the inch-pound units of the English system. Values shall be referenced to the U.S. National Institute of Standards and Technology (NIST) values (formerly the U.S. National Bureau of Standards). The text of this standard does not include equivalent International System of Units (SI) values, which is the system adopted by the International Organization of Standardization (ISO), but guidance for conversion to SI and other metric units is provided in Appendix B, Metric Units, and API *Manual of Petroleum Measurement Standards* Chapter 15.

3.2.2 Basic Units

The unit of length is either the mile, designated mi; the foot, designated ft; or the inch, designated in. The unit of mass is the pound mass, designated pound or lb. The unit of force is the pound force, designated pound-force or lbf. The unit of time is either the hour, designated hr, or the year, designated yr. The unit of temperature is the degree Fahrenheit, designated °F, or the degree Rankine, designated °R.

3.2.3 Pressure

The unit of pressure is the pound-force per square inch absolute, designated psia.

3.2.4 Deck-Seam Loss Factors

The unit of reporting deck-seam loss factors is the pound-mole per foot of deck seam per year, designated lb-mole/ft yr.

The units of the deck-seam loss factor, K_d , do not actually indicate pound-moles of vapor loss over time, but rather are units of a factor that must be multiplied by certain coefficients (which are dimensionless) in order to determine the actual pound-moles of evaporative loss over time for a given liquid product. To convert the pound-mole per foot of deck seam per year units of the deck-seam loss factor to a loss rate in terms of actual pound-moles per foot of deck seam per year, the deck-seam loss factor, K_d , is multiplied by the dimensionless vapor pressure function, P^* , which is a function of the product vapor pressure and atmospheric pressure, and by the dimensionless product factor, K_c .

A pound-mole, designated lb-mole, is an amount of a substance the mass of which, when expressed in pounds, is equal to the numerical value of the molecular weight of the substance.

To then convert the actual pound-moles per foot of deck seam per year to pounds per year of a given liquid product, the loss rate ($K_d P^* K_c$) is multiplied by the total length of deck seam, L_d , having units of feet, and by the molecular weight of the liquid product in its vapor phase, M_v , having units of pounds per pound-mole. Additional information on this formula may be found in the *API Manual of Petroleum Measurement Standards*, Chapter 19.2.

3.2.5 Deck-Joint Loss Factors

The unit of reporting deck-joint loss factors is the pound-mole per year per deck joint, designated lb-mole/yr.

The units of the deck-joint loss factor, K_j , do not actually indicate pound-moles of vapor loss over time, but rather are units of a factor that must be multiplied by certain coefficients (which are dimensionless) in order to determine the actual pound-moles of evaporative loss over time for a given liquid product. To convert the pound-moles per deck joint per year units of the deck-joint loss factor to a loss rate in terms of actual pound-moles per deck joint per year, the deck-joint loss factor, K_j , is multiplied by the dimensionless vapor pressure function, P^* , which is a function of the product vapor pressure and atmospheric pressure, and by the dimensionless product factor, K_c .

To then convert the actual pound-moles per year per deck joint to pounds per year of a given liquid product, the loss rate ($K_j P^* K_c$) is multiplied by the dimensionless total number of floating roof deck joints, N_j , and by the molecular weight of

the liquid product in its vapor phase, M_v , the molecular weight having units of pounds per pound-mole. Additional information on this formula may be found in the *API Manual of Petroleum Measurement Standards*, Chapter 19.2.

3.3 NOMENCLATURE

Symbol	Description
A_p	Constant in the vapor pressure equation, dimensionless.
B_p	Constant in the vapor pressure equation, °R.
C_i	Concentration of hydrocarbon vapor in the test enclosure inlet air, ppmv.
C_o	Concentration of hydrocarbon vapor in the test enclosure outlet air, ppmv.
D	Tank diameter, ft.
D_s	Density of hydrocarbon vapor in the test enclosure outlet air at standard conditions, lb/sft ³ .
E	Test enclosure loss rate, lb/min.
F	Test enclosure loss factor, lb-mole/yr.
K_c	Product factor of the test liquid, dimensionless.
K_d	Deck-seam loss factor, lb-mole/ft yr.
K_j	Deck-joint loss factor, lb-mole/yr.
L_d	Length of test deck seam, ft.
M_v	Molecular weight of the test liquid vapor, lb/lb-mole.
N_j	Total number of deck joints on the floating roof deck, dimensionless.
P	Vapor pressure of the test liquid, psia.
P_a	Atmospheric pressure, psia.
P_d	Pressure difference between the pressure inside the test pan vapor space and the inside the test enclosure, in wc.
P_s	Standard pressure (14.696), psia.
P^*	Vapor pressure function, dimensionless.
Q_s	Volumetric flow rate of the test enclosure outlet air at standard conditions, sft ³ /min.



