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An American National Standard

Standard Practice for Liquefied Natural Gas (LNG) Bunkering Hose Transfer Assembly[1]

This standard is issued under the fixed designation F3312/F3312M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers the minimum requirements for the design, manufacturing, and deployment of bunker hose transfer assemblies for cryogenic service pertaining to bunkering of liquefied natural gas (LNG)-fueled vessels. The bunker hose transfer assemblies addressed by this practice are for connections between the LNG-fueled vessel bunker manifold presentation flange connections and the LNG supplier bunkering manifold presentation flange connections.

1.2 Transfer assemblies are suitable for use in multiple maritime bunkering applications, including but not limited to facilities, vessels, trucks, and other LNG bunkering supply services. This practice will directly address the hose assembly, dry quick disconnect couplings (DQD), breakaway couplings, gaskets, insulating flange, strainers, and associated fittings.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.4 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASME Standards:*[2]

ASME B16.5 Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard

ASME B16.20 Metallic Gaskets for Pipe Flanges: Ring-Joint, Spiral-Wound, and Jacketed

ASME B36.19M Stainless Steel Pipe

ASME B31.3 Process Piping

2.2 *ASTM Standards:*[3]

ASTM DS56L Metals and Alloys in the Unified Numbering System (UNS): 13th Edition

2.3 *EN Standards:*[4]

EN 1474-1 Installation and Equipment for Liquefied Natural Gas. Design and Testing of Marine Transfer Systems. Design and Testing of Transfer Arms

EN 1474-2 Installation and Equipment for Liquefied Natural Gas. Design and Testing of Marine Transfer Systems. Design and Testing of Transfer Hoses

EN 1474-3 Installation and Equipment for Liquefied Natural Gas. Design and Testing of Marine Transfer Systems. Offshore Transfer Systems

EN 13766 Thermoplastic Multi-Layer (Non-Vulcanized) Hoses and Hose Assemblies for the Transfer of Liquefied Petroleum Gas and Liquid Nitrogen, Liquefied Natural Gas

2.4 *IMO Regulations:*[5]

IGF Code International Code of Safety for Ships using Gases or other Low-Flashpoint Fuels

[1] This practice is under the jurisdiction of ASTM Committee F25 on Ships and Marine Technology and is the direct responsibility of Subcommittee F25.11 on Machinery and Piping Systems.

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[2] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, http://www.asme.org.

[3] 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.

[4] Available from European Committee for Standardization (CEN), Avenue Marnix 17, B-1000, Brussels, Belgium, http://www.cen.eu.

[5] Available from International Maritime Organization (IMO), 4, Albert Embankment, London, SE1 7SR, United Kingdom, http://www.imo.org.

IGC Code International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk

2.5 *ISGOTT Publications:*

ISGOTT 5th Edition International Safety Guide for Oil Tankers and Terminals

2.6 *ISO Standards:*[6]

ISO 527-1 Plastics — Determination of Tensile Properties — Part 1: General Principles

ISO 1402 Rubber and Plastics Hoses and Hose Assemblies — Hydrostatic Testing

ISO 1746 Rubber or Plastics Hoses and Tubing — Bending Tests

ISO 2768 General Tolerances

ISO 10380 Pipework — Corrugated Metal Hoses and Hose Assemblies

ISO 13934-1 Textiles — Tensile Properties of Fabrics — Part 1: Determination of Maximum Force and Elongation at Maximum Force Using the Strip Method

ISO 14726:2008 Ships and Marine Technology — Identification Colours for the Content of Piping Systems

ISO TS 18683 Guidelines for Systems and Installations for Supply of LNG as Fuel to Ships

ISO 20519:2017-02 Ships and Marine Technology — Specification for Bunkering of Liquefied Natural Gas Fuelled Vessels

2.7 *MSS Standards:*[7]

MSS SP-43-2003 Wrought and Fabricated Butt-Welding Fittings for Low Pressure, Corrosion Resistant Applications

2.8 *USCG Policy:*[8]

CG-521 Policy Letter No. 01-12, CH-1 Equivalency Determination – Design Criteria For Natural Gas Fuel Systems (Change-1)

CG-ENG Policy Letter No. 02-15 Design Standards for U.S. Barges Intending to Carry Liquefied Natural Gas in Bulk

CG-OES Policy Letter No. 01-15 Guidelines for Liquefied Natural Gas Fuel Transfer Operations and Training of Personnel on Vessels Using Natural Gas as Fuel

CG-OES Policy Letter No. 02-15 Guidance Related ro Vessels and Waterfront Facilities Conducting Liquefied Natural Gas (LNG) Marine Fuel Transfer (Bunkering) Operations

3. Terminology

3.1 *Definitions:*

3.1.1 *breakaway coupling, n*—coupling which separates at a predetermined section when required and each separated section contains a self-closing shut-off valve which seals automatically.

