Ministry of Defence

Defence Infrastructure Organisation

Specialist Works on Petroleum Installations on MOD Property

Technical Standard – Petroleum - 01

ESTATE MANAGEMENT

Version 3.0 – June 2022

Document Information	
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DOCUMENT HISTORY

Date Issued	Version	Author	Reason for Change
The following are the amendments made in this Standard when reviewed against PG 04/12.			
07/09/2020	1.0	Matthew Spare	1.2 (e) Added requirement for ATEX Registers
07/09/2020	1.0	Matthew Spare	1.2 (f) Added requirement for HAC Drawings
07/09/2020	1.0	Matthew Spare	1.2 (g) Added requirement for Cause & Effect Matrix
07/09/2020	1.0	Matthew Spare	2.1.8 Added assembly requirements for flanged connections
07/09/2020	1.0	Matthew Spare	Table 2.1 Changes to small bore flange requirements and bolting requirements
07/09/2020	1.0	Matthew Spare	Table 2.2 Changes to small bore flange requirements and bolting requirements
07/09/2020	1.0	Matthew Spare	4.2 Requirements for filter water separators
07/09/2020	1.0	Matthew Spare	4.3 Requirements for pre-coat filters
07/09/2020	1.0	Matthew Spare	4.4 Requirements for bulk meters
07/09/2020	1.0	Matthew Spare	4.5 Requirements for pumps added from SPEC043, additional details added on pump protection
07/09/2020	1.0	Matthew Spare	13.12.2 Specification for internal coating requirements of vertical storage tanks
07/09/2020	1.0	Matthew Spare	13.12.5 Specification for external coating requirements of vertical storage tanks
07/09/2020	1.0	Matthew Spare	14 Overfill Protection requirements added
07/09/2020	1.0	Matthew Spare	15 Secondary and Tertiary containment requirements added
29/01/2021	1.1	Matthew Spare	3.5 Changes to specification of double block and bleed valves
29/01/2021	1.1	Matthew Spare	2.4 Removal of section on Glass Reinforced Plastic (GRP) Pipework and Fittings
29/01/2021	1.1	Matthew Spare	5.3 Removal of section on GRP Pipework
22/02/2021	1.2	Matthew Spare	1.2 Added requirement for management of change process (also Annex B)
15/03/2021	1.3	Matthew Spare	2.2.4 Added references to Swagelok pipework and fittings
22/10/2021	2.0	Matthew Spare	Reissued
01/06/2022	3.0	Kevin Senior	Minor misspellings and typos corrected throughout. Minor formatting and renumbering changes made throughout. Major update completed to include: Addition of Phased Array Ultrasonic Testing as means of weld testing in Section 7. New section added on MATTE and environmental risk tolerability (Section 15). Additional guidance provided on storage tank internal coatings (Sections 11, 13 & 14). Addition of sub-section 2.5.2 on dispense hoses. Addition of sub-section 1.11.6 on MMO handover responsibilities. Sub-section 1.7.7 updated. Numerous changes made to add note that components/equipment installed downstream of the FWS are to be made from or lined with stainless steel. Annex B added for Torque Specification of Bolted Flange Joints. Schedule – Annex A deleted.

FOREWORD

This Technical Standard here after known as the Standard is published by Defence Infrastructure Organisation (DIO) for application across all areas of the MOD and **replaces** the Practitioner Guide 04/12. The following extant DIO specifications have also been **replaced** by this Technical Standard:

- SPEC 032 – Internal Coating of Aviation Fuel Tanks
- SPEC 043 – Pumps for Bulk Fuel Installations
- SPEC 044 – Fuel Measurement
- SPEC 046 – Aviation Fuel Filtration

The Standard is mandated for all contracts let after publication of this document. For existing contracts, no work involving expenditure on any MOD account is to be entered into without prior authority from the appropriate MOD officer for that location or facility.

DOCUMENT AIM

This Technical Standard sets the MOD standard for the construction, modification, and repair of fixed mechanical equipment at MOD petroleum installations.

DOCUMENT SYNOPSIS

This document provides procedural guidance on the maintenance, inspection and testing of fixed mechanical and electrical equipment installed at petroleum installations on the MOD estate. It is not a standard on the practical aspects of maintenance, inspection and testing of such installations, which is left to the professional skills and judgement of Competent Person(s) undertaking the work.

Contents

1.0 General Requirements

1.1 Scope

1.1.1 The Standard applies to the mechanical and electrical features of the supply of materials and workmanship for the construction of, and modifications to, petroleum installations. The principal types of petroleum installations covered are Petroleum Supply Depots, Bulk Petroleum Storage Installations, Aviation Hydrant Fuelling Systems and On Base Connecting Pipelines.

1.1.2 The Standard does not cover Motor Transport Filling Installations, non-MoD owned Cross Country Petroleum Pipelines and Fuel Oil Storage and Handling Facilities directly associated with heating and power generation plants.

1.1.3 The Standard only covers equipment, installations and pipelines designed for working pressures up to and including 19.3 barg (i.e. normally incorporating ANSI Class 150 flanges, valves, and fittings etc).

1.2 Safety

1.2.1 All work is to be undertaken in accordance with the MoD Safety Rules and Procedures for Work on Petroleum Installations JSP 375 Volume 3, Chapter 2, and Chapter 5.

1.2.2 The AP (Pet) who is responsible for the application of the MOD Safety Rules and Procedures, controls all works on fuel installations under the delegation of the Operating Authority (OA). No inspection, maintenance or testing which could affect the petroleum installation shall be undertaken without first having been authorised to do so by the issue of either a permit to work or standing instruction by the AP (Pet).

1.2.3 Design, procedural or equipment changes must not be initiated on any fuel facility without a documented Management of Change process being undertaken. Annex A of this document provides a template for this process. A Change Manager should be assigned to oversee the process, with a team of competent individuals involved to cover all applicable subject areas. Actions taken should identify appropriate actions to manage the change and ensure ongoing safety from both a personnel and process perspective.

1.2.4 Where process safety changes are required, a recorded HAZOP (Hazards and Operability) study should be undertaken. This will consider the risks to operability, maintainability, loss of containment, accessibility, plant reliability and life expectancy, standard operating and emergency procedures that may be introduced by the change or the new procedure. Records of the change should be maintained for the life of the facility.

1.2.5 For new builds or refurbishment works, ATEX Hazardous Area Equipment Register shall be produced to capture all equipment installed in hazardous areas, as per the requirements of the Explosion Protection Document detailed in JSP 375 Volume 1 Chapter 9.

1.2.6 It is the responsibility for designer / contractor to provide Hazardous Area Classification drawings as part of the project handover. Further information on these requirements can be found in JSP 375 Volume 1 Chapter 9.

1.2.7 A Cause & Effect matrix should be produced for each installation, detailing all instrumentation and the effects that should occur if these instruments are activated (valve closures, pump trips

etc). This document should identify all safety systems at a given installation and detail the desired consequences in the event the safety system is activated. In turn this should allow complete testing of all safety systems in accordance with the requirements identified in Technical Standard - Petroleum - 02.

1.3 Application of the Standard Elsewhere

1.3.1 USVF Bases

(a) The guidelines given in this Standard is applicable to the full range of mechanical equipment found on fuel installations on MOD Establishments occupied by the United States Visiting Forces (USVF)

(b) Both in terms of quality and safety, the standard of work undertaken on USVF sites must not be inferior to those executed on the UK MOD sites

1.3.2 Overseas Estates

(a) On the DIO managed estate overseas the construction, modification, and repair of equipment on petroleum installations, selection of contractors and the appointment of Competent Persons must comply with UK regulations unless host nation regulations are at least as stringent. Hence on remote overseas estates UK regulations are the norm whilst in British Forces (Germany) (BF(G)), Canada and USA, for example, local regulations are applicable

(b) The estates occupied by BF(G) apply their own local (German) regulations. The competency of the contractor is established prior to contract let and local procedures apply to the selection and appointment of the Competent Person. For this reason, while the general principles mentioned in this Standard may be applicable, the document will be of limited use to BF(G) staff

1.3.3 Deployed Operating Bases

Where operational conditions permit the application of peacetime regulations and contractors are engaged on works services under CONDO[1], the guidance given in this Standard should be followed on permanent/semi-permanent deployed operating bases where practicable. The Standard is not applicable for installations designed, executed, and maintained by the Royal Engineers in an operational theatre designated as a Military Works Area[2].

[1] Contractors on Deployed Operations.

[2] Infrastructure Management on Joint Operations: Joint Warfare Publication 4-05.

1.4 Definitions

1.4.1 The terms used within this Standard shall be read as having the definitions given below:

(a) ASME/ANSI/EEMUA STANDARD shall mean ASME/ANSI B31 .3 'Chemical Plant and Refinery Piping' read in conjunction with the related EEMUA Supplement, EEMUA Publication No. 153.

(b) APPROVAL (and words derived there from) shall mean qualified approval in writing by the Project Manager, unless stated otherwise, to the design or commodities concerned, at the time of consideration. Any such approval given shall be without prejudice to the requirement that formal acceptance of the Works shall be subject to such performance, testing and commissioning, as may be specified, and being to the satisfaction of the Project Manager.

(c) AVIATION HYDRANT FUELLING SYSTEMS: systems installed at MOD airfields for fuelling aircraft via underground hydrant pipelines from Aviation Bulk Fuel Installations.

(d) BULK PETROLEUM STORAGE INSTALLATIONS: installations comprising storage tanks, pumps, pipework, valves and handling equipment for receipt, storage, pumping and delivery of fuels. Such installations are mainly located within the boundaries of MOD property. These installations include Bulk Fuel installations (BFIs) on RAF and RNAS Air Stations, MOD(N) Oil Fuel Depots (OFDs), NATO Petroleum Depots and Army Petroleum Depots.

(e) CLASS: followed by a designation (normally 150 throughout this Standard) as used in BS EN 1759 -1 means that the strength or dimensions of the materials referred to must be suitable for design pressures and temperature conditions equivalent to a flange to BS EN 1759 -1 for carbon steel and austenitic chromium-nickel-molybdenum (low carbon) stainless steel in the temperature range -30˚C to 100˚C. For temperatures above 100ºC refer to the appropriate section of ANSI/ASME B31.3.

(f) COMPETENT: someone who has the necessary qualifications, skills, experience, and practical knowledge to safely and successfully complete tasks pertaining to this Standard.

(g) COMPLETE INSTALLATION shall mean not only major items of plant and equipment covered by this Standard, but all incidental sundry components necessary for the complete execution of the works and for the proper operation of the installation, with their labour charges whether or not they are detailed in this Standard or the related documents.

(h) CONTRACTOR shall mean the organisation or individual contracted by the MOD to carry out works on petroleum installations sited on the Defence Estate.

(i) CROSS COUNTRY PETROLEUM PIPELINES not owned by the MoD are not covered in this Standard: Off-base pipelines supplying on-base Bulk Petroleum Storage Installations from Petroleum Supply Depots. These pipelines are normally rated by Oil Companies on behalf of MOD and are generally designed for pressures in excess of 19 barg.

(j) DESIGN PRESSURE shall mean the maximum gauge pressure to which a component may normally be subjected at the coincident design temperature. This pressure may only be exceeded within the component when a pressure relief device is in operation to a maximum of 110% of the design pressure, or during proof testing.

(k) DESIGN TEMPERATURE shall mean the temperature coincident with the design pressure.

(l) FUELS shall include aviation gasolines, aviation turbine fuels, or other similar petroleum products which may contain aromatics, oxygenates, alcohols, lead alkyls, fuel system

icing inhibitor, anti-static additive etc.

(m) HOLIDAY shall mean a fault in an internal or external coating where the metal surface is not fully covered by the coating system.

(n) HOLIDAY DETECTION shall mean electrical inspection of the coating for the holiday faults.

(o) INDEPENDENT WELDING INSPECTOR shall be an engineer, qualified to a recognised standard, employed by an Engineering Inspection/Insurance Company.

(p) INDICATED as used in 'as indicated', 'where indicated', 'unless otherwise indicated' and like phrases, means indicated in the other related documents listed in the invitation to tender.

(q) CONNECTING PIPELINE: a line of pipe of relatively considerable length, principally underground, with few, if any, valves, pipe fittings and equipment incorporated in this length (other than for maintenance purposes). Examples are underground cross base pipelines between Aviation BFIs, sea tanker and ship loading and discharge pipelines, and other long underground pipelines at MOD (N) OFDs, tanks, pumps, pipework, valves and handling equipment for the receipt, storage.

(r) PETROLEUM SUPPLY DEPOTS (PSDs): Off-base Bulk Petroleum Storage Installations generally operated by Oil Companies. These installations are located off-airfields and normally supply on-base aviation BFIs by cross country pipelines.

(s) PIPING SYSTEMS: these are assemblies of pipes, pipe fittings, flanges, pipe supports, valves and ancillary equipment. Examples are pump manifold systems at aviation BFIs and MOD OFDs, and aviation hydrant fuelling systems.

(t) PROJECT MANAGER is either an official of the MOD or a person employed by the contracted Maintenance Management Organisation to operate in that capacity for the specific purpose of satisfactorily managing and administering the works to the requirements contained in this Standard.

(u) SPECIFIED as used in 'as specified', 'where specified', 'unless otherwise specified' and like phrases means specified in this Standard, other applicable standards, other related documents or as directed by the Project Manager.

(v) STAINLESS STEEL shall mean austenitic stainless steel with a minimum chromium content of 16%.

(w) TONE DOWN: Colour painted on aboveground petroleum pipework and facilities when requested by the OA to make them less visible from the air (normally NATO green)

1.5 Related Documents

1.5.1 This Standard should be cited in the contract for works on bulk petroleum installations on the MOD Estate. Any discrepancy between this Standard, the Conditions of Contract, the Contract Drawings or any other documents listed on the tender form shall be referred to the competent relevant person as soon as practicable during the pre-acceptance stage or to the Project Manager (PM) thereafter.

1.6 Proven Performance

1.6.1 Systems and equipment identical to that selected by the Contractor shall have performed successfully for at least the period (under the same conditions) as those required by the tender documents.

1.7 Standards

1.7.1 Conformance with the current BS, BS EN and ISO or other standard or regulation published by the MOD/DIO and they shall bring to the attention of the PM any changes during the course of the Contract in the relevant standards and Codes of Practice.

1.7.2 Conformance with all relevant British Standards and Codes of Practice for the materials and workmanship covered by the Standard unless otherwise stated and supplement British Standards, where appropriate, by other internationally accepted standards. The Contractor shall accept responsibility for obtaining copies of the latest revisions of the standards referred to in this Standard.

1.7.3 All commodities specified to conform to British Standards shall be clearly and indelibly marked with the relevant reference, and where this is impracticable, the relevant advice or delivery notes shall include the BS standard reference with which they are to conform.

1.7.4 Where commodities are specified or manufactured by a BSI Kitemark licensee (under BSI Certification Schemes) or where commodities/services are specified to be by Registered Firms (under BSI Assessment Schemes) the manufacturer/firm shall be a current participant in the relevant scheme.

1.7.5 Where commodities/services are specified to be by registered/approved firms (under Approved Quality Assurance Schemes) the manufacture/firm shall be a current participant in the relevant scheme and shall ensure that those items required to meet the conditions of quality assurance authorities do comply with the current requirements.

1.7.6 Where required, material certificates of conformity shall be provided when required by the PM.

1.7.7 Documents either referred to in this Standard or recommended as additional supporting material are as follows:

ANSI/ASME B16.9 Factory made wrought steel butt welding fittings

ANSI/ASME B16.11 Forged fittings, socket welding and threaded

ANSI/ASME B16.21 Non-metallic flat gaskets for pipe flanges

ANSI/ASME B31.3 Chemical plant and petroleum piping

ASTM A 105/A 105M Standard specification for carbon steel forgings for piping applications.

ASTM A 106/A 106M Specification for seamless carbon steel pipe for high temperature service

ASTM A 182/A 182M Specification for forged or rolled alloy steel pipe flanges, forged fittings, valves, and parts for high temperature service

ASTM A 193/A 193M Specification for alloy steel and stainless-steel bolting materials for high temperature or high-pressure service and other special purpose applications

ASTM A 194/A 194M Specification for carbon and alloy steel nuts for bolts for high pressure or high temperature service or both

ASTM A 234/A 234M Specification for piping fittings of wrought carbon steel and alloy steel for moderate and high temperature service

ASTM A 312/A312M Specification for seamless, welded and heavily cold worked austenitic stainless-steel pipe

ASTM A 403/A 403M Specification for wrought austenitic stainless-steel piping fittings

API 5L Specification for line pipe

API 6D Specification for pipeline valves

API 520 Sizing, selection and installation of pressure relieving systems in refineries

API 599 Specification for steel plug valves

API/EI 1584 4-inch hydrant system components and arrangements

API 2000 Venting atmospheric and low-pressure storage tanks (non-refrigerated and refrigerated)

API 610 Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries

The Electricity at Work Regulation 1989 (EAWR)

The Dangerous Substances and Explosive Atmosphere Regulation 2002 (DSEAR)

The Equipment and Protective Systems Intended for Use in Potentially Explosive Atmosphere Regulation 2016 (EPS Regulations)

BS 1134 Assessment of surface texture

BS 1600 Specification for dimensions of steel pipe for the petroleum industry.

BS 1640 Specification for steel butt welding pipe fittings in the petroleum industry

BS 1868 Specification for steel check valves (flanged and butt-welded ends) for the petrochemical and allied industries.

BS 1873 Specification for steel globe and globe stop and check valves (flanged and butt-welding ends) for the petroleum, petrochemical and allied industries.

BS 2464 Hose couplings for petrol, oil, and lubricants

BS 2633 Specification for class 1 arc welding of ferritic steel pipework for carrying fluids

BS 4164 Specification for coal-tar based hot applied coating materials for protecting iron and steel including a suitable primer

BS 4677 Specification for arc welding of austenitic stainless-steel pipework for carrying fluids

BS 6464 Specification for reinforced plastic pipes, fittings, and joints for process plants

BS 7079 Preparation of steel before application of paints and related products

BS 7430 Code of Practice for Protective Earthing of Electrical Installations

BS 7671 Requirements for Electrical Installations – IET Wiring Regulations

BS EN 485 Aluminium and aluminium alloys, plate, sheet, and strip

BS EN 558-2 Industrial valves - face to face and centre to face dimensions of metal valves for use in flanged pipe systems. Class designated valves

BS EN 586 Aluminium and aluminium alloys, forgings

BS EN 754 Aluminium and aluminium alloys, cold drawn rod/bar, and tube

BS EN 837-1 Pressure gauges, bourdon tube pressure gauges dimensions, metrology, requirements, and testing

BS EN 1011 Welding: recommendations for welding of metallic materials

BS EN 1361 Rubber hoses and hose assemblies for aviation fuel handling: specification

BS EN 1759-1 Flanges and their joints: circular flanges for pipes, valves, fittings and accessories, class designated, steel flanges NP ½ to 24

BS EN 10204 Metallic materials: types of inspection documents

BS EN 10213 Technical delivery conditions for steel castings for pressure purposes.

BS EN 10222 Steel forgings for pressure purposes

BS EN 10226 Pipe threads where pressure tight joints are made on the threads

BS EN 12266-1 Industrial valves. Testing of valves. Pressure tests, test procedures and acceptance criteria

BS EN 12020 Aluminium and aluminium alloys: extruded precision profiles in alloys EN AW-6060 and EN AW-6063

BS EN 12476 Phosphate conversion coatings for metals: methods of specifying requirements.

BS EN 12285 Workshop fabricated steel tanks

BS EN 13480 Metallic industrial piping BS EN 12954 General Principles of Cathodic Protection of Buried or Immersed Onshore Metallic Structures

BS EN 13636 Cathodic Protection of Buried Tanks and Related Pipework1

BS EN 62305-1 Protection Against Lightning. General Principles

BS EN 62305-2 Protection Against Lightning. Risk Management

BS EN 62305-3 Protection Against Lightning. Physical Damage to Structures and Life Hazards

BS EN 62305-4 Protection Against Lightning. Electrical and Electronic Systems within Structures

BS EN 60079-0 Equipment – General requirements

BS EN 60079-1 Equipment protection by flameproof enclosure ‘d’

BS EN 60079-2 Equipment protection by pressurized enclosure ‘p’

BS EN 60079-5 Equipment protection by powder filling ‘q’

BS EN 60079-6 Equipment protection by oil immersion “o”

BS EN 60079-7 Equipment protection by increased safety “e”

BS EN 60079-11 Equipment protection by intrinsic safety "i"

BS EN 60079-14 Electrical installations in hazardous areas (other than mines)

BS EN 60079-15 Construction, test and marking of type of protection "n" electrical apparatus

BS EN 60079-17 Electrical installations Inspection and Testing

BS EN 60079-18 Construction, test and marking of type of protection encapsulation "m" electrical apparatus

BS EN 60079-19 Equipment repair, overhaul, and reclamation

BS EN 60079-25 Intrinsically safe systems

BS EN ISO 1825 – Rubber hoses and hose assemblies for aircraft ground fuelling and defueling - Specification

BS EN ISO 5459 Technical product documentation: sizes and layout of drawing sheets.

BS EN ISO 10434 Specification for steel wedge gate valves (flanged and butt-welding ends) for the petroleum, petrochemical and allied industries

BS EN ISO 15614 Specification and qualification of welding procedures for metallic materials

BS EN ISO 15761 Steel gate, globe, and check valves for sizes DN 100 and smaller for the petroleum and natural gas industries.

BS EN ISO 17292 Specification for steel ball valves for the petroleum, petrochemical and allied industries.

BS EN ISO 28300 Venting of atmospheric and low-pressure storage tanks

BS EN ISO 13588 Non-destructive testing of welds – Ultrasonic testing – Use of automated phased array technology

CIRIA C736 Containment systems for the prevention of pollution

IEC 60079-26 Equipment with equipment protection level (EPL) Ga

IEC 60079-27 Fieldbus intrinsically safe concept (FISCO) and Fieldbus non-incendive concept (FNICO)

IEC 60079-28 Protection of equipment and Transmission systems using optical radiation

ISO 15589-1 Petroleum & Natural Gas Industries. Cathodic Protection of Pipelines Transportation Systems On-Land Pipelines

ISO 22825 Non-destructive testing of welds – Ultrasonic testing – Testing of welds in austenitic steels and nickel-based alloys

ISO 9712 Non-destructive testing – Qualification and certification of NDT personnel

ISO 18563-1 Non-destructive testing – Characterization and verification of ultrasonic phased array equipment – Part 1: Instruments

ISO 18563-2 Non-destructive testing – Characterization and verification of ultrasonic phased array equipment – Part 2: Probes

ISO 18563-3 Non-destructive testing – Characterization and verification of ultrasonic phased array equipment – Part 3: Combined systems

EI Model Code of Practice part 1. The selection, installation, inspection, and maintenance of electrical and non-electrical apparatus in hazardous areas

EI Model Code of Practice part 15. Area classification for installations handling flammable fluids

EI Model Code of Practice part 21. Guidelines for the control of hazards arising from static electricity

EI Guidelines on Earthing, Grounding and Bonding

EI/API Verification of Lighting Protection requirements for Aboveground Hydrocarbon Storage Tanks

EI 1529 – Aviation Fuelling Hoses and Hose Assemblies

EI/JIG 1530 Quality assurance requirements for the manufacture, storage, and distribution of aviation fuel to airports (A4)

EI 1541 Requirements for internal protective coating systems used in aviation fuel handling systems

EI 1581 Specifications and laboratory qualification procedures for aviation fuel filter/water separators

EI 1590 Specifications and qualification procedures for aviation fuel microfilters

EI 1596 Design and construction of aviation fuel filter vessels

EEMUA 186 A Practitioner’s handbook for potentially explosive atmospheres

EEMUA 153 Supplement to ANSI/ASME B31.3

EEMUA 159 Above ground flat bottomed storage tanks - a guide to inspection, maintenance, and repair

HSE - Safety and environmental standards for fuel storage sites - Process Safety Leadership Group Final report

STANAG AFLP-374 Technical guidance for the design and construction of aviation and ground fuel installations on NATO airfields

https://www.sepa.org.uk/media/219154/cdoif_guideline__environmental_risk_assessment_v2.pdf

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/880653/DSA_03_JSP_498_Chap_6_Mar_2020.pdf

https://www.sepa.org.uk/media/219153/detr-guidance-1999.pdf

https://modgovuk.sharepoint.com/sites/defnet/dsa/Pages/DOSR-Toolset-and-Defence-Regulations.aspx

https://modgovuk.sharepoint.com/teams/18553/008

1.8 Regulations

1.8.1 All work in and around petroleum hazardous areas shall be carried out in accordance with JSP 375 Volume 3 Chapter 5 – Petroleum.

1.8.2 When required by JSP 375 Volume 3 Chapter 5 - Petroleum, a covering Permit to Work must be obtained from the responsible AP (Pet) prior to the commencement of any work on or near a petroleum installation which either contains, or has previously contained, petroleum products. Notwithstanding the receipt of a Permit to Work (Petroleum) in such cases, it shall be the responsibility of the Contractor to ensure that the requirements for safety specified in JSP 375 Volume 3 Chapter 5 - Petroleum are strictly complied with at all times.

1.8.3 Conformance with the 'Defence Infrastructure Fire Standards' is required at all times.

1.8.4 The completed work and all aspects of the execution thereof shall comply with all relevant enactments, statutory instruments, regulations, and codes including the following:

(a) Health and Safety at Work Act and Regulations made there under

(b) Electricity Acts and Regulations made there under

(c) Control of Pollution Act and Regulations made there under

(d) Petroleum (Consolidation) Regulations

(e) IEE Regulations for Electrical Installations

(f) Any special regulations issued by the local telecommunications, electricity, gas, or water Authorities

(g) Home Office Model Code of Principles of Construction and Licensing Conditions for Premises Licensed under the Petroleum (Consolidation) Act 1928 - Parts I and II

(h) Statutory Instrument 2001 No 2954 – The Control of Pollution (oil storage) (England) Regulations 2001

(i) Scottish Statutory Instrument 2006 No 133 – The Water Environment (Oil Storage) (Scotland) Regulations 2006

1.9 Drawings

1.9.1 All drawings submitted to the PM should conform to the engineering drawing practice of BS 8888. All drawings submitted to the PM shall be prepared on sheet sizes A0 to A4 as specified in BS 3429. All drawings should be submitted as required below to the PM, for approval:

(a) Where installation forms part of the Contract, installation drawings of all aspects of the works in sufficient detail to enable an installation contractor to build an installation essentially identical to that shown on the drawings

(b) Where installation forms part of the Contract, drawings showing the relationship between works and equipment of different disciplines

(c) General arrangement drawings of all equipment being supplied under the Contract giving overall dimensions, weight, details of all features where equipment joins to other equipment or services and all foundations

(d) Drawings showing greater engineering detail if ordered by the PM

(e) Drawing required by any other documents referred to in this Standard

(f) Record drawings referred to in Section 1.10

(g) Schematic views showing in diagrammatic form all pipe runs, with the identification numbers of storage tanks, pumps, valves etc

(h) The number of copies required shall be specified in the Contract

(i) Drawings shall be submitted to the PM for approval within the time scale specified in the Contract

1.10 Record Drawings

1.10.1 Record drawings shall be provided in a format as stated in Section 1.9. The drawings required for record purposes shall be as follows:

(a) All drawings submitted for approval as described in Section 1.9.1, but amended as required by the PM

(b) All additional drawings required by the PM shall be supplied

(c) The number of copies of each drawing required for record purposes shall be specified by the PM

1.10.2 Record drawings shall be marked as follows:

(a) 'RECORD' or 'AS-INSTALLED' in block letters 19 mm high adjacent to title block

(b) Name of site and/or building

(c) Project Contract number

(d) Name of installation Contractor

(e) Name of Contractor who prepared the drawing if different from foregoing

(f) Date of preparation of drawing

1.11 Maintenance and Operating Documents

1.11.1 The Original Equipment Manufacturer's maintenance and operating manuals should be

provided showing the following for each piece of equipment or system:

(a) A general description of the equipment or system, its operating characteristics, installation and commissioning requirements and any special features

(b) General instructions for dealing with fault-finding diagnosis and recommended remedial actions

(c) Details of all scheduled routine preventive maintenance requirements, including a lubrication schedule (where applicable)

(d) Any precautions necessary for safeguarding the health and safety of operators and maintainers, protecting the environment and avoidance of mal operation

(e) Any features required by any other documents referred to in this Standard

1.11.2 A full set of planned preventative maintenance detail sheets for each installation should be provided. The full particulars of the installation and its component systems and equipment and, where appropriate, initial test results and detail of readings and measurements recorded during commissioning should be provided. The detail sheets provided shall be accurately and legibly completed to the satisfaction of the PM and in all cases the particular installations to which they relate shall be clearly identified in a manner approved by the PM.

1.11.3 A comprehensive list of spares required for the maintenance of the completed Works for a minimum of 2-4 years operation from commissioning should be prepared. The list shall include spares that normally need to be replaced due to fair usage, wear and tear including a statement of likely service life and shelf life for these items together with their source of supply and code numbers.

1.11.4 The number of copies of Maintenance, Operating and Spares documentation that is to be provided by the Contractor shall be specified by the PM.

1.11.5 The MMO shall be responsible for ensuring that initial and/or refresher training for nominated site personnel on all new equipment, installations and systems is provided.

1.11.6 On handover of MMO responsibilities, the outgoing MMO shall ensure that for each of the operational and mothballed petroleum installations that were inspected and maintained under their contractual remit, the following documentation and information (as a minimum) is handed over:

(a) Health & Safety file to enable future users to inspect and maintain the installations safely

(b) Original equipment manufacturers' Installation, Operation & Maintenance documentation

(c) Project Team directory

(d) Subcontractor register

(e) Supplier register

(f) Hazardous materials register

(g) ATEX Register

(h) Drawings and data relating to safe working loads, structural design and alterations

(i) As Built and As Installed drawings

(j) Survey reports relating to:

- Cables
- Ducts
- Buried pipework
- Gas pipework
- Electrical
- Water
- Underground services

1.12 Materials

1.12.1 General: only new materials of construction that conform to the relevant standards shall be used unless otherwise specified; where the PM directs the use of existing materials, these shall meet the specification for new materials.

1.12.2 Ferrous materials other than austenitic stainless steels shall not be used in components that are in contact with aviation fuel or aviation fuel vapour in confined spaces where that fuel is to be transferred directly from operating storage tanks to aircraft or to the aircraft fuelling vehicle, except where one of the following conditions applies:

(a) The ferrous materials are hot-tinned

(b) The ferrous materials are epoxy coated

(c) This specification expressly permits otherwise

(d) The express prior agreement of the PM has been obtained

1.12.3 The following non-ferrous materials must not be used in components which are in contact with the fuel or in components which are in contact with the fuel vapour in confined spaces:

(a) Zinc (including all zinc coatings), zinc compounds and alloys containing zinc

(b) Lead and alloys containing lead

(c) Copper and alloys containing 4% and above copper (unless specifically stated as being allowed in individual equipment specifications)

(d) Cadmium and its compounds

2.0 Pipework and Fittings

2.1 General

2.1.1 The pipework and fitting specifications detailed within this section are intended to be used at PSDs, Aviation Hydrants, Jetty Pipelines and Cross Base Pipelines. These pipelines operate at relatively low pressures and incorporate ANSI Class 150 fittings and equipment with a maximum design pressure of 19.3 barg.

2.1.2 The selection of suitable pipework materials of construction, level of external protection and methods of fabrication are dependent upon the classification of products, service and quality control requirements, and the environmental considerations for which the pipelines are designed.

2.1.3 The pipework materials of construction shall be as shown on the drawings, as one of the following systems:

(a) System 1 AA Stainless Steel

(b) System 1 AB Carbon Steel

2.1.4 Selection of pipeline materials of construction and system design shall comply with the guidelines of this Standard and the following standards:

(a) Code of practice for Control of Undesirable Static Electricity PD CLC/TR 50404

(b) Protection of structures against lightning; BS EN 62305

(c) Code of practice for earthing BS 7430

(d) Cathodic protection of buried metallic tanks and related piping: BS EN 13636

(e) Model Code of Safe Practice for the Petroleum Industry: Part 1 Electrical Safety Code

2.1.5 Prefabricated pipework shall comply with the relevant Materials and Workmanship sections as applicable within this Standard.

2.1.6 All pipe ends shall be protected before despatch from the supplier's works against damage in transit, and suitably closed for the protection of the interior surfaces.

2.1.7 The PM shall be given access to inspect all equipment including pipes before despatch to site. The PM shall be informed before the date of despatch of all equipment, including pipes. The PM shall provide details of the timescales in the Contract.

2.1.8 All flanged connections shall be assembled with appropriate torque values and sequencing in accordance with the requirements of ANSI/ASME B31.3.

2.2 Stainless Steel Pipework and Fittings (System 1AA)

2.2.1 This part of the Standard shall apply to those sections of pipework and fittings shown on the drawings with line numbers ending in "....1AA".

2.2.2 The process conditions for this system of piping shall be specified by the PM and as a minimum include:

- Process fluid
- Normal operating pressure
- Design pressure (19.3 barg max)
- Design temperature

2.2.3 Tolerances on diameter and wall thickness of line pipe shall be as specified in ASTM A 312/A 312M.

2.2.4 Piping materials shall be supplied in accordance with the codes and standards in Table 2.1 below:

Table 2.1 Pipework and Fittings, System 1AA: Stainless Steel.

Pipe	Up to 40 mm	ASTM A 312/A 312M type 316L BS 1600, Sch 80s Seamless - plain ends Swagelok 316L (W/T 1.0mm) (up to 12mm only)
	50 mm and above	ASTM A 312/A 312M type 316L BS 1600, Sch. 10s Seamless or welded - bevelled ends
Pipe Nipples	Up to 40 mm	ASTM A312/A 312M type 316L (material) BS 1600 Sch. 80s (dimensions) Seamless - ends as required 50 mm and 100 mm long
Pulled Bends	Up to 40 mm	Minimum centre line radius - 5 x nominal diameter (DN) Material as for pipe Ends plain
Branch Fittings		See branch schedule at end of table
Fittings	Up to 40 mm	ASTM A 182/A 182M 3000 lb. forged steel Socket weld ends to ANSI B 16.11 Screwed ends to ANSI B 16.11 for instrumentation and low-pressure side of relief valves only. ANSI B 1.20.1 threads. Elbows 45º and 90º long radius Tees: equal and reducing Couplings Swage nipples Caps Sockolets Swagelok 316L (up to 12mm only)
	50 mm and above	ASTM A 403/A 403M, WP 316L Butt weld to ANSI B 16.9 or MSS SP-43-1982 Elbows 45º and 90º long radius only Tees: equal and reducing Reducers: concentric and eccentric

Flanges	Up to 40 mm	ASTM A 182/A 182M-F 316L to BS EN 1759-1 Class 150 (RF) Socket weld or blind
	50 mm and above	ASTM A 182/A 182M-F316L to BS EN 1759-1 Class 150 (RF) Weld neck Blind
Gaskets	All	Rubber bonded jointing for industrial and aerospace purposes Oil resistant, non-graphitized to BS 7531, flat ring 1.5 mm thick Dimensions to ANSI B 16.21 table 4 No jointing compound to be used.
Flange Bolting	All	Uncoated (bare) metal fasteners conforming to: ASTM A 193/A 193M GR B8M stainless steel stud bolts ASTM A 194/A 194M GR 8M stainless steel heavy hex nuts
Sealing Materials		Virgin PTFE tape Do not seal - weld joints

Branch Schedule

Branch size (mm)

Run Size (mm)	20	25	40	50	80	100	150	200	250	300	350
20	STE										
25	STR	STE									
40	STR	STR	STE								
50	SOL	SOL	SOL	WTE							
80	SOL	SOL	SOL	WTR	WTE						
100	SOL	SOL	SOL	WTR	WTR	WTE					
150	SOL	SOL	SOL	WOL	WTR	WTR	WTE				
200	SOL	SOL	SOL	WOL	WOL	WTR	WTR	WTE			
250	SOL	SOL	SOL	WOL	WOL	WOL	WTR	WTR	WTE		
300	SOL	SOL	SOL	WOL	WOL	WOL	WTR	WTR	WTR	WTE	
350	SOL	SOL	SOL	WOL	WOL	WOL	WTR	WTR	WTR	WTR	WTE

STE	Socket weld tee equal	) ASTM A 182/A 182M F 316 L 3000lb forged steel
STR	Socket weld tee reducing	
SOL	Sockolet	
WOL	Weldolet	

WTE	Weld tee equal	)
		) ASTM A 403/A 403M WP 316 L wrought steel
WTR	Weld tee reducing	)

2.2.5 Raised face flanges shall have a serrated spiral (gramophone) finish with a mean roughness of 3.2 – 6.3 CLA micro-metre.

2.2.6 The bore of the flanges and butt weld fittings shall match that of the pipe to which they are to be welded.

2.3 Carbon Steel Pipework and Fittings (System 1AB)

2.3.1 This part of the Standard shall apply to those sections of pipework and fittings shown on the Drawings with line numbers ending in "..... 1AB".

2.3.2 The process conditions for this system of piping shall be –specified by the PM and as a minimum include:

- Process fluid
- Normal operating pressure
- Design pressure (19.3 barg max)
- Design temperature

2.3.3 Tolerances on diameter and wall thickness of line pipe shall be as specified in API 5L.

2.3.4 Carbon steel pipe which may be exposed to the following conditions shall be protected, as directed by the PM, by a phosphate conversion coating.

(a) Pipe stored in atmospheric corrosive conditions, or for a long period, prior to fabrication

(b) Pipe that may release corrosion products upon commissioning with fuel

(c) Pipe that will convey water or other corrosive liquid, and which cannot be internally lined

(d) Any other condition that exposes the internal surfaces of the pipe to corrosion

2.3.5 The phosphate conversion coating shall be as specified in BS EN 12476 with the following classification code Mnph r 7.5 and shall include rinsing and chromate treatment.

2.3.6 Zinc phosphate coating materials shall not be used for pipework that will convey aviation turbine kerosene (AVTUR).

2.3.7 After the pipe has been passivated and thoroughly dried, the ends shall be closed to prevent the ingress of moisture, dirt, and foreign bodies. The closures shall also adequately protect the pipe ends during transit and storage.

2.3.8 A phosphate conversion coating shall not be applied to pipe that will be internally lined.

2.3.9 Piping materials shall be supplied in accordance with the Codes and Standards in Table 2.2.

Table 2.2 Pipework and Fittings System 1AB: Carbon Steel.

Pipe	Up to 40 mm	API 5L GR B or ASTM A 106/A 106M GR B Sch 80 Seamless or ERW Plain ends
	50 mm and above	API 5L GR B Sch 40 Seamless or ERW Bevelled ends
Pipe Nipples	Up to 40 mm	API 5L GR B Sch 80 Ends as required 50 mm and 100 mm long
Pulled Bends	Up to 40 mm	Minimum centre line radius 5 x nominal diameter (DN) Material as for pipe Ends plain
Branch Fittings		See branch schedule at end of table
Fittings	Up to 40 mm	ASTM 240, Type 316L 3000lb steel Socket weld ends to ANSI B 16.11 Screwed ends to ANSI B 16.11 for instrumentation and low-pressure side of relief valves only. ANSI B 1.20.1 threads. Elbows, 45º and 90º long radius Tees equal and reducing Couplings Unions Swage nipples Caps Sockolets
	50 mm and above	ASTM A 234/A 234M GR WPB Butt weld to ANSI B16.9 Wall thickness to match pipe Elbows 45º and 90º long radius only Tees, equal and reducing Reducers, concentric and eccentric
Flanges	Up to 40 mm	ASTM 316L Class 150 (RF) Socket weld Blind
	50 mm and above	ASTM A 105/A 105M to BS EN 1759 -2 Class 150 (RF) Weld neck Blind
Gaskets	All	Rubber bonded jointing for industrial and aerospace purposes Oil resistant, non-graphitized to BS 7531, flat ring Dimensions to ANSI B16.21 Table 4 No jointing compound to be used
Flange Bolting	All	Uncoated (bare) metal fasteners conforming to: ASTM A 193/A 193M GR B7 stud bolts ASTM A 194/A 194M GR 2H heavy hex nuts
Sealing Material		For all other facilities use virgin PTFE tape Do not seal - weld joints

Branch Schedule
Branch size (mm)

Run Size (mm)	20	25	40	50	80	100	150	200	250	300	350
20	STE										
25	STR	STE									
40	STR	STR	STE								
50	SOL	SOL	SOL	WTE							
80	SOL	SOL	SOL	WTR	WTE						
100	SOL	S0L	SOL	WTR	WTR	WTE					
150	SOL	SOL	SOL	WOL	WTR	WTR	WTE				
200	SOL	SOL	SOL	WOL	WOL	WTR	WTR	WTE			
250	SOL	SOL	SOL	WOL	WOL	WOL	WTR	WTR	WTE		
300	SOL	SOL	SOL	WOL	WOL	WOL	WTR	WTR	WTR	WTE	
350	SOL	SOL	SOL	WOL	WOL	WOL	WTR	WTR	WTR	WTR	WTE

STE	Socket weld tee equal	)
		)
STR	Socket weld tee reducing	)
		) ASTM A 105/A 105M 3000lb forged steel
SOL	Sockolet	)
		)
WOL	Weldolet	)
WTE	Weld tee equal	)
		) ASTM A 234/A 234M WPB wrought steel
WTR	Weld tee reducing	)

2.3.10 Raised face steel flanges shall have a serrated spiral (gramophone) finish with a mean roughness of 3.2 – 6.3 CLA micro-metres.

2.3.11 The bore of the butt weld fittings and flanges shall match that of the pipe to which they are to be welded.

2.3.12 For fittings and flanges:

(a) ASTM A 105/A 105M carbon content 0.25% max. Material to be normalised

(b) ASTM A 234/A 234M carbon content 0.23% max

2.4 Selection of Materials

2.4.1 Pipelines

The MoD's preference is for pipelines to be manufactured from either stainless steel or carbon steel. The selection of the material of construction is to consider whether there is a specific military requirement for blast resistance (which is afforded by steel) and the relative costs of fabrication and installation. Stainless steel and carbon steel pipelines are to be in accordance with BS EN 14161. The use of stainless steel is also acceptable for airfield hydrant systems.

Carbon steel pipelines are to be coated in accordance with BS EN 14161.

For single skinned pipelines, consideration must be given to the provision of leak detection systems and the facility to conduct in-line inspections through the use of tools such as intelligent pigging equipment.

Double skinned pipelines shall incorporate a means of monitoring the interstitial space to detect leakage from the primary containment.

The use of polyethylene/GRP pipework may be acceptable in exceptional circumstances and DIO TS should be contacted should this material be proposed as an option.

2.4.2 Pipework

The use of stainless steel pipework is preferred throughout the installation but must always be used downstream of the FWS.

2.5 Pipe Ends for Hose Couplings

2.5.1 Pipe ends for hose couplings (for dispense and slops points). Pipe ends shall be prepared for the connection of vehicle dispense and slops point hoses, to either British or American style threads as required by the user. The thread forms shall be as follows:

(a) Pipe Ends to BS EN ISO 228 parts 1 and 2 (UK Thread).

Material	As pipe material
Thread	BS EN ISO 228 parts 1 and 2 - Male, loose fit, straight
Thickness	Suitable for maintenance of design pressure after threading
Use	For standard female hose couplings threaded to BS EN ISO 228 parts 1 and 2, loose fit, straight
Manufacture	As pipe
Finish	Bare metal

(b) Pipe Ends to BS 2464 (American Thread).

Material	As pipe material
Thread	BS 2464 Annex A, Male, loose fit, straight
Thickness	Suitable for maintenance of design pressure after
Use	For standard female hose couplings threaded to BS 2464, Appendix B, loose fit, straight
Manufacture	As pipe
Finish	Bare metal

(c) Pipe Ends (for off load points and vapour recovery connection). Pipe ends shall be prepared for the connection of vehicle off load and vapour recovery hoses as follows:

Material	As pipe material
Thread	BS EN ISO 288 parts 1 and 2 - Male, loose fit, straight
Thickness	Suitable for maintenance of design pressure after threading
Use	For standard 4" vehicle off-load hoses supplied with screwed couplings
Manufacture	As pipe
Finish	Bare metal

(d) British/American Hose Adaptors.

Adaptors shall be prepared as follows:

Type	Male / Female
Material	As pipe material
Threads	Internal to suit pipe end External to suit hose coupling
Thickness	Suitable for maintenance of design pressure after threading
Use	For attaching 'American' type hose couplings to British pipe ends or vice versa
Manufacture	As pipe
Finish	Bare metal

2.5.2 Hoses.

All rubber hoses used for aviation fuelling and defueling duties on the MoD Estate shall meet the requirements of BS EN ISO 1825 or EI 1529.

The maximum shelf storage life shelf for conforming hoses and flexible joints of a similar hose-type material shall be 2 years and the maximum in-service life shall be limited to 10 years. EI 1540 provides more guidance regarding the storage of new hoses.

Hoses must be replaced before their due life-expired date should they:

- Leak
- Exhibit kinking and/or deformation
- Exhibit significant damage (e.g. Delamination, blistering, scoring) of the outer cover

such that the inner textile reinforcing braided sleeve is exposed

- Be driven over by a vehicle
- Fail electrical resistance testing

2.5.3 Hose Connection Caps.

Provide and fit a stainless-steel threaded cap for each hose connection point. Each cap shall be provided with a chain, or other means of retention, attached to the pipework. The caps shall incorporate an elastomer or polymer seal to protect the end sealing face of the threaded hose connection point.

3.0 Valves

3.1 General

3.1.1 Valves are used for shutting off and controlling the direction of flow, throttling application, pressure or flow control and segregation of process fluids. Details of use and specification are given in Sections 3.2 to 3.9.

3.1.2 All pressure containing parts of valves shall have a design pressure and temperature in accordance with their pressure class. Certificates confirming conformance with this section shall be provided.

3.1.3 Valves shall be closed by either rotating handwheel or levers in the clockwise direction and opened by movement in the anti-clockwise direction. The valve handwheel shall be marked “open” with an arrow pointing to the direction referred. Where valves are required to be locked in position for operation, they shall be provided with padlock, chain and 3 keys or another PM approved locking device.

3.1.4 Valves shall be designed to enable one person to manually open and close the valve to their required torques by rotating the handwheel or lever irrespective of the size of the valve, where this cannot be achieved a gearbox is to be considered.

3.1.5 Valves which are provided with gearboxes shall be designed to ensure that the gearboxes are easily removable and allow for the future provision of electrically powered operators.

3.1.5 When extension spindles are required, these shall be fitted to place the handwheel or lever at the height as shown on the drawings. The handwheel or lever end of the extension spindle shall be supported with a pedestal and headstock such that all normal operating forces can be either withstood by the pedestal or transferred directly to the valve body.

3.1.6 All spindles and operating gear shall be suitable for use in an outside environment as defined in the Schedules. Valves shall remain operational throughout their lives in the conditions to be encountered.

3.1.7 Valves shall comply with the face-to-face dimensions stated in BS EN 558 -2 unless otherwise agreed by the PM. Valve seats shall be renewable on all valves of size 50 mm and greater.

3.1.8 Valves for use on fuel shall incorporate anti-static design features wherever provided for in the particular valve standard.

3.1.9 All valves for use on fuel shall be tested in accordance with BS EN ISO 10497 and BS EN 12266 – 2 and shall comply with the following specific requirements:

Inspection at Works	Not required unless otherwise specified by the PM
Repair of Defective Castings	Approval of the PM must be obtained before carrying out any repairs
Test Fluid	Water. Thorough drying required post test

3.1.10 All valves shall be supplied with appropriate material test certification in accordance with BS EN 10240 - 3.1.

3.1.11 The specification for actuated valves shall be provided by the PM.

3.1.12 Carbon steel valves shall be externally coated with a primer coat only. Finishing topcoats shall be applied to the valves when they have been incorporated into the pipework system and shall be in accordance with the specification for pipework painting.

3.1.13 The valves shall be primed and coated in accordance with the following requirement:

Surface Preparation	Abrasive blast clean to BS 7079 Sa 2½, surface profile 50-75 microns
Primer Coat	Epoxy zinc phosphate Min DFT – 50 microns

3.1.14 End connections shall be protected to prevent damage in transit and entry of dirt. This protection shall not be achieved by driving plugs into the ends of the valves.

3.1.15 All valves shall be fire safe to BS EN 12266 -2.

3.1.16 When selecting isolation valves the leak rate of the valve must be considered. An acceptable 'passing criteria' is to be agreed against the particular application of the valve with consideration being made for future maintenance needs and intrusive works on the system, plant, or equipment. The safe practical application of JSP 375 Volume 3 Chapter 5 must form part of that criteria.

3.1.17 The number of isolation valves for systems involving long runs of pipework must be considered and agreed at the design stage. The number of valves installed should be determined by consideration in line with the operational requirements of the system.

3.1.18 On systems with long buried pipework runs consideration should be given to the ability to pig lines for maintenance purposes.

3.2 Wedgegate Valves

3.2.1 Wedgegate valves provide an open/shut service with a minimum pressure drop across the valve. They are actuated by a rising spindle which indicates the position of the gate and hence whether the valve is fully open or shut. Wedgegate valves are generally used on larger pipelines and on petroleum storage tanks.

3.2.2 Small wedgegate valves, 40 mm and smaller, shall comply with the following requirements:

Size 40 mm and smaller	
Standard	BS EN ISO 15761
Class	800 (socket weld and screwed) 150 (flanged)

Type	Reduced bore, solid wedge, outside screw and yoke, rising stem
Ends	Flanged BS EN 1759-1 RF Class 150 or socket weld ends or screwed to ASNI B1.20.1
Bonnets/Cover	Bolted
Material	Body – carbon steel - stainless steel (when fitted downstream of FWS) Trim – Symbol 18-10-2 (Cr-Ni-Mo stainless steel)
Bellows seal	Not required
Operation	Handwheel

3.2.3 Ends shall be as shown on the drawings. Welded-on flanges shall not be permitted.

3.2.4 Socket weld valves shall be designed such that they will permit installation welding of the valve without damage to the valve internals.

3.2.5 Large wedgegate valves, 50 mm and larger, shall comply with the following requirements:

Size 50 mm and larger	
Standard	BS EN ISO 10434
Class	150
Ends	Flanged BS EN 1759-1 RF Class 150. Welded-on flanges not permitted
Full Bore	Only required when valves are installed on pipelines requiring to be pigged
Shell Tapping's	Required at position G of BS 1414 figure 3. Threads to be to BS 21 taper.
Wedge	Plain (solid)
Lantern Ring	Not required
Materials	Body – carbon steel - stainless steel (when fitted downstream of FWS) Trim – Symbol 18-10-2 (Cr-Ni-Mo stainless steel)
Operation	Hand/Geared/Motorised as specified by the PM.

Note. Other fluid contact materials to be compatible with the process liquid as agreed with the PM.

3.3 Ball Valves

3.3.1 Ball valves are used when an open/shut service is required. Full bore ball valves provide a minimum pressure drop across the valves and are operated from open to shut by a 90˚ turn of the ball. Ball valves are used when a quick shut off is required, for example at off load points.

3.3.2 Small ball valves 40 mm and smaller shall comply with the following requirements:

Size 40 mm and smaller	
Standard	BS EN ISO 17292
Class	800 (socket weld and screwed) 150 (flanged)
Type	Straightway, full bore. Ball and body port diameters to comply with requirements of BS EN ISO 17292
Ends	Flanged BS EN 1759-1 RF Class 150 or Socket weld ends or Screwed to ANSI B1.20.1
Drain Tapping	Not required
Ball Protrusion	Not Acceptable
Lantern Ring	Not required
Materials	Body – carbon steel - stainless steel (when fitted downstream of FWS) Ball/stern-BS EN 10222 -316
Operation	Hand-lever.

Note. Other fluid contact material to be stainless steel to BS EN 10222-316 or virgin PTFE or glass filled PTFE. Do not use other materials without permission of the PM.

3.3.3 Ends shall be as shown on the drawings. Welded-on flanges shall not be permitted.

3.3.4 Socket weld valves shall be designed such that they will permit installation welding of the valve without damage to the valve intervals.

3.3.5 Ball valves shall be firesafe in accordance with the BS EN ISO 10497. Such valves shall be licensed to carry the BSI Kitemark indicating conformance with BS EN ISO 17292 and BS EN ISO 10497 unless otherwise agreed by the PM.

3.3.6 Large ball valves, 50 mm and larger, shall comply with the following requirements:

Size 50 mm and larger	
Standard	BS EN ISO 17292
Class	150
Ends	Flanged BS EN 1759-1 RF Class 150. Welded-on flanges not permitted
Type	Straightway, full bore. Ball and body port diameters to comply with requirements of BS EN ISO 17292.
Drain Tapping	Not required
Ball Protrusion	Not acceptable

Lantern Ring	Not required
Materials	Body-carbon steel - stainless steel (when fitted downstream of FWS) Other fluid contact materials to be stainless steel to BS EN 10222 316 or virgin PTFE or glass filled PTFE. Do not use other materials without the prior permission of the PM.
Operation	Hand/Geared/Motorised as –specified by the PM.

Note. Ball valves shall be firesafe in accordance with BS EN ISO 10497 Such valves shall be licensed to carry the BSI Kitemark indicating conformance with BS EN ISO 17292 and BS EN ISO 10497 unless otherwise agreed by the PM.

3.4 Check Valves

3.4.1 Check valves are used to prevent reversal of flow in pipelines and pipeline equipment. They are also known as non-return valves. Check valves are principally used where reverse flow can cause spillage, for example at off-load points.

3.4.2 Small check valves, 40 mm and smaller, shall comply with the following requirements:

Size 40 mm and smaller	
Standard	BS EN ISO 15761
Class	800 (socket weld and screwed) 150 (flanged)
Type	Piston type for horizontal pipework runs Ball type for vertical pipework runs
Ends	Flanged BS EN 1759-1 RF Class 150 or Socket weld ends or Screwed to ANSI B1.20.1
Materials	Body – carbon steel - stainless steel (when fitted downstream of FWS) Trim – symbol 18-10-2 (Cr-Ni-Mo stainless steel)

3.4.3 Ends shall be as shown on the drawings. Welded-on flanges shall not be permitted.

3.4.4 Socket weld ends shall be designed such that they will permit installation welding of the valve without damage to the valve internals.

3.4.5 Large check valves, 50 mm and larger, shall comply with the following requirements:

Size 50 mm and larger	
Standard	BS 1868
Class	150
Type	Swing
Ends	Flanged BS EN 1759-1 RF Class 150. Welded-on flanges not permitted
Full Bore	Only required when valves are installed on pipelines requiring to be pigged
Shell Tapping's	Drain to be threaded to BS 21 taper. No others required.
Soft Seals	Not required
Cover	Bolted
Materials	Body – carbon steel - stainless steel (when fitted downstream of FWS) Trim – Symbol 18-10-2 (Cr-Ni-Mo stainless steel)

3.4.6 A lever override shall be incorporated as specified by the PM.

3.5 Double Block and Bleed Valves

3.5.1 Double block and bleed valves are a single valve with two seating surfaces that, in the closed position, provides a seal against pressure from both ends of the valve with a means of venting/bleeding the cavity between the seating surfaces.

3.5.2 Double block and bleed valves have the added function of being able to prove an isolation due to the ability to drain the cavity between the seating surfaces. This provides an advantage over traditional valves when isolating plant and equipment.

3.5.3 Double block and bleed valves shall comply with the following requirements:

Size 50 mm and larger	
Standard	ANSI/API 6D
Class	150
Type	Double Block and Bleed / Twin Seal Valve
Ends	Flanged BS EN 1759-1 RF Class 150. Welded-on flanges are not permitted
Body Bleed	Manual with body bleed lock and thermal relief to upstream port
Dimensions	"Face to face" to API 6D
Materials	Body – carbon steel - stainless steel (when fitted downstream of FWS) Trim – Table 3, group 2.2 (18-9-2 Cr-Ni-Mo)

3.5.4 Double block and bleed valves shall be fire safe to BS EN ISO 10497.

3.5.5 Valve types other than plug valves (e.g. slab or ball) may be considered, but only with the PM's approval.

3.6 Line Blind Valves (Spectacle Valves)

3.6.1 Line blind valves, sometimes referred to as Spectacle valves are used when an infallible, leak proof, visible shut-off is required. Line blind valves are used for petroleum storage tank isolation and for isolating sections of pipelines prior to pressure testing. They are commonly found in tank valve access chambers and valve pits.

3.6.2 Line blind valves shall comply with the following requirements:

Size 50 mm and larger	
Standard	ANSI/API 6D
Class	150
Type	Line spread (spill) or Line spread (non-spill) or Non-spread (non-spill)
Ends	Flanged BS EN 1759-1 RF Class 150. Welded-on flanges not permitted
Body Bleed	Manual with body bleed lock and thermal relief to upstream port
Dimensions	"Face to face" to API 6D
Materials	Body – carbon steel - stainless steel (when fitted downstream of FWS) Trim – Table 3, group 2.2 (18-9-2 Cr-Ni-Mo)

3.7 Through-Conduit Valves

3.7.1 Through conduit valves are used on pipelines which may be required to be pigged. Through-conduit valves shall be fully piggable and designed such that there are no recesses or traps within the body to collect debris from pigging whilst the valve is in the open position.

3.7.2 Through-conduit valves shall comply with the following requirements:

Size 100 mm and larger	
Standard	ANSI/API 6D
Class	150
Type	Full bore, with parallel sliding gate, sealing rings and raising stem
Ends	Flanged BS EN 1759-1 RF Class 150.

Dimensions	“Face to face” to API 6D
Materials	Body – carbon steel - stainless steel (when fitted downstream of FWS) Trim - high tensile steel, plated or hardened to suit service fluid

3.8 Relief Valves

3.8.1 Relief valves are used to limit the internal pressure which may develop in pipework and equipment. All sections of pipelines/equipment where hydrostatic pressure may build up through rises in temperature should be protected by thermal pressure relief valves, set in accordance with the design pressure of the system.

3.8.2 On pipelines and equipment which can be subject to pump and surge pressures, larger sizes of relief valves which discharge into slop tanks are used.

3.8.3 Small thermal relief valves shall comply with the following requirements:

Size	As required by the system design
Standard	API RP 526 current edition
Class	Determined by the valve set pressure
Type	Spring loaded, thermal relief
Ends	Inlet – 25 mm flanged Outlet – 25 mm flanged Flanged to BS EN 1759 RF Class 150
Materials	Carbon steel with stainless steel internals Stainless steel when fitted downstream of the FWS
Set pressure adjustment	± 10%
Set pressure tolerance	± 3%
Maximum overpressure	10% during relief
Set point	As required by the system design
Tests	To be pre-set, tested, and stamped at the manufacturer’s works

3.8.4 Full bore pressure relief valves shall comply with the following requirements: -

Size	As required by the system design
Standard	API RP 520 current edition
Class	150
Type	Spring loaded, full bore pressure relief
Ends	Inlet – flanged to BS EN 1759 RF class 150 Outlet - flanged to BS EN 1759 RF class 150

Materials	Carbon steel with stainless steel internals Stainless steel when fitted downstream of the FWS
Set pressure adjustment	± 10%
Set pressure tolerance	± 3%
Maximum overpressure	10% during relief
Set point	As required by the system design
Tests	To be pre-set, tested, and stamped at the manufacturer's works

3.9 Line Pressure Actuated Control Valves

3.9.1 Control valves are usually multi-functional and can be set either to control pressure, meter flow rate or other functions.

3.9.2 Typical control valve applications include:

(a) Flow governing valves downstream of FWS

(b) Dispense pump controller

(c) Offload pump controller

(d) Filter water separator bypass control

(e) Tank high level control

(f) Deadman's control at dispense points

(g) Filter water separator water drains

3.9.3 Control valves shall be of the hydraulically actuated diaphragm globe type. They shall be operated entirely by line pressure. They shall consist of three major components: the body, diaphragm, and cover.

3.9.4 The diaphragm assembly shall be the only moving part. The valve shall be activated by a pilot control, linked directly to the process being controlled, and be hydraulically operated by line pressure.

3.9.5 The valve shall be fail "safe" in a defined position in the event of a diaphragm failure. A pilot line adjustable restrictor needle valve shall be included to ensure slow speed closure of the main valve and unrestricted speed opening of the pilot valve.

3.9.6 Valve closure time shall be greater than 3 seconds unless otherwise indicated in the valve schedule or HAZOP study.

3.9.7 The valve type, function, set point, failure position and opening time, shall be specified by the PM.

3.9.8 Valve bodies shall be carbon steel (stainless steel downstream of the FWS) or aluminium as specified by the PM. Trim material shall be produced from stainless steel to BS EN 10222-5.

3.9.9 The pressure rating of the valve shall be a minimum of 19.3 barg.

3.9.10 All ancillary valves and pipework shall be in stainless steel.

4.0 Incorporated Equipment

4.1 General

4.1.1 All pressure containing parts of equipment shall have a design pressure of 19.3 barg, and a test pressure of 29 barg to be compatible with the class 150 pipework system into which it is incorporated. Where the process conditions do not warrant a design pressure of this magnitude (e.g. in drainage systems) this requirement may be reduced as directed by the PM.

4.1.2 Carbon steel equipment shall be externally coated with a primer coat only. Finishing topcoats shall be applied to the equipment when it has been incorporated into the pipework system and shall be in accordance with the specification for pipework painting.

4.1.3 The equipment shall be primed and coated in accordance with the following requirement:

(a) Surface preparation: Abrasive blast clean to BS 7079 Sa 2½ surface profile 50 – 75 microns

(b) Primer coat: Epoxy zinc phosphate

(c) Minimum DFT: 50 microns

(d) Stainless steel and aluminium equipment shall be supplied uncoated

4.1.4 All equipment shall be left uncoated internally except when specified otherwise by the PM. Internal coating, where required, shall be in accordance with EI 1541.

4.1.5 End connections shall be protected to prevent damage in transit and entry of dirt. This protection shall not be achieved by driving plugs into the ends of equipment.

4.1.6 Equipment that will be used with aviation fuel must comply with the following requirements:

(a) Ferrous materials other than austenitic stainless steels must not be used in components which are in contact with aviation fuel or aviation fuel vapour in confined spaces where that fuel is to be transferred directly from operating storage tanks to aircraft or to the aircraft fuelling vehicle, except where one of the following conditions apply:

(i) The ferrous materials are hot-tinned
(ii) The ferrous materials are epoxy coated
(iii) This Standard expressly permits otherwise
(iv) The express prior agreement of the PM has been obtained

(b) Non-ferrous materials: the following non-ferrous materials must not be used in components which are in contact the fuel or in components which are in contact with the fuel vapour in confined spaces.

(i) Zinc (including all zinc coatings), zinc compounds and alloys containing zinc
(ii) Lead and alloys containing lead
(iii) Copper and alloys containing 4% and above copper (unless specifically stated as being allowed in individual equipment specifications)
(iv) Cadmium and its compounds

4.2 Filter Water Separators

4.2.1 FWS for aviation fuels shall comply with the requirements of the latest edition of EI 1581.

4.2.2 In line with the requirements of EI 1581, FWS shall be housed in vessels meeting the requirements of the latest edition of EI 1596.

4.2.3 The FWS manufacturer's scope of supply shall include, but not be limited to, the following:

(a) Separator

(b) Set of coalescer and separator elements

(c) Differential pressure gauge

(d) Relief valve

(e) Automatic air vent

(f) Automatic water drain valve

(g) Automatic fuel shut off valve (when specified by the PM)

(h) Differential pressure shut-off feature (when specified by the PM)

(i) Differential pressure alarm (when specified by the PM)

(j) Inspection and testing

(k) Painting and preservation

(l) Documentation

(m) Special tools and spare parts

4.2.4 The following items are excluded from the FWS manufacturer's scope of supply:

(a) Site installation

4.3 Microfilters

4.3.1 Microfilters for aviation fuels shall comply with the requirements of the latest edition of EI 1590.

4.3.2 In line with the requirements of EI 1590, microfilters shall be housed in vessels meeting the requirements of the latest edition of EI 1596.

4.3.3 The microfilter manufacturer's scope of supply shall include, but not be limited to, the following:

(a) Filter

(b) Microfilter elements/initial media fill

(c) System for applying and maintaining correct media level on the media supports

(d) System for discharging spent media and contaminants to a slops tank

(e) System for mixing suspensions of media with aviation fuel

(f) Differential pressure gauge

(g) Relief valve

(h) Automatic air vent

(i) Pumps and motors as required by the manufacturer's design

(j) Auxiliary pipework

(k) Inspection and testing

(l) Painting and preservation

(m) Documentation

(n) Special tools and spare parts.

4.3.4 The following items are excluded from the precoat filter manufacturer's scope of supply:

(a) Slops tank

(b) Site installation

4.4 Bulk Meters

4.4.1 Background

Bulk meters are installed at depot/installation dispense points to bulk fuel carrying vehicles. Their purpose is to deliver a pre-set volume of fuel from the facility to the vehicle. When the pre-set volume of fuel is reached the bulk meter activates a shut-off valve to stop the fuel transfer.

Bulk meters shall be of the horizontal positive displacement type. Bulk meters shall be selected to ensure compatibility with the anticipated range of now rates and the maximum pressure that can be generated in the pipework.

Bulk meter (or reducer) flanges shall be selected to match the dispense pipework and comply with the specifications detailed in this document.

The bulk meter manufacturer is to confirm acceptability of the intended maximum pressure drop at maximum flow rate. The accuracy of the bulk meter shall be +/- 0.1%.

4.4.2 Counters

Bulk meters shall be fitted with an eight digit continuously recording counter (totaliser) together with a five-digit resettable counter indicating volume dispensed in litres. The resettable counter shall be provided with a mechanical device to operate the pre-set valve.

4.4.3 Pre-set Valves

A pre-set valve shall be supplied and installed on the bulk meter outlet operated by the counter. The valve shall be of a two-stage slow closing type to avoid shock waves being initiated in the pipework. The accuracy of the valve shall be +/- 1 litre.

4.4.4 Testing

All pressure containing parts shall be hydrostatically tested at 150% of the maximum allowable working pressure. The test shall be considered satisfactory when no leaks are observed for a minimum of 30 minutes.

All bulk meters are to be calibrated at the bulk meter manufacturer's works over a range of flow rates using the intended fuel and a calibration certificate issued.

4.4.5 Painting

The bulk meter manufacturer shall paint all external carbon steel surfaces to their standard paint system suitable for an exposed saline environment. The paint system shall also be resistant to all pumped fluids.

4.4.6 Preservation

Each bulk meter shall be prepared for despatch to site by closing all openings to atmosphere by means of flanges or plugs securely bolted or screwed in place.

Any special requirements for the removal of any preservative shall be clearly indicated on the bulk meter and repeated in the installation and commissioning instructions.

4.5 Pumps

4.5.1 Centrifugal Pumps

Centrifugal pumps should be designed and manufactured in accordance with API 610 – Centrifugal pumps for petroleum, petrochemical and natural gas industries and supplied with a Declaration of Incorporation.

Pumps shall have a stable operating characteristic with a shut-off head between 110% and 120% of rated head. Where pumps operate in parallel the total head difference between the two pumps shall be matched but no less than 5% when operated between 80% and 110% of rated flow.

Pumps shall be designed to operate satisfactorily between the minimum flow condition and at 125% of rated flow.

Pumps procured as replacements for pumps in existing systems should be of suitable specification to operate at a duty point compatible with the system characteristics.

4.5.2 Positive Displacement Pumps

Pumps shall be rated for continuous operation against the relief valve setting without overloading the motor. Pumps shall provide a pulsation free delivery flow.

4.5.3 Pressure Casings

Pressure casings shall be of steel or alloy steel, cast iron is not permissible.

The casing design shall be such that the pump shaft, mechanical seal, and bearings can be removed without disconnecting the suction/discharge pipework (e.g. Back pull-out design). This requirement does not apply to submersible pumps.

4.5.4 Nozzles and Pressure Casing Connections

Pumps that are not self-venting shall be provided with a valved and flanged casing vent connection.

Pump casings shall be provided with a valved and flanged casing drain connection.

Suction flanges shall be designed for. the same pressure as discharge flanges in order that testing can be undertaken to the full test pressure.

Steel flanges shall be in accordance with BS 1560 Part 3 Section 3. Specification for steel flanges shall be Class 150 unless otherwise stated on the data sheet. Bolt holes shall straddle centrelines.

All tapped holes that are not connected to piping supplied by the pump manufacturer shall be provided with threaded bar stock plugs.

4.5.5 Impellers

Impellers shall be produced from corrosion resistant material. They shall be free from blowholes and other defects and designed to be in dynamic balance at all speeds up to 10% above the normal operating speed. Impellers may be of the single or double entry type according to the pump design and shall not be greater than 94% or the largest impeller diameter the casing is designed for.

4.5.6 Screws

Screws shall be produced from corrosion resistant material. Screw type positive displacement pumps shall have match marked driver and driven screws.

Screw pumps shall have external steady bearings and shall be of stiff shaft construction.

The screws shall be in dynamic balance at all speeds up to 10% above normal operating speed and arranged to eliminate end thrust at all speeds.

When timing gears are employed, they shall be totally enclosed in an oil bath and arranged such that contamination of the process fluid being pumped cannot occur.

4.5.7 Wear Rings

Mating wear surfaces of hardenable materials shall have a difference in hardness of 50 BHN unless both the static and rotating wear surfaces have a Brinell hardness greater than 400.

Consideration shall be given to internal running clearances between wear rings and other parts that might be affected by the pumped process fluid's temperature, suction conditions, fluid properties, thermal expansion and the galling characteristics of the materials used. API 610 should be consulted in order to determine the correct material and corresponding running clearances.

4.5.8 Pump Shaft

The shaft material shall be produced from stainless steel, of rigid construction and of an adequate diameter to withstand all imposed loading and have a critical speed, when assembled with its impeller at least 10% above normal operating speed.

4.5.9 Mechanical Shaft Seals

The pump manufacturer shall be responsible for the provision of a suitable API conforming mechanical sealing system for the pump duty.

Pumps operating at sub-atmospheric suction pressures shall be designed to ensure that the mechanical seal fitted will operate with the seal faces above atmospheric pressure to prevent leakage of air into the pump. Seal design shall be adequate to assure sealing against atmospheric pressures when the pumps are not operating

4.5.10 Bearings and Lubrication

All bearings shall be of the anti-friction type with provision for routine lubrication without the need to dismantle the pump. Submersible pumps shall utilise the pumped process fluid as the lubricant.

4.5.11 Couplings and Guards

Couplings shall be of the flexible spacer type. The spacer length shall permit withdrawal of the pump internals without disturbing the pump suction and discharge pipework. Coupling halves shall be match marked.

Guards covering couplings and exposed shafts shall conform to the requirements of PD5304:2019 Guidance on the safe use of machinery, except that aluminium guards are not acceptable. Guards shall be rigid, totally enclose the moving parts and be non-sparking.

4.5.12 Auxiliary Piping

Auxiliary piping shall be in accordance with the requirements identified in this document.

4.5.13 Pump Primers

Where required by the process conditions a primer pump shall be included as part of the installation. The primer pump shall conform to the following:

(a) It shall either be of the positive displacement vane type device driven directly by the pump rotor shaft or a separate motor-driven unit

(b) It shall operate only when the pump's suction line requires priming. The instrumentation controls and linkages required to operate the primer under this constraint shall be provided by the pump manufacturer as part of the pump package. The primer shall be entirely automatic in its operation

(c) In the worst case, it shall be capable of priming the pump suction which may be devoid of process fluid and only contain a mixture of air and vapour. The suction line will need to be immersed in process fluid. The minimum level of product required and the volume of the suction line shall be defined on the data sheet. The primer and any of its associated pipework and controls shall not provide a leak path to the venting system of the primer from the pump and its suction and discharge pipework

(d) The venting system shall be suitable for incorporation into a closed pipework system leading to a slops tank for process fluid recovery. The vent pipework diameter and length and the back pressure in the slops tank shall be defined on the data sheet

4.5.14 Materials of Construction

Materials in contact with the process fluid shall not be affected by it, or by water, or by water containing soluble fuel additives nor shall the materials have any effect upon the process fluid. Metals and alloys that are product wetted shall be corrosion resistant or protected by a coating system in accordance with EI 1541.

Dissimilar metals that will initiate and promote corrosion if in contact shall not be allowed. Copper, copper alloys, light metal alloys containing more than 4% copper, zinc or zinc alloys, cadmium, lead and lead alloys shall not be used in components exposed to the process fluid.

4.5.15 Motors

Motors shall be of the totally enclosed squirrel cage induction type complying with the relevant parts of the BS EN (IEC) 60034 series.

If soft start or variable speed drives are to be used, these should be specified as per the requirements of IEC TS 60034-17. the motor/pump manufacturer must be consulted with regards to suitability and matching, as per the requirements of BS EN 60079-14.

Motors shall be certified for the hazardous area classification, gas grouping and environmental protection as defined on the data sheet. They shall have characteristics to suit the electricity supply and the required power output and shall be continuously rated.

Motors shall be fitted with grease lubricated ball or roller bearings, including a thrust bearing if required. Lubrication of bearings shall be possible without the need for any dismantling.

The motor shall have a rating not less than 115% of the pump power required at the duty point. In the case of a positive displacement pump the motor shall have a rating of 115% of the power required at the relief valve set pressure

Motor anti-condensation heaters shall be provided with connections that shall be brought out to a separate terminal box.

4.5.16. Relief Valves

To protect any positive displacement pump and piping when discharge is restricted or shut off, a pressure relief valve shall be provided in accordance with the requirements detailed in this document.

The set pressure shall be not more than the maximum allowable working pressure of the casing but not less than 110% of the rated discharge pressure. The relief valve shall be able to handle the pump rated flow rate when fully open at a pressure not more than 10% above the set point.

4.5.17 Pressure Indication

When specified on the pump data sheet as a requirement, the pump manufacturer shall supply and install suction and discharge pressure gauges. Pressure gauges shall comply with the requirements of this document.

4.5.18 Testing

All pressure containing parts shall be hydrostatically tested at 150% of the maximum allowable working pressure. The test shall be considered satisfactory when no leaks are observed for a minimum of 30 minutes.

(a) Centrifugal pumps are to be assembled with their motors and tested in the pump manufacturer's works. Composite performance curves from end of curve to shut-off head are to be produced by the pump manufacturer indicating:

(i) Head versus Flow
(ii) Power versus Flow
(iii) Efficiency versus Flow

Note. The test Head-Capacity curve shall not deviate from the proposal curve by more than 0% to +4% of the head at any point. Where specified as a requirement on the pump data sheet, an NPSH test shall be undertaken, and the results plotted as NPSH(Required) versus Flow.

(b) Positive displacement pumps are to be assembled with their motors and performance curves produced for the following:

(i) Discharge Pressure versus Flow
(ii) Power versus Flow
(iii) Efficiency versus Flow

Note. The test capacity shall not deviate from the proposal capacity at the rated pressure by more than 0% to +3%.

(c) Where self-priming is required, it shall be demonstrated that the arrangement operates satisfactorily across the normal operating range of the pump(s).

(d) Motors shall be tested at the motor manufacturers works in accordance with the requirements of BS EN (IEC) 60034 series and issued with a Declaration of Incorporation.

4.5.19 Pump Protection

Where specified on the data sheet, pump protection shall comply with the relevant requirements of the ATEX Regulations. Equipment must be so designed and constructed that sources of ignition do not become active, even in event of rare incidents relating to equipment. The requirements may include, but are not limited to, the following elements:

(a) It must be equipped with means of protection such that:

— either, in the event of failure of one means of protection, at least an independent second means provides the requisite level of protection

— or the requisite level of protection is ensured in the event of two faults occurring independently of each other

(b) For equipment with surfaces which may heat up, measures must be taken to ensure that the stated maximum allowable surface temperatures are not exceeded even in the most unfavourable circumstances. The flash point of the fuel being pumped must be considered

(c) Temperature rises caused by mechanical heat build-ups and chemical reactions must also be considered

(d) Equipment must be so designed that the opening of equipment parts which might be sources of ignition is possible only under non-active or intrinsically safe conditions. Where it is not possible to render equipment non-active, the manufacturer must affix a warning label to the opening part of the equipment

(e) If necessary, equipment must be fitted with appropriate additional interlocking systems. Safety devices must function independently of any measurement and/or control devices required for operation

(f) As far as possible, failure of a safety device must be detected sufficiently rapidly by appropriate technical means to ensure that there is only very little likelihood that dangerous situations will occur

(g) The fail-safe principle is to be applied in general. Safety-related switching must in general directly actuate the relevant control devices without intermediate software command

(h) In the event of a safety device failure, equipment and/or protective systems shall, wherever possible, be secured

(i) Emergency stop controls of safety devices must, as far as possible, be fitted with restart lockouts. A new start command may take effect on normal operation only after the restart lockouts have been intentionally reset

(j) As per EI 1540, all remotely operated pumps shall have no/low flow and high temperature instrumentation that initiates an automatic pump shutdown. Note that flow-related shutdown prevents a high temperature from occurring from the pumped fluid remaining trapped in the casing

(k) Where pumps need to be primed/started against a closed discharge valve, clear guidance shall be provided on how the operation can be carried out safely

4.5.20 Painting

The pump manufacturer shall paint all external carbon steel surfaces to their standard paint system suitable for an exposed saline atmospheric environment. The paint system shall also be resistant to all of the pumped process fluids.

4.5.21 Preservation

Each pump and motor shall be prepared for despatch to site as follows:

(a) All openings to atmosphere shall be closed by means of flanges or plugs securely bolted or screwed in place

(b) All bright metal surfaces shall be given a protective coating against all forms of atmospheric corrosion

(c) Oil filled compartments or equipment shall be emptied and a rust inhibitor* applied

*Any special requirements for the removal of preservative shall be clearly indicated on the pump and repeated in the installation and commissioning instructions.

4.5.22 Special Tools and Spare Parts

The pump manufacturer shall provide one set of commissioning spares and special tools with each pump together with a list of recommended operating spares for a two-year period.

4.6 Sight Glasses

4.6.1 Small sight glasses shall be in accordance with the following requirements:

Size 40 mm and smaller	
Ends	Screwed, female to ANSI B1.20.1
Orientation	Suitable for vertical or horizontal mounting
Materials	Body-carbon steel to BS EN 10213 1-3 Viewing disc – toughened glass Seals – compatible with water and process fluid

4.6.2 Larger sight glasses shall be in accordance with the following requirements:

Size 50 mm and larger	
Ends	Flanged to BS EN 1759 -1 Class 150
Orientation	Suitable for vertical or horizontal mounting
Materials	Body-carbon steel to BS EN 10213 1-3 Viewing disc – toughened glass Seals – compatible with water and process fluid

4.7 Flow indicators

4.7.1 Small flow indicators shall be in accordance with the following requirements:

Size 40 mm and smaller	
Ends	Screwed, female to ANSI B1.20.1
Orientation	Suitable for vertical or horizontal mounting
Indicator Type	Bladed spinner (Stainless Steel)
Materials	Body-carbon steel to BS EN 10213 1-3 Viewing disc – toughened glass Seals – compatible with water and process fluid

4.7.2 Larger flow indicators shall be in accordance with the following requirements:

Size 50 mm and larger	
Ends	Flanged to BS EN 1759 -1 RF Class 150
Orientation	Suitable for vertical or horizontal mounting
Indicator Type	Bladed spinner (Stainless Steel)
Materials	Body-carbon steel to BS EN 10213 1-3 Viewing disc – toughened glass Seals – compatible with water and process fluid

4.8 Basket Strainers

4.8.1 Single basket strainers shall be in accordance with the following requirements:

Size 25 mm and larger	
Standard	PD 5500 or ASME VIII
Type	Inline type with internal, removable mesh basket and bolted top cover
Ends	25 mm – 40 mm screwed to ANSI B 1.20.1 50 mm and larger flanged to BS EN 1759-1RF Class 150
Materials	Body – carbon steel to BS EN 10213 1-3 Basket – stainless steel

4.8.2 Double basket strainers shall be in accordance with the following requirements:

Size 25 mm and larger	
Standard	PD 5500 or ASME VIII
Type	Inline type with internal, removable mesh basket and bolted top cover. The strainer shall include a changeover mechanism so that flow can be diverted from one basket to the other without interruption of flow Safety Interlock to be included on change over mechanism to prevent inadvertent removal of basket that is in use.
Ends	25 mm – 40 mm screwed to ANSI B 1.20.1 50 mm and larger flanged to BS EN 1759-1RF Class 150
Materials	Body – carbon steel to BS 1504 – 161 grade 480 Basket – stainless steel

4.9 Pressure Gauges

4.9.1 Static pressure gauges shall be in accordance with the following requirements:

Size	100 mm diameter face
Standard	BS EN 837 - 1
Type	Bourdon Tube
Ends	Inlet – flanged to BS EN 1759 RF class 150 Outlet - flanged to BS EN 1759 RF class 150
Materials	Body – stainless steel Tube – stainless steel
Scale Range	So that normal operating pressure is read halfway along range The normal operating points, overpressure requirement and end fittings of pressure gauges shall be specified by the PM

4.9.2 The differential pressure gauge shall be suitable for continuous measurement of the pressure drop through equipment and shall be complete with an isolating valve on each branch of the gauge. The normal operating point, range and end fittings shall be specified by the PM.

Differential pressure gauges shall be in accordance with the following requirements:

Standard	Proprietary approved make
Type	Direct reading piston type
Materials	Stainless Steel

4.10 Loading Arms

4.10.1 Loading arms shall be of a proprietary manufacture and conform to international (e.g. ISGOTT) and national standards, approved for use by the PM, and shall include the following features:

(a) Compatible for use with the vehicles or ships to be loaded considering the headroom available and tide levels where applicable

(b) Fully articulated in vertical and horizontal planes by means of low torque swivel joints and counterweights or springs

(c) Self-venting with manual drain valve at the base of the assembly

(d) For marine applications, closed connection for loading into ships' manifold

(e) For marine applications, hydraulic or winch operation

(f) Pressure loss at maximum flow not greater than 1 barg

4.11 Pantographs

4.11.1 Pantographs, a specialised form of loading arm intended for filling aircraft, or aircraft refuelling vehicles, shall be of a proprietary manufacture, approved by the PM and shall include the following features:

(a) Compatible for use with aircraft or road vehicles to be loaded, considering the operating envelopes required

(b) Fully articulated in vertical or horizontal planes by means of low torque swivel joints

(c) Fully mobile for towing behind military servicing vehicles (for aircraft pantographs only)

(d) Stainless steel or aluminium construction on all wetted parts

(e) Connection to hydrant pits as specified by the PM

(f) Connection to aircraft or refueller vehicle as specified by the PM

(g) To include a meter, venturi pressure sensor, flow control valve and dead man's handle as required, as specified by the PM

4.12 Hydrant Fuelling Valves

4.12.1 Hydrant fuelling valves, a specialised form of line pressure actuated control valve, shall be a proprietary manufacture, approved by the PM, and shall include the following features:

(a) Slow operating adjustable between 5 and 10 secs

(b) Slow closing adjustable between 2 and 5 secs

(c) Pressure drop at full rated flow. 0.8 barg max

(d) Stone guard in inlet 4 mesh

(e) Outlet diameter 100 mm for fuelling outlets, 65 mm for defueling outlets unless otherwise indicated

(f) Outlet connection 3-point bayonet or API Std 1584 with lug clamps

(g) Valve closure lanyard, pneumatic, or line pressure hydraulic

4.13 Hydrant Fuelling Pits

4.13.1 Hydrant fuelling pits, to house the hydrant fuelling valves, shall be of proprietary manufacture, approved by the PM, and shall include the following features:

(a) Aluminium cover to BS 1490

(b) Design bearing load 2070 kN/m2

(c) Captive cover cable

(d) Pit body Grade 14 cast iron

(e) Pit diameter 450 mm

(f) Flexible watertight bottom seal and pipe flange

(g) Hydrant fuelling pits used for sampling purposes shall be supplied with a modified bottom flange to accommodate a sample pit pipe in place of the fuelling valve.

4.14 Self-Seal Quick-Release Couplings

4.14.1 Self- seal quick-release couplings shall be of a proprietary manufacture, approved by the PM, and shall be in accordance with the following requirements:

Size 65 mm	
Standard	BS 4C 14 (Aerospace Series)
Materials	Stainless steel or aluminium as specified by the PM

4.15 Insulating Flange Joint

4.15.1 Insulating flanges shall be in accordance with the following requirements:

Size 50 mm and larger	
Flange Standard	BS EN 1759 -1 RF Class 150 weld neck
Gasket Type	Full face, drilled to suit PCD of flange
Materials	Flange – carbon steel, ASTM A 105/A 105M Gasket – acrylonitrile butadiene rubber (NBR) faced phenolic Sleeves – spiral wound polyester, 750 microns thick washers – high strength phenolic, 3 mm thick

4.15.2 The insulation resistance between each bolt and flange shall be not less than 10,000 Ω (ohms) at 100 volts.

5.0 Fabrication of Pipework

5.1 General

5.1.1 All ferrous pipework, within installations (e.g. Bulk Petroleum Storage) and connecting between installations (e.g. cross base pipeline) shall be fabricated and installed in accordance with the requirements of ANSI/ASME B31.3 and applicable ASME/ANSI/EEMUA standards.

5.1.2 All materials required for the completion of the Works shall be provided in accordance with the materials section of this Standard.

5.1.3 It is unnecessary to bond across metal pipelines unless the resistance to earth is greater than 10 Ω (ohms). Continuity bond(s) shall be fitted across flanged joints when required, other than insulating flanged joints, position and detail as indicated on the drawings.

5.1.4 All exposed ferrous pipework, including supports, shall be connected to an earth terminal of approved design, using copper strip 40 mm x 2 mm thick. The resistance to earth at any point on the system shall be less than 10 Ω (ohms).

5.1.5 Conductive non-metallic pipelines shall be earthed so that the resistance to earth at any point should not exceed 10 Ω (ohms).

5.1.6 Screwed, flanged or union joints shall not be buried. Where such joints are sited underground, they shall be in an adequately drained and accessible pit. Screwed joints shall not be back welded unless specifically indicated on drawings or elsewhere in this Standard (see also Section 5.2.10).

5.1.7 Paint or stencil identification marks shall be applied on pipelines, filters, pumps, and other equipment as required by the PM. Marks as letters, numerals, or coloured banding shall be in accordance with the PM's instructions. Each valve shall be numbered as shown on the schematic diagram using an identification disc of the pattern specified.

5.2 Ferrous Pipework

5.2.1 Piping 50 mm DN and larger shall be prefabricated to the maximum extent practicable to minimise in-situ welding. Class 150 pipework larger than 50 mm DN shall be joined by butt welding or by flanged joints.

5.2.2 Piping 40 mm DN and smaller shall be site-run unless the degree of complication makes prefabrication the most practical means of carrying out the work. Class 150 pipework in sizes 40 mm DN and below shall be joined by means of screwed joints to ANSI B1.20.1 taper to taper threads, or by socket weld fittings as indicated on the drawings.

5.2.3 Incorporated equipment shall be joined to the piping by use of flanges or unions as shown on the drawings so that the items of equipment can be removed for repair or replacement.

5.2.4 Pipe bends shall be factory manufactured proprietary butt welding or screwed bends, and not Contractor fabricated, unless otherwise indicated in the drawings. Contractor fabricated bends shall not be used in pipework greater than 250 mm nominal bore.

5.2.5 Contractor fabricated bends in pipe, if permitted, shall be produced by bending to radii as follows:

(i) Size 80 mm and under – not less than 3 x DN
(ii) Sizes 100 mm to 250 mm – not less than 5 x DN

5.2.6 The pipe thickness after bending shall not be less than 70% of the pre-bend thickness of the pipe and shall not be less than that required by the design criteria. Ovality after bending shall not exceed 8% of the outside diameter of the pipe. Bends showing wrinkling characteristics shall not be installed. Mitred joints and gusseted or mitred bends shall not be used.

5.2.7 Transverse segments cut from factory manufactured proprietary bends may be used on pipe sizes 100 mm DN and greater provided that the arc distance measured along the crotch is at least 50 mm.

5.2.8 All flanged joints shall be aligned correctly with the gasket faces in contact and tightened up uniformly with equal tension on the flange bolting. Flanges shall be positioned with bolt holes straddling the centrelines.

5.2.9 On pipe sizes 50 mm DN and below, screw threads shall be cut, where required, to form male ends on pipes using appropriate pipe threading tools. Pipe threads shall be screwed in accordance with ANSI B1.20.1 taper unless otherwise indicated in the drawings or elsewhere in this Standard. Threaded joints shall be sealed with virgin PTFE tape.

5.2.10 When seal-welding is expressly permitted by the PM, the weld seal shall only be applied after the screwed joint has been satisfactorily tightened-up. Seal-welding of the following items shall not be permitted:

(a) Control valves or relief valves with screwed connections

(b) Pressure gauges, thermowells, level gauges, pressure switches or other such instruments directly connected into the piping

(c) Drain or vent plugs

(d) Screwed unions

5.2.11 Vent valves and drain joints shall be provided wherever necessary and are required for the purposes of hydraulic pressure testing during commissioning and in support of maintenance operations. Such arrangements shall comply with this Standard and the Contract drawings. Ball valves shall be used for vents and drains and fitted with caps or plugs.

5.2.12 Pipework shall be supported, anchored, and guided as shown on the drawings. Where it is considered necessary to provide additional supports, the Contractor shall seek the approval of the PM for the type and location of such supports. Additional supports shall be considered where the weight of incorporated equipment or the location of pipe runs is significantly different to that as shown on the drawings.

5.2.13 In all cases support anchors and guides shall be in accordance with the following requirements:

(a) All pipe supports shall be designed and constructed in accordance with BS EN 13480 part 3.

(b) Thermal expansion shall be taken up by changes of direction wherever practicable.

(c) Expansion loops or mechanical devices shall not be used without approval of the PM.

(d) Any additional support required for constructional or testing purposes shall be provided and removed on the completion of testing.

5.2.14 Anchors and supports shall be capable of withstanding all normal forces, pressures, thermal expansion, and any surge pressures which may occur due to starting up or shutting down any portion of the plant. Where possible supports shall be positioned before erection of pipework takes place. Supporting straps shall not be fitted around flanges or welded joints.

5.2.15 The depth of buried pipelines shall be as shown on the drawings and shall be such that cover to pipe plus wrapping is as follows:

(a) Minimum 1.0 m generally

(b) Minimum 1.2 m under roads, hardstanding for vehicles and aircraft pavements or taxiways and for 6 m either side of this

(c) Minimum 1.2 m under aircraft runways and for 27.5 m either side of this

(d) Maximum cover not to exceed minimum cover by more than 0.5 m except as indicated on the drawings or as agreed by the PM. The maximum value shall apply only where necessary to take account of minor variations in contour

Note. The vertical and horizontal separation distance between parallel pipelines and crossing pipelines shall be a minimum of 450 mm (18 inches) in order that physical access for maintenance and inspection reasons can be achieved.

5.2.16 The finished trench for buried pipe shall be free of roots, hard clods, stones, rocks, or other hard objects which may damage the pipe or pipe coating. The below ground pipework shall be provided with a bedding and surround of coarse sand, free from harmful substances and foreign matter, over the full width of the trench. The sand shall be placed in layers not exceeding 100 mm thick (before compaction) and compacted by hand to give a finished bedding thickness of not less than 200 mm and a finished depth of cover over the pipework of not less than 300 mm.

5.2.17 On completion of the initial backfill with coarse sand the main backfilling of the trench shall be carried out using selected excavated material placed in layers not exceeding 300 mm thick (before compaction) and thoroughly compacted.

5.2.18 Mechanical rammers shall not be used until the pipework is covered by at least 600 mm of fully compacted materials and thereafter only with proper care and attention.

5.2.19 Following completion of backfilling the necessary restoration of the topsoil layer or, where applicable, surface reinstatement, shall be carried out as indicated in the project specification or on the contract drawings to the satisfaction of the PM.

5.2.20 On long buried pipe runs, between installations, the pipelines shall be provided with vent points and drain points to ensure that these pipelines can be totally drained and reprimed.

5.2.21 The design and location of vent points and drain points, complete with associated valves shall be shown on the drawings.

5.2.22 Where the elevation of the pipeline is revised from that shown on the drawings, for example, to cross a previously unknown service discovered during excavation of the pipe trench, the Contractor shall provide additional vents and drains, as required, in order to maintain the drainage and venting characteristics of the pipeline.

5.2.23 Additional vents and drain points shall be in positions agreed with the PM.

5.2.24 The line pipe shall be delivered, stored, and handled on site in accordance with the following requirements:

(a) When transporting the pipe, the bottom layer shall be carried in shaped cradles lined with protective rubber or similar sheeting and having a 300 mm minimum support width. Subsequent layers of pipe shall be padded and rest on the previously loaded layer of pipe

(b) On completion of loading, the pipes shall be made secure in a manner as to prevent damage to the protective pipe wrapping during transportation

(c) Pipe storage and stacking shall comply with the requirements of the Institution of Gas Engineers IGE/TD/1 Edition 4 Supplement 1 in addition to those of this section. To prevent damage to the protective coating, pipe materials or fittings shall not be placed on the ground but raised on timbers not less than 230 mm wide and 100 mm thick, and with padding and wedges. The padding shall overhang the 230 mm width of timber by not less than 25 mm each side and shall have a minimum thickness of 50 mm before load compaction. The timbers, padding and wedges shall be provided and placed in position when stacking the line pipe

The height of the pipe stack shall not exceed the numbers set out as follows:

DN of Pipe	Number of Layers in Stack
350 to 450	3 high
250 to 300	4 high
150 to 200	5 high
80 to 100	6 high

5.2.25 Any hay or straw or other material which has been used for packaging purposes shall be removed immediately from the site for destruction. These materials shall not be burned on the site. Materials of differing specifications shall be clearly identified and stored separately.

5.2.26 Long runs of pipelines between installations (e.g. cross base pipelines) shall be strung out ready for welding in accordance with the following requirements:

(a) The pipes shall be strung out to cause the least practical interference with the use of the surrounding area. Gaps shall be left between pipes to permit the passage of equipment across the working width

(b) The cleanliness of the inside of each pipe, fitting and the seats of valves shall be checked prior to the lining up and jointing. All extraneous matter, all abrasive residues and dust left in the pipes because of coating operations, shall be removed. Pipeline numbering labels shall be removed from inside of the pipes prior to welding, but only after recording the relevant information on the welding records and the numbers transferred to the pipe outside

(c) Protection to the ends of the pipes shall be retained for as long as practical before incorporation of the pipes into the works

(d) Short lengths of pipe required for tie-ins or matching pieces (pups) shall be cut from the line pipe. The minimum length of any 'pup' shall be twice the outside diameter of the pipe or 600 mm whichever is the greater, unless otherwise shown on the drawings

5.2.27 Contractor field fabricated/formed bends for pipelines between installations (e.g. cross base pipelines) shall be made in accordance with the following requirements:

(a) Contractor field fabricated/formed bends shall not be used unless it is shown on the drawings

(b) Field bends shall be fabricated/formed using lengths of straight pipe. Unless otherwise directed, field bends shall be cold formed, without kinking, on a suitable machine using an internal mandrel with the pipe formed to an inside radius not less than 40 DN (where DN is the nominal diameter of the pipe) and in such a manner as to ensure that not less than 1200 mm of straight pipe is available before and after the bend

(c) Bends shall be made in such a manner as to preserve the cross-sectional shape of the pipe and ensure freedom from buckling, cracks, or other evidence of mechanical damage. The pipe diameter shall not be reduced at any point by more than 2½% of the nominal diameter (DN)

(d) Test bends shall be manufactured to determine that the field bending procedure used meets the above requirements. One test bend shall be checked ultrasonically for each pipe size and wall thickness checked to ensure that the wall thickness is not less than 98% of the original wall thickness at six equi-spaced points around the outer circumference at the apex of the bend

5.2.28 The field bending procedure shall be amended if the above requirements cannot be met and the bending radii given above shall be increased, with the prior agreement of the PM until satisfactory bends are produced.

5.2.29 All field fabricated/formed bends shall be tested before incorporation into the pipeline, with a gauging device fitted with a sizing plate 95% of the internal diameter and with a gauging device suitable for demonstrating that the inside bend radius is not less than 40 DN (where DN is the nominal diameter of the pipe).

5.2.30 After fabrication of the bends or other special pipes, the coating shall be made restored.

5.2.31 Installation of transverse segments cut from Contractor field fabricated/formed bends will not be permitted.

5.2.32 Details of pipeline crossings with other services are shown as diagrammatic only on the drawings. Method statements and detail designs should be provided for each crossing following excavation and surveying of the service to be crossed and agreed with the PM.

5.2.33 Where existing services or apparatus are covered with slabs, tiles or tapes these shall be removed, stored and replaced on completion of the Works. Any damaged slabs, tiles or tapes shall be replaced with sound items having the appropriate identifying marks.

5.2.34 Fabricated lengths of pipework shall be laid in accordance with the following requirements:

(a) The pipework shall be lowered into the trench as soon as possible after excavation of the trench and preparation of the coarse sand bed. Coating damage shall be avoided by taking special precautions during lowering. The pipework shall not be over stressed during installation.

(b) The pipework shall not be over flexed during the lowering operations. Under no circumstances shall the radius of flexure be less than 1800 times the pipe's DN

(c) Any coating damage indicated by 'holiday' detection or other means during the lowering operation shall be repaired before lowering is completed. To avoid coating damage, lowering operations shall not be carried out when the ambient temperature exceeds 27˚C

5.2.35 Should the Contractor need to move heavy plant across a section of the pipeline which has already been tested, this shall only be done with the approval of the PM who will require adequate protection of the pipeline. Failure to comply with this section may render the Contractor liable to re-test the section of pipeline affected, at his own expense.

5.2.36 Route markers shall be provided for all pipelines on the MOD Estate. The markers shall be provided at 150 m intervals and at each change of direction, in the form of a flat concrete tile, 300 mm x 900 mm laid flush with the ground.

5.2.37 The PM will give details of any lettering required on the slabs.

5.2.38 Piping shall be kept clean and free of all dirt, debris, and foreign materials, during fabrication, construction, installation and where necessary, by swabbing out the piping. The open ends of all piping shall be closed at the end of each day's work and not re-opened until work on the piping is resumed.

5.2.39 Unless otherwise directed, after testing, the pipework shall be finally cleaned as followed:

(a) Remove all items of equipment likely to be damaged by the flushing process

(b) Where necessary, spool pieces and temporary connections shall be fitted to make continuous circuits of pipework, and at least one temporary strainer shall be fitted in each circuit

(c) Flush lines for 2 hours using the process fluid at the normal operational flow rate, as agreed with the PM

(d) After 2 hours examine the strainers and if found clean, the flushing may be considered complete. If not clean, continue with flushing with the strainers being examined every 2 hours until clean

(e) When clean, the system shall be thoroughly drained, temporary spools and connections shall be removed and equipment replaced

5.3 Assembly of Bolted Flange Joints

5.3.1 The guidance provided in Annex B of this technical standard shall be followed when assembling bolted flange joints.

5.3.2 All fasteners used in the assembly of the joints shall be bare metal and the correct torque settings applied, in the correct tightening sequence using a calibrated torque wrench.

5.3.3 The procedure detailed in Annex B is the specified means of producing such joints and deviation from that procedure shall only be permitted following consultation with DIO-TS.

6.0 Welding of Ferrous Pipework

6.1 General

6.1.1 This section of the Standard is applicable to the welding of all ferrous pipework, both carbon steel and stainless steel, within installations (e.g. bulk petroleum storage) and connecting installations (e.g. cross base pipelines).

6.1.2 All welding plant and equipment required for this Work, welding consumables, labour, supervision and facilities for testing and inspection, including provision of a suitably qualified independent welding inspector, shall be provided by the Contractor.

6.1.3 A competent welding supervisor shall be employed with whom the PM and the independent welding inspector may communicate. The welding supervisor shall be familiar with all phases of the fabrication and administration and shall ensure that both the quality of the materials of construction used, and the standard of workmanship comply with the standards specified in this section.

6.1.4 Only qualified registered coded craftsmen shall be employed to perform all aspects of the work, including testing where required. Any craftsmen considered by the PM and the independent welding inspector to be unsuitable shall be removed from the task.

6.1.5 The PM and the independent welding inspector shall be informed before any repairs are made to welds where unacceptable defects have been found.

6.1.6 Procedure and welder approval tests shall be carried out in accordance with the requirements of the relevant sections of this standard.

6.1.7 This section shall be read as supplementary to the indicated British Standards such that sections within this standard form amendments or additions to the requirements of those British Standards.

6.1.8 Before accepting delivery of any pipe, fittings, flanges, or other materials to be welded, all such items shall be inspected for damage, defects and dimensional tolerances and responsibility accepted for ensuring that all such materials of construction are suitable for satisfactory welding.

6.1.9 When one or two welds are required, for example, to replace a short section of pipeline in a maintenance repair situation, the suggested approach is the employment of a specialist welding company with a welder who has recent experience on similar work. The welds must be tested with a suitable NDT technique, and the pipeline hydraulically tested.

6.2 Welding Procedures

6.2.1 Welding procedures shall be proposed to suit the range of materials of construction, weld types and sizes required for the completion of the Works.

6.2.2 Approval shall be obtained for the following documentation prior to commencement of the part of the fabrication to which the procedure applies:

(a) Welding procedures for each feature of the welding

(b) Welding repair procedures

6.2.3 Where required, procedures and reporting systems for visual examinations and non-destructive testing (radiographic, ultrasonic, liquid penetrant and magnetic particle) are to be produced.

6.2.4 Details of timescale and the number of copies of procedures that are to be submitted for approval shall be agreed with the PM.

6.2.5 Efficient weather shielding shall be provided to protect each welding site from rain and wind and prevent water from running into the welding area. Welding shall be discontinued if the weld surfaces are damp and/or the weather conditions are unsuitable for welding.

6.2.6 Tools and equipment shall be provided that are in good operating condition, have been well maintained and of a capacity suited for the task.

6.3 Documentation

6.3.1 Prior to commencement of inspections, documentary evidence of the independent welding inspector qualifications and details of their employing Engineering/Insurance Company shall be submitted to the PM for checking, (with the appropriate testing body), and approval. The independent welding inspector shall be competent in this type of work with a minimum of 3 years welding inspection experience and qualified to CSWIP (Certification Scheme for Weldment Inspection Personnel), PCN (Personnel Certification in Non-destructive Testing) or equal and approved certification scheme.

6.3.2 Following completion of any part of the Works, copies of all non-destructive test reports shall be supplied to the PM.

6.4 Welding Materials

6.4.1 Electrodes, wires, and fluxes shall be selected to produce welds with mechanical properties not inferior to and chemical properties equal to, those for the base material.

6.4.2 Approval of electrodes proposed shall be obtained in advance in welding.

6.4.3 Storage, baking and issue of electrodes shall be in accordance with the manufacturer's recommendations.

6.4.4 Any consumables which are unmarked, or which show signs of deterioration shall be responsibly discarded.

6.4.5 Electrodes shall be supplied in clearly identified hermetically sealed containers.

6.5 Welding

6.5.1 The requirements of BS 2633, BS 4677 and ANSI/ASME B31.3 shall apply except as augmented or modified within this section of the Standard.

6.5.2 Butt joints shall be full penetration and line-up clamps shall be used for all butt welds in piping 80 mm and greater and retained in position until the root pass is complete.

6.5.3 The following welding process only shall be used:

(a) Manual Metal Arc (MMA)

(b) Tungsten Inert Gas (TIG)

6.5.4 The following procedures or materials shall not be used:

(a) The downhill mode of welding progression (unless subject to 100% NDT examination) *

(b) Permanent backing rings

(c) Copper backing bars

(d) Peening

(e) Flame gouging

(f) Arc-air gouging

*Authorisation to proceed must be granted by DIO-TS before any welding is started in the downhill mode.

6.5.5 TIG welding shall be used for all pipes, carbon steel and stainless steel, 80mm diameter and below. This applies to all passes.

6.5.6 For all circumferential welds in pipe with a diameter of 300 mm or larger two welders shall be employed.

6.5.7 The time between completion of the root pass and the start of the second pass shall not exceed 5 minutes for any multi-run weld. Welding shall be continuous until at least 3 runs are completed, and all welds shall be completed on the day in which they are started. All repair welds, fitting welds and tie-in welds shall be completed in one heat cycle. The pipe shall not be lifted until welding is 100% complete.

6.5.8 Internal welding of any kind shall not be carried out.

6.5.9 Damaged pipe ends shall be cut back and bevelled. Machine cutters shall be used as first choice for new bevels and for profiling the ends of branch connections in pipe sizes up to 300 mm diameter.

6.5.10 Longitudinal pipe seams shall be staggered, where such pipe is used by at least 20˚ on adjacent pipe joints. All such seams shall be orientated to lie within the top half of the pipe.

6.5.11 Carbon steel welding procedures shall use the vertical up technique for all carbon steel welding.

6.5.12 Stainless steel welding procedures shall use TIG welding with an approved system for inert gas backing for the root pass of all stainless-steel welding.

6.5.13 Approval of welding procedures shall be in accordance with the following requirements:

(a) Approval of all welding procedures and repair procedures shall be obtained before commencing welding. The approval shall apply only to the Contractor who obtains that approval and to the work site for which it is obtained

(b) Before performing qualification tests preliminary approval shall be obtained for the proposed procedures and shall arrange for witnessing by the PM and the independent welding inspector

(c) Separate procedures shall be specified and approved for each feature of the welding, and approval tests shall be carried out under full site conditions using full lengths of pipe

Note. Welding procedure approval shall be carried out in accordance with BS 2633 or BS 4677 as applicable.

6.5.14 Only welders who have been approved specifically for the Contract shall carry out welding.

6.5.15 All welder approval tests shall be witnessed by the PM and his authorised welding inspector.

6.5.16 A welder shall be re-tested in any one of the following circumstances:

(a) If inspection during fabrication reveals that extensive repairs are necessary

(b) When there is a change to any of the essential variables as defined in BS 2633 or BS 4677 as applicable

(c) When there is a change of welding position

(d) When directed to do so by the PM

6.5.17 Each approved welder shall be given a unique number and this number shall be used to mark all production welds made by that welder in paint or waterproof crayon.

6.5.18 Welder approval shall be carried out in accordance with BS 2633 or BS 4677 as applicable.

6.5.19 Rectification of welds shall be in accordance with the following requirements:

(a) Welds which do not comply with the standard specified in this section of the Standard shall be rectified such that they are brought into compliance

(b) Unacceptable weld defects shall be removed by grinding where welds are to be repaired. Cracked welds shall be cut out. Repairs involving opening of the root bead shall not be permitted. Only one attempt at repairing any given weld shall be permitted

(c) Cutting out of a weld containing unacceptable defects shall be affected by removing a suitable length of pipe containing the weld in all cases

(d) Full records of welding defects and all repairs to welds shall be maintained in a form approved by the PM

6.5.20 A unique number shall be allocated to each production weld. This number shall be marked on the weld and carried forward throughout the Contract to be finally incorporated in the record drawings.

7.0 Weld Testing

Where practicable, radiographic testing shall be the preferred method of conducting NDT examinations of fusion-welded joints. However, the Authority recognises that the safe transportation and storage of radioactive isotypes presents contractors with logistical challenges. Therefore, when met with these particular circumstances, the Authority authorises the use of Phased Array Ultrasonic Testing (PAUT) as an acceptable means* of conducting the NDT examinations.

*Provided that the pipe wall thicknesses exceed 6.00 mm and the geometry and location of the weld guarantees 100% examination.

7.1 Radiographic Testing

7.1.1 The requirements of BS 2633, BS 4677 and ANSI/ASME B31.3 shall apply except as augmented or modified by this section of the Standard.

7.1.2 Each completed joint shall be cleaned and prepared as necessary for visual examination and NDT.

7.1.3 The site activities shall be coordinated so that visual examination by the PM and the independent welding inspector and all necessary inspections by the Contractor are carried out before the weld areas are painted or otherwise covered.

7.1.4 When required to do so in accordance with this specification, the Contractor should carry out all specified NDT.

7.1.5 The PM and the independent welding inspector shall:

(a) Witness all welding procedure and welder approval tests including the mechanical testing of specimens prepared from test welds

(b) Be satisfied that the correct welding equipment, materials, and techniques are being employed and that the specified standards of workmanship are being achieved

(c) Be satisfied that the specified NDT examination of test welds and production welds is being carried out satisfactorily

(d) Visually examine all aspects of the making of test welds and production welds including weld preparation, set up of work for welding, and actual welding in progress

(e) Visually examine all completed test and production welds for quality of workmanship and integrity

(f) Visually examine all specimens prepared from test welds including specimens specially prepared for macro-examination and specimens before and after mechanical testing

(g) Visually examine all radiographs of test and production welds

(h) Witness the appropriate final pressure test

7.1.6 The Contractor should carry out all specified radiographic examinations and development of radiographs and shall submit the developed radiographs and copies of fully detailed radiography reports to the PM for examination.

7.1.7 Radiography shall be used for all weld testing except where the physical position of the weld precludes this. Under these circumstances, Gamma-radiography shall be used, in agreement with the PM.

7.1.8 The Contractor should carry out all other NDT examinations and shall submit copies of fully detailed test reports to the PM for examination.

7.1.9 All radiographic examinations and other non-destructive tests must be carried out by fully competent specialist inspection personnel with adequate experience in the application of the inspection techniques concerned.

7.1.10 Ultrasonic examination shall be used after any field cut-back of pipe and in checking for laminations in an area where an attachment or fitting will be welded. A laminar defect shall not be accepted if it exceeds 25 mm in any direction.

7.1.11 Magnetic particle testing or liquid penetrant testing shall be used on fillet/lap welds and after any site cut-back of pipe in accordance with BS EN 571-1 or BS EN 17638.

7.1.12 A radiographic procedure accompanied by radiographs of sample welds shall be submitted to the PM and the independent welding inspector for approval. Approval of the radiography procedure shall be obtained before the commencement of production welding.

7.1.13 Radiographic examination shall be carried out on all butt welds made in connection with welder and welding procedures approval tests. The radiographic examination shall be carried out over the full length of the weld in every case.

7.1.14 Radiographic examinations shall be carried out on all butt welds described in the following:

(a) Tie-in welds

(b) Welds in sections of pipework crossing roads, hard-standings, taxiway runways and other paved areas

(c) Welds in sections of pipework encased or otherwise concealed within the construction of buildings or other structures

(d) Welds in buried sections of stainless-steel pipework

(e) Welds in buried pipework associated with aviation fuel hydrant fuelling systems

(f) Welds in any special sections of pipework as specified by the PM

(g) Welds in fabricated fittings and manifolds

(h) Welds at joints between components such as pipes or pipe fittings of different material grade or wall thickness

(i) The first two welds made by each welder (or welding team)

(j) The first weld made by each welder (or welding team) after changeover to a different welding procedure.

(k) Radiographic examination shall also be carried out on not less than 10% of each individual welder's (or welding team's) output of butt welds other than those specified in the above. The welds to be radiographed shall be selected by the PM and the independent welding inspector following visual examination. Radiography carried out in accordance with 7.1.14 (c) shall be disregarded for the purposes of this paragraph

7.1.15 In addition to the radiography called for in 7.1.14 (a) and 7.1.14 (b):

(a) All repaired butt welds and all butt welds required because of the cutting out of welds containing unacceptable defects shall be subjected to radiographic examination

(b) If an unacceptable defect in a weld is revealed by radiography carried out in accordance with 7.1.14 (b) two further butt welds produced on the same day by the same welder (or welding team) shall be radiographed. Selection of the welds to be radiographed shall be made by the PM and the independent welding inspector. In the event that radiography reveals an unacceptable defect in either of the two further welds examined, all butt welds produced by that particular welder (or welding team) on the same day as the selected weld previously examined, shall be subjected to radiographic examination

Note. Welds subjected to radiographic examination in accordance with 7.1.14 (a), (b) and (c) above shall be radiographed over the full length of the weld in every case.

7.2 Phased Array Ultrasonic Weld Testing

7.2.1 Semi or fully automated PAUT, in accordance with BS EN ISO 13588, can be carried out on fusion-welded production joints for pipe wall thicknesses exceeding 6.0 mm*. Contractors are to ensure that the equipment selected to carry out the testing shall conform with the requirements of ISO 18563-1, Iso 18563-2 and ISO 18563-3 when applicable.

* Where pipe wall thicknesses are less than 6.0 mm, radiographic testing shall be used.

7.2.2 The technique can be applied to full penetration welded joints of simple geometry in plates, pipes and vessels, where both the weld and parent material are low-alloy and/or fine-grained steel.

Note. Guidance for using this technique to test fusion welded joints in coarse-grained or austenitic steels should be sought using ISO 22825.

7.2.3 Where applicable, the requirements of BS 2633, BS 4677 and ANSI/ASME B31.3 shall apply, unless augmented or modified by this section of the Standard.

7.2.4 When completed, each joint shall be cleaned and prepared as necessary for visual examination and NDT examination.

7.2.5 The site activities shall be coordinated such that visual examination by the PM and the independent welding inspector and all necessary inspections by the Contractor are carried out before the weld areas are painted or otherwise covered.

7.2.6 The Contractor should carry out all specified NDT examinations.

7.2.7 The PM and the independent welding inspector shall:

(a) Witness all welding procedure and welder approval tests including the mechanical testing of specimens prepared from test welds

(b) Be satisfied that the correct welding equipment, materials, surface preparation (e.g. Cleanliness and surface roughness) and techniques are being employed and that the specified standards of workmanship are being achieved

(c) Be satisfied that the specified non-destructive testing of test welds and production welds is being carried out satisfactorily in accordance with ISO 13588

(d) Visually examine all aspects of the making of the test welds and production welds including weld preparation, set up of work for welding, and actual welding in progress

(e) Visually examine all completed test and production welds for quality of workmanship and integrity

(f) Visually examine all specimens prepared from test welds including specimens specially prepared for macro-examination and specimens before and after mechanical testing

(g) Visually examine all phased array data of test and production welds to assess its quality; identify relevant indications; classify relevant discontinuities as specified; determine location and size of the discontinuities as specified and evaluate the data against acceptance criteria

(h) Witness the appropriate final pressure test

7.2.8 The Contractor should carry out all specified phased array data examinations and shall submit them and copies of fully detailed test reports to the PM for examination. Details of what is considered to be the minimum for inclusion in the test report can be found in ISO 13588.

7.2.9 Phased array ultrasonic testing can be used for all fusion weld testing except where the physical location of the weld, surface coating/preparation and complex weld geometry precludes this. Under these circumstances, radiography (e.g. Radiography, Gamma) shall be used, in agreement with the PM.

Note. Special high-temperature phased array probes and couplants shall be used when the surface temperature of the object to be tested exceeds 50^{o}C.

7.2.10 The Contractor should carry out all other non-destructive testing and shall submit copies of fully detailed test reports to the PM for examination.

7.2.11 All phased array ultrasonic testing examinations and other non-destructive testing must be carried out by fully competent specialist inspection personnel with adequate experience in the application of the inspection techniques concerned.

Note. In addition to BS EN ISO 13588, ISO 9712 gives guidance on the necessary requirements to be assessed as competent.

7.2.12 Ultrasonic examination shall be used after any field cut-back of pipe and in checking for laminations in an area where an attachment or fitting will be welded. A laminar defect shall not be accepted if it exceeds 25 mm in any direction.

7.2.13 Magnetic particle testing or liquid penetrant testing shall be used on fillet/lap welds and after any site cut-back of pipe in accordance with BS EN 571-1 or BS EN 17638.

6.7.14 An ultrasonic testing procedure accompanied by phased array data of sample welds shall be submitted to the PM and the independent welding inspector for approval. Approval of the procedure shall be obtained before the commencement of any production welding.

7.2.15 Examination shall be carried out on all butt welds made in connection with welder and welding procedures approval tests. The examination shall be carried out over the full length of the weld in every case.

7.2.16 Phased array ultrasonic examinations shall be carried out on all butt weld joints where the minimum wall thickness exceeds 6.0 mm described in the following:

(a) Tie-in welds

(b) Welds in sections of pipework crossing roads, hard-standings, taxiway runways and other paved areas

(c) Welds in sections of pipework encased or otherwise concealed within the construction of buildings or other structures

(d) Welds in buried sections of stainless-steel pipework

(e) Welds in buried pipework associated with aviation fuel hydrant fuelling systems

(f) Welds in any special sections of pipework as specified by the PM

(g) Welds in fabricated fittings and manifolds

(h) Welds at joints between components such as pipes or pipe fittings of different material grade or wall thickness

(i) The first two welds made by each welder (or welding team)

(j) The first weld made by each welder (or welding team) after changeover to a different welding procedure.

(k) Examination shall also be carried out on not less than 10% of each individual welder's (or welding team's) output of butt welds other than those specified in the above. The welds to be examined shall be selected by the PM and the independent welding inspector following visual examination. Examinations of welds carried out in accordance with 7.2.16 (c) shall be disregarded for the purposes of this paragraph.

7.2.17 In addition to the examinations called for in 7.2.16 (a) and (b):

(a) All repaired butt welds and all butt welds required because of the cutting out of welds containing unacceptable defects shall be subjected to examination

(b) If an unacceptable defect in a weld is revealed by examination carried out in accordance with 7.2.16 (b) two further butt welds produced on the same day by the same welder (or welding team) shall be examined. Selection of the welds to be examined shall be made by the PM and the independent welding inspector. In the event that an unacceptable defect is found in either of the two further welds examined, all butt welds produced by that particular welder (or welding team) on the same day as the selected weld previously examined, shall be subjected to further examination

(c) Welds subjected to examination in accordance with 7.2.16 (a), (b) and (c) above shall be examined over the full length of the weld in every case

8.0 Pressure Testing of Pipework

8.1 General

8.1.1 This section of the Standard applies to the pressure testing of all pipework.

8.1.2 Ferrous pipework shall be pressure tested at the full test pressure using water as the test medium unless this is specifically prohibited – by the PM. When water is prohibited as the test medium, the pipework testing shall commence with a preliminary leak test, using air, followed by full pressure testing using the process liquid as the test medium.

8.1.3 A schedule of operations is required for each test or series of tests to be undertaken, clearly describing the responsibilities during all phases of the testing work, including fabrication of any test instrument tees etc., obtaining any test fluid and method of obtaining additional supplies to cope with any failures, filling, pressurisation, testing, depressurisation and emptying.

8.1.4 A schedule of operations should be submitted as detailed in section 8.1.3 including preliminary leak testing if this is required, to the PM prior to commencement of testing, indicating the proposed test section, source of test fluid, methods of working and the disposal/handover of test fluid after testing. Contaminated test fluid will be disposed of in a manner approved by the PM. The PM's approval should be provided for the complete test procedure in advance of the first test of any description taking place. The programme shall consider the position of test fluid sources and the sequence of operations and provide for the possibility of failure requiring additional test fluids.

8.1.5 The full pressure test should be carried out by a specialist sub-contractor approved by the PM. The specialist sub-contractor or section shall employ an experienced person who shall be in complete charge of all testing, have no other responsibilities, and be on site throughout the duration of the testing operations.

8.2 Preliminary Leak Testing

8.2.1 All leak testing shall be carried out as per the requirements of EEMUA 168.

8.2.2 This shall always be carried out before full pressure testing on pipework for which the process liquid is specified as the test medium. For tie-in welds on buried pipework to join sections of pipework already tested, the preliminary leak test may be waived by the PM provided that the tie-in welds have been 100% tested using a suitable NDT technique.

8.2.3 The preliminary leak tests shall be carried out by pressurising the test section to 10% of the design pressure (1.9 barg) with air. The joints shall be painted with soapy water solution and observed for the formation of air bubbles.

8.2.4 The test pressure shall be maintained whilst the soapy water test is being carried out on each joint.

8.2.5 Safety with air testing: When air is used as the test medium the requirements of HSE Guidance Note GS4 – Safety in Pressure Testing shall be met. Before the pressure is raised the Contractor shall inform the PM of the safety precautions taken.

8.2.6 Any leaks found during the preliminary tests shall be rectified after fully depressurising the pipework, and the preliminary leak tests shall be repeated to the satisfaction of the PM.

8.3 Full Pressure Testing

8.3.1 The pressure for the full pressure test for ferrous pipework = 29.0 barg (1.5 x design pressure (Class 150))

8.3.2 Any equipment in the section of pipework not rated to withstand the test pressure is to be removed and the section blanked off during the test.

8.3.3 Where Tees, elbows, reducers and other fittings are welded into existing pipework, the PM may direct that the old pipework is not subjected to the full pressure test provided that the break in is 100% radiographed and ultrasonically tested and the leak tests in Section 8.2 are applied. This shall be followed by a hydrostatic test of the pipework at its normal operating pressure as agreed by the PM.

8.3.4 The full pressure test shall be carried out when the pipework is at a temperature above 0˚C and below 30˚C. The temperature of the pipe shall be monitored using a suitable and reliable means every 15 minutes.

8.3.5 Should any failure occur during hydrostatic testing this shall be rectified and the test repeated to the satisfaction of the PM. Where fuel is used as the test medium this shall be drawn off for reuse and gas freeing of the pipework competed before repairs are executed. Works shall be undertaken in accordance with the JSP 375 Volume 3 Chapter 5 - Petroleum Installations.

8.3.6 The sections to be hydrostatically tested shall be filled with the liquid test medium. The air shall be eliminated through vent valves at all high points in the pipeline. The temperature of the process fluid in buried sections shall be monitored using a suitable and reliable means and if in the opinion of the PM the difference between it and the underground temperature is likely to cause problems with the test, a stabilisation period shall be allowed before the test commences. Piping systems shall be properly vented wherever possible before the test pressure is applied, in order to prevent the formation of air pockets.

8.3.7 The pressure shall be raised from 2 barg to 7 barg and the volume of process fluid required to raise the pressure to this level recorded. If this volume exceeds 0.2% of the volume of the system under test this indicates that there is either excessive air or vapour and further air/vapour elimination shall be carried out by venting at high points. The complete check shall then be repeated.

8.3.8 If the air content is satisfactory the test pressure shall be raised at a uniform rate of 0.5 barg/min to the test pressure. The test pressure shall be held for a minimum of 2 hours.

8.3.9 After completion of the hydrostatic test, the pressure in the test section shall be lowered immediately and in no circumstances shall the full pressure be maintained for transfer to another section.

8.3.10 Written acceptance is required from the PM that each section of the pipework has satisfactorily passed all aspects of the pressure testing including holding of test pressure without excessive variations for the test duration.

8.3.11 Records shall be maintained to the satisfaction of the PM, to show the testing arrangements and results of each test. Such records shall be unambiguous as to what was included in the testing of each section.

8.4 Test Instruments

8.4.1 Pressure gauges used for the pressure tests shall be calibrated against a dead weight tester. Gauges shall be of a type agreed with the test specialist sub-contractor and submitted with the test procedure for approval by the PM. Current test and calibration certificates for the dead weight testers and associated instruments shall be available on site for inspection by the PM and shall include copies of all such certificates in the pressure test records.

9.0 Protection of Ferrous Pipework

9.1 General

9.1.1 This section of the Standard applies to the protection, both internally and externally, of all ferrous pipework.

9.1.2 Fully detailed data sheets and certificates of conformity with the relevant standards in respect of all materials of construction to be used shall be provided. The data sheets shall include detailed application instructions together with full particulars of the characteristics of the materials and any safety precautions to be adopted in connections with their handling, storage, preparation, application, and disposal. Certificates of conformity shall comply with any applicable requirements of the relevant material standards and shall generally be in a form approved by the PM.

9.2 Internal Protection

9.2.1 The internal surface of all stainless-steel pipework and fittings shall be left as bare metal.

9.2.2 The internal surface of all carbon steel pipework and fittings shall be left as bare metal unless otherwise specified by the PM. Sections which are to be treated internally shall be coated in accordance with EI 1541.

9.3 External Protection - Aboveground Pipework

9.3.1 All stainless-steel pipework, fittings and flanges shall be left as bare metal unless otherwise indicated.

9.3.2 All associated valves, equipment and carbon steel pipe supports shall be prepared and painted in accordance with the requirements specified in section 9.3.3.

9.3.3 When tone-down is required, pipes, fittings, and flanges exposed to external view shall be painted using the following system:

	All Atmospheres
Surface Preparation	Clean and degrease. Abrasive blast clean to BS 7079 Sa 2½ standard with surface profile 25–30 microns, using non-metallic abrasives
Primers	Polyamide cured epoxy containing <100 ppm chloride and free of metallic pigments. Min DFT – 60 microns
Finish	Re-coatable polyurethanes. Min DFT – 50 microns
Colour	Specified by the PM

The external surface of all aboveground carbon steel pipework, fitting supports, valves and equipment shall be protected in accordance with the following requirements, as specified by the PM.

	Normal Atmosphere	Saliferous Atmosphere
Surface Preparation	Abrasive blast clean to BS 7079 Sa 2½ standard with surface profile 50 – 75 microns	
Primer	Epoxy Zinc Phosphate Min DFT: 50 microns	Epoxy Zinc Rich Min DFT: 75 microns
Intermediate	Epoxy, Micaceous Iron Oxide Min DFT: 100 microns	Epoxy, Micaceous Iron Oxide Min DFT: 125 microns
Finish	Recoatable polyurethane Min DFT: 50 microns	
Colour	Specified by the PM	

The zinc rich epoxy shall contain not less than 91% metallic zinc by weight in dry film and shall comply with the requirements of BS 4652.

The external surface of aboveground carbon steel pipework, fittings, supports, valves, and equipment where the PM determines abrasive blast cleaning is not appropriate, shall be painted in accordance with the following requirements:

	Normal Atmosphere	Saliferous Atmosphere
Surface Preparation	Mechanical preparation to BS 7079 Sa 3 standard with surface profile 50 – 75 microns	
Primer	Surface tolerant high build epoxy Min DFT: 75 microns	
Intermediate	Surface tolerant high build epoxy mastic Min DFT: 75 microns	Surface tolerant high build epoxy mastic Min DFT: 125 microns
Finish	Recoatable polyurethane Min DFT: 50 microns	
Colour	Specified by the PM	

The external surface of all aboveground, trace heated carbon steel pipework, fittings, valves, and equipment shall be protected in accordance with the following requirements:

	All Atmospheres
Surface Preparation	Abrasive blast clean to BS 7079 Sa 3 standard Surface profile 30 microns. (-0 + 10 microns)
Single Coat	DFT 60 microns (-0 + 15 microns)
Cure	Cure strictly in accordance with Manufacturer's instructions

9.4 External Protection - Buried Pipework - larger than 80 mm diameter

Note. In the majority of cases and unless specified otherwise by the PM, the external surface of all buried stainless steel pipework and fittings shall be left as bare metal. However, before burying the pipework, the PM is to give consideration and seek expert advice regarding the ph balance and chemical composition of the surrounding soil if pitting corrosion of the stainless steel material is to be avoided. If then deemed necessary, measures to prevent against this can include wrapping of the pipework and the provision of CP.

9.4.1 The external surface of all buried carbon steel pipework and fittings larger than 80 mm diameter shall be protected either with FBE (Fusion Bonded Epoxy), to be applied to meet the requirements of BS EN ISO 21809-2 or with extruded polyethylene as specified in the following sections and as specified by the PM:

9.4.2 The extruded polyethylene coating shall conform to the requirements of DIN 30670 and shall be of the 3-layer type, comprising a fusion bonded epoxy primer, an adhesive inner layer, and an extruded outer layer of black polyethylene.

9.4.3 The extruded polyethylene coating shall consist essentially of a medium density copolymer with the addition of finely divided carbon black.

Note. Except where the reinforced thickness coating is specified –by the PM, the standard thickness coating shall be provided. The coating thicknesses shall not be less than the minimum permissible values indicated in the following table.

DN of Pipe	Minimum Coating Thickness (mm)	
	Standard Coating	Reinforced Coating
100 and below	1.8	2.5
150 to 250	2.0	2.5
300 to 450	2.2	3.0
500 to 600	2.5	3.5

9.4.4 Surfaces to be coated shall be free of all oil, grease, rust, scale etc. The pipes shall be pre-heated to a minimum of 60˚C to remove moisture and abrasive blast cleaned to achieve a surface finish equivalent to BS 7079 Grade Sa 2½.

9.4.5 The pipe shall then be heated to a temperature recommended by the epoxy powder manufacturer followed by application of the epoxy powder primer to the Manufacturer's recommended thickness.

9.4.6 The adhesive shall then be applied by extrusion to the Manufacturer's recommended thickness.

9.4.7 Immediately following the application of the adhesive, the polyethylene shall be applied by either side or ring extension to obtain the required thickness. Where side extrusion is used it is essential that the overlapping individual layers fuse together to form a homogenous sheathing.

9.4.8 The adhesive and polyethylene coating shall terminate 125 ± 25 mm from each end of the pipe.

9.4.9 The coating shall be subjected to 100% holiday detection, using a high-tension electric holiday detector with a voltage appropriate to the thickness of the pipe coating.

9.4.10 All other testing and inspection of the coating shall conform to the requirements of DIN 30670.

9.4.11 If problems are detected, or repairs are needed, the manufacturer shall take immediate steps to correct the situation. All repairs to the coated pipe shall be at the Manufacturer's expense.

9.4.12 Scars, dents, damaged areas, and holidays shall be cleaned by removing all rust, scale, dirt or other foreign materials or loose coating using a small smooth cut file.

9.4.13 Repairs are to be made by means of a repair procedure approved by the PM prior to the commencement of work. Any pipe subject to a coating repair procedure shall be fully re-examined after the repair has been completed.

9.5 External Protection - Buried Pipework - 80 mm diameter and less

9.5.1 The external surface of all buried stainless-steel pipework and fittings shall be left as bare metal unless specified otherwise –by the PM.

9.5.2 The external surface of all buried carbon steel pipework and fittings, 80mm diameter and less, shall be protected in accordance with the following requirements:

(a) The surface shall be protected using a PVC/Laminate tape protection system

(b) Surfaces shall be wire brushed to remove all rust, millscale, weld spatter, dirt and other loose or deleterious matter

9.5.3 Where applicable, factory coating ends shall be wire brushed for a minimum distance of 150mm, ensuring coating ends are bevelled.

9.5.4 Primer shall be applied immediately following completion of surface preparation in accordance with Manufacturer's recommendations.

9.5.5 All surfaces to be wrapped shall be primed and allowed to dry. Primer application shall be limited to that amount that can be wrapped during the working day, after which either re-priming or stripping and re-priming will be required.

9.5.6 Tape shall be applied in a spiral fashion by hand or hand-operated machines to provide a 55% overlap and with sufficient tension to give constant adherence without voids or wrinkles.

9.5.7 Tape shall be a cold applied, self-adhesive tape, comprising of a bituminous resin adhesive on a PVC backing layer. Total thickness of the tape shall be 1.1 mm minimum and the thickness of the PVC backing shall be 0.3 mm minimum, unless a fabric reinforcement is provided in the bituminous resin, in which case thickness of the PVC backing shall be 0.1 mm minimum.

9.5.8 Tape width shall be suitable to conform to the size and shape of the component being wrapped.

9.5.9 Primer shall be that recommended and manufactured by the tape manufacturer and be a fast-drying compound, suitable for cold application by spray or brush.

9.5.10 The applied tape shall be visually inspected to confirm that an effective bond, as defined by the tape manufacturer, is formed between the pipe surface and the tape. This inspection shall be carried out no less than 24 hours after application.

9.5.11 Inspection of coated pipe shall be visual for satisfactory adhesion and 100% holiday inspection by a holiday detector set at the working voltage. The working voltage shall be set at least twice per working day by the following method:

(a) Three layers of tape shall be applied on the pipe to form a patch

(b) The centre of the tape patch shall be punctured with a sharp instrument

(c) The voltage of the holiday detector shall be just high enough to register the puncture in the three tape layers

(d) The working range of the holiday detector shall be a minimum of 10kV and shall not exceed 20kV.

9.6 Wrapping Field Joints and Repairs to Factory Wrapped Pipe Lengths

9.6.1 All field joints of factory-wrapped pipework shall be in accordance with section 9.5.2.

9.6.2 Coating repairs to factory-wrapped pipework shall be in accordance with section 9.5.2.

9.7 External Protection - Pipework in Pits

9.7.1 The external surface of all stainless-steel pipework and fittings in valve pits etc shall remain bare.

9.7.2 The external surface of all carbon steel pipework and fittings in valve pits etc shall be protected in accordance with the following requirements:

Surface Preparation	Clean, degrease and blast clean to BS 7079 Sa 2½ standard – surface profile 50 – 75 microns
Primer Coat	Low VOC, two component epoxy. Min DFT: 75-200 microns
Intermediate Coat	Low VOC, two component high solids internally flexibilised surface tolerant epoxy. Min DFT 75-100 microns
Finish Coat	Low VOC two component high solids flexible aliphatic surface tolerant polyurethane finish coat capable of producing high build films. Min DFT 75-100 microns

9.8 Cathodic Protection of Pipework

9.8.1 A professional investigation is necessary to ascertain the need for, type of and extent of the Cathodic Protection (CP) system required. The investigation shall consider all local corrosion influences and effect on existing buried structures and services.

9.8.2 The detailed design of the CP system shall be undertaken by a company specialising in this field. The CP system, which shall be in accordance with the recommendations of BS EN 13636 and designed in accordance with the specification produced by the PM.

9.8.3 General CP system designs should be for 30 years in-service life.

10.0 Tank Fittings

10.1 General

10.1.1 Tanks shall be provided with fittings as indicated on the drawings.

10.1.2 Equipment that will be used with aviation fuel shall comply with the following requirements:

(a) Ferrous materials other than austenitic stainless steels shall not be used in components which are in contact with aviation fuel or aviation fuel vapour in confined spaces where that fuel is to be transferred directly from operating storage tanks to aircraft or to the aircraft fuelling vehicle, except where one of the following conditions applies:

(i) The ferrous materials are hot-tinned
(ii) The ferrous materials are epoxy coated
(iii) This Standard expressly permits otherwise
(iv) The express prior agreement of the PM has been obtained

(b) Non-ferrous materials: the following non-ferrous materials shall not be used in components which are in contact with the fuel or in components which are in contact with the fuel vapour in confined spaces:

(i) Zinc (including all zinc coatings), zinc compounds and alloys containing zinc
(ii) Lead and alloys containing lead
(iii) Copper and alloys containing 4% and above copper (unless specifically stated as being allowed in individual equipment specifications)
(iv) Cadmium and its compounds

10.1.3 In some cases, tanks will be constructed to aviation fuel standard even though other products will be stored initially. If this is the case the drawings shall highlight this.

10.1.4 The tank and its associated pipework, fittings and walkways should be in electrical contact with each other and with earth so that the resistance at any point is less than 10 Ω (ohms).

10.1.5 Selection of equipment, materials, and system design, shall comply with the guidelines of this Standard and the following standards:

(a) Code of practice for Control of Undesirable Static Electricity PD CLC/TR 50404

(b) Protection of structures against lightning; BS EN 62305

(c) Code of Practice for Earthing BS 7430

(d) Cathodic Protection of Buried Metallic Tanks and Related Piping BS EN 13636

(e) Model Code of Safe Practice for the Petroleum Industry Part 1 Electrical Safety Code

10.2 Tank Manholes

10.2.1 All tanks shall be provided with means of access to the interior by one or more manholes.

Details of the number of manholes and minimum internal diameters are given below unless otherwise specified by the PM. The minimum requirement for tank entry by personnel is two manways.

Tank Type, Size & Diameter:	Manhole Internal Diameter	Minimum Number
Horizontal up to 15 m³	800 mm	1
Horizontal >15 m³ Horizontal <30 m³	800 mm 800 mm	2 2
Vertical up to 10 m Diameter	1000 mm	2
Vertical >10 m Diameter	1000 mm	3

10.2.2 Manholes are to be sized to assure safe entry and exit to tanks for personnel using breathing apparatus and PPE.

10.3 Pressure/Vacuum Valves

10.3.1 Pressure/vacuum (PV) valves are fitted to tanks to restrict the free venting of the tank so conserving vapour. PV valves are to operate within the designed pressure/vacuum limits of tanks containing class I and class II products.

Size	Calculations to be provided by the Contractor to support the size and number of valves selected.
Type	Relief of pressure or vacuum determined solely by the weight of the valve pallet. Spring relief devices are not permitted.
Materials	Cast aluminium body with stainless steel fittings. In larger sizes cast iron bodies are acceptable. PTFE diaphragm seal.
Protective Screen	Both pressure and vacuum outlets to be fitted with wire mesh screen of corrosion resistant material to prevent ingress of birds, leaves etc. Mesh to have a maximum hole size of 6 mm.

10.4 Free Vents

Size	As shown on the drawings and usually at least as large as the incoming fill pipe to act as an overflow in case of tank overfilling.
Type	Free vent fitting complete with weather proofing cowl and wire mesh screen of corrosion resistant material to prevent ingress of birds, leaves etc. Mesh to have a maximum hole size of 6 mm. Screen on aviation tank vents does not have to conform to section 10.1.2.

10.5 Emergency Venting

10.5.1 The venting arrangements described in (10.3 and 10.4) are designed to cope with pressure fluctuations during normal operations. Additional pressure relief is necessary for aboveground tanks to cope with possible fire engulfment. The emergency vent shall be in accordance with API 2000.

10.6 Dip and Sampling Hatches

10.6.1 Proprietary fittings giving access through the tank roof for dip measurement and taking of product samples.

Size	100 mm (4 inches)
Type	Self-closing with provision for padlock.
Material	Cast Aluminium

Note. Unless a depressurising valve is fitted and used, care must be taken when opening dip and sampling hatches on those tanks fitted with PV valves, as on opening the pressure will relieve and vapour may be present.

10.7 Combined Dip and Vent Fittings

10.7.1 These proprietary fittings comprise a 100 mm (4") diameter dip hatch with a free vent.

Size	Vent size as shown on drawings and usually at least as large as the incoming fill pipe to act as an overflow in the case of tank overfilling.
Type	Combined dip and vent fitting complete with lockable with hinged hatch cover, weatherproofing cowl, and wire mesh screen of corrosion resistant material to prevent ingress of birds, leaves etc.

10.7.2 Mesh to have a maximum hole size of 6 mm.

10.7.3 Screens on aviation tank do not have to conform to 10.1.2.

10.8 Dip/Sample nozzle inserts

This tube is fitted between the dip hatch and the floor of the tank to guide the dip tape or sampler.

Size	See drawings
Type	Perforated tube with top flanged to suit hatch and the bottom positively located in a loose fit self-draining socket.
Material	18/8 stainless steel in aviation tanks, otherwise carbon steel.

10.9 Dipstick

10.9.1 A rigid calibrated stick for contents measurement in small tanks.

Material	GRP specially impregnated with carbon and supplied by approved manufacturer. Brass is not suitable for aviation tanks
Dimensions	Carbon impregnated GRP manufacturer's standard – 4 m max length.
Markings	Engraved (one face only). Installation and tank identification (in a form approved by the PM) to be included.

10.9.2 Graduations are required along entire length of dipstick as indicated below:

Nominal capacity of Tank (litres)	Graduations required in increments of:
Up to 5,000	500 litres for main divisions 100 litres for sub-divisions
5,001 to 20,000	1,000 litres for main divisions 200 litres for sub-divisions
20,001 to 55,000	2,000 litres for main divisions 500 litres for sub-divisions

10.9.2 Graduation marks together with corresponding capacity in litre units to appear at main divisions.

10.9.3 Graduation marks alone to appear at sub-divisions.

10.10 Dip Tape

10.10.1 Spring steel with stainless steel dipping weight generally as illustrated in the Institution of Petroleum Measurement manual. To be graduated in millimetres.

10.11 Flame Arrestors

10.11.1 Safety device to prevent the propagation of a flame through a flammable vapour into the tank. Normally only applicable to Class I product tanks.

10.11.2 Capacity To be at least 300% of associated free vents or PV valves. (Reference items 10.3 and 10.4)

10.11.3 Tube Banks shall have the capability of sealing the flame arrester with the tube bank removed. If “dummy” tube banks are required for this, they are to be clearly marked as such.

Body Materials	Carbon steel or cast iron
Tube Bank	18/8 stainless steel materials
Inspection & Maintenance	Tube banks to be removable without the need to dismantle the flame arrester.
Atmospheric Openings	To be fitted with a 6 mm x 6 mm stainless steel mesh screen only.

10.12 Floating Suction Units

10.12.1 General

10.12.1.1 Floating suction units shall be designed such that draw-off takes place from just below the free surface of the fuel within the tank without the formation of a vortex and without the

intake of air or fuel vapour.

10.12.1.2 Each floating suction unit shall consist of a movable suction arm connected to a fixed header by means of a swivel joint together with a float or set of floats attached to the free end of the suction arm such that the arm rises and falls with the level of the fuel in the tank. The use of an articulated suction arm incorporating a further swivel joint shall be avoided whenever practicable. Attachment of the fixed header to the tank nozzle shall be by means of a flanged joint.

10.12.1.3 Suitable means of limiting the movement of the suction arm shall be provided. Unless otherwise indicated, the lower limit shall be such that in the lowest position of the suction arm, the inlet is at least 150 mm and not more than 250 mm above the local level of the tank bottom. The upper limit shall prevent the float or floats from touching the tank plates or other tank steelwork. In its uppermost position the suction arm shall be at an angle not exceeding 60 degrees above the horizontal.

10.12.1.4 The overall dimensions, movement envelope and general arrangement of each floating suction unit shall be designed to suit the tank in which it is to be installed. In this connection due account shall be taken of all relevant tank dimensions and details including the positions of all potential obstructions within the tank such as other internal fittings and internal pipework and any access ladders, structural bracing, columns or roof supporting steelwork.

10.12.1.5 Floating suction units shall be capable of being passed through the tank manhole as a complete assembly (or, failing that, with float or floats detached and passed through the manhole separately) and shall be designed such that the extent of the installation work (including adjustment etc) required within the tank is minimised.

10.12.1.6 The nominal diameter of each floating suction unit shall be as indicated on the drawings.

10.12.2 Materials of Construction

10.12.2.1 All principal components of the floating suction unit shall be constructed of suitable aluminium alloys containing less than 4% copper and the material used shall comply with BS EN 485, BS EN 754, BS EN 586, and BS 1490 as appropriate. All other components and accessories in contact with the fuel, including the lifting cable and associated fittings, float linkage components (including hinge pins) and bolting and other fastenings shall be of stainless steel.

10.12.2.2 Non-machined surfaces of aluminium alloy castings shall be lightly abraded to remove all traces of moulding sand, burrs and loose metal.

10.12.3 Components and Accessories

10.12.3.1 Swivel joints shall be of a well-proven low torque design suitable for fully immersed service. Substantial stainless-steel ball bearings shall be incorporated, and the swivel joints shall be air-tight and fuel-tight under all conditions. The swivel joints shall be designed for long life in service without binding or seizing and periodic greasing or other routine maintenance shall not be required.

10.12.3.2 A lifting cable shall be provided to allow the proper operation of the floating suction unit to be checked on a routine basis. One end of the cable shall be attached to a purpose-

made fixing lug on the suction arm by means of a bolted connection and the free end of the cable shall be suitably terminated and fitted with a bolted shackle for securing as indicated on the drawings. Unless otherwise indicated the lifting cable shall be arranged such that for inspection and maintenance purposes the float assembly may be raised to a position immediately below a tank manhole.

10.12.3.3 Each floating suction unit shall be provided with a small-bore venting device at the free end of the suction arm to release any air or fuel vapour trapped in the suction arm.

10.12.3.4 All small components such as hinge pins, nuts and split pins or other fastenings shall be positively and effectively secured to prevent detachment in service.

10.12.3.5 Floating suction units shall be supplied and installed complete with any necessary ancillary fixtures such as fixed guides or nest supports. In all cases the fixtures shall incorporate bolted connections to be fully demountable and shall be arranged for bolting to separate mounting lugs or brackets attached to the tank structure. In the case of a new tank the necessary mounting lugs or brackets shall be welded to the tank structure. The method of attachment used for existing tanks shall be subject to approval by the PM.

10.12.3.6 Unless otherwise indicated, an external indicator designed to show the position of the suction arm within the tank, shall not be provided.

10.12.4 Pressure Tests

10.12.4.1 The assembled fixed header, swivel joint and suction arm shall be subjected to an air pressure test in the manufacturer's works and shall withstand satisfactorily a test pressure of 1.0 barg applied internally for a period of not less than 1 hour. During the pressure test all joints and weld seams shall be wiped with a soap solution and inspected for signs of leakage and the suction arm (for each section of an articulated suction arm) shall be moved through this full range of movement at least ten times in each direction.

10.12.4.2 Each float shall be pressure tested hydraulically in the manufacturer's works and shall withstand satisfactorily a test pressure of not less than 0.35 barg applied externally for not less than 1 hour.

10.12.4.3 Throughout the specified test periods there shall be no evidence of any leaks, undue distortion, or other defects.

10.12.4.4 Certified fully detailed records of the pressure tests carried out shall be supplied to the PM.

11.0 Horizontal Steel Tanks

Up to and including 90 m^3 capacity for Installation above ground.

11.1 Design and Manufacture

11.1.1 This Standard applies to single skin steel tanks up to 90 m^3 capacity, specification as per BS EN 12285-2. For specification details of tanks larger than 90 m^3, contact DIO TS.

11.1.2 For details of tank fittings including tank manhole requirements see Section 10.

11.1.3 The tanks shall be designed and constructed to BS EN 12285 -2 except as modified by or augmented in this Standard and the drawings.

11.1.4 The density and vapour pressure of the process fluid and the design temperature will be as stated by the PM.

11.1.5 A smooth internal surface shall be maintained inside the tank to facilitate draining and cleaning by keeping it free of bracing gusset plates and all other internal obstructions except essential pipe connections.

11.1.6 Tanks shall be designed to resist loading due to self-weight, wind and hydrostatic testing and where applicable, external loading.

11.1.7 Notwithstanding the number and size of vent connections shown on the drawings. It shall be the Contractor's responsibility to determine the appropriate size and number of venting nozzles in accordance with API 2000. The Contractor shall pay attention to the inflow and outflow rates specified by the PM, when determining the size of vents.

11.2 Shell Plate Arrangement

11.2.1 Shell plate arrangement shall be in accordance with BS EN 12285-2. A butt-welded form of construction shall be adopted throughout as referred to in section 4.5 of BS EN 12285 -2.

11.2.2 The shells shall be fabricated using an approved number of rings each rolled from a single piece of plate or from not more than two plates welded together.

11.2.3 No continuous longitudinal weld in any ring shall lie within the bottom third of the tank circumference and longitudinal seam welds in adjoining rings of plate shall be staggered from each other by a minimum of 45˚.

11.2.4 Where an end plate is made up from two smaller plates, the welded joint between them shall lie at or above the centre of the tank end.

11.3 Fabrication Drawings

11.3.1 Fabrication drawings for the tanks shall be prepared and submitted to the PM before starting

fabrication. The PM shall provide details of timescale and number of drawings required. The drawings shall show full particulars of the tanks including the following:

(a) Plate arrangement and connections

(b) All nozzles and pipe connection details

(c) Method of fabrication

(d) Details of tanks supports

(e) Details and dimensions of manholes

11.3.2 Welding procedures complying with all relevant requirements of BS EN 1011 parts 1, 2 and 3 shall be submitted to the PM at the same time as the fabrication drawings detailed in section 11.3.1.

11.4 Earthing Fittings

11.4.1 The tank and its associated pipework, fittings and walkways should be in electrical contact with each other and with earth so that the resistance to earth at any point is less than 10 Ω (ohms). The earthing of each item shall be tested for electrical continuity and shall have a resistance to earth of no more than 10 Ω (ohms). Selection of the tank materials, internal coating, equipment materials and system design shall comply with the guidelines of this Standard and the following standards:

(a) Electrostatics: Code of Practice for Avoidance of Hazards due to Static Electricity – PD CLC/TR 50404

(b) Protection of structures against lightning - BS EN 62305

(c) Code of Practice for Earthing – BS 7430

(d) Model Code of Safe Practice for the Petroleum Industry: Part 1 Electrical Safety Code

11.4.2 Each tank shall be provided with two welded on earthing bosses, sized at 30 mm x 45 mm diameter, located on the dished ends of the tank at low level unless otherwise indicated on the drawings. These earthing bosses shall be fabricated from carbon steel round bar stock and shall be threaded M16 internally.

11.5 Welding Procedure

11.5.1 Welding procedures shall be produced to BS EN 15607 and welders qualified to BS EN 1011 parts 1, 2 and 3

11.5.2 Welding shall be in accordance with BS EN 1011-1. Butt welding shall be used on shell and dished ends.

11.5.3 The Contractor shall supply all the specialist personnel and equipment required to carry out the welding, inspection and weld tests specified.

11.5.4 All welds shall be visually examined to the requirement of BS EN 12285 -2.

11.6 Tank Testing

11.6.1 A team of specialist testers shall be employed to carry out all tank testing.

11.6.2 Testing shall be in accordance with BS EN 12285.

11.6.3 All tests will be carried out hydrostatically using clean fresh water.

11.6.4 Any faults identified during the tests shall be repaired to the satisfaction of the PM and the tank retested.

11.6.5 Pressure test certificates shall be supplied to the PM. The PM may appoint an inspector to witness any or all the tests.

11.7 Painting/Protection

11.7.1 Protective linings are to be applied to 100% of the interior metal surfaces of all storage tanks, unless fabricated from stainless steel, that are used to direct deliver aviation turbine fuel (AVTUR) and aviation gasoline fuel (AVGAS) on the Defence Estate.

11.7.2 The internal lining/coating to be applied shall conform to the requirements of EI/JIG Standard 1530 and EI 1541. The following table, adapted from EI/JIG 1530, specifies the minimum internal coating requirement where 100% internal coating cannot be achieved.

Note. The MoD interprets the term “direct deliver” as meaning ‘where an aviation fuel storage tank direct delivers via a FWS into a dedicated bowser, refuelling rig, pipeline, hydrant and any other means of delivering fuel to an aircraft’.

Operating Scenario	Minimum Internal Lining Requirement
New storage tanks used to direct deliver aviation fuels	Lining of the tank bottom and the first 1.0 m of the walls
Existing storage tanks used to direct deliver aviation fuels	Lining of the tank bottom and the first 1.0 m of the walls. If not lined – OAs should consider upgrading as soon as practicable
Existing storage tanks that are to be repurposed to direct deliver aviation fuels	Lining of the tank bottom and the first 1.0 m of the walls
Existing storage tanks used to store aviation fuels but do not direct deliver	OAs should consider the benefits of lining

Note. The following non-ferrous materials must not constitute any part of the lining application:

(a) Zinc, zinc rich compounds and alloys containing zinc

(b) Lead and alloys containing lead

(c) Copper and alloys containing 4% and above copper

(d) Cadmium and its compounds

11.7.3 The outside of the tank shall be painted to the following specification:

Surface Preparation	Abrasive blast clean to BS 7079 Sa 2½ surface profile 50-75 microns
Primer Coat	Epoxy zinc phosphate Min DFT - 50 microns
Intermediate Coat	Epoxy micaceous Iron Oxide Min DFT - 100 microns
Finish Coat	Recoatable Polyurethane Min DFT - 50 microns
Colour	Specified by the PM

11.7.4 It should determine if the paint system on an installation requires a full back to bare metal strip and the coating applied to the above specification. Alternatively, if the extant paint system is generally sound, only areas where the paint system has broken down should be stripped back to bare metal, and subsequently re-painted up to the specification above.

11.7.5 The primer coat shall be applied at the factory and once the tank has been installed any damage to the factory applied primer shall be patched and the remaining coats applied at site unless otherwise specified by the PM.

11.7.6 A brass nameplate shall be fitted to the outside of the tank and shall be engraved with the following information:

(a) Name of Supplier

(b) Contract Number

(c) Date of fabrication

(d) Tank reference number as used in construction drawings

(e) Details of internal lining if appropriate

(f) Design Standard

12.0 Horizontal GRP Tanks for Installation Above Ground

12.1 Design and Manufacture

12.1.1 This Standard deals with single and double skin GRP tanks in accordance with BS EN 13923 If single skin GRP tanks are specified, separate secondary containment (bunds) will be required.

12.1.2 For details of tank fittings including tank manhole requirements see Section 10.

12.1.3 The design and detailing of these GRP tanks shall be the responsibility of the Contractor. The design shall accord with the dimensions and general arrangement including the location of fittings shown on the drawings. Nothing however shown on these drawings shall relieve the Contractor of his responsibility to produce a safe and satisfactory design.

12.1.4 The tanks shall be designed and constructed in accordance with BS EN 13923.

12.1.5 The use of storage tanks completely fabricated from high resistivity materials, such as synthetic polymers and GRP having a volume resistivity greater than 108 Ω.m and/or a surface resistivity greater than 1010 Ω.m is not recommended. Tanks should be manufactured from antistatic/conducting material or high resistivity materials that incorporate conducting elements which are in contact with the aviation product. The aviation product must be in contact with the conducting elements material, which shall be in contact with the earth. The conduction element shall be compatible for use with the aviation product.

12.1.6 Full details of the process fluid to be stored including its density and vapour pressure together with the design temperature shall be specified by the PM.

12.1.7 Aboveground GRP tanks are restricted to use on non-aviation Class III and Unclassified products.

12.1.8 Tanks shall be designed to resist loading due to self-weight, hydrostatic testing, wind and any other external loads. Consideration shall also be given to the ability of the GRP composite to withstand ultraviolet radiation; particularly for those tanks that will be positioned outdoors and not under cover. A minimum in-service life of the resins used in the tank construction shall be greater than 20 years.

12.1.9 Notwithstanding the number and size of vent connections shown on the Contract drawings it shall be the Contractor's responsibility to determine the appropriate size and number of venting nozzles in accordance with API 2000. The tank shall be designed for atmospheric pressure with free venting. The Contractor shall note the inflow and outflow rates as stated in the Annex A - Schedule, when determining the size of vents.

12.2 Fabrication Drawings

12.2.1 Fabrication drawings for the tanks shall be prepared and submitted to the PM before starting fabrication. The PM shall specify the timescale and number of drawings required. The drawings shall show full particulars of the tanks including the following:

(a) All nozzles and pipe connection details

(b) Method of fabrication

(c) Details of tank anchors

(d) Details and dimensions of manholes

12.3 Tank Testing

12.3.1 The test pressure shall be specified in the design calculations but shall not be less than 0.7 barg. The test pressure shall be measured at the top of the tank and shall be held whilst the tank is tested for leaks.

12.3.2 Tanks shall be hydrostatically tested at the factory and a factory test certificate issued to the PM.

12.3.3 Tanks shall be hydraulically tested once installed on site to a pressure as per section 12.3.1.

12.3.4 An adequate supply of clean fresh water shall be made available for testing.

12.3.5 Any faults identified during the tests shall be repaired to the satisfaction of the PM and the tank retested.

12.3.6 Pressure test certificates shall be supplied to the PM on completion of site testing. The PM may appoint an inspector to witness any or all the tests.

12.3.7 After testing the tank is to be emptied and internally dried out, cleaned and the water disposed of in accordance with current regulations.

12.4 Installation

12.4.1 The tank shall be installed on prepared foundations/piers as indicated on the drawings.

12.5 Earthing

12.5.1 The tank and its associated pipework, fittings and walkways should be in electrical contact with each other and with earth so that the resistance to earth at any point is less than 10 Ω (ohms). The earthing of each item shall be tested for electrical continuity and shall have a resistance to earth of no more than 10 Ω (ohms). Selection of tank materials, associated equipment materials and the system design shall comply with the guidelines of this Standard and the following Standards:

(a) Electrostatics: Code of Practice for Avoidance of Hazards due to Static Electricity – PD CLC/TR 50404

(b) Protection of structures against lightning - BS EN 62305

(c) Code of Practice for Earthing – BS 7430

(d) Model Code of Safe Practice for the Petroleum Industry: Part 1 Electrical Safety Code

12.6 Material Compatibility

12.6.1 All materials shall be subject to approval by DIO TS. Resins used in the construction of the tank shall remain unaffected by both product and additives. No significant deterioration of the material is acceptable over a 30-year life.

13.0 Semi-Buried, Concrete Encased, Vertical Steel Tanks

13.1 Design and Manufacture – General

13.1.1 The structural design and detailing of the steel tank and fittings shall be the responsibility of the appointed Contractor. The tank design shall accord with the general sizes and plate thickness, arrangements and layouts shown on the drawings and must also be compatible with the details of the reinforced concrete encasement shown on the drawings.

13.1.2 The design, detailing and construction of the steel tank and fittings shall be in accordance with BS EN 14015, except where otherwise indicated in this Standard or on the drawings.

13.1.3 The density and vapour pressure of the process fluid and the design temperature shall be specified by the PM.

13.1.4 The tank shall be designed as a low-pressure tank in accordance with BS EN 14015.

13.1.5 Design calculations shall be provided for the tanks. These shall be subject to an independent structural check on the design concept and calculations to be made by a suitably qualified and experienced professional engineer.

13.1.6 Copies of the design calculations and a certificate of structural adequacy in a form approved by the PM, and signed by the above professional engineer, shall be submitted to the PM before tank fabrication commences

13.1.7 The number of copies and lead time prior to fabrication shall be – specified by the PM.

13.2 Tank Bottom Design

13.2.1 Tank bottoms shall be conical with a uniform fall towards the centre of the tank of 1 in 20 (vertical to horizontal) for tanks of diameter up to and including 33 m and 1 in 50 (vertical to horizontal) for tanks of diameter greater than 33 m.

13.2.2 The layout and general arrangement of the floor plates shall be such as will ensure that water drains freely towards the centre of the tank and that the floor is generally self-draining.

13.2.3 Unless otherwise specified by the PM, the floor plates shall be lap welded throughout except for the joint between the floor and annular plates which shall be butt welded. The lap shall be welded top side only. A central sump shall be incorporated in the tank bottom to facilitate water draw-off and shall be designed in accordance with figure O.5 of BS EN 14015, using the alternative detail for connecting it to the main floor.

13.2.4 Detail drawings shall be provided of the concrete screed beneath the tank floor plates to show a pattern of drainage channels compatible with the choice of floor plate layout such that weld backing strips are positioned over the drainage channels. Drawings shall be forwarded to the PM before construction of the screed commences. The number of copies and lead time prior to construction shall be – specified by the PM.

13.3 Tank Roof Design

13.3.1 Tank roofs shall be designed in conjunction with tank roof columns to take account of the loads imposed by the concrete slab and earth cover, which is provided to give tank protection, together with any other equipment or structures located on the tank roof.

13.3.2 A conical tank roof shall be provided with a minimum fall of 1 in 100 (vertical to horizontal) from the centre to the outside. Cleats shall be welded to the roof plates to key into overhead concrete protection as shown on the drawings.

13.3.3 The tank roof columns shall be circular in cross section. Columns shall not be out of plumb by more than 6 mm – i.e. no point on a line on a column intended to vertical to be more than 6 mm away from a true vertical line.

13.3.4 Column end plates shall be circular, and all sharp corners and crevices eliminated to facilitate application of the coating. Column base plates and column cap plates shall be continuously welded to the tank floor and tank roof respectively.

13.3.5 All hollow columns shall be filled with grade C25 concrete leaving no voids. The specification for the concrete shall be specified by the PM.

13.4 Tank Wall Design

13.4.1 Tank walls shall be designed to withstand all concrete and earth pressures.

13.5 Connections and Attachments

13.5.1 The tank shall be provided with nozzles as shown on the drawings.

13.5.2 All nozzles and openings shall be reinforced in accordance with BS EN 14015. All nozzles shall be extended to pass through the concrete encasement.

13.5.3 Roof nozzles shall be terminated such that any attached fittings requiring protection remain below the level of the top of the mound in a well, formed within the mound and where necessary the concrete.

13.5.4 For details of tank fittings including tank manhole requirements see Section 10.

13.6 Earthing

13.6.1 Earthing bosses shall be provided at the upper end of each manhole nozzle. The tank and its associated pipework, fittings and walkways should be in electrical contact with each other

and with earth so that the resistance at any point to earth is less than 10 Ω (ohms). The earthing of each item shall be tested for electrical continuity and shall have a resistance to earth of no more than 10 Ω (ohms). Selection of tank materials, associated equipment materials and the system design shall comply with the guidelines of this specification and the following standards:

(a) Electrostatics: Code of Practice for Avoidance of Hazards due to Static Electricity – PD CLC/TR 50404

(b) Protection of structures against lightning: BS EN 62305

(c) Code of Practice for Earthing: BS 7430

(d) Cathodic Protection of Buried Metallic Tanks and Related Piping: BS EN 13636

(e) Model Code of Safe Practice for the Petroleum Industry: Part 1. Electrical Safety Code

13.7 Workmanship – Preparation of Plate and Members

13.7.1 The floor plates shall be shaped for the arrangements shown on fabrication detail drawings. Site cutting of closing plates shall be in accordance with agreed fabrication procedures.

13.7.2 Suitable external corrosion protection shall be applied to the underside of all tank bottom plates prior to assembly.

13.7.3 The edges of floor plates shall be prepared in accordance with agreed welding procedures. The tank shell and roof plates shall be prepared to the arrangements shown on the fabrication detail drawings. Tank floor plates shall follow the contours of the supporting concrete screed below, prior to welding of adjacent plates.

13.7.4 Approval for manual cutting of edges to be welded shall be obtained from the PM.

13.7.5 Ends of compression members shall be prepared at splices, caps, or bases for transmission of compressive stress. The butting faces shall be in contact over the required area. Preparation shall be carried out by machining or other approved means.

13.7.6 A marking drawing shall be prepared, and all steel marked to indicate its position in the structure to assist erection.

13.7.7 A weld procedure shall be prepared for butt joints in base plates and submitted to the PM for approval.

13.7.8 All burrs and sharp edges shall be removed by hand-grinding.

13.8 Workmanship – Tank Floor

13.8.1 The internal drainage fall to the centre sump shall not be impaired and should this occur proposals shall be submitted to the PM for correcting such faults.

13.8.2 The drain sump shall be shop fabricated and shop tested to the satisfaction of the PM.

13.8.3 Shop testing shall include subjection of all welds to dye penetrant NDT examination.

13.8.4 The bottom plates shall not be bolted or otherwise permanently fixed to the concrete floor slab.

13.9 Workmanship – Tank Roof

13.9.1 Internal supports shall be pre-loaded as required by the PM to ensure that base plates under supports are in direct contact with concrete screed below.

13.9.2 Plate laps and nozzles shall be seal welded on the underside of the roof before applying either internal or external surface treatment.

13.10 Workmanship – Tank Walls/Encasement

13.10.1 The PM shall be furnished with full details of the proposed methods for protection of the shell during erection, prior to the commencement of construction.

13.10.2 All temporary works necessary to support the steel tank during casting of the concrete jacket shall be designed and provided.

13.10.3 Vertical tank concrete encasement shall not commence, to the shell of the tank, until the internal column support bases and perimeter wall of the tank have been shown to be in direct contact with supporting screed below. The tanks shall be filled with water for hydraulic testing before pouring the concrete encasement and the water retained in the tank for at least for three days curing following the pouring of concrete.

13.11 Workmanship – Welding

13.11.1 This section of the Specification shall be read as supplementary to BS EN 14015 such that sections within this Specification form additions to the requirements.

13.11.2 All necessary welding plant and equipment required for this work, welding consumables, labour, supervision and facilities for testing and inspection, including provision of a suitably qualified independent welding inspector shall be provided.

13.11.3 A competent representative shall be designated, with whom the PM and the independent welding inspector may communicate. The representative shall be familiar with all phases of the fabrication and administration. Competent supervisors shall be employed to ensure that both the quality of the materials used, and the standard of workmanship comply with the specified standards.

13.11.4 Only qualified craftsmen shall be employed to perform any aspect of the work including testing were required. Any craftsman considered by the PM to be unsuitable shall be removed from the task.

13.11.5 Prior to commencement of inspections by the Contractor, documentary evidence of the independent welding inspector qualifications and details of his employing Engineering / Insurance Company shall be submitted to the PM for checking, (with the appropriate

testing body), and approval. The independent welding inspector shall be competent in this type of work with a minimum of 3 years welding inspection experienced and qualified to CSWIP (Certification Scheme for Weldment Inspection Personnel), PCN (Personnel Certification in Non-destructive Testing) or equal and approved certification scheme.

13.11.6 The PM and the independent welding inspector shall be informed before making any repairs to welds where defects have been found.

13.11.7 Before accepting delivery of any plate, pipe, fittings, or other materials of construction to be welded, all such items shall be inspected for damage, defects and dimensional tolerances and responsibility accepted for ensuring that all such materials are suitable for satisfactory welding.

13.11.8 Unless approved otherwise by the PM, welding shall only be by the manual metal-arc or the submerged arc process. Welding procedures shall comply with the following requirements:

(a) Approval shall be obtained for the following documentation prior to commencement of the part of the fabrication to which the procedure applies:

(i) Welding procedures for each feature of the welding

(ii) Weld repair procedures

(iii) Where required procedures and reporting systems for NDT (visual, radiographic, ultrasonic and magnetic particle)

Note. The PM shall specify the documentation and timescale requirements.

(b) Efficient weather shielding shall be provided to protect each welding site from rain and wind and prevent water from running into the welding area. No welding of any kind shall be performed when the surfaces of the parts to be welded are wet from rain, snow or ice; when rain or snow is falling on such surfaces, or periods of high winds, unless the welder and work are properly shielded

(c) Tools and equipment shall be provided in good operating condition and of a capacity suited for the work

13.11.9 Documentation shall comply with the following requirements:

(a) Where inspection is to be carried out by the Contractor, documentary evidence shall be submitted of inspector qualifications for approval prior to commencement of such inspection

(b) Following completion of any part of the works, copies of all non-destructive test reports shall be supplied to the PM. The PM shall specify the number of copies required

13.11.10 Welding Materials shall comply with the following requirements:

(a) Electrodes wires and fluxes shall be selected to produce welds with mechanical properties not inferior to and chemical properties equal to those for the base material

(b) Approval of proposed electrodes shall be obtained in advance of welding

(c) Storage, baking and issue of electrodes shall be strictly in accordance with the manufacturer's recommendations. A procedure shall be provided, for approval, dealing with the receipts, storage, baking and issue of welding consumables

(d) Any consumables which are unmarked, or which show signs of deterioration shall be discarded

(e) Electrodes shall be supplied in clearly identified hermetically sealed containers

13.11.11 Welding Standard shall be in accordance with BS EN 14015 and as augmented in the Specification.

13.11.12 Qualification of welding procedures shall comply with the following requirements:

(a) Details of procedures shall be provided in a form approved by the PM

(b) Approval of each welding procedure shall be obtained before commencing production welding using that procedure

(c) Electroslag and electrogas processes shall not be used

(d) A separate sheet shall be submitted with the welding procedures clearly detailing the sequence in which the joints are to be welded. Once approved this sequence shall be strictly adhered to

13.11.13 Qualification of Welders shall comply with the following requirements:

(a) Only qualified welders shall carry out welding. Prequalified welders from past projects are not acceptable

(b) All welder qualification tests shall be witnessed by the PM and the independent welding inspector

(c) Welders required to make only fillet welds shall successfully complete a fillet weld test

Note. The test plate and fillet size shall be not less than the maximum shell plate thickness and fillet leg length for which the welder is to be qualified. The test shall be carried out on a plate for a minimum length of 300 mm. The acceptance shall be assessed on visual examination and two macros samples. The test shall be rejected if the macro samples show cracks, lack of fusion, lack of penetration, undercut or poor profile.

