



GS 138-3

MARINE LOADING ARMS

November 1994

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BP GROUP RECOMMENDED PRACTICES AND SPECIFICATIONS FOR ENGINEERING			
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MARINE LOADING ARMS (Replaces BP Engineering CP 52 Sections 26-34)			
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SCOPE AND PURPOSE This document specifies general requirements for steel articulated marine loading arms for liquid, liquidified gas and vapour services in petroleum and petrochemical installations. Its purpose is to guide the purchaser's professional engineer and the supplier through the process of procurement, manufacture, installations, testing, commissioning and operation of new loading arm installations refurbishment of existing equipment.			
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FOREWORD

Introduction to BP Group Recommended Practices and Specifications for Engineering

The Introductory Volume contains a series of documents that provide an introduction to the BP Group Recommended Practices and Specifications for Engineering (RPSEs). In particular, the 'General Foreword' sets out the philosophy of the RPSEs. Other documents in the Introductory Volume provide general guidance on using the RPSEs and background information to Engineering Standards in BP. There are also recommendations for specific definitions and requirements.

Value of this Guidance for Specification

This Guidance for Specification defines requirements for the design, selection and supply of marine loading arms based upon BP's knowledge and experience worldwide and application of the Oil Companies International Marine Forum (OCIMF) - 'Design and construction specification for marine loading arms'. Currently OCIMF is understood to be considering a revision to its specification and BP would anticipate withdrawal of this Guidance on publication of the new OCIMF document.

Application

This Guidance for Specification is intended to guide the purchaser in the use or creation of a fit-for-purpose specification for enquiry or purchasing activity.

Text in italics is Commentary. Commentary provides background information which supports the requirements of the Specification, and may discuss alternative options. It also gives guidance on the implementation of any 'Specification' or 'Approval' actions; specific actions are indicated by an asterisk (*) preceding a paragraph number. Resolution of the 'Approval' actions is the responsibility of the purchaser's professional engineer.

This document may refer to certain local, national or international regulations but the responsibility to ensure compliance with legislation and any other statutory requirements lies with the user. The user should adapt or supplement this document to ensure compliance for the specific application.

Principal Changes from Previous Edition

The principal change from the previous edition (BP Std 178) is the requirement on general liquid service for an emergency release coupling incorporating a single isolating valve in the vertical section of the triple swivel. Previously, the quick connect/disconnect coupler was relied on for emergency release, but, it was found to be relatively slow to release and caused clashing of flanges.



Feedback and Further Information

Users are invited to feed back any comments and to detail experiences in the application of BP RPSE's, to assist in the process of their continuous improvement.

For feedback and further information, please contact Standards Group, BP International or the Custodian. See Quarterly Status List for contacts.



1. GENERAL

1.1 Introduction

Marine loading arms are vital items of terminal equipment. Their design involves many different engineering specialisms, including stress analysis, materials, mechanical, electrical, hydraulic, and surge analysis. Apart from the fundamental product transfer duty, the design must account for the overall process system design, vessel details and behaviour, climatic effects, mooring practices, operating and emergency procedures, safety issues and protection of both the environment and the assets.

For most services the duty will require electro-hydraulic articulated marine loading arms, capable of accommodating all relative ship movements within a defined envelope and safely separating under controlled conditions in an emergency without loss of product.

As loading arm technology continues to evolve, this specification reflects the complexity of the equipment and the many lessons learned to date in its operation. With precision equipment of this nature the achievement of minimum operating costs depends not only on meeting high quality specifications for design and manufacture, but also on subsequent standards for maintenance. Whilst this Specification assumes a satisfactory level of maintenance, design cautions are included to minimise the risks from potential shortcomings.

1.2 Scope

This Specification covers general requirements for all new steel articulated marine loading arms for liquid, liquefied gas and vapour services in petroleum and petrochemical installations.

It may be used for the assessment and modification of existing loading arms subject to a review of the limitations imposed by the original design and any subsequent amendments, and the present condition of all relevant components.

1.3 Alternative Designs

* Alternative designs to those prescribed will be acceptable provided that it can be shown to the satisfaction of the purchaser that the required performance and function can be attained.



1.4 Quality System

Verification of the vendor's quality system is normally part of the pre-qualification procedure, and is therefore not specified in the core text of this Specification. If this is not the case, clauses should be inserted to require the vendor to operate and be prepared to demonstrate the quality system to the purchaser.

Further suggestions may be found in the BP Group RPSEs Introductory Volume.

2. DESIGN

2.1 General

2.1.1 Design codes to be applied shall be as follows :

Parts containing process fluids (cargo, vapour return, ballast, etc.) shall conform to [ANSI B31.3](#) and/or [ASME Pressure Vessel Code](#) Section VIII Division 1 and Section IX or [BS 5500](#) as appropriate.

Structural parts (which may include parts containing process fluids) shall conform to the AISC codes, particularly [AISC S328](#), or [BS 5950](#).

Hydraulic systems shall conform to BP Group [GS 134-1](#).

2.1.2 The vendor shall determine the configuration of the arms to meet the operating envelope and simultaneous connection requirements. Vessel drift along and off the jetty shall be assumed to occur simultaneously.

2.1.3 Arms shall be fully balanced in all attitudes when empty.

This is common practice since it normally results in the least expensive design for both the loading arm and the foundation works. However, some existing loading arms may be balanced when full. The vendor may offer new designs to be balanced full if significant advantages can be demonstrated.

2.1.4 Connection to the vessel manifold shall be bolted, hydraulic quick connect/disconnect coupler (QCDC) or manual coupler as specified by the purchaser.

2.1.5 All marine loading arms shall be provided with a hydraulically operated emergency release system (ERS).

The ERS is required to provide;

- (a) *reduced health hazards,*
- (b) *environmental protection, and*
- (c) *asset protection (jetty equipment and vessel).*

For small diameters (not exceeding 150 mm), and in very sheltered waters, consideration may be given to omission of the ERS and adoption of manual



operation. This will only be permissible for the transfer of wholly non-hazardous products, or very low risk products, and subject to a full quantified risk assessment to confirm the acceptability of the proposal.

All new loading arms having emergency release systems (ERS) shall be manoeuvred hydraulically.

Following an emergency release the loading arm will be full of liquid, which even with a small diameter (say 150 mm), is not easy to manoeuvre manually. Since hydraulic power is required to achieve the emergency functions (including raising of the arm), it is cost effective to provide hydraulic power for the additional normal manoeuvring functions. Furthermore hydraulic is safer than manual manoeuvring when the loading arm is full of product.

2.1.6 Interchangeability of loading arm components should be provided for each bank of arms.

2.1.7 When stowed, no portion of the arm shall extend beyond the jetty edge.

The geometry of the loading arm should provide adequate clearance between the edge of the jetty and the manifold end of the stowed loading arm. It should be recognised, however, that such a clearance may not afford complete protection during berthing or departure of a vessel.

2.1.8 Arm movements shall allow the outboard arm triple swivel to be positioned on the jetty or on an elevated platform for maintenance. A working area of 1 m minimum clear space around the triple swivel shall be provided. Maintenance and access facilities are required for the apex and inner swivel.

2.1.9 The vendor shall perform clash checks on any adjacent arms and shall state the minimum clearances, and locations, for the worst stowed, operating and maintenance positions. The vendor shall review the jetty layout drawings to establish clearances with new and existing equipment.

Whilst the overall responsibility for clash checking may rest with the main contractor it is important to ensure that the vendor is involved as soon as possible in developing layouts. Particular attention should be given to the location of the counterweights.

2.2 Operating Envelope

2.2.1 A typical operating envelope for a single loading arm is shown in Figures 1 and 2. It is based on the location of the ship's flange, tidal changes, ship's draft and drift along and off the jetty. The drift area (shaded) within the operating envelope represents, in both plan and elevation, the range of operating movements of the ship's flange which will not initiate an alarm.



2.2.2 It is recommended that the purchaser establishes the main operating envelope parameters prior to specification for enquiry or purchase as shown in Figures 3 and 4. These details should be entered on Data Sheets 1 and 2.

2.2.3 The spacing between maximum reach and stage 3 alarm depends on the vessel drift off rate and the opening time for the emergency release coupling (ERC). The spacing between stages 2 and 3 depends on the vessel drift off rate and the ERS valve(s) and emergency shut down (ESD) valve(s) closure times. Stage 1 location is a compromise between having a maximum sized drift area and the earliest warning of a problem which may lead to a shut down.

Note that ESD valve(s) are not within the scope of supply for marine loading arms.

2.2.4 The vessel drift off rate shall be 150 mm/s.

This rate is normal for open and exposed locations. A lower drift off rate may be agreed for protected or enclosed locations.

2.3 Stress Analysis

2.3.1 The vendor shall submit stress and deflection analyses for the loading arms in all arm conditions.

2.3.2 The allowable tensile stress in the loading arm is given by multiplying the basic allowable stress with the stress factor K (see Tables I and II). The basic allowable stress shall be the lower of either 0.29 x tensile strength or 0.49 x yield strength of the material in the annealed condition. Tensile and yield strength data shall be the smaller of the published range of values for the relevant ambient and design temperatures.

2.3.3 Pressure loads (PLD and PLT) shall be based on the design and test pressures stated by the purchaser on Data Sheet 3.

2.3.4 Fluid load (FL) shall be based on:-

(a) 1.03 specific gravity (seawater) for arms in general liquid service.

or

(b) The specific gravity of the product for arms in liquefied gas or liquid chemical service, and the test medium used in factory acceptance tests.



- 2.3.5 Wind load (WL) shall be based on a design wind speed U (m/s) calculated for the most unfavourable wind direction:-

$$U = V \bullet \left[\frac{z}{10} \right]^{\frac{1}{7}}$$

where

V = specified wind speed (3 second gust) at 10 m above lowest water as given on Data Sheet 2 (m/s).

When not given on the Data Sheet, a wind speed of 45 m/s shall be used for the stored attitude.

z = height above lowest water (m).

Wind pressures acting on the loading arm in the direction of the wind shall be calculated from:-

$$P = 0.64 \bullet U^2 \bullet C_f$$

where

P = wind pressure (N/m²) at z (m) above lowest water.

C_f = shape factor, 0.7 for cylindrical surfaces, 2.0 for rolled shapes or rectangular surfaces.

For values of z smaller than 10 m, linear interpolation may be used between P at 10 m and 60% of that value at lowest water level.

- 2.3.6 For general services in cold climates where temperatures fall below freezing, the self weight (DL) shall include an allowance for 6 mm of ice (unless otherwise specified) on all surfaces in any arm position.

For liquefied gas services, self weight (DL) and wind load (WL) shall include an allowance of 25 mm of ice on all product lines. In cold climates, as above, there shall be an additional allowance of 6 mm of ice (unless otherwise specified) on all surfaces in any arm position (ice specific gravity = 0.80).

- 2.3.7 Earthquake loads (EL) when specified shall be considered to act on the arm in the stowed position, in directions parallel and perpendicular to the jetty face.

- 2.3.8 Thermal loads (TL) shall be based on the maximum difference between ambient and the product temperature, with consideration given to solar radiation where applicable.



- 2.3.9 For liquefied gas arms, the vendor shall state the temperature profiles assumed across fluid and structural members. Stress analysis shall be performed on integrally reinforced fluid members in both steady state and during rapid cool down.
- 2.3.10 Stress intensification factors for elbows and pipe bends shall be as per [ANSI B31.3](#). Correction factors for flanged ends shall be restricted to arc angles of 90 degrees or less and two flanges maximum. Swivel outer raceways and stiffening rings may be considered equivalent to a flange.
- 2.3.11 The implications of strength reduction in weld areas shall be examined.
- 2.3.12 Wire ropes shall comply with [BS 302](#) and shall have a minimum safety factor of 5 based on the minimum breaking strength for all design conditions. The arm stress analysis shall take account of all rope loads, including pre-tensioning.
- 2.3.13 This Specification is based on a steel manifold to [ANSI B31.3](#), with Class 150 flanges, and otherwise in accordance with the appropriate OCIMF series of 'Recommendations for Tanker Manifolds' according to the product carried. (See details in Appendix B.) If other conditions are required then the purchaser shall define these on Data Sheet 1.
- The vendor shall ensure that the loads transmitted to the ship's presentation flange under all circumstances are limited to the maxima given in the appropriate OCIMF 'Recommendations for Tanker Manifolds'. In particular, where an ERS is required, the loads shall be determined with account taken for the ERC components which remain attached to the manifold in an emergency disconnection.

2.4 Swivel Joints

- 2.4.1 Swivel joint assemblies shall permit re-packing without dismantling major sections of arms. The triple swivel is the only exception to this.
- 2.4.2 Swivel joints shall have ball or roller bearings.
- 2.4.3 The triple swivel, support device, coupler and valving, shall be balanced so that the outboard flange remains in the vertical plane for all arm attitudes.
- 2.4.4 Combined swivel design load PCA is given as a static axial load based upon the most critical arm attitude and combination of loads (see Tables I and II).



$$PCA = FA + \frac{5M}{d} + 2.3 FR \tan A$$

where

FA = total axial load (N) (the absolute value of the sum of axial fluid pressure and the externally applied axial load).

M = externally applied bending moment (Nm).

d = raceway diameter (m).

FR = radial load (N).

A = contact angle (the angle between the plane of the balls/rollers and the centre of contact at the raceway interface).

2.4.5 Swivel joints shall also be designed with test load factors (TLF) applied to PCA (see 7.5).

2.4.6 Where the product temperature prevents the use of lubricating grease, the swivel joints shall include a nitrogen purge system. The nitrogen shall circulate through each swivel joint and onto the adjacent swivel joint in a series type system, with final controlled exhaust to atmosphere unless otherwise stated.

2.4.7 All swivel joints shall prevent water ingress, but this is particularly important where the swivel joint operating temperature would cause such water to freeze.

2.4.8 Swivel joint seals for liquefied gas shall accommodate temporary vacuum conditions and reseal properly afterwards.

2.5 **Emergency Release System (ERS)**

2.5.1 All Services

* 2.5.1.1 The ERS shall comprise an emergency release coupler (ERC) and associated isolating valve(s) mounted as low as practicable on the outboard arm. ERS selection shall be subject to purchaser approval.

2.5.1.2 The ERC shall be positioned in the vertical section of the triple swivel assembly in order to minimise the forces at the coupling faces during disconnection. It is not acceptable to utilise a QCDC for ERC duty because the emergency arm movements cause mechanical clashes and the operating time is generally excessive.



Ships manifolds to OCIMF recommendations have vertical presentation flanges, thus arm movements in an emergency disconnect using a QCDC would cause damage to the gasket and flange faces and possibly give rise to sparking.

- * 2.5.1.3 All isolating valves shall be ball type, with a liner in the case of a hollow ball. Reduced bore valves are preferred (because of weight saving) where the associated increase in pressure drop is acceptable. However, butterfly valves may be acceptable for general liquid service in accordance with 2.5.2.2. Whilst these isolating valves are usually part of an integral proprietary ERC design, as far as possible they should comply with the requirements of 2.7.4.7 and all deviations must be advised for approval by the purchaser.
- 2.5.1.4 Valves shall be hydraulically actuated, the design closure time shall be 5 seconds adjustable up to 15 seconds. The emergency release coupler (ERC) release time shall not exceed 2 seconds.

The ERS valve closure time may be set according to the results of a surge analysis (carried out by others), whether products are being loaded or offloaded or both, and also whether loading arms are to accommodate surge pressures. The closure time and the drift off rate must be compatible with the spacing of the envelope stages. When offloading a vessel consideration must be given to the negative surge effects, on the loading arms and the downstream system, of an emergency shutdown of valves.

The release time is measured between receipt of the Stage 3 signal and complete opening of the coupling.
- 2.5.1.5 On actuation of the ERS, the arm(s) shall automatically rise clear by a minimum of 2 m above the ERC level in a controlled manner, without risk to personnel and with the arm(s) full or empty of product. It shall not be possible for the arm(s) to fall onto the manifold deck during or after completion of this operation. The vendor shall state for approval the separation velocities for one arm and all arms, for both an electro-hydraulic and pure hydraulic (accumulators) separation.
- 2.5.1.6 The ERC must be fully open and released before the loading arm extends to the maximum reach position (see Figure 1) at the vessel drift off rate given in 2.2.4.
- 2.5.1.7 The ERC shall be operated by a double acting hydraulic cylinder.
- 2.5.1.8 In the event of hydraulic or electric power failure, the ERC shall remain securely closed.
- 2.5.1.9 The ERC release mechanism shall incorporate a shear pin to protect against accidental manual activation.



- 2.5.1.10 The ERC and arm components remaining on the ship after release shall not fall onto the ship's deck or manifold service platform. Coupling components shall be restrained to prevent impact with adjacent arms.
- 2.5.1.11 Unless otherwise specified the vendor shall provide facilities, either separately or as part of the riser, to support the components normally attached to the tanker manifold for routine testing of the ERS.
- 2.5.1.12 The strength of the ERC shall be based on the design equivalent load (LCA), which is the maximum combination of design pressure, total axial load, bending moment and shear acting at the ERC for the most critical arm attitude and combination of loads on the loading arm (see Tables I and II). The ERC shall also be designed with test load factors (TLF) applied to LCA (see 7.6).
- 2.5.1.13 Testing of the ERS components and system shall be possible without release of the ERC. Testing devices shall not jeopardise the system release when it is required.
- This test checks the operation of the release cylinder and linkages without separation of the coupling. It should be performed prior to each loading operation.*
- 2.5.1.14 Aids shall be provided in the design to ease and ensure proper reassembly of the ERC after release.
- 2.5.2 General Liquid Service
- 2.5.2.1 Arms on general liquid service shall be provided with a single integral ball valve above the ERC, unless otherwise specified. Where specified with double valves the design shall comply with 2.5.3.
- 2.5.2.2 Robust, offset trunnion type butterfly valves are acceptable in this service provided they are leak tight under all operating conditions. However the wafer type of mounting is not acceptable.
- 2.5.3 Liquefied Gas and Toxic Service
- 2.5.3.1 Arms on toxic or liquefied gas service shall be provided with double ball valves, one provided on either side of the ERC.
- 2.5.3.2 The trapped volume between the valves shall be minimised to limit spillage on release.
- 2.5.3.3 Double ball valves shall be mechanically linked to ensure simultaneous closure. Valves shall be closed prior to ERC release. The link shall allow clean separation after ERC release.



- 2.5.3.4 The ERS shall ensure the product line cannot separate before the 'piggy back' vapour return line where fitted.
- 2.5.3.5 'Piggy back' vapour return lines having spring loaded double check valves may be proposed.
- 2.5.3.6 For cryogenic duties, the ERC shall incorporate self energising features to ensure break-out of any ice formation.

For these duties ice formation is greater in humid conditions and the maximum depth has been found to be 25 mm. See section 2.3.6 for ice specific gravity.

- 2.5.3.7 The ERS valve linkages shall be designed to prevent unplanned release of the ERC during valve operation, as a result of improper alignment on assembly.

2.6 Quick Connect/Disconnect Coupler (QCDC)

- 2.6.1 QCDC clamps shall operate simultaneously on closing and opening.
- 2.6.2 In the event of hydraulic or electric power failure, the QCDC shall remain securely fastened to the tanker manifold. Designs relying on hydraulic pressure to remain clamped are unacceptable. A manual release shall be provided.
- 2.6.3 Aligning and centring devices shall be provided based on the sizes of flanges to which the coupler will connect.
- 2.6.4 The coupler shall have a flange rating to [ANSI B16.5](#) or [BS 1560](#), Class 150 minimum and have a flat face.
- 2.6.5 The coupler shall mate with [ANSI B16.5](#) Class 150, [BS 1560](#) Class 150 and [DIN 2633](#) weld neck or slip on flanges, flat faced or raised face, and provide the following dimensional tolerances.

Flange Size (in)	OD (mm)	ID (mm)	Thickness (mm)
10 and smaller	± 1.6	+ 0.8, - 1.6	+ 3.2, - 0
12 to 18 incl.	± 1.6	+ 1.6, - 1.6	+ 3.2, - 0
20 to 24 incl.	± 1.6	+ 3.2, - 6.35	+ 4.8, - 0
larger than 24	± 3.2	+ 3.2, - 6.35	+ 4.8, - 0

- 2.6.6 Coupling and uncoupling operations and isolation shall be possible from the pendant control unit.
- 2.6.7 The coupler shall be designed to hold a flange cover. This cover shall be designed to support the static fluid pressure. An NPS 1/2 (DN 15) drain connection shall be provided on the cover.



- 2.6.8 Lubrication of all moving parts shall be possible without dismantling the coupler.
- 2.6.9 Coupler strength shall be based on the design equivalent load (LCA) which is a maximum combination of design pressure, total axial load, bending moment and shear acting at the coupler/tanker manifold for the most critical arm attitude and combination of loads on the loading arm (see Tables I and II). The internal fluid pressure shall be 19 bar (ga) (275 psig) minimum, or the specified design pressure, whichever is higher. The QCDC shall also be designed with test load factors (TLF) applied to LCA (see 7.7), with the minimum number of clamps in tension.
- 2.6.10 Positive indication shall be provided to enable the operator to ensure the coupler is properly locked after connection to the vessel manifold.
- 2.6.11 It shall not be possible to release the QCDC while loading is in progress.
- 2.7 Accessories**
- 2.7.1 Storm Locks
- 2.7.1.1 All loading arm functional movements shall be lockable in the stowed position, and shall remain secure for the worst load conditions. Stowing locks shall be easily released and operable by one person.
- 2.7.1.2 It shall be possible to lock the slew motion when in the maintenance position.
- 2.7.1.3 Locks shall not be engageable during normal operation.
- 2.7.1.4 Any hydraulic locks shall be manually operated and independent of the control system.
- 2.7.1.5 System pressure relief valves shall operate if movement is attempted whilst the locks are engaged.



- 2.7.2 Supports (Jacks)
- 2.7.2.1 Permanently attached, adjustable supports shall be included on all arms where, without them, loads at the ship's presentation flange would exceed the limits given in 2.3.13.
- 2.7.2.2 It shall not be possible for the base of the supports to retract above the lowest protrusion of the loading arm coupling. The support shall extend 1.4 m below the manifold centre line.
- 2.7.2.3 Supports shall be mounted such that the loading arm is free to move with the vessel to which it is connected.
- 2.7.3 Stray Current Protectors
- 2.7.3.1 An insulating flange shall be provided in the outboard end of the arm, to isolate electrically the tanker from the loading arm. It shall be located where it cannot contact the tanker structure.
- * 2.7.3.2 Design details of insulating flanges shall be submitted for approval by BP. Gaskets used in the insulating flange shall project approximately 3 mm into the flange bore.
- 2.7.3.3 The annular space at the flange outside diameter shall be filled with non-conductive material and wrapped to prevent penetration of moisture and paint. Insulating materials used shall be impervious to moisture and shall be compatible with the product properties and temperatures.
- 2.7.3.4 Insulating non-metallic hose shall be used in any systems that bridge the insulating flange.
- 2.7.3.5 The electrical resistance between the shore side flange and the outboard end of the freely suspended arm, shall be measured in dry conditions; both at the works and once installed. The resistance of the insulating flange, including all hoses bridging the flange, shall exceed the following values:
- | | |
|--|------------------------|
| At the works | - 10,000 ohms at 1000V |
| After installation and hydrostatic testing | - 1,000 ohms at 20V |
| When the arm is in service | - 1,000 ohms at 20V |
- 2.7.3.6 The insulating joint shall comply with the strength and safety requirements of section 2.3.