3.1.2 *design pressure, n*—the pressure to which each piping component of a piping system is designed.

3.1.3 *design temperature, n*—the temperature at which each piping component is designed to operate.

3.1.4 *dry quick disconnect (DQD), n*—a device designed to make a quick, secure connection and disconnection between a hose and pipe, two pipes or between two hoses.

3.1.5 *flange, n*—a joint in a bolted connection.

3.1.6 *insulating flange, n*—a flanged joint incorporating an insulating gasket, sleeves, and washers to prevent electrical continuity between ship and shore.

3.1.7 *gasket, n*—a mechanical seal which fills the space between two or more mating surfaces, generally to prevent leakage from or into the joined objects while under compression.

3.1.8 *hose assembly, n*—components of the hose including inner liquid barriers, reinforcement, protective covers, and end configurations like flange or threads that have been assembled and tested to meet specification requirements.

3.1.9 *maximum allowable working pressure (MAWP), n*—the maximum pressure of a piping system determined, in general, by the weakest piping component in the system or by the relief valve setting.

3.1.9.1 *Discussion*—The MAWP is not to exceed the design pressure.

3.1.10 *polytetrafluoroethylene (PTFE) reinforced gasket material, n*—a flat gasket material made from PTFE with special fillers designed to increase the materials tensile properties and decrease the creep relaxation that can occur with virgin PTFE material in cryogenic applications.

3.1.11 *presentation flange, n*—the last permanent flange at the transfer manifold of both the bunker receiver and supplier.

3.1.12 *seal, n*—a mechanical device that helps join mechanisms together by preventing leakage, containing pressure, or preventing contamination.

3.1.12.1 *Discussion*—In most cases a seal is dependent on compression between a compressible material or device and solid mating surface.

3.1.13 *spiral wound gasket, n*—a gasket categorized as semi-metallic gasket consisting of sealing elements formed by winding two materials (one for sealing, one for resilience) into thin v-shaped spirals.

3.1.14 *transfer assembly, n—liquid or vapor transfer assembly*, components of the transfer system that include the hose assembly, dry quick disconnect couplings (DQD), breakaway couplings, insulating flange, and gaskets that connect the bunker supply of LNG to the bunker manifold of an LNG-fueled vessel.

[6] Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, http://www.iso.org.

[7] Available from Manufacturers Standardization Society of the Valve and Fittings Industry (MSS), 127 Park St., NE, Vienna, VA 22180-4602, http://www.mss-hq.org.

[8] Available from United States Coast Guard (USCG), 2703 Martin Luther King Jr Ave SE, Washington, DC, 20593-700, https://www.uscg.mil.

3.2 *Acronyms:*

3.2.1 *ISO*—International Organization for Standardization

3.2.2 *LNG*—liquefied natural gas

3.2.3 *MAWP*—maximum allowable working pressure

3.2.4 *PPE*—personal protective equipment

3.2.5 *SGMF*—The Society for Gas as a Marine Fuel

3.2.6 *USCG*—United States Coast Guard

4. Significance and Use

4.1 This practice provides guidance on the minimum requirements for the design, manufacture, installation, and operation of bunker hose transfer assemblies for cryogenic service pertaining to bunkering of LNG-fueled vessels. The bunker hose transfer assemblies addressed by this practice are for connections between the LNG-fueled vessel bunker manifold presentation flange connections and the LNG supplier bunkering manifold presentation flange connections.

5. Transfer Assembly

5.1 The bunker hose transfer assemblies are connections between the receiving LNG-fueled vessel bunker manifold and the LNG supplier bunkering manifold. A bunker hose transfer assembly may be for either a liquid natural gas transfer or a combination of liquid and vapor transfer. The transfer system assembly consists of numerous components which may include but not limited to the hose assembly, DQD breakaway couplings, insulating flange, strainers, gaskets, and associated fittings.

5.2 *Materials:*

5.2.1 Examples of approved materials are but not limited to 9 % nickel steel, type 304, 304L, 316, 316L, 321, and 347 solution treated stainless steel and aluminum alloy such as type 5083 annealed.

