INTERNATIONAL STANDARD

ISO 28460

First edition
2010-12-15

Petroleum and natural gas industries — Installation and equipment for liquefied natural gas — Ship-to-shore interface and port operations

Industries du pétrole et du gaz naturel — Installations et équipements relatifs au gaz naturel liquéfié — Interface terre-navire et opérations portuaires

Reference number
ISO 28460:2010(E)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 28460 was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*.

Introduction

The original liquefied natural gas (LNG) business was based on long-term sale and purchase agreements with essentially dedicated fleets and terminals and each party having a thorough understanding of the particular ship/shore interface, which resulted in a safe and reliable operation.

The considerable growth of the LNG short-term and spot cargo markets has resulted in the requirement to ensure that the ship/shore interface issues are standardized and well understood to ensure the continuing safe transportation of LNG.

It is necessary that each LNG port facility and terminal have its own specific safety and operational systems and that LNG carriers using the facility comply with these systems. For all vessels, it is necessary to take particular care to ensure that the basic requirements laid down in this International Standard are understood and applied at each cargo transfer in order to ensure the safe, secure and efficient transfer of cargo between ship and shore or vice versa.

This International Standard relates to marine operations during the vessel's port transit and the transfer of cargo at the ship/shore interface taking into account the publications of the International Maritime Organization (IMO), the Society of International Gas Tankers and Terminal Operators (SIGTTO), the International Group of Liquefied Natural Gas Importers (GIIGNL) and the Oil Companies International Marine Forum (OCIMF). Relevant publications by these and other organizations are listed in the Bibliography.

It is not necessary that the provisions of this International Standard be applied retrospectively and it is recognized that national and/or local laws and regulations take precedence where they are in conflict with this International Standard.

Petroleum and natural gas industries — Installation and equipment for liquefied natural gas — Ship-to-shore interface and port operations

1 Scope

This International Standard specifies the requirements for ship, terminal and port service providers to ensure the safe transit of an liquefied natural gas carrier (LNGC) through the port area and the safe and efficient transfer of its cargo. It is applicable to

a) pilotage and vessel traffic services (VTS);

b) tug and mooring boat operators;

c) terminal operators;

d) ship operators;

e) suppliers of bunkers, lubricants and stores and other providers of services whilst the LNG carrier is moored alongside the terminal.

This International Standard includes provisions for

— a ship's safe transit, berthing, mooring and unberthing at the jetty;

— cargo transfer;

— access from jetty to ship;

— operational communications between ship and shore;

— all instrumentation, data and electrical connections used across the interface, including OPS (cold ironing), where applicable;

— the liquid nitrogen connection (where fitted);

— ballast water considerations.

This International Standard applies only to conventional onshore liquefied natural gas (LNG) terminals and to the handling of LNGC's in international trade. However, it can provide guidance for offshore and coastal operations.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IMO[1)], *International ship and port facility security code (ISPS Code)*, 2003

IMO, *International code for the construction and equipment of ships carrying liquefied gases in bulk (IGC Code)*, 1993

SOLAS[2)] chapter II-2 and chapter V, regulation 12

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1
communication
all methods of transmitting written or verbal information, including information covered by data links

3.1.2
control room
area situated in the terminal from which cargo operations are monitored and controlled

3.1.3
conventional onshore LNG terminal
LNG export or receiving terminal that is located on-shore and that has a marine transfer facility for the loading or unloading of LNG carriers in a harbour or other sheltered coastal location

NOTE The transfer facility consists of a wharf or fixed structure capable of withstanding the berthing loads of a fully laden LNG carrier of a given specification and mooring the vessel safely alongside. This includes any structure connected to the shore by a trestle, tunnel or other means, facilitating the LNG transfer and ancillary services and providing safe access and egress for personnel performing maintenance or operational duties.

3.1.4
emergency release system
ERS
system that provides a positive means of quick release of transfer arms and safe isolation between ship and shore, following a predefined procedure including an **emergency shut-down** (ESD)

NOTE The operation of the emergency release system can be referred to as an “ESD II”.

3.1.5
emergency shut-down
ESD
method that safely and effectively stops the transfer of LNG and vapour between ship and shore or vice versa

NOTE The operation of this system can be referred to as an “ESD I”. Ship/shore ESD systems should not be confused with other emergency shut-down systems within the terminal or on board ship.

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1) IMO International Maritime Organization

2) SOLAS: International Convention for Safety of Life at Sea.

3.1.6
fail-safe
property of a component or system that fails towards a safer or less hazardous condition

3.1.7
jetty
facility consisting of a trestle or similar structure, berthing facilities including fendering and topside equipment to enable the transfer of LNG between ship and shore

3.1.8
LNGC cargo control room
area situated on board the ship from which the control of the ship's transfer operation is directed

3.1.9
LNGC heel
quantity of cargo that remains on board (ROB) after discharge to maintain the cargo tank temperature and/or to provide fuel gas

3.1.10
marine exclusion zone
area around the **jetty** (3.1.7) in which no unauthorized traffic is allowed to enter

NOTE 1 This may vary according to jetty operations and security levels.

NOTE 2 There may also be a land-use planning exclusion zone, in which no public permanent human activity is allowed.

3.1.11
moving safety zone
area around the transiting LNG carrier, into which no unauthorized traffic is allowed to enter, so as to protect the vessel from marine hazards (collision, grounding) while in transit

3.1.12
onshore power supply
OPS
provision of electrical power to a vessel from shore to minimize local atmospheric pollution

NOTE This can be referred to as “cold ironing”.

3.1.13
ship's cargo manifold
flanged pipe assembly, mounted on board ship to which the outboard flanges of the transfer arms are connected

NOTE See also OCIMF[4].

3.1.14
ship/shore compatibility study
study undertaken by the ship owner or technical manager and terminal operators to ensure the vessel can safely berth and transfer cargo at a particular terminal

3.1.15
ship/shore interface
matching of ship to shore and all operations relating to LNG cargo transfer, ship's access and ship's supplies

3.1.16
ship/shore safety check-list
list of items that are checked by ship and shore prior to commencing cargo operations using the current ISGOTT edition as applicable to the transfer of LNG

NOTE See Reference [2].

3.1.17
vessel traffic services
VTS
shore-side systems which range from the provision of simple information messages to ships, such as position of other traffic or meteorological hazard warnings, to extensive management of traffic within a port or waterway

NOTE SOLAS Chapter V (Safety of Navigation) states that governments may establish VTS when, in their opinion, the volume of traffic or the degree of risk justifies such services.