- 2.7.4 Valving, Flanges and Connections
- 2.7.4.1 Valved drain connections shall be provided, one on the lowest point of the outboard arm, one immediately above the upper ERS valve and one on the riser, so the arm can be completely drained before disconnection. Outboard arm drains shall have an outer cover to protect against damage but not prevent removal of the valves for maintenance. The size of the drain connections shall be based on the size of the loading arm, but shall not be less than NPS 2 (DN 50) on the riser or NPS 1 (DN 25) on the outer arm. All connections shall be flanged and provided with blanks. NPS 1 connections shall be reinforced.
- 2.7.4.2 A drain valve shall be provided to monitor isolating valve leakage at the ERC during routine pressure testing.
- 2.7.4.3 Stainless steel vacuum breakers shall be provided at the apex of all loading arms that do not have an inert gas purge. Vacuum breakers shall be ball or plug type, sized to give a short run-down time, and fitted with stainless steel non-return valves that function properly in all arm positions. Operation of the vacuum breaker shall be from the manifold end of the loading arm, via a rubber sheathed wire rope for the first 2 m and synthetic rope for the remainder. A method for indicating the position of the vacuum breakers shall also be provided at the manifold end of the arm.
- 2.7.4.4 Liquefied gas arms shall have a nitrogen purging connection at the apex, plus stainless steel piping and valving extending to the base of the riser.
- 2.7.4.5 All flanges shall be to [ANSI B16.5](#) or [BS 1560](#) Class 150 minimum, with the outboard flange flat-face and riser connection raised-face. Bolting shall comply with BP Group [GS 142-9](#). Gaskets shall comply with BP Group [GS 142-7](#).
- 2.7.4.6 Neither bellows nor hoses shall be used in product lines. Hoses may be acceptable for vapour return lines.
- 2.7.4.7 Gate, globe and check valves shall comply with BP Group [GS 162-1](#). Ball valves shall comply with [BS 5351](#) or [API 6D](#) and shall be trunnion mounted for sizes greater than [DN 150](#). Valves for refrigerated liquefied gas services shall comply with [BS 6364](#).
- Soft seated valves shall exhibit no visible leakage when tested at 1.1 x rated pressure. Metal seated valves shall be in accordance with [BS 6755](#) Part 1, Rate C.



2.7.4.8	A stripping system and pump for draining the inboard arm and the riser into the outboard arm shall be provided when specified on Data Sheet 2.
2.7.5	Lubrication
2.7.5.1	Lubrication of all equipment shall be possible without dismantling.
2.7.5.2	Lubrication points shall be accessible in the stowed and maintenance positions. Components that are not readily accessible shall be served by a central lubrication system.
2.7.5.3	Readily visible, lubrication relief ports shall be provided.
2.7.5.4	Grease cartridges shall be easily installed by one man from the jetty or maintenance platform.
2.7.5.5	The lubrication system shall be filled with the required grease prior to site acceptance of the loading arms.
2.7.5.6	Grease lines and fittings shall be of austenitic stainless steel, and shall be at least NPS 1/2 (DN 15) in order to ensure an adequate supply of grease to all lubrication points at the ambient temperature of the installation.
2.7.6	Steel Structures, Access Ladders and Platforms
* 2.7.6.1	Ladders and platforms shall be provided for maintenance access to the trunnion and apex swivels and associated equipment, where these are inaccessible from the jetty deck. Their design shall be subject to approval by the purchaser.
2.7.6.2	Platforms shall be open grid type, made of welded or pressed steel and designed for a superimposed load of 5 kN/m ² (100 lb/ft ²) with a deflection not exceeding 9.5 mm. They shall be hot dip galvanised. The width of the opening shall not exceed 25 mm. Rectangular pattern tread is preferred with 5 mm thick main bearing bars. In all other respects they shall comply with BS 4592 .
* 2.7.6.3	Provision shall be made for earthing, which will be subject to approval by the purchaser.
2.7.7	Thermal Insulation
2.7.7.1	Materials for thermal insulation shall comply with BP Group GS 152-1 .
2.7.8	Lifting Equipment



- 2.7.8.1 Lifting gear must be certified to the statutory requirements of the country of installation. Lifting hooks shall have safety latches fitted. Lifting points shall be provided to assist installation and maintenance of the loading arm.

2.8 Fire Resistance

ERS hydraulic components and valves shall be protected against fire so that they remain fully operable for 1.5 minutes at 1100°C and 10 minutes at 350°C.

Other valves incorporating plastic or elastomeric seats or seals, which are located in fire hazard areas, and which are on flammable or toxic service, shall be of a fire tested design, certified in accordance with [ISO 10497](#), [BS 6755](#) or [API 6FA](#).

3. HYDRAULIC POWER SYSTEMS

3.1 General

- 3.1.1 When hydraulically powered arms are specified, a common hydraulic power system shall be provided for all arms as specified. The power system shall be designed for:-

- (a) Luffing of the inboard and outboard elements of the arms.
- (b) Slewing.
- (c) Clamping and releasing of the ERC and QCDC when supplied.
- (d) Operation of ERS valves.
- (e) Raising the arms following an emergency release.
- (f) Maintaining a power reserve for ERS operation during an electrical failure.

- 3.1.2 The control system shall include a freewheeling facility.

The freewheeling mode is required to accommodate the six degrees of movement of a berthed vessel.

- 3.1.3 The hydraulic system shall prevent damage to the equipment if the vessel should move whilst the arms are partly or fully connected to the manifold and still under hydraulic control.

Pressure relief valves for this duty, must be capable of passing the maximum hydraulic fluid flow, at the relieving pressure. The flow will be related to a vessel moving at the speed stated in 3.1.8 (d).



- 3.1.4 The hydraulic system shall prevent cavitation of the hydraulic fluid in the low pressure side of the actuators during testing of the ERS, freewheeling and the condition discussed in 3.1.3 above.
- 3.1.5 There shall be sufficient relief valves to protect the loading arms, including the hydraulic system, from damage during normal operation and emergency release or due to maloperation, malfunctioning, hydraulic or electric power failure.
- 3.1.6 In the event of hydraulic or electric power failure, the control system shall allow the arms (whilst full of product) to be returned from any position to the stowed position either manually, or by means of a secondary manually operated hydraulic pump.
- 3.1.7 The hydraulic power pack shall incorporate two 100% duty electro-hydraulic pumps, one being a standby. The power pack shall be weatherproof and fitted with twin (2 x 100%) 25 micron replaceable element strainers in the return line. A 12 micron (nominal) pressure filter with replaceable element, a high pressure bypass and clear/blocked indicators shall be provided in the pressure line. Suction strainers shall be fitted to all pumps. A lockable tamperproof cover shall be provided over the power pack. The reservoir drain shall be located at the lowest point in the base.
- 3.1.8 The hydraulic power pack shall be sized for the following:-
- (a) Wind, self weight, product and ice loads.
 - (b) Swivel and rotating sheaves frictional torque.
 - (c) 10% of values (a) and (b) for efficiency losses.
 - (d) A minimum rate of motion at the outboard swivel joint of 150 mm per second and the resulting acceleration load.
 - (e) Specified requirements for the addition of larger arms on the berth in the future.
 - (f) Lifting at the approved velocities following an emergency release.
 - (g) Manoeuvring to reconnect, or to the stowed position, after emergency release in full and empty conditions with both the complete and reduced weight of the ERS.
 - (h) Raising the full outboard arm above the horizontal to facilitate draining with both the complete and reduced weight of the ERS.
 - (i) ERS and QCDC requirements for coupling and uncoupling.
- 3.1.9 Hydraulically powered arms shall have an independent speed control valve installed in each cylinder line, each of which shall have a lockable tamperproof cover.



- 3.1.10 Where arms are balanced in the full condition, all arm motions shall be provided with a proportional speed control system.
- 3.1.11 Hydraulic cylinders shall be weather and corrosion proofed for a marine atmosphere and fitted with a plug at each end.
- 3.1.12 Hydraulic piping and fittings shall be Type 316 stainless steel or equivalent corrosion resistant material. Pipe runs shall be positioned to avoid mechanical damage. All fittings shall be of a single standard and double ferrule type. All piping shall be securely supported and, where attached to carbon steel, insulated fittings shall be used to avoid corrosion.
- 3.1.13 Hydraulic hoses shall be of the swaged coupling type with working pressure and test pressure clearly marked.
- The use of sealing materials (e.g. PTFE tape) is **STRICTLY PROHIBITED**.
- Sealing materials for threaded hydraulic connections get fragmented on breaking and remaking the joints. This has caused severe operational problems by blocking the ports on spool valves.*
- 3.1.14 Spool type selector valves shall be such that it is impossible to reassemble the valve incorrectly. Spool valves shall be provided with drain ports to prevent their leakage from inadvertently pressurising hydraulic systems such as the ERC or QCDC release.
- 3.1.15 Hydraulic reservoirs shall be fabricated from austenitic stainless steel and shall be provided with a diaphragm. Fill ports shall be provided and fitted with strainers.
- 3.1.16 Hydraulic fluid shall be suitable for operation at a temperature which is at least 15°C below the minimum ambient, taking into consideration wind chill effects.
- Heaters in the hydraulic reservoir are not considered satisfactory for cold climates because they do not transfer any significant energy to the hydraulic fluid in the reticulation.*
- 3.1.17 It shall be possible to isolate each loading arm from all other arms and the hydraulic power pack.
- Isolation is required to allow other arms in a group to operate normally following damage or serious leakage in the hydraulic system of one arm.*



3.2 Emergency Release System (ERS)

- 3.2.1 In the event of hydraulic or electric power failure and where the emergency release system relies on hydraulic pressure, sufficient stored energy shall be provided through pre-charged hydraulic accumulators to activate the ERS, at least one hour after such failure, and raise the arms, either empty or full of product, into a secure position. Separate accumulators shall be provided for each loading arm.
- 3.2.2 Low pressure alarms shall be provided with automatic pump start to recharge the accumulators.

4. CONTROLS

4.1 General

- * 4.1.1 All hydraulically powered arms shall be equipped with:-
- (a) A common central control console, positioned on the jetty to give good visibility of all arms when they are being presented to the tanker, being stowed or parked for maintenance. If visibility is likely to be restricted a pendant control at the console may be proposed.
 - (b) A permanently connected pendant control unit, at the manifold end of each loading arm.
- Where loading arms are to be frequently used portable units can suffer damage to the intrinsically safe connections. Portable pendants may be considered for arms which are expected to be used infrequently.*
- Alternative loading arm remote control systems may be proposed for approval.
- 4.1.2 Pendants shall operate the arms in all motions, operate ball valves and hydraulic couplers where applicable and have a control/freewheel switch.
- 4.1.3 Pendants shall be of robust design and shall securely hold the attached cable. Cable lengths shall be minimised. It shall not be possible to bridge the electrical insulating flange.
- 4.1.4 The design shall ensure that only one arm in the bank can be manoeuvred at a time. When one arm is being manoeuvred all other arms connected to the tanker manifold shall be immobilised.



- 4.1.5 Manoeuvring controls on the console shall be inoperable when the pendant controls are in use, and vice versa. A selector switch shall be provided on the central console that is robust and provides a positive location for each operating position.
- 4.1.6 Motion controls shall return to the hydraulically locked condition on release of the push button controls.
- 4.1.7 Control equipment shall be housed in a weatherproof cabin and easily accessible for maintenance.
- 4.1.8 Pressure indicators shall be provided on the jetty control console to display the hydraulic oil pressure in the arm, QCDC and ERC hydraulic systems, ERS header and control circuits and ball valve hydraulic systems, as applicable.
- 4.1.9 An interlock on the hydraulic control system, based on high liquid level in the riser, shall be provided so that arms not designed for manoeuvring full of product, can only be moved from the stored position when empty. On general liquid service a level gauge shall also be provided on the riser. Indicating lights shall be provided on the control console.

For some duties, e.g. deballasting, there is a possibility of sludge deposits impairing the operation of limit switches, which should be designed and positioned accordingly.

4.2 Overreach Alarm and Shutdown System

- * 4.2.1 Loading arms shall be provided with the following shutdown stages (see Figures 1 and 2):-

Stage 1 - An audible and visual alarm to indicate that the manifold has reached a pre-alarm position in the operating envelope.