5.3 *Physical Properties:*

5.3.1 All materials must be capable of withstanding cryogenic temperatures of –320°F [–196°C] found in liquid nitrogen. The use of liquid nitrogen is commonly used for the testing of components with a non-volatile cryogenic liquid or vapor. Common usages would include cool down of equipment before the LNG transfer and in purging cycles. All components shall be employed in accordance with the recognized standards (inch-pound and SI) and applicable regulations as referenced in Section 2.

5.4 *Design:*

5.4.1 The transfer assembly is to have an internal MAWP at least 150 PSIG [10.34 BAR].

5.4.2 The design pressure is not to be less than the pressure of the most severe condition of coincidental internal or external pressure and temperatures (maximum or minimum) expected during service. However, this practice does impose a specific minimum design pressure that has the potential to exceed the maximum expected service pressure

5.4.3 The design temperature is not to be greater or less than the temperature of the piping component material at the most severe condition (maximum or minimum) of temperature and coincidental pressure expected during service.

5.4.4 Suitable means shall be provided to relieve the pressure and remove LNG from any piping between the outermost manifold valves and bunker hoses to the tanks, or other suitable location, prior to disconnection.

5.4.5 Means are to be provided for the elimination of any sparks or static electricity when bunkering systems are in use, connected or disconnected. The hose, pipes, and transfer system components shall be electrically continuous, but shall be electrically insulated from the vessel receiving the bunker and compliant with a recognized standard, see 5.7.

5.5 *Fittings:*

5.5.1 The selection of the proper fittings for all cryogenic applications needs are to be in accordance with the following:

5.5.1.1 Welding (ASME B31.3).

5.5.1.2 National Pipe Thread (NPT) (ASME B31.3).

5.5.1.3 Flange bolting dimensions (ASME B16.5).

5.5.1.4 JIC threaded connections for sizes 1 in. [25 mm] and below.

5.5.1.5 Floating flange and turn back nipples as in accordance with MSS SP-43 as part of ASME B36.19M.

5.6 *Gaskets:*

5.6.1 The gaskets must be capable of maintaining a seal at temperatures as low as –320°F [–196°C].

5.6.2 Spiral wound gaskets are to comply with ASME B16.20.

5.6.3 Virgin PTFE shall not be used as it susceptible to creep and can be displaced during thermal cycling.

5.6.4 The gaskets are to be fabricated of compound materials. This would include 'semi-metal' gaskets containing expanded graphite or PTFE filler or expanded PTFE with multi directional strength.

5.6.5 Gaskets are to be used in accordance with manufacturer recommendations. To mitigate the risk of spraying leaks, flange connections must be protected by a spray shield.

5.6.6 Gaskets need to be regularly inspected.

5.6.7 Gasketed pipe joints and hose connections shall generally be electrically bonded. However, an approved insulating flange shall be in a section of the hose string between the bunker supply and the vessel receiving the bunker fuel (refer to 5.7 of this practice).

5.7 *Insulating Flange:*

5.7.1 The use of an approved insulating flange shall be in a section of the hose string between the bunker supply and the vessel receiving the bunker. The specification of this insulation flange can be found in ISO 20519, Section 5.5.6, and ISGOTT, 17.5.5.

5.8 *Strainer:*

5.8.1 Strainers shall be placed in use as close to the bunkering manifolds as possible.

5.8.2 Strainers are to be made of materials that will be suitable for the cryogenic temperatures found in LNG transfer, nitrogen testing, cool down, and purging operations.

5.8.3 The proper sizing of strainers shall be employed to protect the valves, pumps, and engine components from damage causing dirt, debris, and ice.

5.9 *Dry Quick Disconnects (DQD):*

5.9.1 A DQD is a device that will allow for quick connection or separation of the vessel from its bunker supply in the event of an emergency, while providing protection for the operators, vessel, and the environment.

5.9.2 The design of a DQD, will consider the trapped liquid volume. A hose or pipe fitted with a DQD will be considered as a valve in a pipe section. A thermal protection device is to be fitted due the possibility of trapped liquid between a DQD and a valve. (Refer to Appendix X1 for sample diagram.)

5.9.3 A DQD designed for bunker application shall meet with the criteria established in ISO 20519. An example of the presentation flange connection dimensions is found in the Annex A1 and ISO TS 18683.