R	Universal gas constant (10.731), ft ³ psia/lb-mole °R.
RVP	Reid vapor pressure of the test liquid, psi.
S	Slope of the test liquid ASTM-D86 distillation curve at 10 volume percent evaporated, °F/volume %.
T_l	Temperature of the test liquid, °F or °R.
T_s	Standard temperature (60°F or 519.67°R), °F or °R.

4 Summary of Test Method

The test method described in this standard uses a mass balance procedure to measure a rate of evaporative loss through a test deck seam or a test deck joint. A test pan is fitted with a test deck seam that may include a test deck joint. A test enclosure is placed over the test deck seam and is sealed to the top deck of the test pan. The test pan is filled to an appropriate height with a volatile hydrocarbon test liquid of known properties, such as normal-hexane or iso-hexane. A measured flow rate of air is passed through the test enclosure and is controlled to maintain prescribed levels of pressure difference between the pressure in the test pan vapor space and the pressure in the test enclosure. The total hydrocarbon concentration in the air entering the test enclosure and in the air leaving the test enclosure are continuously measured using total hydrocarbon analyzers. A mass balance of the total hydrocarbon vapor in the air entering and in the air leaving the test enclosure is then made to determine the evaporative loss rate of hydrocarbon vapors through the test deck seam or test deck joint. The test enclosure loss rate is then factored for certain properties of the test liquid and the length of the test deck seam to determine an evaporative deck-seam loss factor or deck-joint loss factor.

5 Significance and Use

This test method establishes a procedure for measuring the evaporative deck-seam loss factor or deck-joint loss factor of mechanically joined deck seams that are used on internal floating-roof tanks. The testing is to be performed in a laboratory that has been approved by the API for this purpose, in accordance with the API *Manual of Petroleum Measurement Standards*, Chapter 19.3, Part G, “Certified Loss Factor Testing Laboratory Registration.” The values determined by this method are to be evaluated in accordance with the API *Manual of Petroleum Measurement Standards*, Chapter 19.3, Part F, “Evaporative Loss Factor for Storage Tanks Certification Program,” in order to assign API-certified loss factors to the particular deck seam or deck joint tested. The laboratory approval procedure, the test method, and the evaluation

method together constitute a procedure by which manufacturers of floating-roof deck seams or floating-roof deck joints may obtain API-certified loss factors for deck seams or deck joints of their proprietary design.

6 Limitations To Test Method

6.1 EVALUATION OF RESULTS

The results of this test method are not intended to be used apart from their evaluation in accordance with the API *Manual of Petroleum Measurement Standards*, Chapter 19.3, Part F, “Evaporative Loss Factor for Storage Tanks Certification Program.”

6.2 LOW LOSS RATES

This test method is not valid for deck seams or deck joints that have a loss rate lower than the specified tolerance of the instruments.

If it is determined that the loss rate of the test deck seam or test deck joint is less than the detection limit of the instrumentation, the report of test results shall state the de minimus value for the deck-seam loss factor or deck-joint loss factor that is based on the instrumentation detection limit.

7 Test Apparatus

7.1 TEST APPARATUS ILLUSTRATIONS

Figures 1, 2, and 3 are illustrations of the test apparatus that is to be used to obtain the measurements necessary for establishing a certified evaporative deck-seam loss factor or deck-joint loss factor for a mechanically-joined deck seam or deck joint that is used on an internal floating roof. Figure 1 is a flow diagram of the test apparatus that illustrates the test equipment and instrumentation. Figure 2 is a plan view of the fugitive emission test facility that illustrates the placement of the test equipment in the test room. Figure 3 is a view of the test assembly that illustrates the placement of the test enclosure over the test deck seam on the test pan.

7.2 TEST ROOM

The test room is to be large enough to house the test equipment, instrumentation, and personnel required for the test method. The test room shall be constructed and controlled such that the air temperature in the test room is capable of being maintained within $\pm 5^\circ\text{F}$ of a selected test room temperature for the duration of the test period.

7.2.1 Insulation

The test room should be insulated to aid in the control of the air temperature within the test room.



7.2.2 Air Temperature Control System

The test room shall have a dedicated temperature control system for maintaining the air temperature within the test room. The test room may also have a dedicated heater and air conditioner.

7.2.3 Circulation Fan

The test room shall be equipped with a fan that circulates the air within the test room to reduce air temperature variations in the test room.

7.2.4 Test Enclosure Inlet Air

The air that is directed into the test enclosure may be drawn from the air inside of the test room.

7.2.5 Access Doors

The test room shall be equipped with an equipment access door that is large enough to permit installation or removal of a test assembly. The test room may also be equipped with a smaller personnel access door to provide access to the instrumentation and data acquisition system, as well as to permit inspection of the test assembly during the test period.

7.3 TEST ASSEMBLY

Figure 3 illustrates a test assembly, which consists of a test pan, test deck seam or test deck joint, test enclosure, and test liquid.

7.3.1 Test Pan

The test pan is of rectangular shape and incorporates a top deck that simulates the deck of an internal floating roof. The test pan incorporates a fill connection and a drain connection for use in filling or draining test liquid from the test pan. The test pan shall be long enough to permit installation of a test deck seam that is a minimum of 10 feet long.

The test pan may incorporate multiple test deck seams. When multiple test deck seams are installed on the top deck of the test pan, there shall be a minimum spacing of at least 1 foot between the centers of adjacent test deck seams. There shall also be a minimum spacing of 1 foot from the longitudinal edge of the test pan to the adjacent test deck seam.

The test pan shall be equipped with a vent connection that permits the test pan vapor space above the test liquid to operate at near atmospheric pressure. The vent connection may be connected to a vent pipe that extends outside of the test room.

The test pan shall be equipped with a thermocouple that permits measuring the temperature of the test liquid during the test period.

The test pan may rest on any suitable surface, but its position shall be adjusted to insure that the level of the test liquid is essentially the same throughout the test pan relative to

the position of the test deck seams or test deck joints. When testing deck seams or deck joints that normally contact the liquid product in a floating roof tank, the level of the test liquid and the position of the test pan shall be adjusted to insure that all portions of the test deck seam or test deck joint contact the test liquid in the same manner as occurs in normal service.

7.3.2 Test Deck Seam

To measure the deck-seam loss factor of a specific type of deck seam, the deck seam to be tested shall be mounted on the top deck of the test pan using the assembly and installation procedures that are normally used for the deck seam, as specified by the deck seam manufacturer. The only exception to the use of normal installation procedures involves the end joints where the test deck seam intersects the ends of the test pan. If these end joints are not contained within the test enclosure, their construction may be selected to facilitate installation of the test deck seam on the top deck of the test pan.

The surfaces of the test deck seam shall be clean and free of oil or other materials that may affect the deck-seam loss factor test results.

7.3.3 Test Deck Joint

To measure the deck-joint loss factor of a specific type of deck joint, the deck joint to be tested shall be mounted on the top surface of the test pan using the assembly and installation procedures that are normally used for the deck joint, as specified by the deck joint manufacturer. The test deck joints shall be incorporated into the portion of the deck seam that is contained within the test enclosure.

A specific test deck seam may incorporate multiple test deck joints. When multiple deck joints are incorporated into a test deck seam, there shall be a minimum spacing of at least 1 foot between the centers of adjacent test deck joints.

The surfaces of the test deck joint shall be clean and free of oil or other materials that may affect the deck-joint loss factor test results.

7.3.4 Test Enclosure

A test enclosure shall be placed over the test deck seam and test deck joint, if a test deck joint is incorporated into the test deck seam.

The test enclosure shall be sealed to the top surface of the test pan deck, as well as to the portions of the test deck seam which penetrate the ends or side walls of the test enclosure. A caulk, such as silicone caulk, may be used to provide the required seal.

A leak-tightness test may be performed on the test enclosure to ensure that there are no leak paths around the perimeter of the test enclosure where it is sealed to the top