3.1.18
vetting
process of marine quality assurance by assessing ship quality against a known standard to determine acceptance for use

NOTE 1 The process of assessing the ship quality should include the assessment of operational standards of the vessel, including crew competency and training, adherence to class and international rules and the ship's physical condition.

NOTE 2 Recognized industry inspection reports of the ship, ship manager, port state control databases and class reports provide some of the information that assist in determining the vetting decision.

3.2 Abbreviated terms

ERC emergency release coupling

LNG liquefied natural gas

LNGC liquefied natural gas carrier

QC/DC quick connection/disconnection coupling

ROB remaining on board

SSL ship/shore link

4 Description and hazards of LNG

The characteristics of LNG are described in EN 1160[28].

The main hazards are also defined in EN 1160 and those most important in the transfer of LNG are:

— the cryogenic temperatures, which can cause injury to people (frostbite), and also cause damage to non-cryogenic materials such as carbon steel, which lose their mechanical properties, become brittle and fracture;

— fire, explosion or asphyxiation from possible leaks or spillage of LNG;

— the overpressure resulting in shock waves, caused by rapid phase transition (RPT) of LNG due to the interaction between LNG and water;

— overpressure due to thermal expansion of trapped LNG.

Release to the atmosphere should be avoided as methane is considered a greenhouse gas.

NOTE It is necessary that standards for security, fire protection equipment and explosion-proof equipment be in accordance with local rules and regulations as appropriate to the application.

5 Potential hazardous situations associated with LNG transfer

The following hazardous situations should be considered for operational and contingency planning by all relevant parties:

- failure of ship's mooring;
- incorrect adherence to cool-down or warm-up procedures, including purging and draining of transfer arms and piping;
- flange and valve leaks including QC/DC;
- overfilling of tanks (ship and shore);

  NOTE Experience shows that overfilling of ship's tanks, due to human error, also occurs during discharge operations.

- failure of ERC, including activation of coupler whilst ball valves are still open;
- overpressure/underpressure of tanks (ship and shore);
- excessive surge pressure in transfer lines.

6 Possible factors affecting ship/shore interface and port operations

The following factors should be considered for operational and contingency planning by all relevant parties:

a) environmental factors;

b) atmospheric conditions (wind, lightning, etc.);

c) sea conditions;

d) current effects to determine the berthing strategy;

e) seismic conditions (potential for earthquake and/or tsunami);

f) rise and fall of the tide;

g) silt (turbidity) in harbour water that can be deposited in ballast tanks;

h) ice conditions affecting navigation, port and jetty operations;

i) tropical revolving storms;

j) high latitude factors;

Other factors that should be considered are

- heavy jetty contact during berthing or unberthing;
- impact from another ship;
- LNG ship movement along the jetty, e.g. due to engine control malfunction, tidal forces, wind and wind gusts, failure or slackening of mooring lines, or by the interaction effect from ships passing nearby;
- grounding and other navigational errors during port transit;

— loss of LNG ship power or tug line or engine failure during ship manoeuvring;

— bunkering and storing;

— noxious or flammable gas release at the terminal or its surroundings;

— emergencies including fire on vessel or shore.

NOTE See Annex A for information on ship's equipment.

7 Jetty

7.1 Siting of jetty

The location and configuration of the LNG jetty and marine exclusion zone should be the result of a risk assessment taking into consideration, as a minimum, the following:

— physical location of the berthing facility with regard to marine topography;

— local oceanographic and meteorological conditions;

— frequency, displacement and types of passing ships;

— closest point of approach and course of passing ships, including the requirements of a moving safety zone;

— distance to populated areas and population density;

— potential for future increase in port traffic;

— total inventory of flammable products on the jetty;

— emergency departure considerations;

— potential for uncontrolled sources of ignition nearby, over which the terminal operator might not have control;

— distance from other berths;

— type of products and operations on adjacent berths, including the different safety philosophies and requirements between LNG and other cargo types;

— proximity, displacement and type of vessels manoeuvring at adjacent berths.

Mitigation measures may include stopping cargo transfer whilst a vessel is manoeuvring at an adjacent berth, increasing the number and power of tugs, and more restrictive environmental windows.

All applicable national statutory and regulatory requirements shall be complied with.

Risk assessments required or recommended by Clauses 7 and 8 should be undertaken by a team including personnel with marine expertise, LNG carrier operational experience and local knowledge.

Sources of additional information and guidance are listed in the Bibliography.

7.2 Multi-product berths

A berth may be designed to handle LPG, condensates, other hydrocarbons or liquefied gas products in addition to LNG.

The differing safety philosophies and process requirements of the LNG industry to those of the dry cargo trades shall preclude the sharing of marine facilities between these trades due to unacceptably high levels of risks.

7.3 Vapour return system

Pressure management for the ship's tanks should be provided through the vapour arm linking with the terminal.

The vessel shall not be loaded unless the vapour arm is connected. The system shall be operational and capable of accepting the maximum vapour flow required to meet the loading rate.

The vessel should not normally discharge unless the vapour arm is connected. However, on a non-routine basis, it might be acceptable for the ship to discharge while maintaining its tank pressure using on-board vaporizers, e.g. during vapour arm maintenance.

Venting by either ship and/or terminal shall be permitted only under emergency conditions.

NOTE Many ships are now being fitted with gas combustion units (GCUs) to control a tank's pressure in the event of excessive boil-off. The US CFR 154.703[24] requires that these units have a maximum exhaust temperature of 535 °C and do not exhibit a visible flame.

8 Marine operations

8.1 General

A ship/shore compatibility study shall be undertaken prior to any LNGC visiting a terminal for the first time.

Every phase of the LNGC's transit from the open sea to its terminal berth and return to sea shall be analysed to mitigate the potential for an incident. Both the physical features of the transit and associated port services, including pilotage and towage, shall be examined to ensure the safety and security of the operation.

Port and/or terminal operators should ensure that the condition of the vessel is suitable to transfer cargo at their terminal; this normally requires a vetting inspection.

The terminal should ensure that it is operating to best industry practice, such as OCIMF[23].

It is recommended that, where possible, the terminal access reports from an existing ship inspection system to minimize the burden on the ship's staff due to repetitive inspections.

8.2 Port transit

8.2.1 Passage planning

The vessel shall have available a passage plan for the port transit. The plan shall include careful evaluation of the berthing strategy, particularly in ports with strong currents and large tidal ranges.

There shall be an exchange of information between ship's master and pilot in safe water prior to commencing the port transit.

It is recommended that passage plan information (including “abort” procedures) be provided to the LNGC in advance of arrival, so that the ship's master can incorporate it into the vessel's passage plan.

8.2.2 Moving safety zones

A moving safety zone shall be established around the transiting LNGC, into which no unauthorized traffic shall be allowed to enter. The purpose of this zone is to protect the vessel from marine hazards (collision, grounding) while in transit. The dimensions and shape of this zone and the necessity for escort vessels shall be determined by a risk assessment and/or local requirements, giving, as a minimum, consideration to traffic type, movement and density, channel dimensions, tidal factors and meteocean factors.

8.2.3 Limiting environmental conditions for operations

Limiting meteorological and/or bathymetric conditions for both ship operations alongside and port transits shall be established and reviewed as necessary.

Current weather forecasts shall be made available to the ship from shore. The decision to berth or unberth should take into consideration the time required for cargo transfer and the safe departure of the vessel taking into account any restrictions of partial filling of cargo tanks (see 8.4.1). Real-time wind speed and direction at the berth should be available to the vessel prior to berthing and while alongside.

Weather forecasts generally give average wind speeds at 10 m height. This should be taken into consideration when making operational decisions for berthing high-sided LNG carriers.

8.2.4 Anchorages

No anchorage dedicated for use by laden LNG carriers shall be located in a position where there is a risk of collision with large-displacement vessels travelling at speed.

If deemed necessary, provision should be made for an emergency anchorage if it is required for the vessel to abort the port transit and be unable to return to sea.

8.3 Port services

8.3.1 General

All providers of operational port services should have a quality assurance system in place.

8.3.2 Vessel traffic services

A vessel traffic service shall be provided in accordance with the requirements and recommendations of SOLAS chapter V (Safety of Navigation).

Vessel traffic services (VTS) contribute to the safety of life at sea, the safety and efficiency of navigation and the protection of the marine environment, adjacent shore areas, work sites and offshore installations from possible adverse effects of maritime traffic.

The level of services provided by the VTS shall be commensurate with the volume of traffic and/or degree of risk associated with the approaches, pilotage and berthing at the LNG terminal.

8.3.3 Tugs

The number and power of the tugs should be such that they can safely berth the LNG carrier if one of the tugs or the LNG carrier loses propulsive power or steerage, at the maximum operational weather conditions permitted for berthing. Escort towage philosophy should consider the risks of grounding or collision through loss of steerage or power by the LNG carrier.

When there is a possibility during towing operations that the load on the towing line can exceed the safe working load of any part of the system, a tension meter should be fitted on the tug. See OCIMF[2].

8.3.4 Pilotage

Pilots of LNG carriers shall assist in the development of the ship-handling parameters for the terminal and undergo training in the handling of these vessels. Where possible, this development and training should be in conjunction with tug masters, at a full mission (real-time) bridge simulator prior to the commencement of operations.

Depending on the frequency of pilotage operations, it can be necessary to undertake regular retraining utilizing real-time simulators and manned models.

8.4 Marine interface

8.4.1 Berth area

The berth area shall be maintained at a suitable depth to ensure sufficient under-keel clearance at all states of the tide.

It is preferable to locate a jetty where vessels have the ability to leave the berth at all states of the tide. There can be situations where it is essential that the vessel be able to depart the berth at any time due to external hazards, e.g. in ports that can be affected by sudden katabatic winds, tsunamis, etc.

It can be necessary for an emergency departure to take into account weather conditions and the possibility that the vessel can experience unacceptably high dynamic loading (sloshing) to the containment system and its supporting structure if it proceeds to open sea with partially filled tanks. Any critical tank-filling limits shall be stated at the ship/shore meeting and contingency plans developed for departure scenarios.

Prior to any departure, the ship's master shall be satisfied that it is safe to do so.

Port operators should be aware that a large number of LNGC's have steam turbine propulsion, the shaft of which, constantly at low speed using a turning gear, whilst the vessel is at the berth. Care should be taken that ropes and booms are kept clear of the propeller.

8.4.2 Restricted areas in the vicinity of the berth

To guard against collision or interaction from passing vessels when the LNG carrier is alongside the berth, restricted areas for other maritime traffic shall be defined by the appropriate authorities and the terminal. These should be the result of both simulations and risk assessment undertaken to evaluate the possibility of damage from passing vessels, taking into consideration traffic frequency, possible impact angle, speed and displacement of passing vessels relative to the location of the jetty.

Mitigation measures may include speed and distance limits for passing vessels, the presence of standby tugs, escort towage for passing vessels or protective berth location.

8.4.3 Berthing and mooring aids

The following berthing and mooring aids should be provided:

- speed of approach indication;
- wave height indication, if necessary;
- tide and current indication, if necessary;
- anemometer;
- mooring tension indication.

8.4.4 Fenders

The fenders shall be located so as to contact the LNGC's hull on the parallel body. The fenders should have sufficient surface area to avoid damaging the ship's hull. The terminal should ensure that both the ship's master and pilot are aware of the maximum speed and approach angle to ensure that the berthing speed can be undertaken safely and the ship's master and pilot should ensure compliance with these berthing operating limits.

8.4.5 Mooring arrangements

The ship's mooring operation shall be controlled by the ship's master, assisted by the pilot and the terminal representatives positioned on the jetty.

The management of the mooring arrangements is of utmost importance to ensure that the ship remains secure in its position relative to the transfer arms envelope. Proposed mooring arrangements for an LNG carrier shall be assessed using validated computer-based programmes developed for this purpose, taking into consideration local environmental data and criteria.

The ship's mooring equipment should be as given in OCIMF[2]. At exposed locations where significant ship motions occur, the tail length of 11 m might not be adequate and can lead to immediate tensile failure or, in the long term, to fatigue failure. Longer tails can be required for such locations.

The following points shall be taken into account, where applicable:

— current;

— wind loads;

— surge due to passing ships;

— tidal range;

— waves and swell;

— change of freeboard;

— ice;

— size of vessel.

Mooring tension data should be available to the vessel in real time.

An emergency towing-off pennant (fire-wire), if required by the terminal or port authority, should be rigged by the ship at both bow and stern with the eye of the wire rope maintained just above sea level to facilitate easy connection by tugs in the event of an emergency (see ISGOTT, section 26.4, OCIMF[10]).

8.4.6 Winches or capstans

Winches or capstans on the jetty or ship area shall be suitable for operation according to the hazardous area classification in which they are located.

8.4.7 Mooring hook release system

Quick-release mooring hooks shall be provided.

Where a remote release system is provided, failure of a single component or electrical power failure shall not result in the release of mooring hooks.

The design of release systems shall be such that all moorings cannot be released simultaneously, thus avoiding the possibility of an uncontrolled release of the mooring lines with consequential damage to the transfer arms, gangway, possible fouling of the propeller and loss of control of the vessel.

The release of the ship shall be initiated only with the full knowledge and agreement of the ship's master.

NOTE The primary purpose of quick-release mooring hooks is to reduce the manual handling requirements of the mooring crew.

8.4.8 Ship's manifold arrangement

The ship's manifold should be specified in accordance with OCIMF/SIGTTO recommendations.

NOTE On many vessels, the structure immediately under the manifolds might not be designed to take the loads imposed by support jacks on transfer arms and additional support arrangements can be required.

8.4.9 Cargo strainers

As a general precaution, it is accepted practice to fit strainers with a mesh size no finer than ASTM 20, i.e. nominal aperture 0,84 mm, in the transfer line at the vessel's manifold.

For those periods when general contamination is more likely, a finer mesh strainer, up to ASTM 60 mesh, i.e. nominal aperture 0,25 mm, may be used. This should occur only as an extra precaution following terminal start-up or maintenance, vessel dry docking and/or maintenance to cargo systems.

Reference should be made to current SIGTTO recommendations for cargo manifolds and strainers on liquefied gas carriers; see references in the Bibliography.

NOTE Recognizing the energy absorption and consequent additional boil-off resulting from any restriction placed in the way of the cargo flow, a mesh finer than ASTM 60 may be used on occasion by some terminals or ships. However, it can be necessary to consider higher differential pressures and strainer strength.

8.4.10 Bunkering and storing

Generally, these operations are carried out prior to the commencement of cool-down or on completion of cargo transfer. They shall not be carried out simultaneously with cargo transfer, unless approved by the local port authorities and with the agreement of the ship's master, following a detailed safety and environmental assessment, which shall examine, as a minimum, the following:

— availability of competent staff;

— crew fatigue;

— conflict with critical operations (e.g. topping off, cool-down, etc.);

— increased sources of ignition;

— means of delivery of stores and/or bunkers and lubricants.

If a crane is provided on the jetty for the ship's storing, it shall comply with the appropriate area classification in which it is operated.

9 Hazardous areas and electrical safety

9.1 Jetty's electrical safety

All electrical equipment instrumentation in hazardous areas shall be explosion-proof, intrinsically safe or of a certified safe type in accordance with national standards.

The hazardous area on the terminal and jetty is classified into two types:

- zone 1: for areas where the risk of an explosive atmosphere exists during normal operation;
- zone 2: for areas where an explosive atmosphere can occur in the event of deviation from normal operation.

For a definition of these hazardous areas, reference should be made to local rules and regulations or to IEC 60079-10[25].

When the ship is moored at the jetty, the ship's gas-dangerous space or zone may encroach into the jetty's hazardous area.

The possibility of uncontrolled sources of ignition from adjacent operations, particularly if these are not handling flammable or dangerous products, shall be taken into account.

Within the jetty area, the safety level of equipment shall be in accordance with existing national and local rules and regulations. Reference should be made to the relevant parts of IEC 60079[25] for electrical apparatus and with EN 1127-1[27] for non-electrical equipment, taking into account the zone where they are used.

The ship's hazardous areas and electrical equipment should be as defined in, and required by, the applicable Gas Carrier Code published by IMO.

9.2 Insulating flanges

Due to the difference in electrical potential between the ship and the jetty, there is a risk of an incendive arc when the transfer arms are being connected or disconnected. Arrangements should be made to avoid the risk of arcing from this source by the installation of an insulating flange in the transfer arm.

Care should be taken that the insulation flange is not shorted out by the use of electrically continuous hydraulic hoses.

CAUTION — The use of a ship-to-shore bonding cable is not only considered to be ineffective but can also be dangerous if it breaks in a flammable atmosphere (e.g. during ESD II). For further information the use and testing of insulating flanges, see Ref. 9.3.4.1 of IMO[1] and ISGOTT[10].

10 Security

The minimum security requirements shall be in accordance with the IMO ISPS Code.

It should not be possible for unauthorized persons to gain access to the jetty area.

When security arrangements restrict access, consideration should be given to means of emergency egress to a safe area.

11 Hazard management

11.1 Protection from leakage and spillage of LNG

Means of protection shall be provided both on the ship and on shore to minimize the consequences of spillage and leakage of LNG. This may be by provisions for containment of LNG spill, brittleness protection of carbon steel structural members, a water curtain or other appropriate measures.

Gas and leak detection equipment on the jetty shall comply with the applicable design code and/or national regulations.

Closed-circuit monitoring systems may be used as an aid in the detection of leakage.

11.2 Fire hazard management

11.2.1 Fire detection

Fire detection equipment on the jetty shall comply with the applicable design code and/or national regulations.

NOTE The LNGC's fire and gas detection system is specified by the SOLAS Convention and the IGC Code and it should be fully operational and ready for immediate use as stated in the ship/shore safety checklist.

11.2.2 Fire protection

Measures shall be provided to protect personnel, structures and essential equipment from a fire, both on shore and on board ship, so that the risk of escalation of an incident is minimized. These measures should be determined as a result of a risk assessment and may include water spray, water monitor or passive fire protection measures.

Water monitors and sprays shall be capable of being operated from a safe location.

NOTE Water sprays can prove effective in limiting the migration of gas clouds.

11.2.3 Fire fighting

Permanently installed equipment for fire-fighting on the jetty should be kept ready for instant use while the ship is alongside.

The extent and type of the jetty fire-fighting equipment supplied may be site-specific and should be the subject of a risk assessment by the terminal and local emergency services, compliant with national regulations. If it is intended to provide additional fire-fighting support for the ship, fixed fire-fighting equipment shall be installed at a high enough level on the jetty to ensure sufficient range to reach the vessel's tank domes during the highest tide.

The following items should be considered:

- causes and types of fire that can be encountered;
- escape routes for ship and shore personnel;
- size, nature and frequency of ships using the terminal;
- size of the berths and of the ships and their distance from other industrial hazards and population centres;
- time required to mobilize the local fire authority and any fire-fighting tugs.

Provision shall be made to protect all water-based fire hazard management equipment from damage by freezing.

The LNGC's fire-fighting equipment shall be at least to the level specified by the SOLAS Convention and the IGC Code and it shall be ready for immediate use.

There shall be plans to control and fight a fire on both the jetty head and the LNGC. The terminal plan should be compiled by the terminal in cooperation with the port authority and other local emergency services and be made available to the ship's crew. It should be practised at regular intervals. A minimum of one tug with water monitors meeting national or local requirements shall be available. Where there are no national or local regulations, a tug meeting the FiFi 1 requirements of a recognized classification society is recommended.

A suitable number of portable fire extinguishers to the appropriate standard should be available in appropriate positions so that the outbreak of a small fire can be immediately tackled.

A plan showing the location and type of all fire-fighting equipment on or adjacent to the jetty should be permanently displayed at the berth, along with any necessary instructions and fire-fighting procedures. A safety plan complying with applicable IMO conventions should be available on board ship. See also SIGTTO[7], SIGTTO[11] and SIGTTO[13].

12 Access and egress

12.1 General

Procedures shall be in place to ensure the safe and controlled access of authorized visitors to the ship. These may include, but are not limited to, ship's agents, customs and immigration officials, owners, representatives and superintendents, ship's chandlers, vetting inspectors and crew reliefs. Authorization for visitors to the ship shall be given by the ship's master.

These procedures shall be in compliance with the requirements of the IMO ISPS Code.

The movement of vehicles on the jetty during cargo operations should be under a permit and limited to those fitted with suitable protection to allow their use in hazardous areas.

12.2 Normal access and egress

There shall be safe access between ship and shore.

In normal circumstances, access shall be provided by a gangway from the jetty. This primary access should be placed as close to the accommodation areas and as far away from the manifold as possible.

If the primary access is located forward of the manifold, then the access route to the accommodation areas should be clear of the manifold area and suitably identified.

12.3 Emergency access and egress

A secondary means of access and egress used for escape in the event of an emergency shall be available. It shall be located near the ship's accommodation area; this can be another gangway from the jetty or a combination of a support boat and the ship's outboard accommodation ladder and/or outboard lifeboat.

In the case of a support boat, it shall be in attendance and capable of taking both the whole ship's crew and jetty staff. The crew of the support boat shall be trained in safety evacuation. The accommodation ladder shall be rigged on the outboard side of the vessel ready for immediate use, while taking into account the requirements of the ISPS Code.

Where mooring lines or other obstructions can hinder it's launching, a stern-launched free-fall lifeboat should not be considered as a secondary means of egress when the ship is moored.

For safety reasons, gangways shall not retract on ESD but should be protected from damage, e.g. by shear bolts.

13 Onshore power supply

If an onshore power supply (OPS) is provided, the design shall be such as to minimize the possibility of loss of power to the vessel during an emergency situation and ensure that no electric circuit can be broken in a hazardous area or gas-dangerous space.

14 Ship/shore communications

14.1 General

When the ship is moored at the jetty, there is a requirement to transfer data, ESD and ERS signals and voice communication signals between ship and shore. This may be achieved by electric, fibre-optic, pneumatic or wireless links, or a combination of these systems.

Unless otherwise agreed between ship and shore, all voice communication shall be in the English language.

NOTE In general, the reliability of wireless systems makes them unsuitable for ESD and ERS systems due to the shielding effect of some vessels' control rooms and spurious signals, particularly in urban areas.

14.2 Voice communications

14.2.1 For emergency

An emergency telephone (hot line) shall be provided to link the ship to the control room. There shall be a back-up communication system, which may be an additional phone and/or radio communication.

14.2.2 For normal operations

An additional telephone connection between the ship and the terminal cargo control rooms may be provided for normal operations.

Hand-held VHF/UHF intrinsically safe radios should be provided to enable operational communication between terminal staff and ship's crew outside their respective control rooms.

Appropriate precautions shall be taken to ensure that personnel boarding the vessel for operational matters do not use unauthorized radio communication equipment in hazardous areas. Particular care should be taken to ensure that those boarding prior to berthing do not use non-IS radio communication equipment in hazardous areas.

A multi-channel marine VHF radio should be available in the control room for communication by the terminal with the port authority and other relevant bodies whilst the vessel is alongside. It is recommended that a marine VHF radio be fitted in the LNGC's cargo control room.

14.3 Data communications

Mooring tension, wave height and other data may be transmitted through fibre-optic or electric links.

Wireless systems may be acceptable for non-emergency data transmission if a suitable aerial can be provided.

14.4 Emergency shut-down signal

Emergency shut-down shall be fail-safe and transmitted by an electric or fibre-optic ship/shore link (SSL). An independent back-up system, which may be electric, fibre-optic or pneumatic, shall be provided so that a common failure mode is reduced as far as is reasonably practicable.

The pin configuration should comply with the SSLs given in Annex D. This shall be confirmed as part of the ship/shore compatibility study (see the flow chart in Annex C).

NOTE The emergency release system should be activated only manually by the terminal or automatically due to excessive transfer arm movement or acceleration.

15 Cargo transfer

15.1 Pre-cargo-transfer meeting

15.1.1 Meeting

To ensure the safe and reliable management of all operations whilst the vessel is alongside, a ship/shore meeting shall take place prior to cargo transfer. This should be attended by senior officers of the ship and the terminal representatives responsible for the cargo transfer.

Items that it is necessary to discuss and agree on shall include:

— completion of the ship/shore safety checklist (see current edition of OCIMF *(ISGOTT)*[10]);

— emergency procedures and contingency arrangements;

— communication protocols and responsibilities;

— agreed cargo transfer rates and maximum manifold pressure;

— procedures for commencing and for completion of cargo transfer;

— LNGC heel quantity and stripping procedures;

— cool-down procedures;

— custody transfer and quantities;

— bunkering and storing;

— ballasting and draught management;

— any maintenance requirements;

— weather conditions for the duration of the operation.

Any maintenance on the ship or jetty shall not impact the safety of the operation.

Emergency procedures and contingency arrangements should be discussed to ensure there is a coordinated response. These should include fire, security and natural threats such as tsunamis and cyclones.

15.1.2 Information exchange

The terminal shall make the following information available to the ship:

— terminal safety and security information;

— emergency procedures;

— contingency arrangements;

— operational limits for cargo and marine operations;

— contact details of essential personnel.

The ship shall make the following information available to the terminal:

a) ship emergency procedures (fire and safety plan);

b) contingency arrangements;

c) crew list.

15.1.3 Post-cargo-transfer meeting

On completion of cargo transfer, a meeting should be held to discuss the transfer and any matters arising to improve the safety and efficiency of future operations.

15.2 Marine transfer arms

15.2.1 General

Marine transfer arms shall be used for the transfer of LNG at conventional onshore terminals. These shall be equipped with an emergency release system.

For the transfer of small quantities of LNG, hoses may be used if the total volume of LNG in the hose transfer system does not exceed 0,5 m^3 and the length of hoses does not exceed 15 m.

15.2.2 Conditions to be fulfilled prior to the transfer of LNG

It is necessary to fulfil the following provisions prior to the transfer of LNG.

— Critical safety devices shall be tested and operational.

— Suitable personal protective equipment shall be used by those involved in the cryogenic transfer operation.

— The vapour arm should be connected first.

— The arms shall be inerted and leak-tested prior to the introduction of LNG.

— Communication links to confirm proper operation of the ESD signal shall be mutually tested.

— A function test of the ERS may be undertaken by the terminal.

— Systems, including the transfer arms, shall be cooled down to avoid excessive thermal stresses.

15.2.3 Cargo transfer operations

During the cargo transfer operation, the transfer system should be continuously monitored to ensure the safety of the system.

The following items should be checked at regular intervals by ship and terminal, as applicable:

— integrity of the transfer system (checking for leaks);

— communications;

— tank levels, flow rates, pressures;

— draft, trim and list;

— moorings and gangway;

— ship/shore safety checklist repetitive checks;

— security;

— weather and tides.

An ERS can be actuated automatically and with little warning; therefore, access to the ship's manifold area should be restricted to that required for periodic operational checks during an LNG transfer operation.

15.2.4 Normal disconnection

The design of the LNG transfer system should take into consideration local weather conditions (e.g. potential for katabatic winds) that can impact the time available for safe disconnection without the necessity of using the ERS.

On completion of cargo transfer, the disconnection of transfer arms shall be made only after

a) all pumps have been stopped;

b) all valves have been closed in accordance with the agreed procedures;

c) the arms have been drained of liquid and inerted;

d) agreement has been reached between ship and shore staff that the arms can be disconnected.

The vapour arm shall be disconnected last and should preferably remain connected until just prior to departure.

15.3 Emergency shut-down and emergency release systems

15.3.1 General

The LNG transfer system shall be fitted with an emergency shut-down system (ESD) and an emergency release system (ERS), having a ship/shore link to ensure the coordinated operation of both ESD and ERS functions and the prevention of overpressure in the transfer system. Prior to cargo operations, or as required by local regulations, the timing of ESD valves shall be verified regularly. Closing times of ship's ESD valves shall be as required by the IGC Code. See also SIGTTO[5].

The overall design of the transfer arms, ESD and ERS systems should take into account drifting scenarios commensurate with the terminal environment and location. A study should be undertaken to simulate and determine the acceleration and velocity of drift likely to occur due to a possible failure of the mooring system, taking into consideration the range of vessels that are likely to use the terminal. This should take into account, as a minimum, the following:

— wind speeds and direction;

— current and bank effect;

— tidal range;

— waves and swell height, period and direction;

— surge from passing vessels;

— inadvertent operation of vessel's propulsion or of mooring system;

— ice floes.

Indication of an ESD and ERS shall be given to both ship and shore. A typical ESD/ERS flow chart is given in Annex B.

15.3.2 Emergency shut-down system

The function of the ESD system is to safely stop and isolate the transfer of liquid and vapour between ship and shore.

Typically, this system may be activated by the following:

- fire or gas detection;
- power failure;
- tank high level or abnormal pressure;
- ship's drift;
- manual signal.

It shall result in the tripping of transfer pumps, both ship and shore as applicable, and the timed closure of ship and shore ESD valves. It is not necessary to interrupt the supply of fuel gas to the LNGC's engine room or gas combustion unit. An anti-surge system may be fitted on shore in addition to, or in lieu of, tripping the shore pumps.

15.3.3 Emergency release system

The function of the ERS is to protect the transfer arms by disconnecting them, if the ship drifts out of the design envelope. The ERS may also be activated from the jetty by manual operation. The ERS consists of an ERC, interlocked isolating valves to minimize loss of product when the ERC parts, and sensors to monitor the transfer arm angle. The design of this system shall take into account possible ice build-up.

Initiation of the ERS shall result in the simultaneous closing of interlocking ERS isolating valves, followed by activation of the ERC. The disconnected arm(s) shall retract to a safe position away from the ship's manifold and shall lock hydraulically. The design of the systems should be such that the ERS cannot be activated unless the functions of the ESD have commenced.

Precautions should be taken to prevent inadvertent or unauthorized manual operation of the ERS.

If the owner requires the ERS isolating valves to close on ESD, a risk assessment shall be undertaken, using validated data, to ensure that this is beneficial to the overall safety and integrity of the system. This should consider, as a minimum, any increasing complexity of the control system, possible drift speeds of the LNG carrier, the possibility of LNG being “locked in” between the isolating valve and the effect of surge pressures generated in the transfer system including that part between LNGC's ESD valve(s) and the ERC valves.

NOTE 1 For marine operators, the operation of the emergency shut-down system is regularly referred to as an “ESD I” and that of the emergency release system as an “ESD II”.

NOTE 2 See SIGGTO References [5] and [8].

15.4 Safety and maintenance of ESD, ERS and QC/DC systems

In the event of serious failure, these systems have the potential to result in large releases of LNG. These systems shall be maintained based on the manufacturer's instructions and schedules. Work shall be undertaken only by personnel who have been suitably trained.

16 Custody transfer

Custody transfer shall be done in accordance with the commercial agreements between the parties. It is recommended that these refer to the applicable ISO standard (see note).

NOTE ISO 13398[26], which in the future will be superseded by ISO 10976, deals with on-board custody transfer. Complementary information can be found in a GIIGNL publication[14].

In the interest of the environment, it is recommended that, where possible, the vessel burn gas during cargo transfer operations.

17 Provision and training of staff

17.1 Staff for the terminal

The terminal should ensure that the staff has sufficient staff trained in ship/shore LNG operations to ensure the safe transfer of cargo between ship and shore. The terminal should provide a dedicated staff member with managerial responsibility for the ship/shore interface and marine-related matters, e.g. pilots, maritime authorities, vetting, etc.

17.2 Coordination

Before commencement of initial marine operations, there should be a consultation among the terminal operators, port authorities, ship operators, pilots and tug masters. Pre-operational full mission bridge training, using simulators should be undertaken, involving, at a minimum, pilots and tug masters.

Annex A
(informative)

Ship's equipment

A.1 General

LNG carriers are designed and constructed in accordance with the IMO *International code for the construction and equipment of ships carrying liquefied gases in bulk (IGC Code).* Older vessels may have been constructed or may comply with the predecessors of this code.

These codes, supported by the rules of the classification societies that classify these vessels, ensure that items such as the materials of construction, cargo containment system, cargo transfer system, electrical installation, fire and safety equipment and instrumentation are of an internationally accepted standard.

A.2 Ship's cargo control room equipment

The ship's cargo control room should normally be equipped with the following primary equipment:

— multi-band marine VHF communications with the port authority;

— communications systems for the cargo transfer operation;

— general tank information, such as temperature and pressure;

— tank-level monitoring equipment;

— ESD control devices;

— boil-off gas compressor controls and monitoring devices;

— pump controls and monitoring devices;

— cargo transfer valve controls and monitoring devices;

— trim and list monitor;

— ballasting controls and monitoring devices;

— gas-monitoring system;

— fire alarm monitoring system.

The monitoring equipment provided in the jetty control centre should be as described in national standards.

Annex B
(informative)

Typical cargo operation flow chart

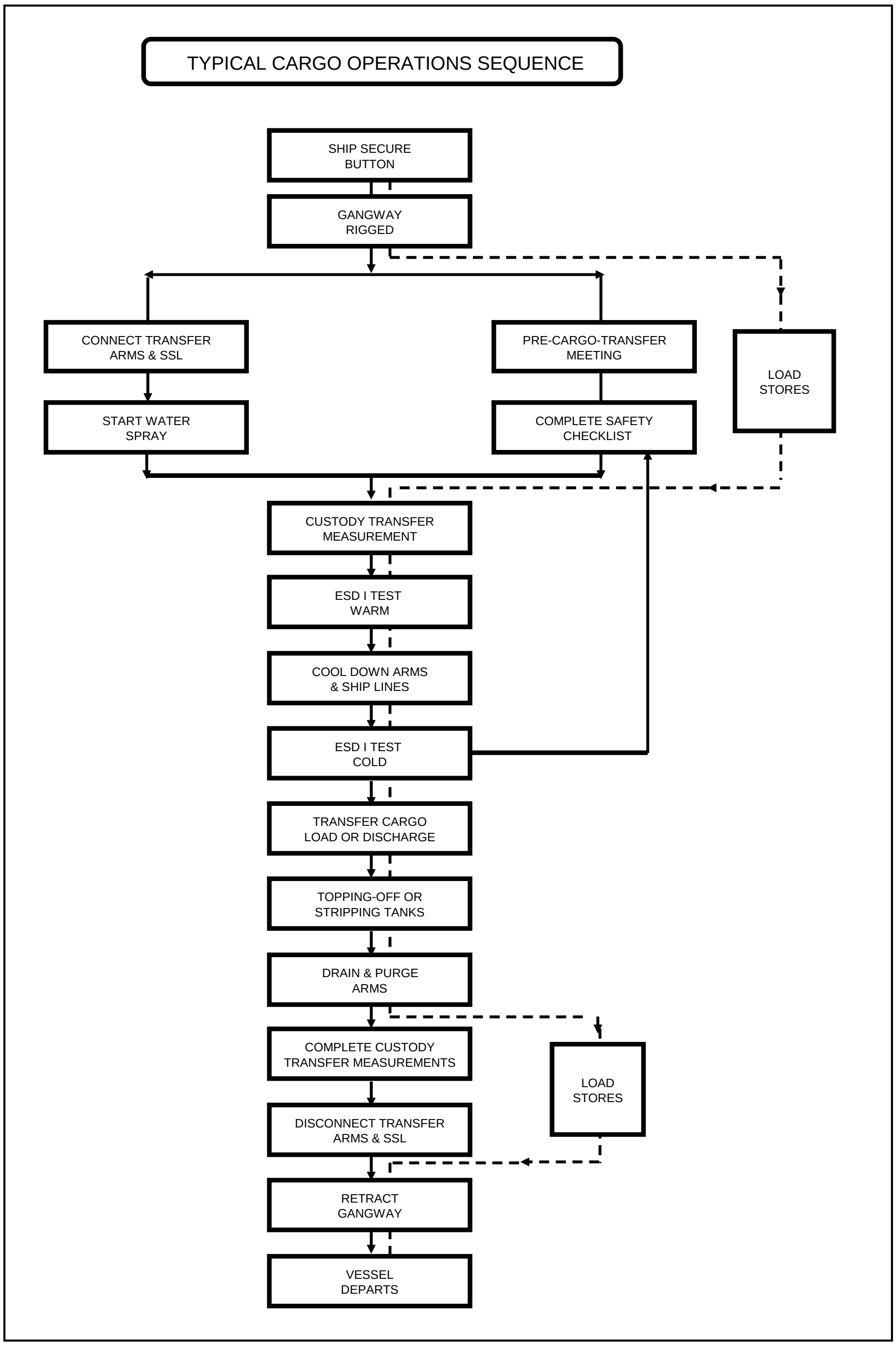

Figure B.1 — Typical cargo operation flow chart

Annex C
(informative)

General safety philosophy for stopping LNG transfer

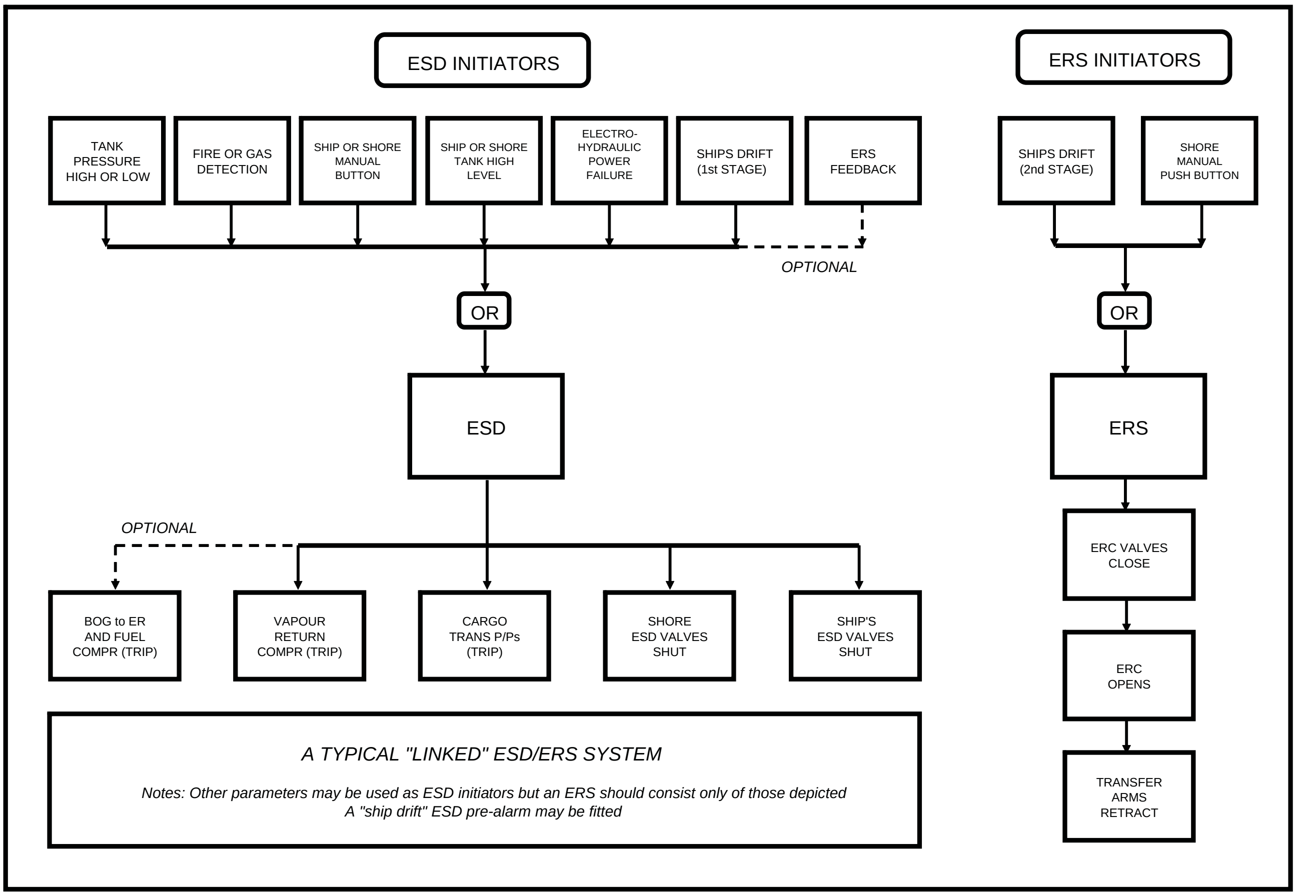

Figure C.1 — General safety philosophy for stopping LNG transfer

Annex D
(informative)

Recommended pin configurations for fibre-optic and electric ship/shore links (SSLs)

Table D.1 — Fibre-optic ship/shore link (SSL) recommended pin configuration

Signal	Direction	Optical fibre number
4-channel multiplex data	Ship-shore	1
4-channel multiplex data	Shore-ship	2
ESD volt-free circuit	Ship-shore	3
ESD volt-free circuit	Shore-ship	4
Spare	Ship-shore	5
Spare	Shore-ship	6

Table D.2 — PYLE national recommended pin configuration

Pin	Standard	Comment
1	Sound-powered telephone	Few terminals currently use this
2		
3	EX'ia' telephone	Dual LPG LNG jetty use only
4		
5	InterPhone or hotline telephone	InterPhone/hotline telephone using either Iwatsu DC shift CALL or 48 V AC signalling
6		
7	PABX telephone (#1)	Standard 600 Ω off hook/6 000 Ω on-hook 48 V DC/80 V AC ring type
8		
9	PABX telephone (#2)	Standard 600 Ω off hook/6 000 Ω on-hook 48 V DC/80 V AC ring type
10		
11	Not connected	Used by two older US terminals although not in general use. 4 mA to 20 mA ship-shore return gas pressure set point
12		
13	ESD shore-ship	ESD shore-ship free contact on shore side, closed in healthy condition
14		
15	ESD ship-shore	ESD ship-shore free contact on ship side, closed in healthy condition
16		
17	Continuity check linked on ship	Continuity link on ship – Link for umbilical connected confirmation circuit on shore side
18		
19	Spare	Used for continuity check in some terminals
20		
21	Not used	Shore-ship shore tank HL ESD trip (not normally used for current installations)
22		
23	Not used	ESD shore-ship in some terminals
24		
25	Not used	ESD ship-shore, loading arms 1st stage (not normally used for current installations)
26		
27	Not used	ESD ship-shore, loading arms 2nd stage (not normally used for current installations)
28		
29	+24 V/35 mA max. for ship-shore (i.e. on-board shore systems) test circuit	Safe power for shore test circuit
30		
31	MLM data connection	Ground
32		Rx — Shore-ship
33	MLM data connection	Tx — Ship-shore
34		Ground
35	+24 V/35 mA max. for ship-shore (i.e. on-board shore systems) test circuit	Safe power for ship test circuit
36		
37	Not connected	Not connected

Table D.3 — Miyaki Denki pin configuration

Pin	Standard ESD receptacle connection	Standard telephone receptacle connection
1	ESD ship-shore	InterPhone or hotline telephone
2		
3	ESD shore-ship	PABX telephone
4		
5	Spare	Public telephone
6		

Table D.4 — ITT Cannon pin configuration

Pins	Standard connection
A	Public telephone
B	
C	—
D	Hotline telephone
E	
F	—
G	—
H	Plant (PABX) telephone
J	
K	—
L	—

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ICS 75.200
Price based on 28 pages