5.9.4 There shall be no visible leak of liquid or vapor from the DQD connection.

5.9.5 The design of the DQD shall minimize the potential for valves or poppets from being stuck in an open position.

5.9.6 The DQD must prevent the loss of vapor or liquid LNG during the connection and disconnection process.

5.9.6.1 The placement of a DQD in service shall be such that any LNG liquid or vapor expelled is directed in a safe manner away from personnel and critical structures or equipment.

5.9.7 The DQD shall allow for emergency disconnects while at full operating pressures. During emergency the DQD will be capable of disconnecting at operational pressure with no loss of liquid or vapor and no risk to operators, equipment, or the vessel.

5.9.8 The DQD shall be designed and tested to a minimum of a 4 to 1 safety factor. The DQD shall not be deformed or suffer any leaks beyond what are established as considered normal operation.

5.10 *Breakaway Couplings:*

5.10.1 A breakaway coupling is used to prevent damage to LNG bunker system and allow for a safe separation of the transfer assembly and to provide a means to make an emergency separation of the bunker supply and bunker receiver while shutting off the flow and loss of LNG liquid and vapor. A breakaway coupling can be activated automatically by excessive forces or though mechanical/hydraulic controls.

5.10.2 The design of the breakaway coupling will consider the trapped liquid volume. A hose or pipe fitted with a breakaway coupling will have the same considerations as a valve in a pipe section. A thermal protection device is to be fitted due the possibility of trapped liquid between the breakaway coupling and a valve. (See sample diagram Fig. X1.1.)

5.10.3 The design of the breakaway coupling shall minimize the potential for valves or poppets from being stuck in an open position.

5.10.4 The design of the breakaway coupling and the arrangement of the coupling in the system needs to minimize or eliminate any potential damage to the transfer system in the event of vessel movement. The specified separation force is to be below any force that would cause mechanical or structural damage to the LNG bunker system or associated support components. The design shall prevent spark generation and minimize LNG liquid or vapor release when activated.

5.10.5 The breakaway coupling shall be designed to have a minimum of a 4 to 1 safety factor. The breakaway coupling shall not be deformed or suffer any leaks beyond what are established as considered normal operation.

5.10.6 The placement of the breakaway coupling in service shall be such that any LNG liquid or vapor expelled is directed in a safe manner away from personnel and critical structures or equipment.

5.11 *Identification of Transfer Systems:*

5.11.1 The transfer piping systems are to be clearly color marked for safe and reliable fuel transfer operation and maintenance in accordance with EN ISO 14726:2008.

5.11.2 The fuel transfer and associated piping systems to be labeled include LNG fuel, NG vapor, inert gas, and compressed air.

5.12 *Hose Strings:*

5.12.1 A hose string is more than one hose assembly joined together to get to desired total length. When multiple hose assemblies are connected together in one string, the string of hose assemblies shall be tested as a single unit. The operator is to ensure that the bolted connections are not tampered with after testing.

5.13 *Hose Transfer Handling/Lifting Device:*

5.13.1 Hose handling device (pad eyes or collar etc.), shall be designed as part of the system and in accordance with EN 1474-1 and EN 1474-3. Specific hose handling instructions shall be issued.

5.13.2 Bending stiffener/restrictor is an optional item, either embedded into or mounted onto the hose at either one or both terminations, when required. It has the function of providing a smooth transition of bending forces, if existing from the end fitting to the hose structure. A hose bun provides extra resistance to over bending. The inclusion of a bend stiffener is at the vendor's recommendation if operational conditions are shown to exceed hose design and construction parameters.

5.13.3 Hose handling/lifting devices which come in contact directly with the hose surface during transfer operations shall meet the same operating requirements as the hose which they support.

5.13.4 Appropriate arrangements are to be provided to securely keep the hoses in a stored position when not in service or in transport.

5.13.5 The hose handling/lifting device shall be arranged in such a way not to interfere with the release of the dry break away coupling.

5.14 *Transfer Assembly Tagging:*

5.14.1 *Tagging:*

5.14.1.1 The transfer assembly shall be temporarily labeled with a removable tag. The tag is to be fitted on the inlet end. This tag shall be updated/replaced each year and must include:

(1) Each transfer assembly component serial number,

(2) Last test date of the transfer assembly, and

(3) Test pressure.

5.15 *Transfer Assembly Testing:*

5.15.1 The transfer assembly shall be tested each year and must include: