CONTENTS

TABLES

FIGURES

REVISION MEMO

03/04 General 5-year update to further clarify safety considerations and to make them consisent with the Marine Terminal Standards document. New sections were also added to provide guidelines for: Foam Application and Additional Considerations for Sites Using Roving Operators.

SCOPE

This section covers safety considerations and features that should be incorporated to ensure safe operation of new, fixed (conventional dock-type) marine terminals. The considerations herein represent the cumulative experience of ExxonMobil terminals worldwide along with appropriate guidelines from international standards.

To determine the applicability of these safety features for existing facilities, a site specific study that incorporates the local conditions and risk management methodology is recommended.

REFERENCES

DESIGN PRACTICES

DP XV-F	Emergency Isolation, Depressuring and Shutdown Systems
DP XXXI-F	Cargo Transfer Equipment - Loading Arms
DP XXXI-J	Ship-to-Shore Electrical Isolation
DP XXXI-N	Gangways

GLOBAL PRACTICES

GP 3-2-3,	Firewater Systems
GP 3-7-1,	Piping Layout, Supports and Flexibility
GP 3-11-1,	Marine Cargo Transfer Hose
GP 3-11-2,	Marine Loading Arms
GP 3-12-1,	Valve Selection
GP 14-3-1,	Fireproofing
GP 15-7-2,	Protective Systems
GP 15-9-2,	Electric Motor Operators for Valves
GP 16-1-1,	Area Classification and Related Electrical Design for Flammable Liquids, Gases or Vapors

OTHER REFERENCES

1. Exxon Company International, *Safety in LPG Design*, January 1996.
2. Oil Companies International Marine Forum, *Design and Construction Specification for Marine Loading Arms*, Third Edition Revision 1999.
3. *Marketing Engineering Standard - Marine Facilities Design, Specification and Evaluation*, ER&E Report EE.3M.86, 1986.
4. Oil Companies International Marine Forum, *Mooring Equipment Guidelines*, Second Edition, 1997.
5. ExxonMobil Research & Engineering Co., PC-SMART Users Guide v.2.4, CPEE 136, 1997.
6. *LHG Marine Cargo Transfer Fire/Explosion Risk Assessment Procedure*, 93 CMS2 010, Jan. 1993.
7. *Fire Protection and Safety Guidelines for Marine Terminals*, ER&E Report EE.5TT.81.
8. *Guidelines for Marine Terminal Training and Drills to Improve Emergency Readiness*, ER&E Report EE.1TT.86, 1986.
9. *Planning and Selection Guide for Oil Spill Response Equipment*, ER&E Report EE.101E.94, 1994.
10. *Guidelines for Prevention of Electrostatic Ignitions*, ER&E Report EE.3M.96, 1996.
11. Exxon International Tanker Department, *Underkeel Clearance in Ports*, EII.ITTM.82, Nov. 1982.
12. *Guidelines for Selection and Installation of Emergency Block Valves*, ER&E Report EE.27E.84, March 1984.
13. *Emergency Shutdown Systems (ESSs) for Marine Terminals*, ER&E Report EE.108E.98, Dec. 1998.
14. International Chamber of Shipping, Oil Companies International Marine Forum, International Association of Ports and Harbors, *International Safety Guide for Oil Tankers & Terminals (ISGOTT)*, Fourth Edition, 1996.

INTRODUCTION

Marine terminalling operations involve hydrocarbon cargo transfers, where the potential for an incident is always present; and a large inventory of product is on hand. In view of the vital importance of marine facilities to the continuing operation of most plants, it is necessary to avoid hydrocarbon releases, to control ignition sources, and to provide adequate fire protection by proper design and effective operations. Some of the features described herein will be useful in preventing oil spills; however, Report EE.101E.94 (**Reference 9**) should be consulted for further information on oil spill response.

SETTING THE SAFETY BASIS

Protective equipment recommended for a marine terminal depends upon many factors including the following:

- Potential for personal injury.
- Criticality of the terminal to the supply/distribution circuit.
- Proximity of the terminal to populated areas and non-petroleum industry facilities.
- Product volatility.
- Layout of marine facilities.
- Available fire fighting capabilities.
- Ship size and cargo transfer rate.

For purposes of Fire Protection, Emergency Shutdown (Isolation) Systems and Cargo Drainage and Containment, all facilities should be classified based on the importance of the terminal's marine operations to the business interest (product supply system) of the company. Classification is according to Group I, II, or III based on the criteria in Table 1.

Table 1 - Classification Criteria for Marine Terminals

Group I	Those marine terminals, which are **critical to the business interests of the company**, are in **highly congested** areas, or for other reasons require a high level of protection (normally includes refining terminals and large distribution terminals).
Group II	Those marine terminals which are **important to the business interests of the company** (normally includes distribution terminals which supply a large area, are a single source of company product for an area or country, or for other reasons are judged to require some degree of protection).
Group III	Those marine terminals where elimination of the terminal would **not seriously affect the business interests of the company** (normally includes distribution terminals which either supply a small area or for which there are alternative sources of product).

Classification by Group should include appropriate input from senior management of the affiliate company. The purpose of classifying marine terminals according to Group is to identify the level of investment justified to protect against a financial loss that would impact the facility for an extended period of time. In all cases, safety, health, environmental and public impacts will be addressed.

MINIMUM SPACING CRITERIA

Summarized in the following section are spacing and dimensioning guidelines for multiple berth piers and vessel turning basin.

TURNING BASIN

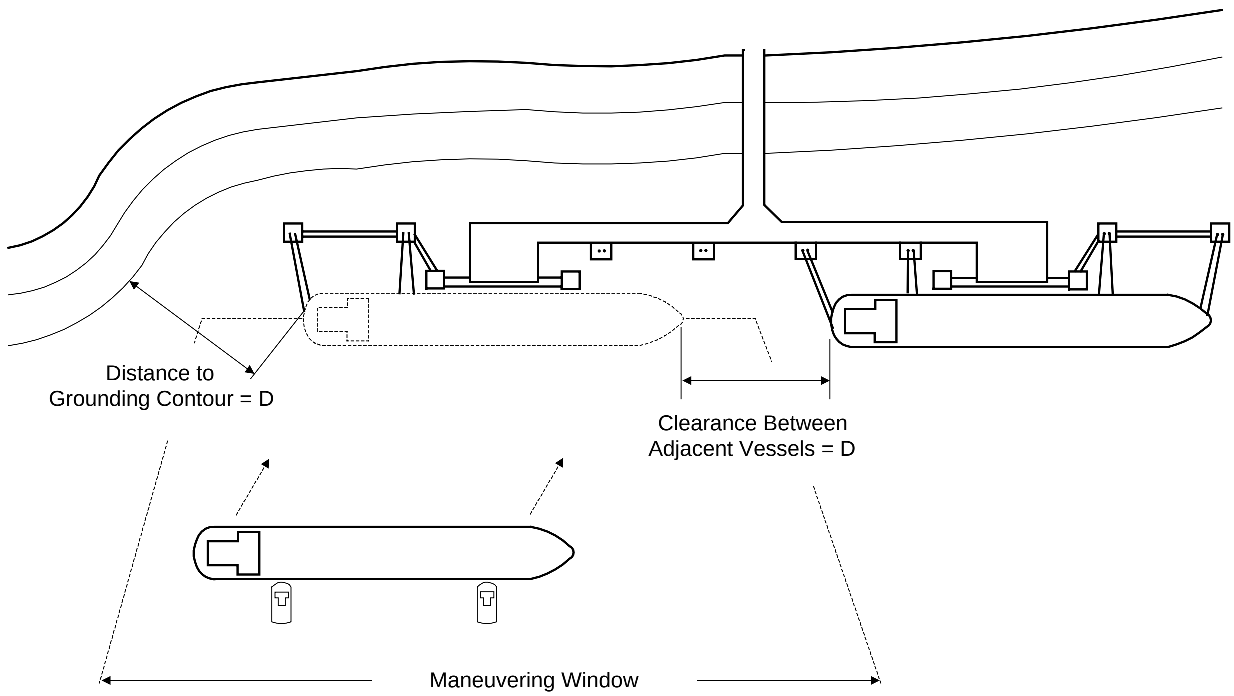
The turning basin is an area designed to allow a vessel to turn, usually in a 180° direction from that which it entered. Turning a vessel is usually done prior to berthing to allow departure from the berth under a wider range of environmental conditions.

For larger vessels, tug assistance is usually required for any turning maneuver due to the excessive area required if the turn was unassisted. The minimum diameter of the turning basin should be 4 times the overall length of the ship (LOA) for unassisted vessels and 2 times LOA for vessels where tugs assist.

SPACING BETWEEN BERTHS

Considerations for clearance spacing (bow to stern, bow to bow, stern to stern) between vessels in shallow water are shown in Figure 1.

Figure 1 - Spacing Between Berths



Minimum Spacing Distances for Various Ship Sizes

TYPE OF VESSEL	DISTANCE (D)
Tug-Maneuvered Barges and Vessels < 2,000 DWT	30 ft (9.1 m)
Self Propelled Barges and Vessels < 10,000 DWT	60 ft (18.3 m) or One Vessel Width, Whichever is Larger
Vessels < 50,000 DWT	100 ft (30.5 m) or One Vessel Width, Whichever is Larger
Vessels > 50,000 DWT	150 ft (45.7 m) or 1.5 Vessel Widths, Whichever is Larger

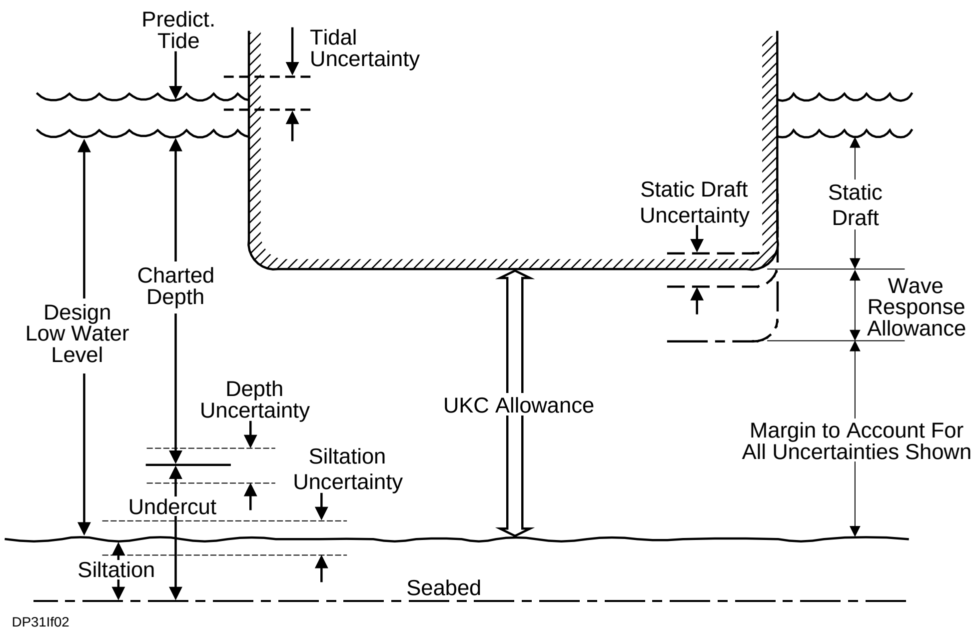
Note: Final clearances should be based on discussions with approprate marine specialists

DP31If01

UNDERKEEL CLEARANCE AT BERTHS

Determination of the underkeel clearance (UKC) as a function of vessel size and sea conditions at a port is a complicated subject which can be dependent upon numerous factors which are summarized schematically in Figure 2. Among the most important of these factors for establishing a vessel's UKC is the Design Low Water Level. For coastal areas subject to semidiurnal tide, the design low water level is typically set equal to the mean low water (MLW). For coastal areas subject to diurnal or mixed tides, the design low water level is typically equal to the mean lower low water (MLLW). Other factors are discussed in the next section.

Figure 2 - Underkeel Clearance Factors



FACTORS AFFECTING UNDERKEEL CLEARANCE

Charted Depth - This is obtained from surveys, and the precision of the information varies depending on survey errors, round-off errors, and the like. As a result, there is some allowance for uncertainty associated with the charted depth. For locations with a muddy bottom, the depth can be defined as the depth at which a material density of 15.5 lb/ft^3 (1.2 g/cm^3) is first encountered.

Tide - The periodic rise and fall of sea level causes the available water depth to fluctuate. Tidal predictions are used to forecast the actual working depth at any given time. These predictions account for astronomical effects, but not other unpredictable effects such as wind shear forces, fresh water run off, unknown current, storms, barometric variations, etc. Therefore, in addition to the tidal allowance due to astronomical effects, an allowance must be added to UKC based upon the tidal uncertainty due to the factors mentioned above.

Undercut - In certain areas the ship channel is dredged deeper than indicated by the charts (to account for future siltation). The charted depth uncertainty usually covers the undercut uncertainty.

Siltation - Water depth is often reduced by siltation. This siltation can be accounted for if siltation rates are known. However, if siltation rates are not known, then a siltation uncertainty or deviation must be included to account for possible depth reduction due to siltation.

UNDERKEEL CLEARANCE GUIDELINES

The minimum underkeel clearance refers to the distance between the ship's bottom and the seabed that will provide for the maximum vessel draft while providing an appropriate allowable to prevent grounding. The general requirements for minimum underkeel clearance at a berth are as follows:

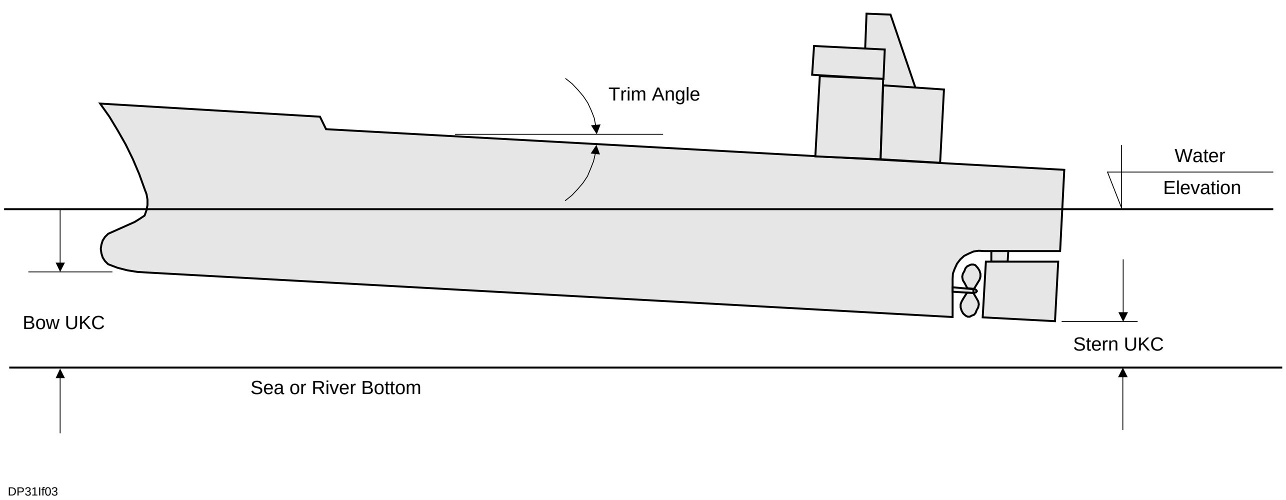
1. Minimum underkeel clearance at a berth located in sheltered waters should be not less than 5-10% of the maximum draft of the vessel unless a more detailed analysis is performed. The 10% value should be considered for sites having rocky bottoms, high sediment rates, strong currents, and for early planning studies. For terminals handling only light draft vessels, a check should be made to ensure the minimum underkeel clearance is satisfied at the appropriate trim angle (see Figure 3). Typical trim angles range from up to: 5° for ships <16,000 Dead Weight Tons (DWT); up to 2.5° for ships <150,000 DWT; and 0.5°-1.0° for ships >150,000 DWT.

S ➧ 2. The practice of "pumping-over-the-tide," whereby the vessel relies on high tide to maintain minimum underkeel clearance, is not permitted at ExxonMobil terminals

3. For berths located in exposed locations subject to waves with a significant height of 3.1 ft (1 m) or more, the underkeel should be established by rigorous calculation. **Reference 11** provides a rational method for determining UKC using a generalized probabilistic procedure. The minimum UKC can also be estimated by performing a dynamic mooring analysis.

   In the absence of a detailed analysis, the minimum average UKC should be not less than 10-15% of the maximum draft of the vessel. Contact IMT, SeaRiver Maritime, or EMRE for assistance. The 15% value should be considered for sites having rocky bottoms, high sediment rates, strong currents, and for early planning studies.

Figure 3 - Underkeel Clearance at the Berth

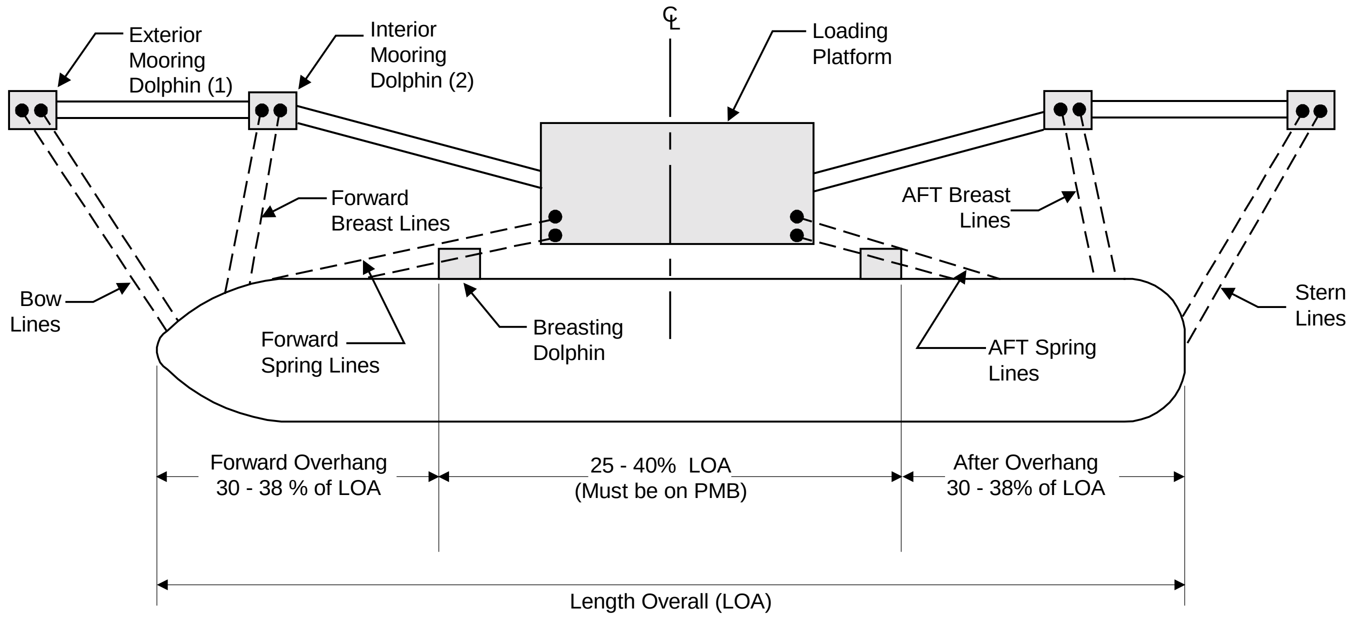


MOORING ARRANGEMENTS

The mooring facilities provided at a berth should be designed to permit the full range of vessel sizes that are to be accommodated to remain safely moored alongside. Mooring structures of a facility restrain the vessel against wind, wave, and current forces.

The procedures for calculating the wind, wave and current forces on ships are covered in **Reference 4**. Because of the complexity of these calculations, they are generally performed using a computer program such as PC-SMART (**Reference 5**) which is maintained by the Marine Terminalling Section of ExxonMobil Research & Engineering.

Figure 4 - Typical Mooring Arrangement



Notes:
(1) Distance from berth centerline to the center of the exterior dolphin should be slightly more than 1/2 of the LOA of the largest vessel which will normally call at the berth.
(2) Interior mooring dolphins should be located to optimize the breast lines (as perpendicular to vessel longitudinal center-line as possible) for the full range of vessels that will call at the berth. DP31If04

An appropriate mooring arrangement can be developed by adhering to the general mooring principles listed below. An example of a good mooring arrangement is shown in Figure 4.

1. Mooring points should be arranged as symmetrically about the center point as possible. The ideal mooring layout allows for mooring lines (breasting lines) to be run perpendicular from the bow and stern of the vessel such that they restrain lateral motions away from the pier. Additional mooring points are provided to allow for spring lines to be run parallel to the vessel to restrain longitudinal motions.
2. To minimize the amount of mooring line tending required to accommodate tide or vessel draft changes and for efficient use of mooring lines to resist mooring loads, mooring points for breasting lines should be set back far enough to keep the vertical angles less than 30°. Mooring points for spring lines should also be located such that vertical angles of spring lines are kept below 30°.
3. When mooring dolphins are used, they should be set back sufficiently from the breasting face to prevent being struck by vessels berthing/departing at angles of up to 15°.
4. The design wind and current forces on the ship should be calculated for the wind and current conditions under which the ship may remain moored at the berth.
5. S➧ Maximum allowable loads in any one mooring line should not exceed 55% of its Minimum Breaking Load (MBL) for the most severe environment in **Paragraph 4** above. For cargo transfer operations, mooring line loads should not exceed 35-40% of the MBL.
6. Mooring limits for mooring facilities should be developed using the PC-SMART computer program. EMRE can provide affiliates with the necessary assistance or appropriate training.

SHIP TO SHORE ACCESS

S ➧ All berths should have provisions for safe ship-to-shore access. Where the berth has adequate clear space, the ship's accommodation gangway may be used provided the berth has a written ship's gangway safety criteria in line with the requirements for manual gangways as outlined in Section XXXI-N, and a documented procedure is in place for inspecting the ship's gangway to ensure it meets the safety criteria prior to commencing cargo transfer. Where the berth does not have adequate clear space for landing a ship's accommodation gangway, or at locations that commonly handle barges or other vessels that do not have gangways, the berths should have a shore based gangway to ensure safe ship/shore access.

Manual type "conventional" gangways, including those with fixed, non-leveling steps, may be used provided the walkway has a step design which provides safe footing at all operating inclinations, and is rated by the gangway manufacturer for the angles of inclination used at the berth.

For additional information on general gangway design considerations see Section XXXI-N.

S ➧ CARGO TRANSFER

Liquid cargo transfer can be accomplished by systems ranging in complexity from strings of flexible rubber hose to hydraulically operated all metal loading arms. The optimum system for a particular product or berth will vary from location to location depending upon several factors including life cycle cost, historical practice, variability of ship sizes and product types, and risks in the cargo transfer operations.

For refrigerated or partially refrigerated Liquefied Petroleum Gas (LPG), all metal marine loading arms are recommended. The general design guidelines for cargo facilities for LPG transfer are covered in **Reference 1**.

LOADING ARMS

The design requirements for marine loading arms and ancillary equipment are covered in **GP 3-11-2** and Section XXXI-F. Key safety considerations are as follows:

1. Every LPG arm should be equipped with a hydraulically operated Emergency Release System (ERS) designed in accordance with **Reference 2, GP 3-11-2,** and Section XXXI-F. See **Reference 1** for circumstances where LPG transferred without an ERS may be considered.
2. The arm should be designed to slowly return to the stored position in the empty condition. For hydraulically operated arms, this should occur for the free-wheel condition or if the hydraulic system fails.
3. Range monitoring systems per **GP 3-11-2** are recommended for hydraulically operated loading arms. For a discussion of range monitoring systems, including their limitations at certain sites, see Section XXXI-F.
4. In order to minimize the risk of sparking or arcing at the cargo transfer connection, one electrically insulating flange should be installed at the outboard arm, behind the triple swivel and on any other support which may come in contact with the vessel, such as the support jack. See Section XXXI-J for a discussion of the design details for electrically insulating flanges.
5. Loading arms for liquefied gases should have a connection allowing liquid to weather off into the vapor return line upon completion of loading or unloading. If a vapor line is not available, the liquid can be drained to a knockout drum vented to a flare or other safe location.
6. Appropriately sized vacuum breaker vents should be fitted with a check valve and block valve. Consideration can also be given to providing connection to the loading arm drain system, to avoid spillage if a vent is inadvertently left open during a transfer.
7. If ladders are provided for access to the top of the riser and apex swivels, they should be double-step with provisions for a safety hook from a climbing harness.

HOSE SYSTEMS

Specifications for hoses used at fixed marine berths are covered in **GP 3-11-1**. Key safety considerations are as follows:

1. Hoses shall be manufactured in accordance with **GP 3-11-1**.
2. Hoses shall have a pressure rating equal to or greater than maximum operating/working pressures.
3. Allowable temperatures and product service should not exceed the limits per **GP 3-11-1**.
4. Marine cargo dock hose should not be used for refrigerated or partially refrigerated LPG.
5. Hoses should be supported by saddles or double slings to avoid excessive bending.
6. In order to prevent arcing or sparking at the cargo manifold, an insulating flange should be installed at the shore manifold connection. See Section XXXI-J for a discussion of the design details for electrical isolation of hoses. A length of electrically discontinuous hose may be used as alternative to an insulating flange.

PIPING SYSTEM

PIER PIPING

This section identifies some of the alternative piping and manifolding systems typically in use, and discusses their applications and limitations. Design requirements for piping and manifolding are beyond the scope of this document; however, key safety considerations, specific to docks, are provided.

Two types of pipeline networks exist for transporting product between the pier and shore, or directly between the pier and tankage facilities. The simplest network consists of individual, segregated lines dedicated to a single grade of product. These systems are usually the most expensive but may be justified when only two or three product grades are handled, or when contamination is a major concern. The second option is the use of common pipelines for either light or dark products. This minimizes the number of required pipelines which can result in significant investment savings, especially when long distances or large diameter pipe are required.

When changing between products in a common pipeline, some method must be used to displace the original product. This displacing can be done with either the next product, with gas or with mechanical pigs.

S ➧ Key safety considerations for pier piping include:

1. Displacing products with compressed air should be limited to lube oils or asphalts. Air displacement with other products is hazardous, especially with low flash products, since an explosive mixture may be formed. Water washing or displacing between products should be avoided when possible since it is a major source of contamination, particularly with distillates.
2. Dock pipelines must be protected against thermal expansion where product may be blocked in by operation valves or the emergency isolation system. This is done with a 2 in. (50 mm) bypass (with thermal relief valve or check valve, and CSO valve) around each block valve where product would be contained. The bypass allows liquid on the dock side to relieve into the main shore line, which is in turn protected by a thermal relief valve or other means.

S, E ➧

DRAINAGE AND CONTAINMENT

Terminals should provide provisions for the safe handling of product releases and from draining, stripping, or purging of loading equipment/piping and inadvertent flange leaks. Shown below in Table 2 are the provisions for safely draining the cargo transfer systems at Group I, II, and III terminals. An example of a typical drainage system for loading arms at Group I and II terminals is shown in Figure 5.

Table 2 - Cargo Transfer System Drainage Requirements

➧

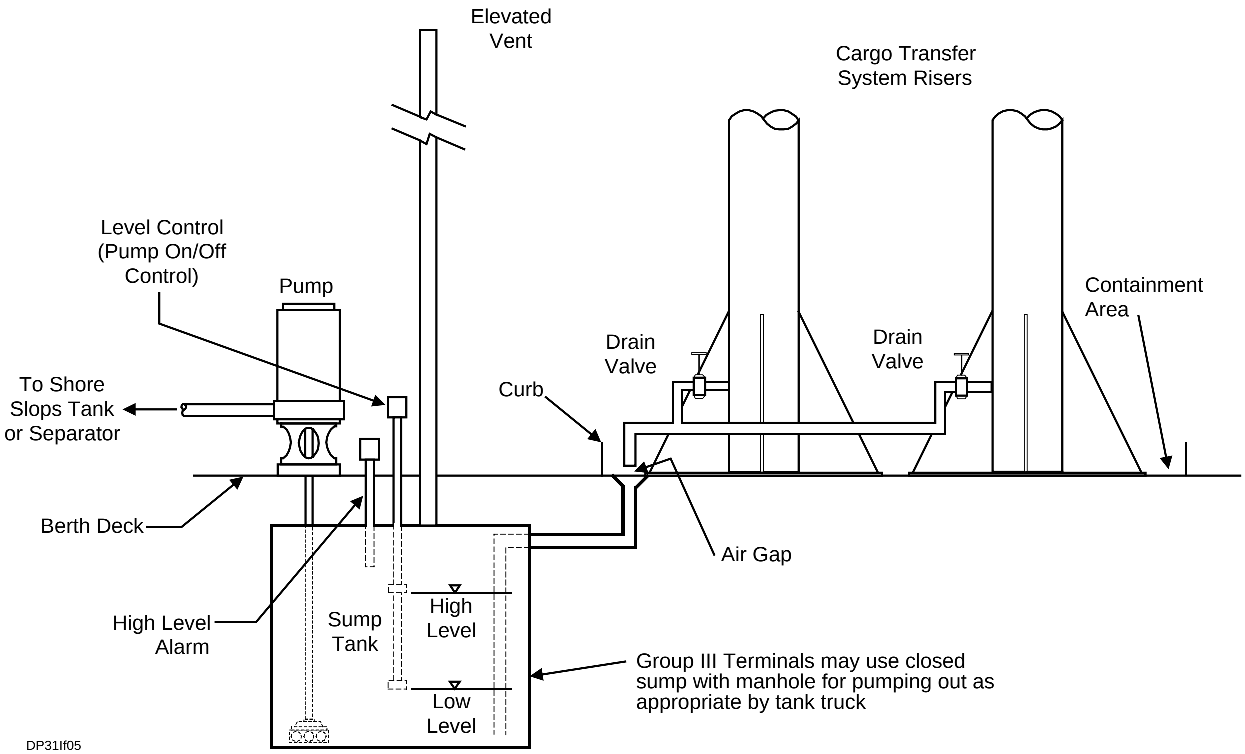
TERMINAL GROUP	REQUIREMENTS
I or II	Berths shall have a **closed sump system with a vent** to atmosphere at a minimum elevation of 10 ft (3 m) above any platform, elevated roadway etc. within a horizontal distance of 50 ft (15 m), and fitted with automatic pumps for discharging the sump contents to appropriate shore piping or shore tanks and a local high level alarm in event of pump failure. Alternatively, Group I or Group II berths shall be provided with **cargo transfer system stripping pumps or purging systems** which empty the cargo transfer systems into appropriate shore piping or shore tanks.
III	Berths shall be fitted with either a closed sump system or cargo transfer system stripping or purging system. Sumps **shall be fitted with a mechanical level gauge and elevated vent (as above)** but do not require automatic pump out and may be fitted with sealed manhole covers to allow pumping out by a pumper truck as required.
I, II, and III (LPG or Toxic Chemicals)	**Irrespective of berth classification**, cargo transfer systems handling **LPG or toxic chemicals** shall be fitted with **purging systems** which empty the cargo transfer systems into appropriate shore piping or shore tanks. Where approved by affiliate management, LPG systems may be vented to atmosphere after shutdown or cargo transfer via a minimum 10 ft (3.1 m) elevated vent located outside of the berth electrical classification area.

The following are general requirements and considerations for the design of drainage and containment for marine terminals:

1. To permit access and prevent pollution, berth manifolding should be constructed over a solid steel or concrete deck structure.
2. Curbing should be placed around cargo transfer loading equipment and around flanged pier manifolding to contain product in the event of an inadvertent release. The area within the curbing should be sloped to collect released product and divert it to a sump tank, which is typically located on the pier.
3. Drip trays should be placed in locations subject to frequent small releases of product such as under the connection flanges of a hose transfer system. Drip trays should have a tight fitting cap to minimize vapor release when not in use.

4. The vents should be pressure/vacuum regulated and discharge a minimum of 10 ft (3 m) above platforms and any equipment within a horizontal distance of 50 ft (15 m). Sumps, which provide drainage for more than one pier, should be equipped with seals so that a fire on one pier cannot spread to other piers via the connecting drainage pipelines.
5. For new construction, sump tanks should be located at least 25 ft (7.5 m) from the hose manifolds and loading arms.
6. Separate sump tanks for heavy and light products should be considered, especially to minimize vapor releases when heavy products must be heated to maintain their ability to be pumped.
7. Sump tanks should be designed with high level alarms (Group I and II Terminals) or a mechanical level gage (Group III Terminals) to prevent overfilling. Also, automatic high and low level pump cut in/cut out is required for all Group I and II Terminals.

Figure 5 - Drainage and Containment System for Group I & II Terminals



ELECTRICAL AREA CLASSIFICATION

For Class I, Division 1 areas, electrical equipment must not constitute a source of ignition for a flammable atmosphere either by sparking during normal operation or failure. For Class I, Division 2 areas, equipment only must not constitute a source of ignition by sparking during normal operation. To establish the electrical classification, it is necessary to consider the probability of flammable vapor/air mixtures occurring in the various areas of the facility based on the Electrical Area Classification Procedure.

The Electrical Area Classification Procedure used at Exxon marine terminals is based on the National Electrical Code 70 and the rules/guidelines per API 500A as modified and clarified below. Local area classification codes and approvals should be applied where appropriate.

DEFINITIONS

Marine terminals are considered API 500A Class I locations if they handle products with flash points less than 100°F (38°C) and products whose temperatures are above or within 15°F (8°C) of their flash point. Within Class I designations, there are two criteria applicable to locations as follows:

Class I, Division 1

1. Locations where ignitable concentrations of flammable gases or vapors exist under normal operating conditions, or
2. Ignitable concentrations may exist frequently because of repair or maintenance operations or because of leakage, or
3. In which breakdown or faulty operation of equipment might release ignitable concentrations of flammable gases and might also cause simultaneous failure of electrical equipment.

Class I, Division 2

1. Locations where flammable liquids or gases are handled, but where liquids and gases will normally be confined within closed containers from which they can escape only in case of accidental rupture or breakdown of such containers or systems, or in case of abnormal operation of equipment, or
2. In which ignitable concentrations of gases are normally prevented by positive mechanical ventilation, or
3. Adjacent to Class I, Division 1 locations where concentrations of gases might occasionally be communicated unless such communication is prevented by adequate positive-pressure ventilation from a source of clean air.

Flammable Gas Groupings - Flammable gases can be grouped according to their flammability characteristics as follows:

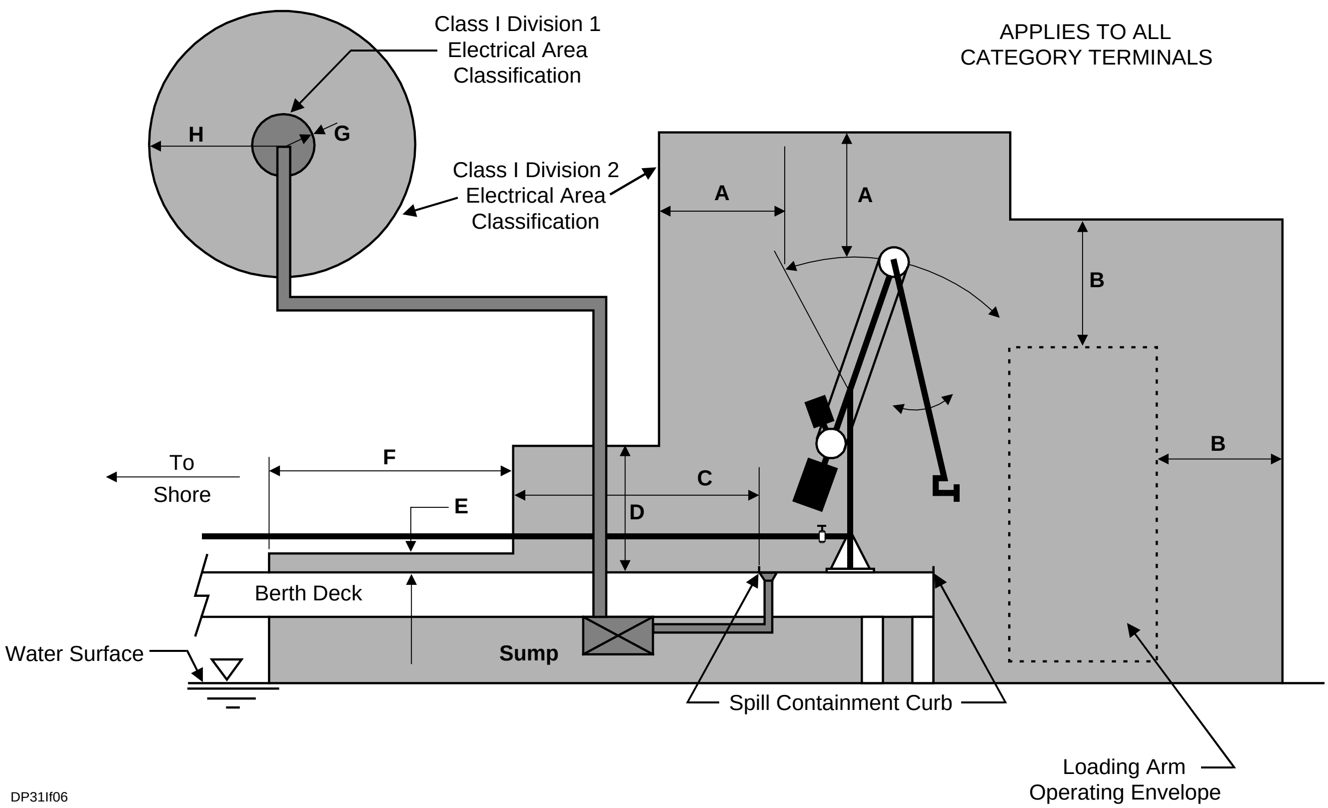
- Group A: Atmospheres containing acetylene.
- Group B: Atmospheres containing hydrogen or gases of equal hazard.
- Group C: Atmospheres containing ethyl ether, ethylene or cyclopropane.
- Group D: Atmospheres containing gasoline, hexane, naphtha, benzene, butane, propane, alcohol, acetone, benzol lacquer solvent vapors, natural gas or ammonia.

In general Group D gases are associated with the facilities covered by this guide.

RULES / GUIDELINES FOR DETERMINING EXTENT OF CLASSIFIED AREAS

S ◗ The extent of typical classified areas (per API RP 500) is shown in Figure 6 (elevation view) and Figure 7 (plan view).

Figure 6 - Electrical Area Classification (Elevation View)



Legend:

A. 25 ft (7.6 m) from the arc created by the loading arm apex swivel as the arm moves through the operating envelope. For hose systems, 25 ft (7.6 m) from the highest flange connections in the system.

B. 25 ft (7.6 m) from the upper and outer limits of the loading arm or hose system operating envelope.

C. 50 ft (15.2 m) from any curbing forming part of a spill containment area.

D. 25 ft (7.6 m) from the platform or trestle deck.

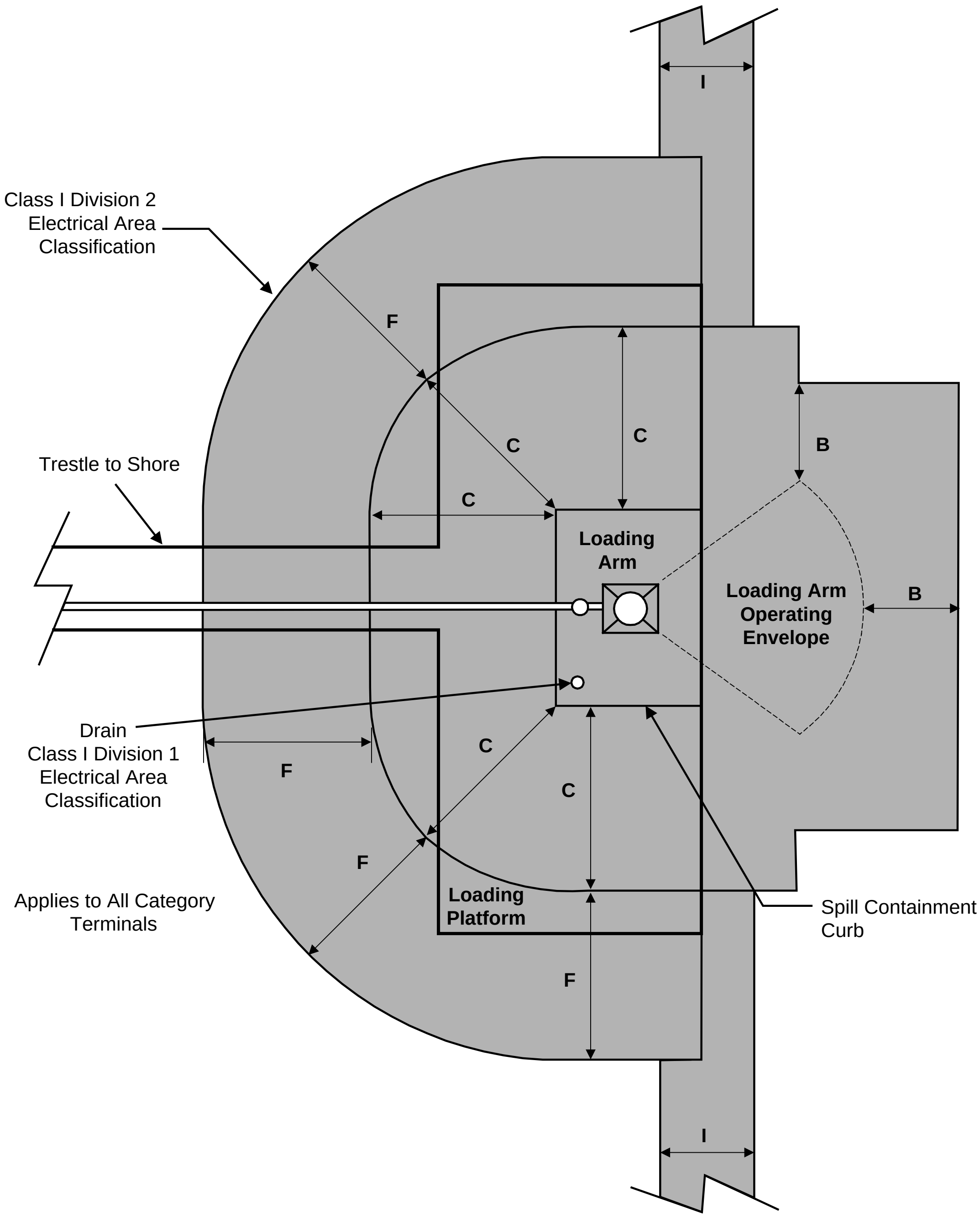
E. 2 ft (0.6 m) from the platform or trestle deck.

F. 50 ft (15.2 m) from “C,” i.e., 100 ft (30.4 m) from any curbing forming part of a spill containment area.

G. 5 ft (1.5 m) from sump vent release.

H. 10 ft (3.1 m) from sump vent release.

Figure 7 - Electrical Area Classification
(Plan View Top of Deck Elevation)



Legend:
C. 50 ft (15.2 m) from any curbing forming part of a spill containment area.
B. 25 ft (7.6 m) from the outer limits of the loading arm or hose tower operating envelope.
F. 50 ft (15.2 m) from C, i.e. 100 ft (30.4 m) any curbing forming part of a spill containment area.
I. 25 ft (7.6 m) from the side of moored vessl.

DP31If07

ELECTRICAL EQUIPMENT SELECTION

S ➧ Equipment for use in classified areas should be certified by a nationally recognized testing organization or its design should conform to the standards of the organization. Table 3 indicates the type of equipment, which should be provided for the specified NEC area classification. To correlate the class and division designations per NEC with the zone designation system for classified areas used by the International Electrotechnical Commission (IEC) and other regional or national standards, see **GP 16-1-1**.

Table 3 - Equipment for Classified Areas

AREA CLASSIFICATION	EQUIPMENT TYPE
Division 1 NEC Groups B, C, D, or equivalent	Intrinsically safe or explosion proof, approved for the gas group involved.
Division 2 NEC Groups B, C, D, or equivalent	1. Same as Division 1, or 2. Oil-immersed approved for the gas group involved, or 3. Hermetically sealed with enclosure providing suitable mechanical protection
Division 2 NEC Group B or C or equivalent	If equipment meeting the above is not available, oil-immersed approved for NEC Group D.
Division 1 & 2 NEC Groups B, C, D, or equivalent	If equipment meeting the above is not available, pressurized equipment shall be used. Design of equipment shall be approved by Owner.

FIRE PROTECTION

S ➧ In the event that a fire occurs despite a facility's fire prevention measures, fire protection systems and equipment should be available to minimize its consequences. ExxonMobil's basic philosophy towards fire protection systems is to stop the flow of fuel to the fire, contain the fire and prevent it from spreading, use water to cool and maintain the integrity of structures and critical fire protection equipment, and extinguish or allow the fire to burn itself out. This section contains general requirements and recommendations for fire protection capabilities. Specific requirements for fire protection system and emergency equipment must be obtained from each region and must conform to local regulations.

In terms of the importance of the terminals' marine operations to the local product supply system, the fire protection philosophies are as follows:

Group I and II Terminals - Fire protection philosophy is to stop the flow of fuel to the fire (emergency shutdown and isolation) and keep berth, cargo transfer, and vessel manifold equipment cool until the fire either burns out or is extinguished. To assist in extinguishing fires, a proportioning foam system is required for Group I and Group II Terminals, except for those facilities, which only handle liquefied gas.

Group III Terminals - Fire protection philosophy is to provide sufficient portable fire fighting equipment to allow small fires to be extinguished, but to rely on local services for major fire fighting.

FIRE FIGHTING CAPABILITY AND EQUIPMENT GUIDELINES

The desired capability is to provide coverage of the pier, pier manifold, cargo transfer equipment and ship manifold areas. The level of firefighting capability will depend upon the area to be covered, size and number of arms/hoses , pier layout and products handled. ➧ Fire water flow rates and pressures should be sufficient to cover both extinguishing and exposure cooling water requirements assuming a credible sized fire. Table 4 presents guidelines on recommended firewater source/capacity, foam capability and monitor coverage for the different classes of terminals.

Table 4 - Marine Terminal Fire Protection

GROUP	FIREWATER SOURCE & CAPACITY	FOAM REQUIREMENTS(1)	MONITOR COVERAGE(2)
I	Reliable pressurized supply or local pump to meet the required capacity given below, plus a 2nd backup pump of equal capacity: Vessel Size — Capacity <15 kdwt — 1500 gpm (5700 l/min) 16-99 kdwt — 2000 gpm (7600 l/min) >99 kdwt — 3000 gpm (11400 l/min)	Dry foam line in conjunction with a proportioning truck or fixed foam system. Foam supply adequate to supply a minimum of two monitors for 30 minutes Back-up foam supply should be available	Minimum of two fixed water/foam monitors per berth
II	Reliable pressurized supply or one firewater pump with capacity of 1500 gpm (5700 l/min)	Foam concentrate supply adequate to supply one monitor or nozzle for 30 minutes	Minimum of one fixed water/foam monitor and one portable water/foam monitor or nozzle per berth
III	Reliable pressurized supply or one firewater pump with capacity of 500 gpm (1900 l/min)	Foam concentrate supply adequate to supply one monitor or nozzle for 15 minutes	None
GROUP	**HYDRANTS AND HOSE STATIONS**	**DRY CHEMICAL EXTINGUISHERS(3)**	**OTHER**
I	Hydrants and hose stations with 200 ft (60 m) of hose per station located every 300 ft (90 m) along pier	Two 150 lb (70 kg) Dry Chemical Wheeled Extinguishers per berth	None
II	Hydrants and hose stations with 200 ft (60 m) of hose per station located every 300 ft (90 m) along pier	One 150 lb (70 kg) Dry Chemical Wheeled Extinguisher per berth	None
III	Hydrants and hose stations with 200 ft (60 m) of hose per station located every 300 ft (90 m) along pier	One 150 lb (70 kg) Dry Chemical Wheeled Extinguisher per berth	Additional 150 lb. (70 kg) Dry Chemical Wheeled Extinguisher per berth if vessels >15 kdwt

Notes:

(1) Foam not required for dedicated liquefied gas berths.

(2) Monitors (minimum 500 gpm) should provide coverage for loading arm or hose, berth manifold area and vessel manifold area.

(3) Wheeled extinguishers may be of 50kg (vs. 70kg) in countries where this is the standard, but in no case shall smaller or multiple units suffice in lieu of one large wheeled unit.

(4) All berth operator shelters, storage sheds, or other enclosed work spaces should be fitted with 9 lb (4 kg) portable dry chemical extinguishers.

For existing piers constructed of combustible materials (e.g., timber) consideration should be given to providing additional firewater capability via automatic sprinklers/monitors especially for otherwise inaccessible areas below decks.

FIRE PROTECTION SYSTEM EQUIPMENT

The following are general guidelines for fire protection systems:

1. Where separate firewater pumps are provided, they should have a discharge pressure of 125 psig (862 kPa) at the rated capacity. Primary pumps (to meet the required firewater capacity) should be electrically driven. Back-up pumps should have an independent power source, e.g. diesel driven.
2. Continuous positive pump suction must be provided. Priming devices are not acceptable.
3. The firewater piping system shall be designed to insure that a piping failure does not affect more than 1,000 ft (300 m) of the system. For multi-berth piers an isolation valve should be installed between berths so that a failure at one berth does not disable the entire system. Looped systems should therefore be considered for multiple berth terminals.
4. Piping to marine terminals shall be protected from direct exposure to a spill fire (fire on water surface) by preferably installing it above the pier deck. Lines below deck should be fireproofed. For additional fireproofing requirements see **GP 14-3-1**.
5. In freezing climates piping should be heat traced and insulated or kept in dry conditions. Valved hose connections in appropriate locations should permit fire boats or pumping trucks to supplement the primary supply system.
6. An International Shore Fire Connection per Appendix E of ISGOTT (**Reference 14**) should be provided to allow the erminal to supply water to a tanker's fire main, when required.
7. Minimum pressure in the piping system at full design flow rate should be 80 psig (550 kPa).
8. A sufficient number of hydrants (minimum of 2) should be provided to supply the required water rate. Hydrants should be located within 300 ft (90 m) of any point where water will be required.
9. Monitors (fixed or elevated) should have an effective nozzle range of at least 100 ft (30 m) and should be located approximately 50 ft (15 m) (horizontal distance) from equipment being protected.

   The actuating valve must be at least 50 ft (15 m) horizontally from the protected equipment if monitor must be located closer to the equipment being protected.
10. Firewater pumps and fixed foam concentrate tanks should be located at least 200 ft (60 m) from the nearest berth.
11. Fire equipment cabinets containing fire hose nozzle fittings, hydrant/hose wrenches and adaptor couplings should be provided in areas where access by trucks containing these items is not possible or would take a considerable amount of time. At least one cabinet should be provided at each berth. The need for additional cabinets should be determined based on size and layout of the facilities.
12. Portable dry chemical fire extinguishers enable operating personnel to quickly attack small fires. Distance from the protected equipment to the extinguisher should not exceed 50 ft (15 m). In addition to small [20 lb (10 kg)] extinguishers handled by one man, 150 lb (70 kg) wheeled dry chemical extinguishers should be provided in high-risk areas.
13. Where a single foam monitor is provided for fire fighting duty, the discharge capacity of the monitor in foam/water solution should be 500 US GPM (115 M^3/hr).

FOAM APPLICATION

It should be noted that bulk foam concentrate supplies (usually 3-6% concentration) are specified to provide continuous foam application until the arrival of adequate backup fire fighting resources, either water borne or land based. The basis is 30 minutes of continuous foam application at the monitor design flow conditions.

The standard design flowrate for monitors is 500 gpm (M^3/hr). However, 750 gpm (58 M^3/hr) and 1000 gpm (230 M^3/hr) are available. The table below shows the volume of foam (3% concentation) required and effective coverage area assuming 30 minutes foam application at various standard monitor flow rates.

Table 5 - Effective Coverage Area Of Foam Application

Monitor Flowrate (gpm)	Rate of Foam at 3% concentration	Volume of Foam Required for 30 min. Application	Effective Coverage Area [(1)]
500	15 gpm	450 gal.	2,250 ft^2
750	22.5 gpm	675 gal.	3,375 ft^2
1000	30 gpm	900 gal.	4,500 ft^2

Notes: [(1)] Assuming 0.2 gpm foam per ft^2 of plan area

Example Problem:

Question: For smaller terminals with monitors that use direct foam induction via a flexible pickup tube, how much foam (at 3% concentration) supply is required for 30 minutes continuous application.

Answer: Assuming the monitor has the standard 500 gpm capacity 450 gal. of foam supply would be required.

S, E

EMERGENCY ISOLATION

The ability to effectively deal with a fire or other emergency at a marine terminal requires the capability to stop the flow of product in each loading and unloading line. Isolation valves and shut off controls are the key to stopping the flow. The type of valve or shutoff system employed is selected to provide a speed of closing and degree of reliability that is appropriate for the hazard anticipated when a component of the transfer system fails.

The level of isolation/shutdown capability is a function of the following factors:

- Volatility of the product - high flash, low flash, or liquefied gas.
- Transfer operation - loading, unloading, or both.
- Importance of the terminal - Group I, II, or III classification.
- Line size.
- Pier layout and construction, and local environmental conditions.
- Pier manning.

The areas most susceptible to releases are the loading arms/hoses and pipelines. Therefore, it is recommended that block valves be installed at the hose/loading arms and at the shore to provide the necessary isolation. The valves must be provided with a means for their safe effective actuation. Isolation systems can be comprised of remotely operated valves, manually operated valves and check valves.

EQUIPMENT GUIDE

Table 6 presents guidelines for determining the number and type of block valves recommended according to the terminal Group Number (I, II or III). As with the firefighting equipment, the minimum acceptable level of isolation for existing facilities will depend greatly on the local conditions/experience. Also additional isolation capability may be required to respond adequately to environmental emergencies or to satisfy local regulations.

Table 6 - Marine Terminal Isolation System

GROUP	VALVE REQUIREMENTS(1)(2)
All Groups	Isolation valves are required at the shoreline and at the berth manifold area for each loading or unloading line. The use of motor operated valves versus manual valves is a function of line product and pipe diameter (see requirements below). However, for liquefied gas, motor operated valves are required at both the shore and berth manifold area regardless of line size. The berth manifold area for Offshore Buoy Berths (MBM or SPM) is the hose connection to the submarine pipeline. For dedicated unloading lines, an additional check valve is required for each line, unless a motor operated valve is provided.
Additional Requirements For Group I	For high flash lines both the shore and berth manifold valve may be manual. However, if the line is greater than 8 in. (20 cm) in diameter a risk assessment of the safety and spill aspects of using manual valves shall be conducted. High flash lines shall be treated as low flash if simultaneous loading of low flash material at the same berth can occur. For low flash lines, the following requirements apply: • One valve shall be manual and the other valve shall be motor operated. • If any portion of the lines are vulnerable to damage from a ship collision, then the motor operated valve should be located on shore.
Additional Requirements For Group II	Same as "Additional Requirements for Group I" except that motor operated valve requirements for low flash lines only apply to lines greater than 8 in. (20 cm) in diameter. For lines 8 in. (20 cm) in diameter and smaller a risk assessment of the safety and spill aspects of using manual valves is required.
Group III	Manual valves may be used at both shore and berth manifold area regardless of product or pipeline size with the exception of pipelines that handle liquefied gas.

Notes:

(1) A surge pressure analysis is required if any of the piping system valves, whether manual or motor operated, are rapid closing (lessthan 30 seconds).

(2) Motor operated valves associated with the Emergency Shutdown System (ESD) must be tied into the common control system. Ifadditional motor-operated valves are used on the door, they may remain independent of the ESD but consideration should be given to tying them into the ESD system.

(3) The requirements of this table applies to berths that are continuously manned during cargo transfer.

ISOLATION VALVES

Emergency isolation valves as discussed in this section are referred to as Type C, or D. These valve types are defined below.

Type C Valve

This is a power operated emergency block valve (EBV), with its actuating button adjacent to it. Type C valves are selected for isolation purposes to ensure rapid closure of large valves. Normally, this is applied only to 10 in. (25 cm) and larger or greater than 300 psig flange rating valves, but smaller sizes may be considered if there are special factors, which would increase the difficulty of closure, e.g., high-pressure drop. Their location is subject to limitations on elevation (to permit rapid access) and proximity to the equipment being isolated (to avoid fire exposure). (When the actuating button is located remote from the valve, to permit safe access, then the valve by definition becomes Type D.)

Type D Valve

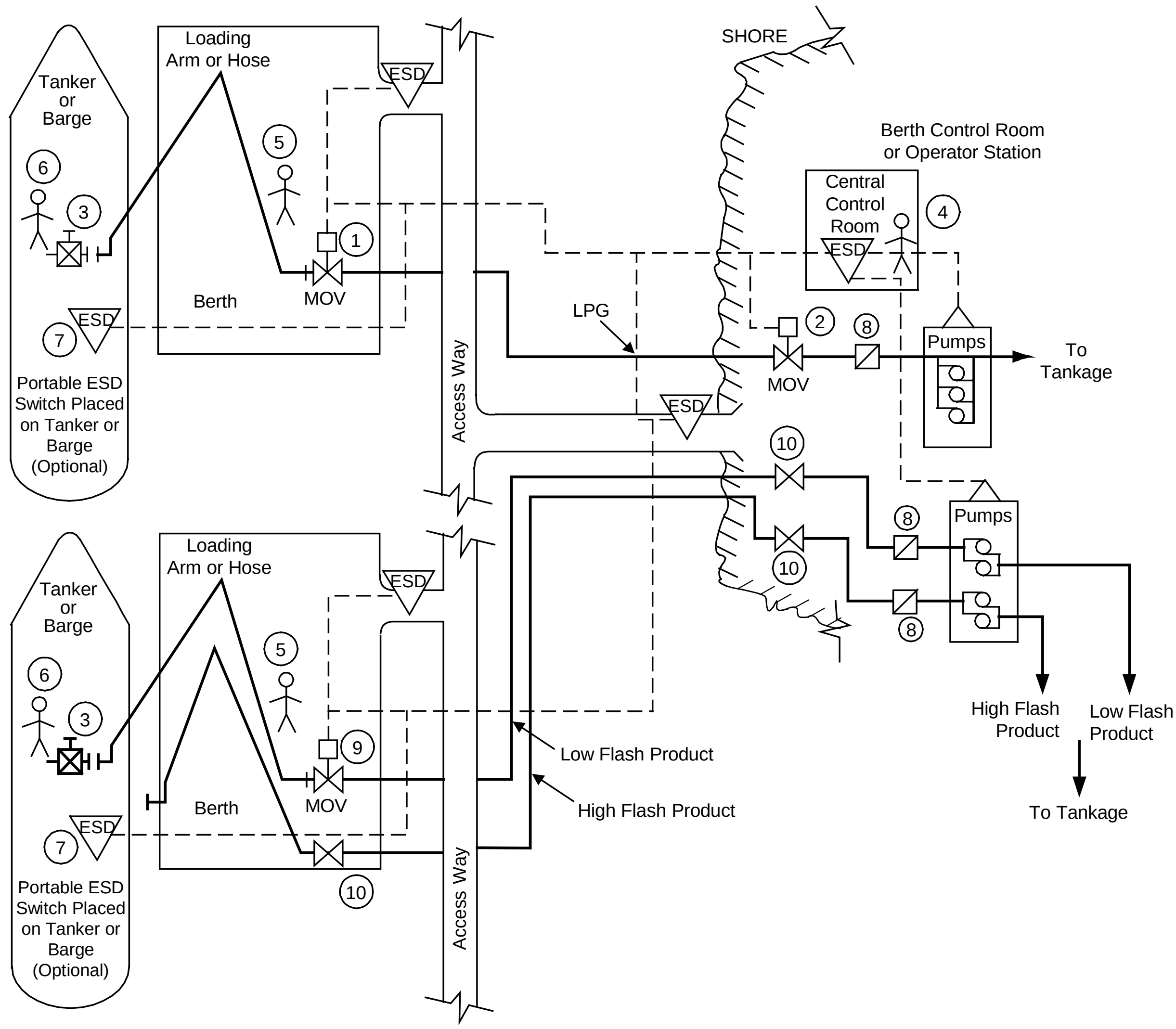
This is a power operated emergency block valve (EBV), located remote from its actuating button. Type D valves are selected for isolation purposes where the valve would not be readily accessible in an emergency (due to fire exposure or elevation), while allowing the actuating button to be placed at a readily accessible and safe location. Valves make actuation easy, quick and safe but may complicate the system.

SHUTDOWN OF LOADING / UNLOADING OPERATIONS

Several key points relating to isolation system requirements are presented below. A more detailed discussion of requirements and guidelines on isolation valve selection/installation is contained in Report EE.27E.84 *Guidelines for Selection and Installation of Emergency Block Valves* (**Reference 12**). **Reference 13** presents the results of a study that identifies the features found at most existing marine terminals and provides guidelines for assessing/upgrading existing Emergency Shutdown Systems. This report also provides a comprehensive list of the IPs and DPs appropriate for the special isolation system configuration. Figure 8 illustrates the emergency isolation systems for Group I and II Terminals.

1. The emergency block valve (EBV) must comply with all relevant Type D requirements specified in Section XV-F, **GP 3-7-1**, **GP 15-9-2**, plus the following:
    a. The EBV actuating button should be at locations on the dock which are convenient and accessible in the event of a fire in the manifold area. The recommended locations are at the dock shelter, personnel emergency egress route, and terminal office/control room. At least one of the actuating buttons should be located at least 100 ft (30 m) from high-risk areas (e.g. the dock manifold).
    b. The EBV and its actuating and signal systems must be fireproofed within 100 ft (30 m) of fire risk areas, and where they could be exposed to a spill fire.
2. Rapid closure of an EBV or emergency release system (ERS) must not cause surge pressures exceeding the safe limits of piping, supports, and accessories.
3. Upon system failures the preferred action for pier isolation valves is to remain stationary. This avoids nuisance trips but requires fireproofing of actuator and power/signal cables if they are within 100 ft (30 m) of the leak source.
4. Activation of the emergency shutdown system should stop the flow of all products to the berth. EBV actuation should stop the loading pumps automatically. This provision prevents pumping against a closed discharged.
5. Additional emergency actuation stations should be considered for large piers in the event the primary station cannot be reached or the operator is disabled. Multiple stations should be wired in parallel so that damage to the closer station will not eliminate control from others.
6. The activation of the emergency shutdown system should sound an alarm locally at the pier and consideration should be given to a remote alarm in the shore control room depending on the layout of the facilities.
7. The actuating button should be clearly identified and shielded to prevent accidental operation.
8. To be effective, the isolation system must be designed so that it can be maintained and tested periodically.
9. 1st stage setting on loading arm range monitoring system of loading arms with an ERS should stop the loading pumps automatically.

Figure 8 - Emergency Isolation for Group I and II Terminals



Legend:

1. MOV at Loading Arm
2. MOV on Shore
3. Valve on Ship or Barge
4. Manned Control Room or Operator Station
5. Berth Operator
6. Tanker or Barge Operator
7. Portable EDS Switch is in a Pendant Extension Placed on Board Tanker or Barge After Secured and Before Cargo Transfer Begins. Pendant Extension may also include a vigilance (Deadman) Switch
8. Dedicated Discharge Lines May Have a Check Valve as an Option
9. MOV at Loading Arm or Hose (Only required at Group II terminals if line size is greater than 8 in. (20 cm))
10. Manual Valve

DP31If08

EMERGENCY EGRESS

The objective of emergency egress is to insure terminal personnel have a safe/secure means of exiting from the normal work areas on the berth should a fire, explosion or other emergency occur. The guidelines presented in Table 7 meet this objective by providing two escape paths (primary and secondary) to shore from personnel work areas on every pier.

The primary emergency egress route is the day-to-day accessway from normal work areas to shore. Normal work areas are those areas the berth operator would be expected to be in during cargo transfer operations. Areas which the berth operator might visit during mooring and unmooring operations, such as mooring dolphins, are not considered part of the berth operator's "normal" work area. The secondary emergency egress route is defined as a separate accessway, preferably in an opposite direction to the primary egress route, which leads from the normal work areas to shore or to a secondary evacuation point such as a mooring dolphin located 200 ft (60 m) or more from all high fire risk areas.

Table 7 - Design Guidelines for Marine Terminal Egress
(Two Escape Paths From Work Areas to Shore)

PRIMARY ESCAPE PATH(7)		
Route	-	Normal accessway from work areas(1) to shore. For breasting islands this is the normal access from the island to the shore, which in emergencies will serve as the primary evacuation point(2) for pick-up by rescue craft(3).
Construction	-	Open grating is acceptable.
Spacing	-	Primary evacuation point for breasting islands shall be at least 200 ft (60 m) from all fire risk areas(4).
Egress Equipment	-	Escape craft(5), emergency cabinet(6), and a reliable communication system shall be provided at the primary evacuation point on breasting islands. No special egress equipment is required along the primary escape route for finder or marginal piers.
SECONDARY ESCAPE PATH(7)		
Route	-	To shore or to a secondary evacuation point in a different, preferably opposite, direction from the primary escape path. Some pier configurations, such as "T" piers, may require more than one secondary escape path. Mooring points/dolphins can be utilized for this purpose.
Construction	-	Open grating is acceptable.
Spacing	-	Secondary evacuation shall be at least 200 ft (60 m) from all fire risk areas.
Water Access	-	Permanent ladder to 3 ft (1 m) below low water level.
Egress Equipment	-	Escape craft, emergency cabinet, and a reliable communication system shall be provided at all secondary evacuation points.
ADDITIONAL EGRESS EQUIPMENT		
Evacuation Ladders	-	Provide permanent ladders to 3 ft (1 m) below low water level at each emergency evacuation point. An emergency cabinet shall be located on the pier within 15 ft (4.5 m) of each ladder.

Notes:

(1) **Work Areas** include operator shelters as well as the manifold, mooring point areas, etc.

(2) **Evacuation Point** is the designated location where personnel continue their escape to shore utilizing a water craft.

(3) **Rescue Craft** shall be reliable, mobile, motor propelled, have a capacity equal to 1.5 times the number of people anticipated to be on the pier which may include maintenance and contract personnel and shall be capable of reaching the evacuation point within 15 minutes of alarm. Existing tugs, environmental launches and mooring launches can be utilized as a rescue craft. A communication system compatible with that at the evacuation points should be provided.

(4) **Fire Risk Area** is normally considered as the loading arm/hose manifold area but shall be expanded to include drainage sumps that are not tightly covered and/or properly vented per Section XV-J.

(5) **Escape Craft** shall have a capacity equal to the number of people anticipated to be on the dock which may include maintenance and contract personnel. Normally, a canister launched inflatable raft will be adequate. However, local conditions or regulations may require more sophisticated equipment.

(6) **Emergency Cabinet** should contain first aid supplies, life jackets, portable alarm devices, survival suits for cold water locations and other emergency equipment that local regulations may require.

(7) Both Primary and Secondary escape paths shall be clearly marked to permit easy identification.

When a mooring dolphin is designated as a secondary evacuation point, evacuation boats should be able to reach the dolphin within 15 minutes of an emergency being declared, or a permanent rescue craft should be provided at the dolphin. Rescue craft may be reliable motor propelled launches, tugs or other vessels with a capacity equal to 1.5 times the maximum number of persons expected on the pier. Canister type inflatable rafts may be used as rescue craft subject to approval by local management and if they are compatible with local conditions and regulations. Permanent ladders should be provided extending to 3 ft (1 m) below low water level at each emergency evacuation point. An emergency cabinet should be located within 15 ft (5 m) of each ladder.

Where the berth layout does not lend itself to installation of a secondary egress route, the primary egress route may be acceptable as the only emergency egress provided that the following provisions are met.

1. The primary egress route does not pass through a high fire risk area.
2. The safety aspects of a single emergency egress route has been reviewed and a risk assessment with appropriate mitigating and preventive measures has been conducted in accordance with the site's normal OIMS procedures.

The escape paths must be clearly marked to permit easy identification. Table 6 contains guidelines for minimum egress capability and the associated facility/equipment requirements. Factors such as harbor congestion, environmental conditions/tides, proximity to shore and local regulations may increase or decrease the facility requirements.

EGRESS APPLICATION EXAMPLES

Shown in Figure 9 is the application of the emergency egress guidelines to a shore connected finger pier and a breasting island. For these examples, the secondary emergency egress is an evacuation point. Shown in Figure 10 for a marginal pier is an example of a secondary emergency egress route that is a fixed accessway connected to shore.

Shown in Figure 11 is an example of the use of only a primary emergency egress route that does not pass through a high-risk fire area.

Figure 9 - Emergency Egress Example Applications Shore Connected Finger Pier & Breasting Island

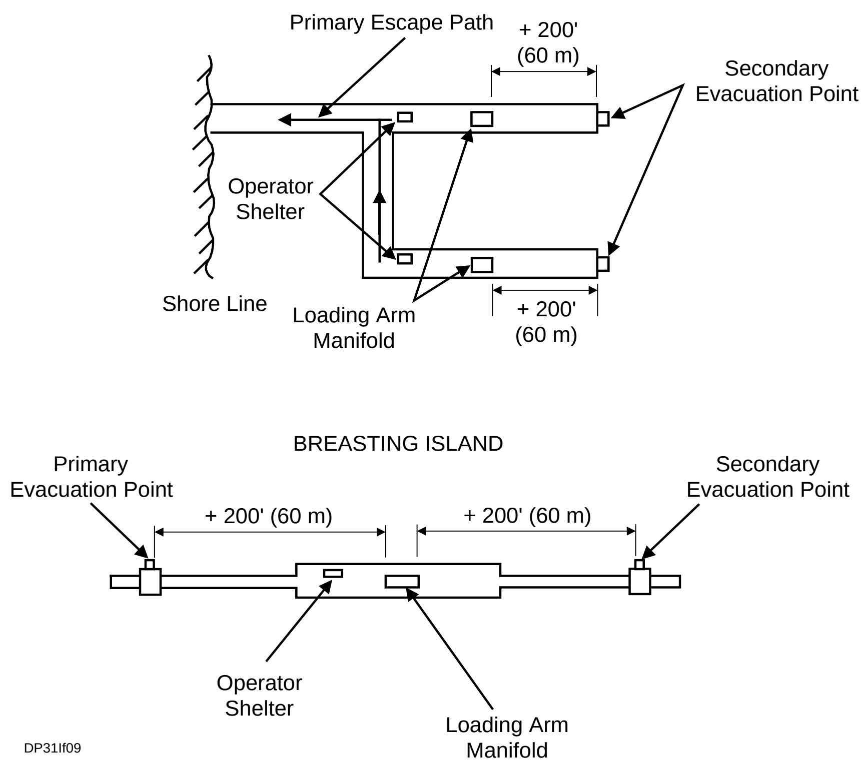


Figure 10 - Emergency Egress Example Applications Shore Connected Marginal Piers

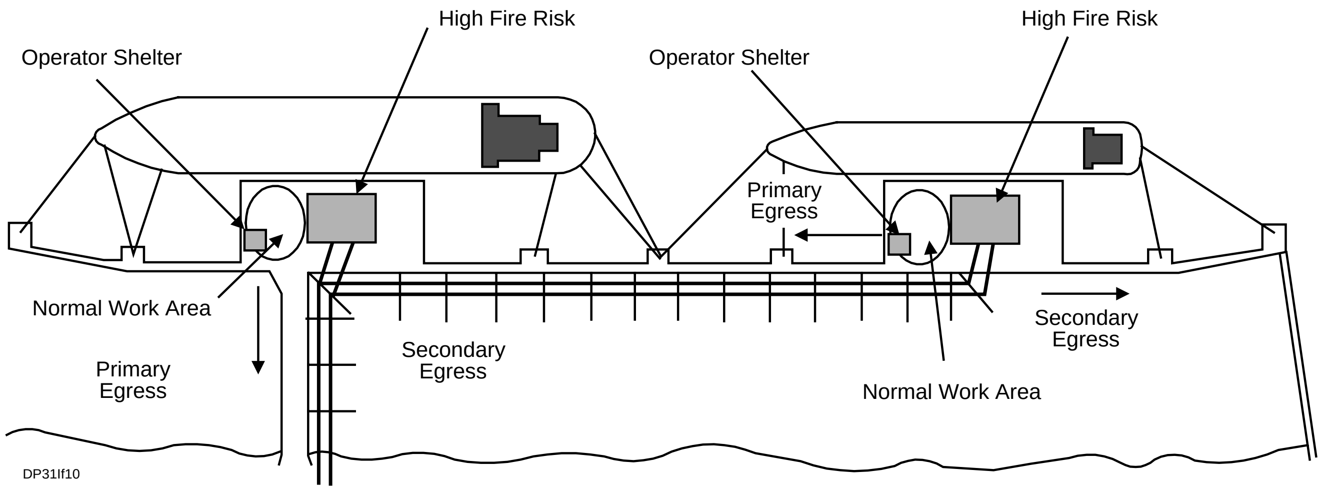
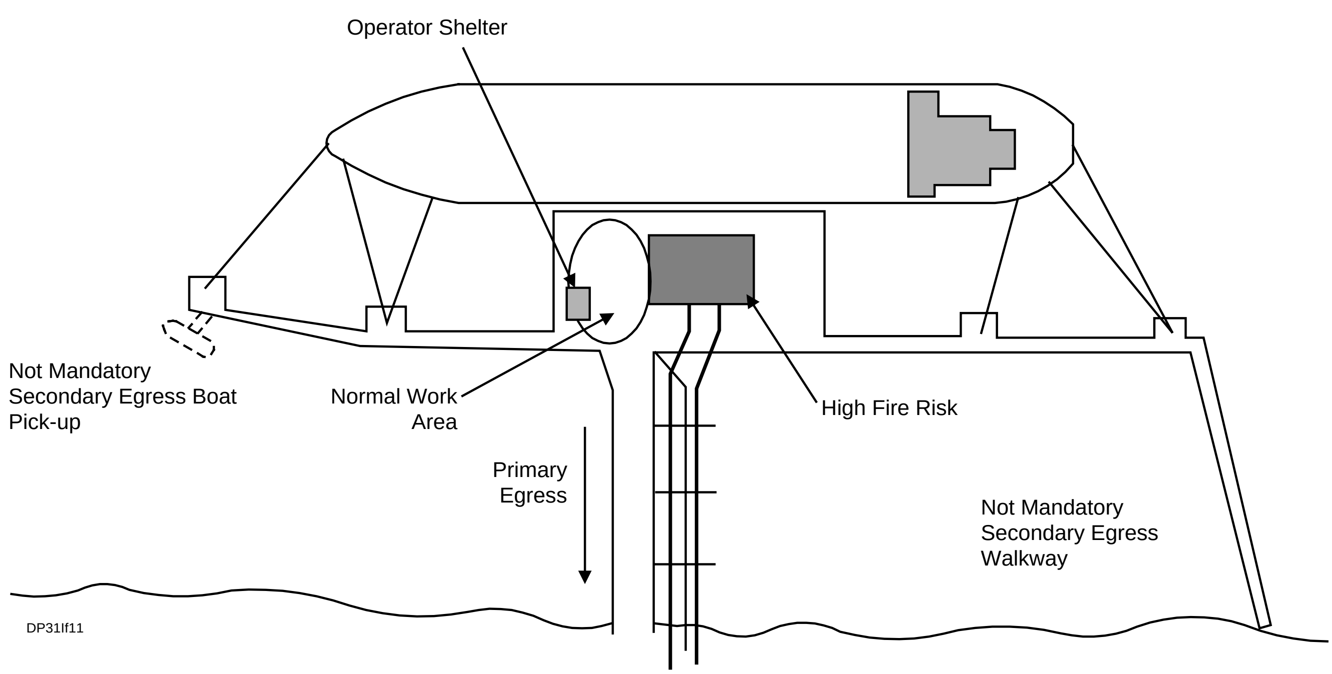


Figure 11 - Emergency Egress Example Applications Shore Connected Marginal Pier



PROTECTIVE SYSTEMS AND MONITORING EQUIPMENT

There are a number of protective systems and monitoring equipment that can be used to help prevent fires/explosions and/or limit the size of a product spill during cargo transfer operations. The equipment and systems can be used singly or in combination. A brief discussion of the various proven and unproven protective systems and monitoring equipment is as follows:

Emergency Release System (ERS)

ERSs are recommended for LPG loading arms. They allow for a rapid dry break disconnection from the marine vessel's cargo manifold. ERSs should be activated automatically by a range monitor when the vessel exceeds allowable motion along or off the pier. Provisions should also be provided to allow the operator to activate the system by a remote button (see DP XXXI-F).

ERSs are considered the final means to protect the arm from damage due to excessive vessel motion. Also, disengagement of a loading arm by an ERS is a significant event. Therefore, EMRE does not recommend activating ERSs by other protective equipment, such as anemometers.

Loading Arm Range Monitors

Range monitors have been in use on loading arms to detect excessive vessel motion in the berth. The most common means employ limit switches, both to measure movement off berth and up/down the berth. Sonar or ultrasonic sensors are alternatives to limit switches to detect ship movement off the berth (drift off). These kinds of sensors have the advantage of being able to be set to alarm at the same degree of horizontal motion regardless of the vessel's deck elevation. In some instances, and where passing ships are not a problem, limiting monitoring to drift off with sonar or ultrasonic sensors may be sufficient.

Dual range monitoring systems are recommended. When the inner zone is violated, an audible and visible alarm occurs. When the outer zone is violated, a signal can be sent to automatically activate other protective equipment, such as emergency release systems (ERSs) and emergency block valves (EBVs).

Range monitors provide a rapid detection of vessel movement. When used in combination with ERSs, a dry break capability from the vessel's manifold is possible, thereby avoiding spills, fires and explosions.

Anemometers

At many berths, the safety of the moored ship is effected by winds. For this reason, anemometers are recommended to record the wind speed and direction and to sound alarms. One recent innovative application of anemometers is to use the high wind signal to automatically activate EBVs and shut shore pumps. It also can be a low wind alarm to warn of still air conditions.

ADDITIONAL CONSIDERATIONS FOR SITES USING ROVING OPERATORS

Certain terminals have previously adopted a "Roving Operator" concept to reduce manning and OPEX costs. In 1996, a workgroup of managers from these terminals reviewed their manning practices and site experience, and reconfirmed that terminals can be safely operated with reduced manning provided certain safety, control, and surveillance systems are in place.

The roving operator differs from a full time operator primarily during the cargo transfer period. During cargo transfer, physical presence of the operator on the berth is limited to periodic short visits of 5-15 minute length every 1 to 2 hours. This permits one operator to cover multiple berths (2-3 berths if separated, or 3-4 berths if clustered), or cover one berth along with offsite/tank farm duties. Roving operators provide the same pre-transfer and post-transfer duties as a traditional full-time berth operator.

The roving operator concept relies in part on the full-time presence of one person from the vessel crew to remain within close proximity of the manifold area. Therefore, it is important that the responsibilities of the operator and vessel crew are defined, documented and understood and that interface of responsibilities is clear.

The roving operator concept also relies on equipment/systems linked to a permanently manned control room to effectively replace the observational and response capability offered by a full-time berth operator, and to control risks to acceptable levels. For terminals considering use of the roving operator concept, it is recommended that specific equipment requirements be evaluated based on risk assessment. Minimum safety, control, and surveillance system requirements recommended by the workgroup are shown in Table 8.

Table 8 - Safety, Control & Surveillance Systems for Roving Operators

A.	Emergency Shutdown System for Berths and Terminal
B.	Shore Operations Pendant (provided to vessel) • Cargo Transfer Start/Stop • Shore ESD Activation • Crew Vigilance (timed alarm)
C.	Ship-Shore Communication System
D.	Anemometer (for wind monitoring)
E.	Slop/Sump Tank Remote Level Control & Monitoring
F.	Closed Circuit Camera Surveillance System
G.	Hydrocarbon Vapor and Fire Detection System
H.	Remote Controlled Firewater System
I.	Loading Arms with ERS (for Liquefied Gas)