Stage 2 - An audible and visual alarm to indicate that the manifold has reached a position in the operating envelope where the closure of the ERS valve(s) is initiated. At this stage initiation of the jetty side isolating/ESD valves closure and the shutting down of product pumps is required. The loading arm control system shall include voltage free output contacts to permit this.

Stage 3 - An audible and visual alarm to indicate that the manifold has reached a position in the operating envelope where the loading arm must be disconnected from the tanker. An independent electrical circuit shall be used to close the ERS valves at Stage 3 (in case of failure to close at Stage 2) before release of the ERC.



The audible alarms for each of the three stages shall be different.

- 4.2.2 The ERS valves shall close at Stage 2 on receiving a signal from both Stages 1 and 2. The ERC shall release on receiving a signal from either Stage 1 or 2 and Stage 3.
- 4.2.3 There shall be an audible and visual alarm if Stage 2 is detected without detection of Stage 1.
- 4.2.4 The alarms shall be on the central control console with repeats in the jetty control room.
- * 4.2.5 The positions of the alarm settings in the operating envelope and the allowance between Stage 3 and the maximum reach shall be agreed with BP.
- * 4.2.6 Stages 2 and 3 may only be combined with BP approval.

This could be necessary where the ERS valve closure time is large, its initiation is delayed by ESD valve operation and there is insufficient margin between Stage 3 and the maximum reach of the arm.

- 4.2.7 Magnetic proximity limit switches shall be used to avoid spurious signals arising from vibrations during operation.

4.3 Emergency Release System (ERS)

- 4.3.1 The ERS shall be operable from the central control console, and if specified, from a remote location. Separate switches shall be provided on the central console for Stage 2 and Stage 3 shutdown functions. Activation of the Stage 3 shutdown shall also activate all Stage 2 shutdown functions. Control switches shall be protected against accidental operation by a safety pin or cover.
- 4.3.2 A manual control, with protective cover, shall be provided at the hydraulic power pack to enable initiation of the ERS during an electrical power failure.
- 4.3.3 Switches shall be provided on the pendant and central control console to operate the ERS valves independently of the emergency functions.
- 4.3.4 In an emergency release the slew functions shall remain in freewheel mode unless otherwise stated.
- 4.3.5 ERS controls shall actuate the components on all connected arms simultaneously.



- * 4.3.6 Mechanical or hydraulic interlocks shall prevent release of the ERC before closure of the ERS valve(s). The vendor shall demonstrate the integrity of the total control system and the emergency release system by conducting a failure mode and effects analysis for approval by the purchaser. The ERS valve(s) shall be inoperable whilst the ERC is disconnected.

4.3.7 ERS valve hydraulic interlocks shall have the following features:-

- (a) A three port spool type hydraulic interlock valve, having a positive seal on the pressure side and a central drain port to prevent leakage pressurising the ERC circuit. The drain shall be independent of any other drain system. Alternatively an atmospheric vent, designed to prevent water/dirt ingress, may be used.

These important recommendations follow a fatal accident and are intended to prevent an unplanned opening of the ERC.

- (b) A mechanically activated hydraulic interlock valve spool to positively close the pressure side when the ERS valves are open. Devices relying on spring closure only are not acceptable.

This is to prevent opening of the ERC whilst the ERS valves are open and passing product.

- (c) A pressure switch with lockable isolating valve and a pressure gauge downstream of ERC solenoid valve. The pressure switch shall initiate an audible and visual alarm on rising pressure and the Stage 2 shutdown sequence.

- (d) A double valved vent with orifice adjacent to the pressure switch, to permit manual pressure relief of the ERC circuit in the event of malfunction. Valves shall be labelled with their function.

4.3.8 The ERS control system shall have the following features:-

- (a) Separate hydraulic solenoid valves for ERS valve closure and ERC release.
- (b) Automatic electrical and mechanical interlocks to prevent ERC initiation when one arm is being manoeuvred anywhere within the envelope and in the stowed or maintenance positions.

Interlocks shall not rely on operator intervention.



- (c) ERC hydraulic actuator drain line shall be run to the tank via the ERC solenoid spool valve.
- (d) The ERC valve return to tank drain shall be separate from other control circuit drains.
- (e) The Stage 3 overreach alarm shall only be mutable by a key operated switch.
- (f) Simultaneous actuation of Stage 2 and Stage 3 overreach shutdowns due to electrical failure shall not initiate operation of the ERS valves and the ERC (e.g. cables cut conditions). On power reinstatement the reset logic must also prevent such operation.
- (g) The Stage 3 shutdown electrical system shall prevent ERC activation on either short circuit or open circuit conditions.
- (h) Limit switches shall be closed during normal operation. An exception to this is the limit guard switch which closes to provide an override on arm manoeuvre.
- (i) Facilities for routine testing of system components

4.3.9 Lamps shall be provided on the central control console to indicate the open/closed status of the ERS and loading arm isolating valves. Provision shall be made for individual valve repeats in the jetty control room. Local valve position indicators shall be provided at the ERS valves.

4.3.10 The ERC shall have indicators to confirm its correct position when reassembled after activation of the system.

5. ELECTRICAL AND INSTRUMENTATION

5.1 General

* 5.1.1 Electrical and instrumentation equipment for use in areas classified as hazardous shall be flame proof or intrinsically safe. It shall be certified by a nationally recognised body for use in the hazardous area (gas temperature class and group as specified).

5.1.2 All equipment and materials shall be suitable for operation in the specified ambient temperature range. Enclosures shall be as a minimum



to [IEC 529](#), class IP 55 and corrosion resistant to a salt-bearing and refinery atmosphere.

5.2 Electrical

- 5.2.1 Electrical equipment shall be suitable for the specified operating voltage range and frequency.
- 5.2.2 Electrical equipment shall be designed for continuous operation.
- 5.2.3 The main switchboard shall be supplied as a floor mounted unit ready for field installation. Equipment and materials shall be supplied complete with all interconnecting cables, junction boxes, cable glands, fixings, etc. and an isolating switch complete with cable gland to terminate the incoming power supply cable. All accessories not specified, but required to complete the installation, shall be supplied unless specifically excluded.
- 5.2.4 The equipment and installation shall meet with the requirements of the Institute of Petroleum Model Code of Safe Practice, Part 1, and BP Group [GS 112-1](#).
- 5.2.5 The main power supply cable (provided by others) will have overload protection. The isolating switch, provided by the loading arm manufacturer, shall be rated accordingly.
- 5.2.6 Low voltage switchgear and control gear located in a non-hazardous area shall comply with BP Group [GS 112-8](#).
- 5.2.7 Motors shall comply with BP Group [GS 112-3](#).
- 5.2.8 Where motors are not visible from the control position, the 'start/stop' control station shall be equipped with motor 'running' and 'stop' indication. For motors above 3.75 kW output, this shall consist of an ammeter with the scale marked in red at full load current. For motors up to 3.75 kW output, indication shall be given by ammeter or coloured lamps.
- 5.2.9 Motor 'stop' pushbuttons shall be self reset type with mushroom heads and a guard. Pushbuttons for motor starting duty shall be shrouded reset type.

Self reset 'stop' pushbuttons are required to ensure the availability of automatic hydraulic pump motor start on falling pressure in the accumulators.



- 5.2.10 Cables installed on the loading arm shall be for intrinsically safe circuits only and comply with the certification requirements with regard to limiting cable parameters.
- 5.2.11 Flexible cables shall be installed on the articulated sections of the loading arms. The outer sheath of flexible cables shall be impervious to hydrocarbon and salt water and shall maintain flexibility within the temperature range specified in the service conditions.
- 5.2.12 Equipment shall have internal and external earth terminals. Earth bonding shall be provided by two independent earth connections.
- 5.2.13 HRC fuses are preferred but miniature or moulded case circuit breakers may be used provided tripping discrimination is assured.
- 5.2.14 Where plug and socket assemblies are used they shall be of a certified explosion protected design, interlocked such that the plug cannot be withdrawn until the circuit has been switched off, or intrinsically safe as applicable.
- 5.2.15 Electrical equipment shall be clearly labelled with function, cable and wiring identification reference numbers, etc. The numbers shall be indicated on the makers' drawings.
- 5.2.16 Automatically controlled heaters shall be provided if necessary, to prevent condensation forming but avoid overheating the equipment. When heaters, thermistors or temperature detectors are provided, connections shall be made at terminal boxes, separated from each other and from the main cable box.

5.3 Instrumentation

5.3.1 Instrumentation Cable

- (a) Cable shall maintain adequate flexibility at temperatures down to 10°C below minimum ambient temperature without sustaining damage. The cable vendor shall specify the minimum bending radius for continuous flexing.
- (b) Cable cores shall be of multi-strand conductor construction.
- (c) Cable shall have galvanised or stainless steel wire braided armour.
- (d) The cable outer sheath shall be resistant to crude oil and oil products and, for intrinsically safe applications, should be coloured light blue.



- (e) Instrumentation cable shall comply with certification requirements where used on intrinsically safe circuits.
- 5.3.2 Pendant plugs and sockets shall be weatherproof and suitable for marine applications.
- 5.3.3 Plastic housings shall be of anti-static material.
- 5.3.4 Junction boxes shall be weatherproof and preferably be made of stainless steel or plastic.
- 5.3.5 Intrinsically safe (rather than flame proof) equipment shall be supplied for areas having a high risk of impact damage.
- 5.3.6 All instrumentation cable and fittings shall be securely attached to the loading arms with stainless steel fixtures electrically insulated from any carbon steel to avoid corrosion.

6. CONSTRUCTION AND MATERIALS

6.1 General

- 6.1.1 Welding shall be to BP Group [GS 118-3](#), [118-5](#) and [118-7](#) and [AWS D1.1](#).
- 6.1.2 Materials of major components shall be stated in the tender. Identifiable material source certificates detailing mechanical properties and chemical analysis shall be provided for the material used in the fabrication of all pressure components.
- * 6.1.3 Weld procedures shall be submitted at the tender stage for approval by the purchaser.
- * 6.1.4 Fabricated pipework shall be tested to the requirements of BP Group [GS 118-5](#) and [118-7](#), also:-
 - (a) After final heat treatment all pressure-containing welds shall be subject to 100% radiography.
 - (b) Critical welds whose integrity affects the strength of the arms shall be non destructively examined preferably by radiography. These welds shall be subject to approval by the purchaser.
- 6.1.5 Impact toughness criteria for materials containing products in the temperature range -10°C to -50°C shall not be less than those specified



for [ASTM A 333](#) Grade 6. Below -50°C special requirements may be imposed by the inspection authority.

- 6.1.6 Exposed parts shall be corrosion resistant to a marine environment.
- 6.1.7 Swivel joints and other components shall not cause galvanic action with the pipe used in the arm.
- Swivel seals shall be suitable for the product and the specified temperature range. Swivel sealing faces shall be austenitic stainless steel or other corrosion resistant material. A minimum of 3 mm thick overlay material shall be provided.
- 6.1.8 The use of aluminium in loading arm components which are structural or contain products is not acceptable.

7. TESTING AND INSPECTION

7.1 General

- * 7.1.1 Testing shall meet local statutory requirements and shall be witnessed by BP.
- 7.1.2 Before painting at the vendor's works, all arm sub-assemblies shall be hydrostatically tested to 1.5 x design pressure and maintained for at least 30 minutes.
- 7.1.3 If stainless steel is used in construction of the arm, the chloride content of the test water shall not exceed 30 ppm.

7.2 Normal Temperature Service (Above 0°C)

- 7.2.1 A complete hydrostatic test shall be performed at site with the arm fully assembled in the hydrostatic test position, when the test pressure shall be held for 2 hours.
- 7.2.2 During hydrostatic testing the arm shall be restrained to reduce stresses from external sources.

7.3 Low Temperature Service (0°C or Lower)

- 7.3.1 During testing, the arm should be restrained if required for personnel safety.
- 7.3.2 After the hydrostatic tests at the vendor's works, all sub-assemblies shall be dried. Then at site before operation, the fully assembled arm



shall be leak/soap tested with nitrogen or dry air. The test pressure shall be 6 bar(ga) (87 psig) and shall be maintained for at least 30 minutes.

7.4 Operational Tests

7.4.1 The test procedure shall be submitted to the purchaser for approval.

7.4.2 One arm of each size being supplied, complete with its hydraulic power unit, shall be erected at the vendor's works. The following tests shall be carried out and recorded on video film with suitable marking of dates and times of events to enable accurate assessment of performance:-

- (a) Balance test.
- (b) The empty loading arm to be manoeuvred to its maximum reaches within the envelope and to its maintenance position.
- (c) The ERS to be fully tested with the loading arm full, or simulated full, by manoeuvring through the three alarm stages in the envelope for drift off, drift fore and drift aft.
- (d) The full loading arm to be manoeuvred from the raised position, following separation, to the stowed position.
- (e) A reconnection operation to be carried out with the fully loaded arm.
- (f) The ERS to be further tested from a static position (location in the envelope to be agreed) using:-
 - the push button on the control panel
 - the accumulators to simulate a power failure.

Simultaneous functions applicable to a bank of arms (e.g. (c) and (f) above) may be tested using just one arm, provided the available hydraulic fluid flow is limited in proportion to the number of arms in the bank.

7.4.3 The works tests shall demonstrate the following:-

- complete hydraulic power system
- control and alarm systems
- operating times of the ERS valves and ERC
- safe operation of the loading arm and the ERS
- operation of the various interlocks



- operation of the control panel and pendant
- operating envelope at jetty level.

7.4.4 For liquefied gas arms 7.4.2 (c) and (d) shall be performed at the minimum design temperature and repeated at least twice from ambient temperature through the complete thermal cycle. Distortion of the major arm components during the test shall be monitored and critical areas examined for cracks after the test.

7.4.5 After installation at site, the vendor shall repeat the above operational tests (n.b. the requirements of 7.4.4 shall not apply) on all arms simultaneously, checking that the loading arms, in combination, will reach all positions of the vessel manifold envelopes and all the specified vessel manifold spacings. All clearances shall be checked to confirm freedom from clashes. Each loading arm shall be checked for balance and adjusted if necessary. The site tests will also be recorded on video film.

7.4.6 The complete hydraulic circuit shall be pressure tested on site to 1.5 x design pressure. After flushing the system, cleanliness shall be demonstrated by inspecting the filters. Cleanliness shall be the lesser of class 6, NAS 1638 (or equivalent) or the standard set for the valve assemblies by their manufacturer. The water content of the hydraulic fluid shall not exceed 0.1%.

7.5 Swivel Tests

7.5.1 After hydrostatic testing at the vendor's works, swivel assemblies shall be partial vacuum tested at 0.515 bar(abs) (7.5 psia). The operating pressure shall then be applied to demonstrate that the seals re-seat correctly.

7.5.2 Swivel assemblies shall be leak tested whilst being rotated at a pressure of 10 bar (ga) (145 psig), or the specified operating pressure, if higher.

7.5.3 If proof test certificates (for swivels of the type and size proposed and having at least the same loading) are unavailable or unacceptable, the swivel shall be proof tested at the vendor's works, at design pressure, with test loads PCT.

7.5.4 PCT shall be maintained if internal pressure is lost by increasing other test loads accordingly.

$$PCT = TLF \quad PCA$$

where



PCT = Test load

TLF = Test load factor

PCA = Combined swivel design load

* 7.5.5 Test loads shall be applied as follows:-

Test	1	2	3	4	5	6	7
Service	-----Liquefied Gas----- -----General Liquid-----						
TLF	1.4	1.5	1.6	1.9	2.0	3.5	4.0

Acceptance criteria:-

- (a) At test 2 brinelling shall be below acceptable levels.
- (b) At test 5 there shall be no leakage.
- (c) At test 6 there shall be no structural failure - general liquid duties.
- (d) At test 7 there shall be no structural failure - flammable liquefied gas duties.

The swivel shall be disassembled and inspected for brinelling after each of the tests 1 - 3. Brinelling is considered to be no longer acceptable when the indentation in a swivel raceway is equal to or greater than 8% of the ball diameter.

The need for tests 6 and 7 will be determined by BP. If they are not required, the vendor shall demonstrate the acceptance criteria by calculations.

7.5.6 For cryogenic applications, the swivel shall be tested for leakage and load capacity at both ambient and minimum design temperature. Tests 6 and 7 shall be conducted at ambient temperature only. The swivel leakage rate shall not exceed 4 cc/h of liquid per centimetre of seal diameter or 1050 cc/h of vapour (0°C, 1 bar) per centimetre of seal diameter. The vendor shall submit a test procedure detailing the test set-up and measuring apparatus proposed.

7.5.7 If test certificates are unavailable for swivel nitrogen purge systems provided on cryogenic applications, the following works proof test shall be carried out:



With the nitrogen purge system in operation, expose the swivel to design temperature and stabilise. Spray with water until a 25 mm layer of ice forms. Temperature shall be held for one hour. Allow the swivel to return to ambient temperature and dry externally. Disassemble the swivel and inspect the internals for water collection, formation of ice or damage to the seals. Monitor nitrogen purge pressure throughout the test and maintain it at the pressure level/rate specified for the field application. The swivel shall be rotated throughout the test.

7.6 Emergency Release Coupler (ERC) Tests

7.6.1 Where test certificates are available for an ERC of the same type, size, materials, duty and loading conditions, tests 7.6.2, 7.6.3, 7.6.4, 7.6.5 and 7.6.6 are not required.

7.6.2 One ERC of each size shall be tested at the works, at the equivalent load (LCT), to demonstrate that it meets the requirements of 2.5.1.12.

7.6.3 The test equivalent load (LCT) is expressed as:-

$$LCT = TLF \quad LCA$$

Where

LCT = Test equivalent load.

TLF = Test load factor.

LCA = Maximum design equivalent load at release (See 2.5.1.12).

* 7.6.4 The test loads shall be applied as follows:-

Test	1	2	3	4	5	6
Service	-----Liquefied Gas-----					
	-----General Liquid----					
TLF	1.9	2.0	2.1	3.5	3.9	4.0

Acceptance criteria:-

- (a) At test 2 there shall be no liquid leakage - all duties.
- (b) At test 2 there shall be no permanent deformation - all duties.
- (c) At test 4 there shall be no structural failure - general liquid service.



- (d) At test 6 there shall be no structural failure - flammable liquefied gas service.

ERC tests 1 and 2 are mandatory. However, tests 3 and above shall only be necessary where the acceptance criteria cannot be proven by calculation.

For units in liquefied gas service, test loads 1 and 2 shall be applied at ambient and minimum design temperatures. If leakage occurs at test 3 or above, LCT shall be increased to re-establish the internal pressure loading. Test conditions shall be maintained for 30 minutes.

7.6.5 One ERC of each size proposed shall be tested for release performance under the following conditions. The test shall be performed three times. In all tests the coupling shall release immediately upon activation.

- (a) Minimum cargo temperature.
- (b) External loading, equivalent to the maximum load applied by the arm/ship on the ERC (see 2.5.1.12) shall be applied to create an unbalanced load condition.
- (c) For liquefied gas service, an ice build up of 25 mm.

7.6.6 For liquefied gas services, tests shall be carried out at the minimum cargo temperature on ERS valves of each type, size and material proposed. Test procedures shall include the following:-

- (a) Once the temperature has stabilised, valve operating torques shall be recorded for 20 operations.
- (b) Seat and gland seal leakage rates shall be measured and recorded with the unit pressurised with vapour to 3 bar(ga) (43.5 psig), 10 bar(ga) (145 psig), and 19 bar(ga) (275 psig). Tests shall be repeated until two successive tests give similar leakage rates for the same pressure.
- (c) Minimum cargo temperature shall be held for one hour.

* 7.6.7 The ERS shall be tested to show that accidental release with the ERS valves open, cannot occur due to failure of electric or hydraulic power or components. The components shall be tested to prove the integrity of the system under the failure conditions determined from the failure mode and effects analysis. Test procedures shall be approved by the purchaser before the tests commence.



- * 7.6.8 After hydrostatic testing, all ERC valves shall be dried and subjected to pneumatic seat and gland seal leak tests. Pressure shall be applied at 3 bar(ga) (43.5 psig), 10 bar(ga) (145 psig), and 19 bar (ga) (275 psig) (or the design pressure if higher). Acceptable leakage rates shall be approved by the purchaser before the test.

7.7 Quick Connect/Disconnect Coupler (QCDC) Tests

7.7.1 Operation shall be demonstrated at the coupler vendor's works for:-

- (a) Each size of adapter to be supplied,
- (b) The full range of flange sizes and outside tolerances specified.

7.7.2 If proof test certificates for couplers of the type, size and materials proposed and having at least the same loading conditions are unavailable or unacceptable, one coupler of each size shall be proof tested at the works by applying the test loads (LCT) at the coupler/spool piece joint.

- * 7.7.3 Proof tests shall be carried out on the complete range of flanges to which the coupler can connect. The maximum length of spool pieces shall be 300 mm. A new spool piece shall be used for each test. Dimensions of all spool pieces shall be recorded before the test and witnessed by the inspector.

For general liquid services, tests shall be on carbon steel spool pieces to [ANSI B16.5](#) or [BS 1560](#) Class 150 with weld neck flanges in ASTM A 105 Gr.1 or A 181 Gr.1 materials and ASTM A 106 pipe.

For liquefied gas services, material and flange specification shall be subject to approval by the purchaser.

7.7.4 The test equivalent load (LCT) is expressed as:-

$$LCT = TLF \bullet LCA \bullet \frac{DS \text{ [Spool piece]}}{DS \text{ [Manifold]}} \bullet \frac{TS \text{ [Spool piece]}}{TM \text{ [Manifold]}}$$

Where

LCT = Test equivalent load.

TLF = Test load factor.

LCA = Design equivalent load (See section 2.6.9).

DS = Spool piece/manifold design stress (See 2.3.2 & 2.3.13)



TS = Measured wall thickness of spool piece.

TM = Minimum specified wall thickness of manifold.



- * 7.7.5 The test load shall be applied as follows:-

Test	1	2	3	4	5	6
Service	-----Liquefied Gas----- -----General Liquid-----					
TLF	1.9	2.0	3.4	3.5	3.9	4.0

Acceptance criteria:-

- (a) At test 2 there shall be no liquid leakage - all duties.
- (b) At test 2 there shall be no permanent deformation - all duties.
- (c) At test 4 there shall be no structural failure - general liquid service.
- (d) At test 6 there shall be no structural failure - flammable liquefied gas service.

Proof tests shall be conducted at least for tests 1 and 2 and held for 30 minutes. The need for test 3 and above will be determined by BP. The coupler shall be inspected for permanent deformation after tests 3 and above. Where spool piece design stresses are higher than specified, loads for test 3 and above shall be approved by the purchaser.

The coupler clamps shall be orientated so that a minimum number of clamps are in tension from the test bending moment.

- 7.7.6 Proof tests shall be conducted at the loading arm specified design pressure. If pressure is lost at test 3 and above, the test bending moment shall be increased to re-establish the internal pressure component of the loading.

- 7.7.7 For liquefied gas services, proof tests 1 and 2 shall first be performed at minimum design temperature, then the complete range of tests performed at ambient temperature.

7.8 Inspection

- * 7.8.1 Shop inspection will be required by the inspection authority. The extent of inspection will be specified by the purchaser. As a minimum, the inspector will need to be satisfied with the items listed below:-
- (a) Materials of all components.
 - (b) Welding qualifications and heat treatment procedures.



- (c) Non destructive testing.
- (d) Proposed repair procedures.
- (e) All tests within scope of supply.
- (f) Dimensions of all components.
- (g) Weight of major components to be lifted during maintenance.
- (h) Cleanliness of hydraulic system.
- (i) Painting and corrosion prevention.
- (j) Certification and testing of all lifting gear components.
- (k) Proof assembly of structural steelwork.
- (l) Certification and testing of electrical and instrumentation equipment.
- (m) Electrical resistance of insulating flanges.
- (n) Packing and preservation.

8. PAINTING

8.1 General

- * Painting shall conform to BP Group [GS 106-2](#). Preparation and priming shall be completed at the vendors' works. If approved by the purchaser, finishing coats may be applied at site.

8.2 General Liquid Service at Ambient Temperatures

Painting shall comply with BP Group [GS 106-2](#), Schedule C6.

8.3 Liquefied Gas Service

- * Paint systems for liquefied gas arms shall be approved by the purchaser.



9. INFORMATION AND DRAWINGS REQUIRED WITH TENDER

9.1 General

- 9.1.1 A list of deviations from this Standard, or confirmation that no deviations exist.
- 9.1.2 Data sheets 1 and 2 shall be completed by the client for tendering and data sheet 3 shall be completed by the vendor.

9.2 Mechanical

- 9.2.1 Dimensioned general arrangement drawings of the bank of loading arms showing:-
- (a) Arm configuration and basic dimensions.
 - (b) Arm locations on jetty dock.
 - (c) Design operating envelopes.
 - (d) The relationship of the arms when operating together and individually, giving minimum clearance at critical positions within the envelopes at the minimum vessel manifold spacing.
 - (e) Product pressure drop.
 - (f) Recommended location of equipment.
 - (g) Estimated jetty foundation loading and the application points of these loads.
 - (h) Manifold, coupler and ERC loadings and weights.
 - (i) Arm attitudes for maintenance of swivels, storage and hydrostatic testing.
- 9.2.2 A list of materials to be used for the principal loading arm components and proposed weld procedures.
- 9.2.3 Completed data sheets.
- 9.2.4 Drawings showing ERC/ERS details and valve arrangement.
- 9.2.5 Drawing showing details of QCDC claw engagement when connected to each size and type of flange specified.



9.3 Electrical

9.3.1 List of all electrical equipment.

9.3.2 Technical description of electrical equipment.

9.3.3 The kW rating of all equipment.

9.4 Spares

Recommended commissioning and 12 months operating spares.

9.5 Testing

9.5.1 Descriptions of the test facilities.

9.5.2 Test procedures proposed to qualify swivels, QCDC, ERS, ERC and valves.

10. INFORMATION AND DRAWINGS REQUIRED DURING CONTRACT

10.1 General

10.1.1 Latest revisions of drawings and documents, submitted with tender.

* 10.1.2 Completed manufacturing and certification dossier, submitted for approval by the purchaser prior to shipment of the loading arm.

10.2 Mechanical

10.2.1 Drawings of major fabricated sections.

10.2.2 Welding qualifications and procedures.

10.2.3 Complete calculations, supporting data and drawings of:-

- (a) Stresses in critical components (including welds) of the loading arms and tanker manifolds.
- (b) Maximum lateral deflection of the arm in the connected, stored and manoeuvring attitudes.
- (c) Maximum equivalent axial loads on swivels.
- (d) Maximum bending moment and loads at couplers.



- 10.2.4 Swivel cross sectional drawings and data, giving results of laboratory tests on swivels of the same size, design and materials used in the arms.
- 10.2.5 Laboratory test results on ERCs and QCDCs of the same size, type and materials as used and with spool pieces as required, and with the same loading conditions.
- 10.2.6 Drawings and calculations of loading arm clash checks.
- 10.2.7 Design data and specification for all components in the electro-hydraulic control system, including detailed hydraulic pressure loss calculations.
- 10.2.8 Paint specification.
- 10.3 Electrical**
- 10.3.1 Wiring diagrams.
- 10.3.2 Electrical and cable routing diagrams.
- 10.3.3 Cable schedules.
- 10.3.4 The fuse rating of power supply.
- 10.4 Instrumentation**
- 10.4.1 Hydraulic control circuit diagram and description.
- 10.4.2 Electrical control circuit diagram and description
- 10.4.3 FMEA report and actions taken
- 10.4.4 Utility loads
- 10.5 Manufacturing, Installation and Operating Information**
- 10.5.1 A manufacturing record and certification dossier for each loading arm with ancillary and spare equipment, supplied not later than the date of shipment, and containing:-
- (a) Material and test certificates for pressure containing components.
 - (b) Records of all tests within scope of supply.



- (c) Test certification for pressure-containing equipment as required by the statutory regulations in the country of installation.
- (d) Safety certification of all electrical components.
- (e) Calibration certification for all instruments.
- (f) Proof test certificates for swivels and couplers.
- (g) As built general arrangement drawings.
- (h) Installation and interconnection details.

10.5.2 The following data shall be provided prior to shipment:-

- (a) Procedures for assembly, balancing and installation, including maximum installation weight and location of lifting eyes.
- (b) Operating and maintenance manuals, including routine test procedures for safety components and a complete spare parts list referenced to cross sectional drawings.

10.6 Guarantee

A guarantee shall be given for the equipment against faulty performance, design, materials or workmanship for the period stated in the Conditions of Contract.



BASIC ARM DATA													
	Arm Designation	Dia in (mm)	Product	Arm Operation									
				Single	Combinations of simultaneous operation								
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													

CARGO DATA									
	Arm Designation	Dia in (mm)	Product	Density kg/m ³	Viscosity cSt at °C	Cargo Temp °C		Design Pres. barg	Max Flow m ³ /h
						Min	Max		
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

TANKER DATA				Tanker Sizes DWT or m ³			
21	Manifold Deck Height To Waterline	Min	m				
22		Max	m				
23	Manifold Height Above Deck	Min	m				
24		Max	m				
25	Drift Fore		m				
26	Drift Aft		m				
27	Drift Off Jetty Face		m				
28	Distance Manifold Flange To Ship Side	Min	m				
29		Max	m				
30	Manifold Material						
31	Manifold Flange Size Range	Min					
32		Max					
33	Flange Type/Rating						
34	Minimum Wall Thickness		mm				
35	Manifold Spacing	Min	m				
36		Max	m				
37	Connecting Arm Numbers						
38							
39							
40							

SHEET 1

Basic Arm, Cargo and Tanker Data



BERTH DATA				ENVIRONMENTAL DATA			
1	Site Datum			51	DESIGN	Stored	m/s
2	Jetty Level Relative to Datum m			52	WIND	Manoeuvring/Connected	m/s
3	Highest High Water Relative to Datum m			53	SPEEDS	Maintenance	m/s
4	Lowest Low Water Relative to Datum m			54	Design for Earthquake When Stored Yes/No		
5	Jetty Face to Centreline Risers Min m			55	Seismic Probability Coefficient		
6	Distance Berthing Fender Relaxed m			56	Seismic Acceleration		
7	Line To Jetty Edge Fender Compressed m			57	Ambient Temperature Minimum °C		
8	Maximum Jetty Length Available m			58	Ambient Temperature Maximum °C		
9	Maximum Jetty Width Available m			59			
10	Maximum Height of Obstructions m			60			
11	Electrical Supply Volts/Phase/Hz			MATERIALS			
12							
13							
14							
15							
ARM OPERATING DATA				61	Structural		
16	Drives: Slewing	Hydraulic/Manual/Optional		62	Piping		
17	Inboard Arm	Hydraulic/Manual/Optional		63	Elbows		
18	Outboard Arm	Hydraulic/Manual/Optional		64	Swivels	Forgings	
19	Control System	Central Control	Yes/No	65		Balls	
20		Local Control	Yes/No	66		Races	
21				67		Product Seals	
22	QCDC Coupler Required	Yes/No		68		Atm. Seals	
23	ERC Coupler Required - Liquid Line	Yes/No		69	Boilting	Structural	
24	ERC Coupler Required - Vapour Line	Yes/No		70		Piping	
25	Reduced Bore Ball Valves	Yes/No		71	Hydraulic	Piping	
26	Counterweight Condition	Inboard Arm	Full/Empty	72		Fittings	
27		Outboard Arm	Full/Empty	73		Rams	
28				74		Valves	
29	Prevention Of Arm	Counterweight Provision	Yes/No	75	Valves	Body	
30	Falling On Ships	Hydraulic Control	Yes/No	76		Balls	
31	Deck By:	Other		77		Seals	
32	Empty Arms to be Operated Simultaneously	Yes/No		78		Packing	
33	ERC Activated Automatically	Yes/No		79	QCDC	Body	
34	ERC Ball Valves Activated Automatically	Yes/No		80		Claws	
35	Over-reach Two Stage Audio-Visual Alarm	Yes/No		81		Pins	
36				82	ERC	Body	
37				83		Clamps	
38				84			
39				85			
40				MISCELLANEOUS ARM DATA			
41				86	Vacuum Breaker at Apex	Yes/No	
42				87	N2 Purge at Apex/Base	Yes/No	
43				88	Access to Apex and Trunnion Swivels	Yes/No	
44				89	Foundation Bolts to be Supplied	Yes/No	
45				90	Foundation Bolts to be Specified	Yes/No	
46				91	Foundation Bolt Template Supplied	Yes/No	
47				92	Jack to be Provided at Triple Swivel	Yes/No	
48				93	Washing Connection Required	Yes/No	
49				94	Stripping System to Outer Arm	Yes/No	
50				95	Stripping Pump Required	Yes/No	
				96	N2 Purge System to Swivels Required	Yes/No	
				97	Vapour Return Line Mounted "Piggy Back"	Yes/No	
				98			

SHEET 2

Berth, Operating, Environmental, Materials and Micellaneous Arm Data



DESIGN DATA				LAYOUT	
1	Arm Manufacturer			51	Minimum Centreline Spacing For Risers m
2	Arm Size And Type			52	Maximum Slew Angle
3	Operating Pressure barg			53	Maximum Inc Angle Inner/Outer Arm
4	Design Pressure barg			54	Maximum Inner Angle Tuck Back Angle
5	Test Pressure barg			55	Maximum Outer Angle Tuck Back Angle
6	Surge Pressure barg			56	Riser Height/Diameter m/mm
7	Minimum Design Temperature °C			57	Inner Arm Length/Diameter m/mm
8	Design Flow Rate m³/h			58	Outer Arm Length/Diameter m/mm
9	Maximum Flow Rate m³/h			59	Min Manifold Size - With Jack m/mm
10	Foundation Loads	Weight	kg	60	Min Manifold Size - Without Jack - m/mm
11		Shear	kN	61	Riser Production Flange
12		OT Moment	kNm	62	Size/Rating/Facing m/mm
13	Foundation Bolts No/Size /mm			63	Tanker Connection Flange
14	Swivel Maximum Pca kN			64	Size/Rating/Facing m/mm
15	OCCDC: Vendor			65	
16	Type/Size			CONTROLS	
17	Number Of Claws			66	Control Console Manufacturer
18	Hydraulic Pressure barg			67	Pendant Control Manufacturer
19	Flowrate l/m			68	Over-reach Alarm System Type
20	Viscosity cSt/°C			69	Hydraulic Power Pack Manufacturer
21	Min/Max Clamping Times sec			70	Capacity/Pressure l/min/Barg
22	Min/Max Releasing Times sec			71	Hydraulic Pump Manufacturer
23	Weight kg			72	Type/Model
24	Design Bending Moment kNm			73	Motor kW
25	Design Range Of Flanges			74	
26	Manual Over-ride Yes/No			75	
27	ERC: Vendor			76	
28	Type/Size			77	
29	Hydraulic Pressure barg			78	
30	Flowrate l/m			79	
31	Viscosity cSt/°C			80	
32	Time To Release sec			81	
33	Weight With Valves etc. kg			82	
34	Design Bending Moment kNm			83	
35	ERC Valves: Vendor			84	
36	Type/Size			85	
37	Flange Size/Rating mm/			86	
38	Closing Time Min/Max sec			87	
39	Hydraulic Pressure barg			88	
40	Flowrate l/m			89	
41	Viscosity cSt/°C			90	
42	Jack Adjustable Height Min/Max m			91	
43	Nz Purging-Apex Cap/Pres kg/h/barg			92	
44	Nz Purging-Swivels Cap/Pres kg/h/barg			93	
45	Stripping System	Pump Manufacturer		94	
46		Cap/Pres m³/h/barg		95	
47	Vacuum Breaker	Manufacturer		96	
48		Type/Capacity m³/h		97	
49				98	
50				99	

SHEET 3

Design Data, Layout and Controls



CASE	MODE	LOADING COMBINATION	STRESS FACTOR K	REMARKS
1	Stored	DL	1.2	WL - Survival Condition
2		DL+WL/EL	1.6	
3		PLD	0.9	
4		DL+FL+PLD	1.2	
5		DL+FL+PLD+WL/EL	1.6	
6		DL+FL+PLD+WL/EL+TL	2.0	
7	Manoeuvring	DL+WL	1.0	
8		PLD	0.9	
9		DL+WL+FL+PLD	1.0	
10		DL+WL+FL+PLD+TL	2.0	
11	Connected	PLD	0.9	
12		DL+WL+FL+PLD	1.0	
13		DL+WL+FL+PLD+TL	2.0	
14	Maintenance	DL+WL	1.2	Vendor to advise maximum wind speed
15		DL+WL+FL+PLD	1.8	
16	Hydrostatic Test	PLT	1.3	
17	ERS Pre-release	DL+WL+FL+PLD	-	Vendor to advise K for client approval
18	ERS Released	DL+WL+FL+PLD	-	

LEGEND

DL	-	Self Weight Load
FL	-	Fluid Weight Load
PLD	-	Design Pressure Load
PLT	-	Test Pressure Load (1.5 x Design Pressure)
WL	-	Design Wind Load
TL	-	Thermal Load
EL	-	Earthquake Load
WL/EL	-	Either WL or EL

TABLE I
LOAD COMBINATIONS AND STRESS FACTORS FOR
ARMS IN GENERAL LIQUID SERVICE



CASE	MODE	LOADING COMBINATION	STRESS FACTOR K	REMARKS
1	Stored	DL	1.2	WL-Survival condition
2		DL+WL/EL	1.6	
3		PLD	0.8	
4		DL+FL+PLD	1.0	
5		DL+FL+PLD+WL/EL	1.4	
6		DL+FL+PLD+WL/EL+TL	1.7	
7	Manoeuvring	DL+WL	1.0	See Note See Note
8		PLD	0.8	
9		DL+WL+FL+PLD	0.9	
10		DL+WL+FL+PLD+TL	1.7	
11	Connected	PLD	0.8	See Note See Note
12		DL+WL+FL+PLD	0.9	
13		DL+WL+FL+PLD+TL	1.7	
14	Maintenance	DL+WL	1.2	Vendor to advise Max. Wind Speed
15	Hydrostatic Test	PLT	1.3	
16		DL+WL+FL+PLD	1.8	
17	ERS Pre-release	DL+WL+FL+PLD	-	Vendor to advise K for client approval
18	ERS Released	DL+WL+FL+PLD	-	

LEGEND

DL	-	Self Weight Load
FL	-	Fluid Weight Load
PLD	-	Design Pressure Load
PLT	-	Test Pressure Load (1.5 x Design Pressure)
WL	-	Design Wind Load
TL	-	Thermal Load
EL	-	Earthquake Load
WL/EL	-	Either WL or EL

Note: DL to include weight of ice for combinations full of product.

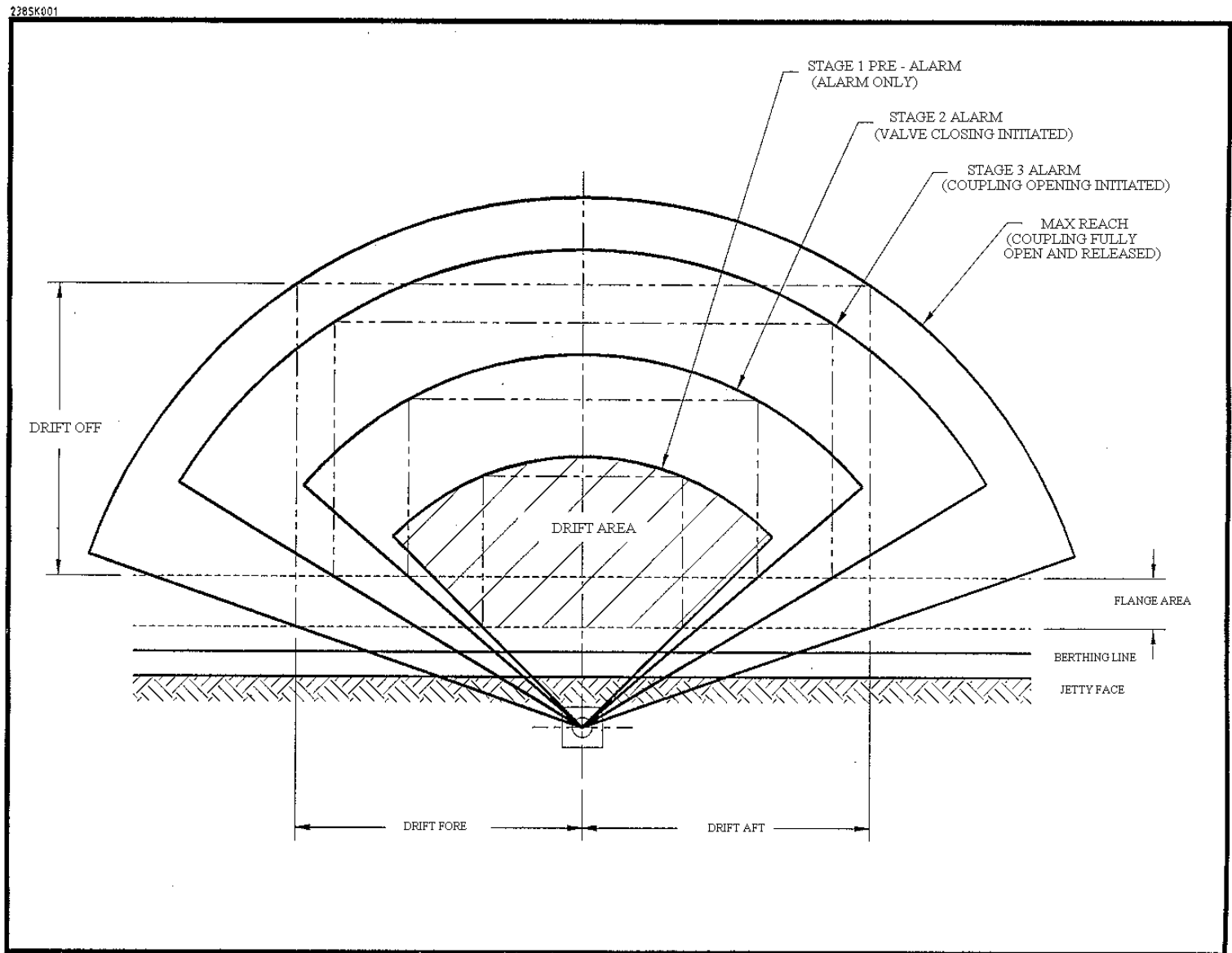
TABLE II
LOAD COMBINATIONS AND STRESS FACTORS
FOR ARMS IN LIQUEFIED GAS SERVICE





OPERATING ENVELOPE - PLAN VIEW

FIGURE 1



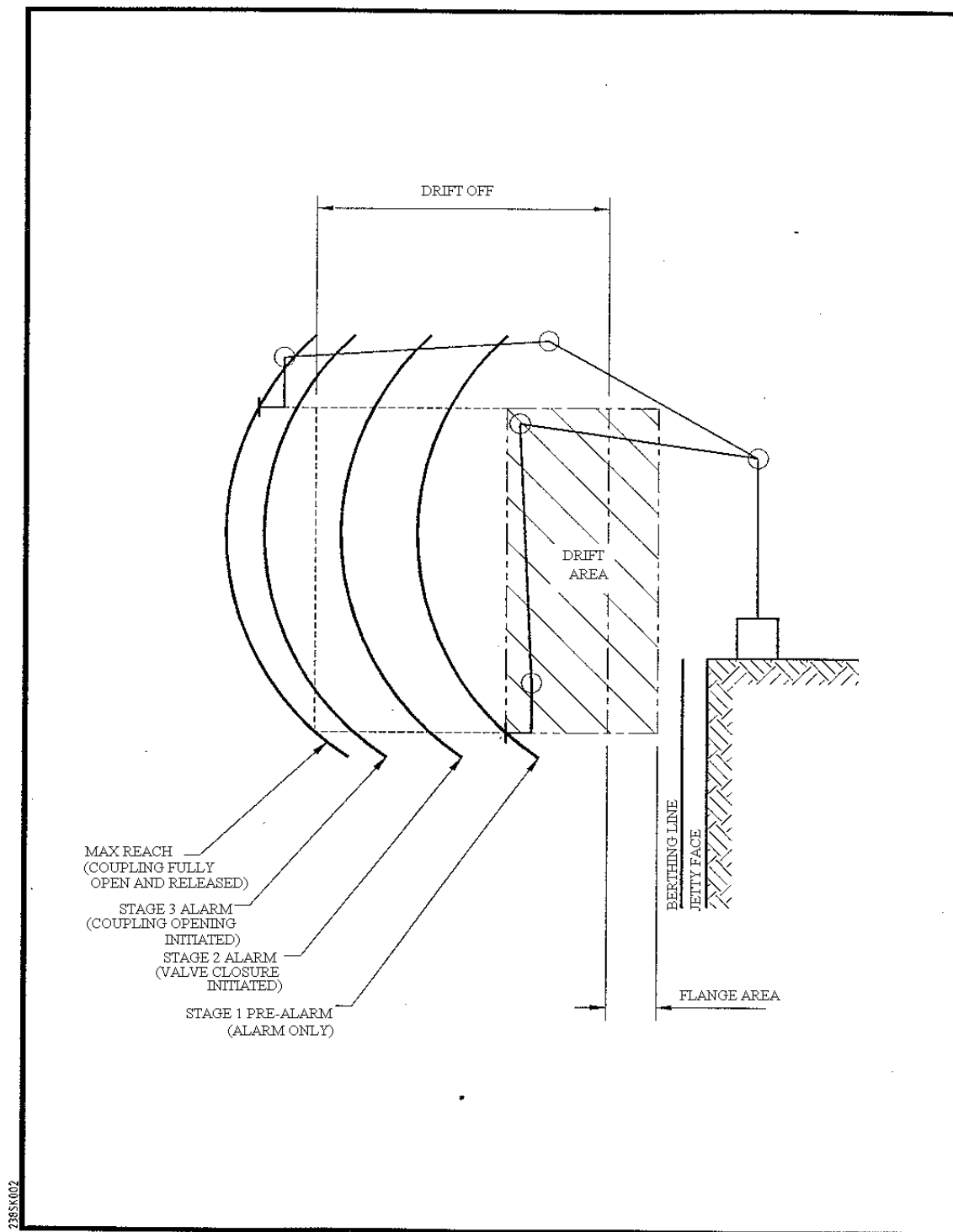


FIGURE 2

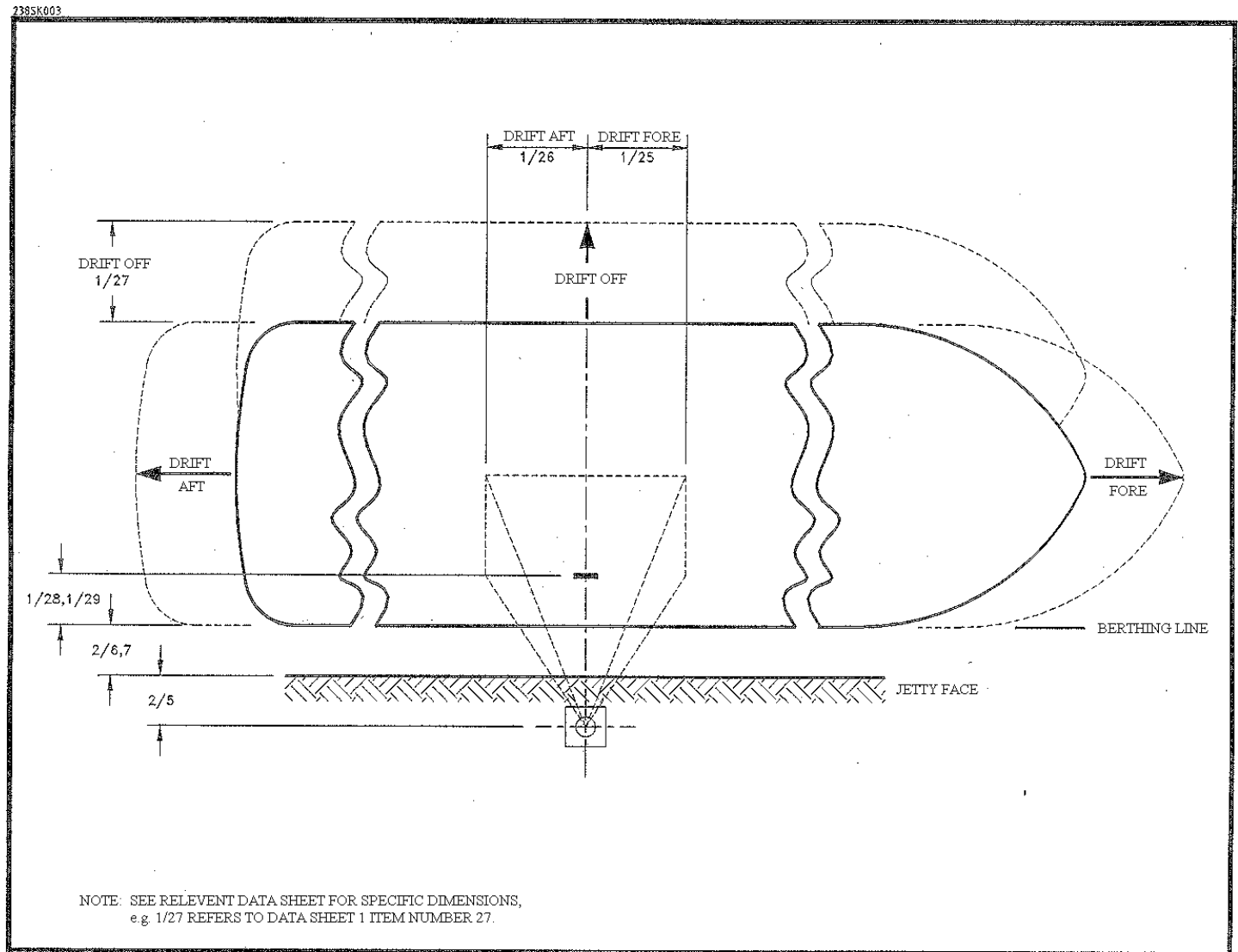
OPERATING ENVELOPE - ELEVATION





SHIP MOVEMENTS - PLAN VIEW

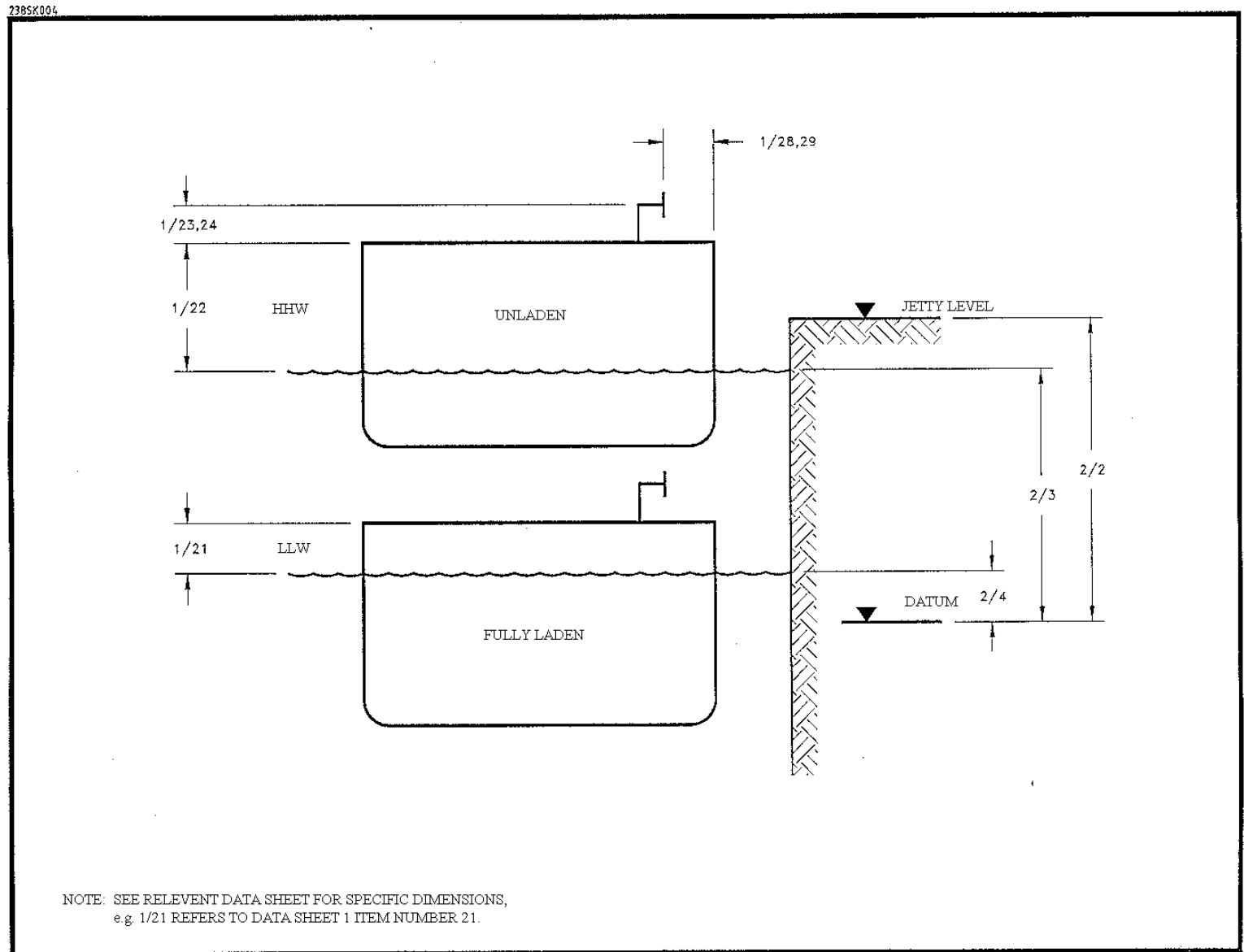
FIGURE 3





SHIP MOVEMENTS - ELEVATION

FIGURE 4



DEFINITIONS AND ABBREVIATIONS

Definitions

Standardised definitions may be found in the BP Group RPSEs Introductory Volume.

bar: Except when referring to a pressure differential, the unit is stated either as gauge pressure, bar (ga) or absolute pressure, bar (abs). Gauge pressure is measured from standard atmospheric pressure of 1.01325 bar.

Cryogenic Service: For the purpose of this Specification, cryogenic service is where the product temperature is below -80°C.

Abbreviations

AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society Inc.
BS	British Standard
DIN	Deutsche Industrie Normalen
DN	Nominal diameter (millimetres)
ERC	Emergency Release Coupler
ERS	Emergency Release System
ESD	Emergency shut down
FMEA	Failure mode and effects analysis
HRC	High rupturing capacity
ID	Inside diameter
IEC	International Electrotechnical Commission
ISO	International Organisation for Standardisation
LCA	Design equivalent load
LCT	Test equivalent load
NAS	National Aerospace Standard
NPS	Nominal pipe size (inches)
OCIMF	Oil Companies International Marine Forum
OD	Outside diameter
PCA	Combined swivel design load
PCT	Test Load
PTFE	Polytetrafluorethylene
QCDC	Quick connect/disconnect coupler
TLF	Test load factor



LIST OF REFERENCED DOCUMENTS

A reference invokes the latest published issue or amendment unless stated otherwise.

Referenced standards may be replaced by equivalent standards that are internationally or otherwise recognised provided that it can be shown to the satisfaction of the purchaser's professional engineer that they meet or exceed the requirements of the referenced standard.

International

Institute of Petroleum	Model Code of Safe Practice in the Petroleum Industry, Part 1 - Electrical Safety Code
IEC 529	Degrees of Protection Provided by Enclosures (IP Code)
ISO 10497	Testing of Valves: Fire Type-Testing Requirements
OCIMF	Design and Construction Specification for Marine Loading Arms
OCIMF	Recommendations for Oil Tanker Manifolds and Associated Equipment
OCIMF	Recommendations for Manifolds of Refrigerated Liquefied Gas Carriers for Cargoes from 0°C to -104°C.
OCIMF	Recommendations for Manifolds for Refrigerated Liquefied Natural Gas Carriers (LNG)

British Standards

BS 302	Stranded Steel Wire Ropes
BS 1560	Circular Flanges for Pipes, Valves and Fittings (Class Designated): Part 3: Section 3.1: Specification for Steel Flanges
BS 4592	Industrial Type Metal Flooring, Walkways and Stair Treads
BS 5351	Specification for Steel Ball Valves for the Petroleum, Petrochemical and Allied Industries
BS 5500	Specification for Unfired Fusion Welded Pressure Vessels
BS 5950	Structural use of Steelwork in Building
BS 6364	Specification for Valves for Cryogenic Service
BS 6755	Testing of Valves: Part 1: Production Pressure Testing Requirements, and Part 2: Specification for Fire-Type Testing Requirements

American



AISC S328	Specification for Structural Steel Buildings - Load and Resistance Factor Design
ANSI B16.5 ANSI B31.3	Pipe Flanges and Flanged Fittings Chemical Plant and Petroleum Refinery Piping
API Spec 6D	Specification for Pipeline Valves (Gate, Plug, Ball and Check Valves)
API Spec 6FA	Specification for Fire Test for Valves
ASME	Boiler and Pressure Vessel Code - Section VIII, Rules for Construction of Pressure Vessels - Division 1
ASME	Boiler and Pressure Vessel Code - Section IX, Qualification Standard for Welding and Brazing Procedures
ASTM A 105 ASTM A 106 ASTM A 181 ASTM A 333	Forgings, Carbon Steel, for Piping Components Seamless Carbon Steel Pipe for High-Temperature Service Forgings, Carbon Steel, for General-Purpose Piping Seamless and Welded Steel Pipe for Low-Temperature Service
AWS D1.1	Structural Welding Code - Steel
NAS 1638	Cleanliness Requirements of Parts Used in Hydraulic Systems

German

DIN 2633	Welding Neck Flanges; Nominal Pressure 16
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BP Group Documents

BP Group GS 106-2	Painting of Metal Surfaces (replaces BP Std 141)
BP Group GS 112-1	Electrical Engineering Specification for Materials and Workmanship (replaces BP Std 121)
BP Group GS 112-3	Low Voltage Induction Motors (replaces BP Std 221)
BP Group GS 112-8	Low Voltage Switchgear and Control Gear (replaces BP Std 227)
BP Group GS 118-3	General Standard for Welded Fabrication and Construction (replaces BP Std 164)



BP Group GS 118-5	The Fabrication, Assembly, Erection and Inspection of Carbon, Carbon Manganese and Low Alloy Ferritic Steel Pipework to ANSI/ASME B31.3. (replaces BP Std 167, Parts 1 and 2)
BP Group GS 118-7	Fabrication of Pipework to ANSI B.31.3, Part 3: Austenitic and Duplex Steel Pipework, Cupro-Nickel and Nickel Base Alloy Pipework (replaces BP Std 167, Part 3)
BP Group GS 134-1	Hydraulic Power Supplies (replaces BP Std 115)
BP Group GS 142-7	Supply of Gaskets and Joint Rings for Bolted Flanged Joints (replaces BP Std 173)
BP Group GS 142-9	Bolting for Flanged Joints (Unified Inch Series) (replaces BP Std 175)
BP Group GS 152-1	Materials for Thermal Insulation of Pipework and Equipment (replaces BP Std 172)
BP Group GS 162-1	Steel Gate, Globe and Check Valves (replaces BP Std 150 & 181)