13.11.14 Requalification of welders shall be in accordance with the following requirements:

(a) In addition to the requirements of BS EN 14015 requalification of welders shall be carried out if any of the following applies.

(i) The standard of workmanship is below the requirement
(ii) There is a change in the electrode coating type/trade name
(iii) There is a change in the welding position
(iv) There is a change from vertical up to vertical down or vice versa
(v) There is a change in polarity
(vi) There is a change in process

13.11.15 Following Tank Production Welding all manual oxygen cut edges shall be dressed to a smooth clean profile by hand-grinding. Undercuts for horizontal butt joints or fillet welds shall not exceed 0.5 mm.

13.11.16 Preheating shall be in accordance with BS EN 1011 parts 1 and 2. In addition, where the parent metal temperature is lower than 0˚C, the surfaces on both sides of the joint shall be preheated to 50˚C.

13.11.17 Distortion control during tank production welding shall comply with the following requirements:

(a) Welding of floor plates shall use manual metal arc or submerged arc welding or other approved low distortion control method and shall be in accordance with the welding procedure

(b) Shell and roof plates shall be welded strictly in accordance with the approved welding procedure

(c) Temporary attachments shall be provided to ensure plate joint alignment and level prior to commencement of any weld

(d) The gap between adjacent plates to be welded shall not exceed tolerances permitted within the approved welding procedures

(e) Plate distortion shall be monitored as work proceeds, and reports made to the PM of any apparent distortion which would prevent achievement of satisfactory floor drainage or direct contact with concrete base under supports.

(f) Any area exhibiting distortion which does not meet the requirements regarding floor drainage and direct contact with concrete base under supports shall be repaired at no additional cost to the Authority

13.11.18 Welding Inspection of tanks shall be co-ordinated so that all inspection work is carried out before the weld areas are painted or covered. Before inspections each completed joint shall be thoroughly cleaned.

13.11.19 The PM and the independent welding inspector will carry out the interpretation of NDT

work covered by this subsection.

13.11.20 Such facilities and attendance will be provided (including affording adequate prior notice) as may reasonably be required to enable the PM and the independent welding inspector to:

(a) Carry out his inspection duties as described in this sub-section

(b) Check the welding techniques and materials being used or to be used

(c) Be satisfied that all welders employed are sufficiently competent and experienced in and qualified for the type of work to be done

(d) Examine the joints before and during welding

(e) Inspect the finished work using visual techniques

(f) Witness the appropriate final tests

13.11.21 As a minimum level of inspection there is a requirement to:

(a) Carry out all inspections called for in BS EN 14015, read in conjunction with this sub-section employing specialist personnel expert in inspection techniques for the work and supplying all necessary inspection equipment. The inspectors employed shall be suitably qualified in the following techniques:

(i) Visual examination
(ii) Radiographic interpretation
(iii) Magnetic particle examination
(iv) Ultrasonic examination
(v) Dye penetrant examination

(b) To obtain approval of all qualification certificates

(c) To appoint a chief inspector to liaise with the PM and the independent inspector and to organise the inspectors so that they carry out their duties in an efficient manner and to prepare all necessary reports

(d) To examine production welds by NDT methods of examination in accordance with BS EN 14015, and with the additional requirements specified in this sub-section including the carrying out of radiography and ultrasonic examinations

(e) To examine all areas where temporary attachments have been removed by magnetic particle inspection

13.11.22 Radiography shall be carried out in accordance with the following requirements:

(a) A supervisor shall be employed to supervise all radiography

(b) A radiography procedure shall be submitted to the PM and the independent welding inspector in sufficient time to gain approval. The radiography procedure shall be

accompanied by radiographs of sample welds of a quality sufficient to achieve approval

(c) The approval of the radiography procedure shall be obtained before the commencement of production welding. X-radiography techniques only shall be used

13.11.23 The Contractor shall carry out ultrasonic testing of 25% (based on linear measurement) of the welds in the tank floor and shall provide certified records of all testing undertaken.

13.12 Tank Testing

13.12.1 Tanks shall be tested in accordance with BS EN 14015; section 19 and all testing shall be carried out before external painting and concrete encasement. Pneumatic testing of reinforcing plates shall be carried out in accordance with BS EN 14015 section 19

13.12.2 The vacuum box method shall be used for testing the tank bottom weld seams.

13.12.3 An adequate supply of fresh clean water shall be provided for the purpose of testing. The water supply shall be maintained in a clean and un-contaminated condition within the tanks during testing and all necessary provisions for the safe disposal of the water shall be made on completion.

13.12.4 The Contract programme should consider the time required for tank filling. Before tank filling operations are commenced, adequate provisions shall be made for the safe disposal of the water in the event of the tank needing to be off loaded rapidly in an emergency.

13.12.5 Water filling operations shall be carried out in the following manner:

(a) Fill tank to half capacity at the agreed rate per hour

(b) Check levels to ensure no uneven settlement is occurring

(c) Continue to fill tank to ¾ capacity

(d) Check levels to ensure no uneven settlement is occurring

(e) Fill tank to full capacity

(f) Check levels remain constant for at least 48 hours.

13.12.6 Before any testing operations are started, detailed hydrostatic test procedures shall be provided to the PM.

13.12.7 At least eight equi-spaced reference points around the perimeter of the tank shall be established, clearly marked, and recorded for load/settlement purposes. The reference points shall be approved by the PM.

13.12.8 Levels shall be recorded at each reference point against a known datum during each stage of filling and shall be submitted to the PM for approval.

13.12.9 At all stages during tank water testing, the plumbness of the shell shall be such that at no point shall the top and bottom of the shell be out of plumb by more than 1/200 of the total shell height.

13.12.10 In the event of uneven settlement or leakage occurring, the water filling shall be stopped immediately and reported to the PM. With the PM's approval, the emergency procedures shall be implemented.

13.13 Paintings/Coatings

13.13.1 Protective linings are to be applied to 100% of the interior metal surfaces of all storage tanks, unless fabricated from stainless steel, that are used to direct deliver aviation turbine fuel (AVTUR) and aviation gasoline fuel (AVGAS) on the Defence Estate.

13.13.2 The internal coating to be applied shall conform to the requirements of EI/JIG Standard 1530 and EI 1541. The following table, adapted from EI/JIG 1530, specifies the minimum internal coating requirement where 100% internal coating cannot be achieved.

Note. The MoD interprets the term "direct deliver" as meaning 'where an aviation fuel storage tank direct delivers via a FWS into a dedicated bowser, refuelling rig, pipeline, hydrant and any other means of delivering fuel to an aircraft'.

Operating Scenario	Minimum Internal Lining Requirement
New storage tanks used to direct deliver aviation fuels	Lining of the tank bottom and the first 1.0 m of the walls
Existing storage tanks used to direct deliver aviation fuels	Lining of the tank bottom and the first 1.0 m of the walls. If not lined – OAs should consider upgrading as soon as practicable
Existing storage tanks that are to be repurposed to direct deliver aviation fuels	Lining of the tank bottom and the first 1.0 m of the walls
Existing storage tanks used to store aviation fuels but do not direct deliver	OAs should consider the benefits of lining

Note. The following non-ferrous materials must not constitute any part of the lining application:

(a) Zinc, zinc rich compounds and alloys containing zinc

(b) Lead and alloys containing lead

(c) Copper and alloys containing 4% and above copper

(d) Cadmium and its compounds

13.13.3 After tack welding of backing strips but prior to fitting up and welding, the underside of the tank bottom plates and the exterior surfaces of the sump shall be prepared and painted in accordance with the following requirements leaving unpainted margins at weld locations as necessary.

(a) The surfaces to be painted shall be clean, dry, and free from rust. A priming coat of zinc phosphate primer is to be applied, followed by two coats of High Build Bituminous Paint with a minimum thickness of 125 microns per coat

13.13.4 After tank erection and satisfactory completion of tank testing, the exterior surfaces of the roof plates, shell plates and all associated external mountings, and other steelwork shall be prepared and painted in accordance with the following requirements:

(a) The surfaces to be painted shall be clean, dry, and free from rust. A priming coat of zinc phosphate primer is to be applied, followed by two coats of High Build Bituminous Paint with a minimum thickness of 125 microns per coat

13.14 Cleaning

13.14.1 On completion of coating and other internal work, the interior of the tank shall be left clean, dry, free from foreign objects and in all other respects fit to receive fuel.

14.0 Unprotected Vertical Steel Tanks

14.1 Design and Manufacture – General

14.1.1 The structural design and detailing of the steel tank and fittings shall be the responsibility of the Contractor. The tank design shall accord with the general sizes and plate thickness, arrangements and layouts shown on the drawings. Nothing however shown therein shall relieve the Contractor of his responsibility to produce a safe and satisfactory design.

14.1.2 The design, detailing and construction of the steel tank and fittings shall be in accordance with the requirements of BS EN 14015 except where otherwise indicated in this specification or on the drawings.

14.1.3 The density and vapour pressure of the process fluid and the design temperature shall be specified by the PM.

14.1.4 The tank shall be designed as a low-pressure tank in accordance with table 3 of BS EN 14015.

14.1.5 Design calculations shall be prepared for the tanks by a suitably qualified professional engineer. Design calculations in a form approved by the PM shall be supplied. The number of copies and lead time prior to fabrication shall be specified by the PM.

14.2 Tank Bottom Design

14.2.1 Tank bottoms shall be conical with a uniform fall towards the centre of the tank of 1 in 20 (vertical to horizontal) for tanks of diameter up to and including 33 m and 1 in 50 (vertical to horizontal) for tanks of diameter greater than 33 m.

14.2.2 The tank bottom plates shall be lapped in such a manner that ensures that water drains freely towards the centre of the tank and that the tank floor is generally self-draining.

14.2.3 A central sump shall be incorporated in the tank bottom to facilitate water draw-off and be designed in accordance with figure 0.5 – alternative arrangement: BS EN 14015.

14.3 Tank Roof Design

14.3.1 A conical tank roof shall be provided with a fall of 1 in 5 (vertical to horizontal) from the centre to the outside. Roof plates shall be lapped and welded on the inside and the outside.

14.3.2 The roof shall be designed as a self-supporting structure.

14.4 Connections and Attachments

14.4.1 The tank shall be provided with nozzles and openings as shown on the drawings.

14.4.2 All nozzles and openings shall be reinforced in accordance with BS EN 14015 and have at least one tapped hole 6 mm diameter for inspection purposes.

14.4.3 For details of tank fittings including tank manhole requirements see Section 10.

14.5 Earthing

14.5.1 The number of earthing bosses required shall be specified by the PM, and these shall be spaced symmetrically around the tank shell.

14.5.2 The tank and its associated pipework, fittings and walkways should be in electrical contact with each other and with earth so that the resistance at any point is less than 10 Ω (ohms). The earthing of each item shall be tested for electrical continuity and shall have a resistance to earth of no more than 10 Ω (ohms).

14.5.3 Selection of tank materials, associated equipment materials and the system design shall comply with the guidelines of this specification and the following standards:

(a) Electrostatics: Code of Practice for Avoidance of Hazards due to Static Electricity – PD CLC/TR 50404

(b) Protection of structures against lightning - BS EN 62305

(c) Code of Practice for Earthing – BS 7430

(d) Cathodic Protection of buried Metallic tanks and Related Piping - BS EN 13636

(e) Model Code of Safe Practice for the Petroleum Industry: Part 1. Electrical Safety Code

14.6 Workmanship – Preparation of Plate and Members

14.6.1 The floor plates shall be shaped for the arrangement shown on the Contractor's fabrication detail drawings. Site cutting of closing plates shall be in accordance with agreed fabrication procedures.

14.6.2 External protection shall be applied to the underside of all bottom plates prior to assembly.

14.6.3 All burrs and sharp edges arising shall be removed by hand-grinding.

14.7 Workmanship – Tank Floor.

14.7.1 The internal drainage fall to the centre sump shall not be impaired and should this occur, proposals shall be submitted to the PM for correcting such faults.

14.7.2 The drain sump shall be shop fabricated and shop tested to the satisfaction of the PM.

14.7.3 Shop testing shall include subjection of all welds to dye penetrant examination.

14.8 Workmanship – Tank Roof

14.8.1 Plate laps and nozzles shall be seal welded on the underside of the roof before applying either internal or external surface treatment.

14.9 Workmanship – Tank Shell

14.9.1 The PM shall be furnished with full details of his proposed method for the protection of the tank shell during erection. The following factors shall be considered when determining the suitability of the proposed method of protection:

(a) Tank size

(b) Location and degree of exposure to wind loads

(c) Construction method

(d) Number and type of key plate equipment

(e) Availability of reliable meteorological data during periods of erection

14.9.2 The use of steel wire guys or cables may not necessarily be adequate and consideration should be given to the use of temporary wind girders.

14.10 Workmanship – Welding

14.10.1 This section of the specification shall be read as supplementary to BS EN 14015 such sections within this specification form additions to the requirements.

(a) All necessary welding plant and equipment required for this work, welding consumables, supervision and facilities for testing and inspection, including provision of a suitably qualified independent welding inspector, shall be provided by the Contractor

(b) A competent representative shall be designated with whom the PM may communicate. The representative shall be familiar with all phases of the fabrication and administration. Competent supervisors shall be employed to ensure that both the quality of the materials used, and the standard of workmanship comply with the specified standards

(c) Only qualified craftsmen shall be employed to perform any aspect of the work including testing where required. Any craftsman considered by the PM to be unsuitable, shall be removed from the task

(d) Prior to commencement of inspections by the Contractor, documentary evidence of the independent welding inspector qualifications and details of his employing Engineering/Insurance Company, shall be submitted to the PM for checking (with the appropriate testing body), and approval. The independent welding inspector shall be competent in this type of work with a minimum of 3 years welding inspection experience and be qualified to CSWIP (Certification Scheme for Weldment inspection Personnel), PCN (Personnel Certification in Non-Destructive Testing) or equal and approved certification scheme

14.10. 2 The PM and the independent welding inspector shall be informed before repairs are made to welds where defects have been found.

14.10.3 Procedure and welder qualification tests shall be carried out in accordance with the sections which follow:

(a) Before accepting delivery of any plate, pipe, fittings, or other materials to be welded, all such items shall be inspected for damage, defects and dimensional tolerances and responsibility accepted for ensuring that all such materials are suitable for satisfactory welding.

14.10.4 Unless approved otherwise by the PM, welding shall only be by the manual metal-arc or the submerged-arc process. Welding procedures shall comply with the following requirements:

(a) Approval shall be obtained for the following documentation prior to commencement of the part of the fabrication applies:

(i) Welding procedures for each feature of the welding
(ii) Welding repair procedures
(iii) Where required procedures and reporting systems for non-destructive testing (visual, radiographic, ultrasonic, and magnetic particle)

(b) Efficient weather shielding shall be provided to protect each welding site from rain and wind and prevent water from running into the welding area

(c) Tools and equipment shall be provided in good operating condition, be well maintained and of a capacity suited for the work

14.10.5 No welding of any kind shall be performed when the surfaces of parts to be welded are wet from rain, snow or ice; when rain or snow is falling on such surfaces, or periods of high winds, unless the welder and work are properly shielded.

14.10.6 Documentation shall comply with the following requirements:

(a) Where inspection is to be carried out by the Contractor, documentary evidence shall be submitted of inspector qualifications for approval prior to commencement of such inspection

(b) Following completion of any part of the works, copies of all non-destructive test reports shall be supplied to the PM.

14.10.7 Welding materials shall comply with the following requirements:

(a) Electrodes, wires, and fluxes shall be selected to produce welds with mechanical properties not inferior to, and chemical properties equal to those for the base material

(b) Approval of proposed electrodes shall be obtained in advance of welding

(c) Storage, baking and issue of electrodes shall be strictly in accordance with the manufacturer's recommendations. A procedure shall be provided, for approval, dealing with the receipt, storage, and issue of welding consumables.

(d) Any consumables which are unmarked, or which show signs of deterioration shall be discarded responsibly

(e) Electrodes shall be supplied in clearly identified hermetically sealed containers

14.10.8 Welding standards shall be in accordance with the requirements of BS EN 14015 as augmented in the specification.

14.10.9 Qualification of welding procedures shall comply with the following requirements:

(a) Details of procedures shall be provided in a form approved by the PM

(b) Approval of each welding procedure shall be obtained before commencing production welding using that procedure

14.10.10 Electroslag and electrogas processes shall not be used.

14.10.11 A separate sheet shall be submitted with the welding procedure, clearly detailing the sequence in which the joints are to be welded. Once approved this sequence shall be strictly adhered to.

14.10.12 Qualification of welders shall comply with the following requirements:

(a) Only qualified welders shall carry out production welding. Prequalified welders from past projects are not acceptable

(b) All welder qualification tests shall be witnessed by the PM and the independent welding inspector

(c) Welders required to make only fillet welds shall successfully complete a fillet weld test. The test plate and fillet size shall be not less than the maximum shell plate thickness and fillet leg length for which the welder is to be qualified. The test shall be carried out on a plate for a minimum length of 300 mm

(d) The acceptance shall be assessed on visual examination and two macro samples. The test shall be rejected if the macro samples show cracks, lack of fusion, lack of penetration, undercut or poor profile

14.10.13 Requalification of welders shall be in accordance with the following requirements:

(a) In addition to the requirements of BS EN 14015, requalification of welders shall be carried out if any of the following applies.

(i) The standard of workmanship is below the requirement
(ii) There is a change in the electrode coating type /trade name
(iii) There is a change in the welding position
(iv) There is a change from vertical up, to vertical down or vice versa
(v) There is a change in polarity
(vi) There is a change in the process

14.10.14 Following tank production welding, all manual oxygen cut edges shall be dressed to a smooth clean profile by hand-grinding. Undercut for horizontal butt joints or fillet welds shall not exceed 0.5 mm.

14.10.15 Preheat shall be in accordance with BS EN 14015 and BS EN 1011 parts 1 and 2. In addition, where the parent metal temperature is lower than 0˚C, the surfaces on both sides of the joint shall be preheated to 50˚C.

14.10.16 Distortion control during tank production welding shall be in accordance with BS EN 14015. In addition, prior to the commencement of tank erection the contractor shall provide a document detailing all the measures that will be taken to avoid tank distortion. This will include erection sequences and methods, welding sequences, on-site dimensional control, and supervision. Welding inspection of tanks shall be co-ordinated so that all inspection work is carried out before the weld areas are painted or covered over.

14.10.17 Before inspection, each completed joint shall be thoroughly cleaned.

14.10.18 The PM and the independent welding inspector will carry out the interpretation of NDT work covered by this sub-section. The contractor shall carryout all specified NDT work.

14.10.19 Inspection by the PM and the independent welding inspector shall not relieve the contractor of his responsibility to produce materials and workmanship capable of meeting all proving / commissioning tests and of performing satisfactorily in service.

14.10.20 The contractor shall provide such facilities and attendance (including affording adequate prior notice) as may reasonably be required to enable the PM and the independent welding inspector to carry out the following inspection activities:

(a) Check the welding techniques and materials being used or to be used

(b) Satisfy themselves that all welders employed are sufficiently competent and experienced and qualified for the type of work to be done

(c) Examine the joints before and during welding

(d) Inspect the finished work using visual techniques

(e) Witness the appropriate final tests

14.10.21 The inspection duties to be carried out by the contractor shall include (but shall not be limited to) the following:

(a) To carry out all inspections called for in BS EN 14015, read in conjunction with this sub-section employing specialist personnel expert in inspection techniques for the work and

supplying all necessary inspection equipment. The inspectors employed shall be suitably qualified in the following techniques:

(i) Visual examination
(ii) Radiographic interpretation
(iii) Magnetic particle examination
(iv) Ultrasonic examination
(v) Dye penetrant examination

(b) To obtain approval of all qualification certificates

(c) To appoint a chief inspector to liaise with the PM and organise the inspectors so they carry out their duties in an efficient manner and to prepare all necessary reports

(d) To examine production welds by non-destructive methods of examination in accordance with BS EN 14015 and with additional requirements specified in this sub-section, including the carrying out of radiography and ultrasonic examinations

(e) To examine all areas where temporary attachments have been removed, by magnetic particle inspection

14.10.22 Radiography shall be carried out in accordance with the following requirements:

(a) A supervisor shall be employed by the contractor to supervise all radiography

(b) A radiography procedure shall be submitted to the PM and the independent welding inspector in sufficient time to gain approval. The radiography procedure shall be accompanied by radiographs of sample welds of a quality sufficient to achieve approval

(c) The approval of the radiography procedure shall be obtained before commencement of production welding. X- radiography techniques only shall be used

14.11 Tank Testing

14.11.1 A comprehensive hydraulic test procedure shall be provided by the contractor and agreed with the PM.

14.11.2 The test procedure shall specify, maximum filling rate, hold periods, normal and emergency emptying details, method of settlement measurement, limits for differential and maximum settlement of foundations.

14.11.3 Tanks shall be tested in accordance with BS EN 14015 section 19. Pneumatic testing of reinforcing plates is required and shall be carried out in accordance with BS EN 14015 section 19.

14.11.4 The vacuum box method shall be used for testing the tank bottom seams. Fresh clean water shall be provided for the purpose of testing, maintain the water supply in a clean and un-contaminated condition within the tanks during testing and make all necessary

provisions for the safe disposal of the water on completion of testing. If fresh water is not available, sea water or brackish water may be used. However, the tank internal surfaces must be jetted clean with fresh water on completion of test and draining down.

14.11.5 Before tank filling operations are commenced, adequate provisions shall be made for the safe disposal of water in the event of the tank needing to be off loaded rapidly in an emergency.

14.11.6 If the ambient temperature is equal to or below 0˚C, the necessary measures are to be taken to avoid freezing.

14.11.7 The contract programme shall consider the time required for tank filling.

14.11.8 Water filling operations shall be carried out in the following manner:

(a) Fill tank to half capacity at the agreed rate per hour

(b) Check levels to ensure no uneven settlement is occurring

(c) Continue to fill tank to ¾ capacity

(d) Check levels to ensure no uneven settlement is occurring

(e) Fill tank to full capacity

(f) Check levels remain constant for at least 48 hours

14.11.9 At least eight equi-spaced reference points around the perimeter of the tank shall be established, clearly marked, and recorded for load/settlement purposes. The reference points shall be approved by the PM.

14.11.10 Levels shall be recorded of each reference point against a known datum during each stage of filling and shall be submitted to the PM for approval.

14.11.11 At all stages during the tank testing, the plumbness of the shell shall be such that at no point the top and bottom of the shell be out of plumb by more than 1/200 of the total shell height.

14.11.12 In the event of uneven settlement or leakage occurring, the water filling shall be stopped immediately and reported to the PM. Previously agreed procedures shall then be put into operation.

14.11.13 No connections shall be made to the tank, other than those required for filling and emptying of test water, until the tank has been successfully tested.

14.12 Painting/Coating

14.12.1 Protective linings are to be applied to 100% of the interior metal surfaces of all storage tanks, unless fabricated from stainless steel, that are used to direct deliver aviation turbine fuel (AVTUR) and aviation gasoline fuel (AVGAS) on the Defence Estate.

14.12.2 The internal coating to be applied shall conform to the requirements of EI/JIG Standard 1530 and EI 1541. The following table, adapted from EI/JIG 1530, specifies the minimum internal coating requirement where 100% internal coating cannot be achieved.

Note. The MoD interprets the term “direct deliver” as meaning ‘where an aviation fuel storage tank direct delivers via a FWS into a dedicated bowser, refuelling rig, pipeline, hydrant and any other means of delivering fuel to an aircraft’.

Operating Scenario	Minimum Internal Lining Requirement
New storage tanks used to direct deliver aviation fuels	Lining of the tank bottom and the first 1.0 m of the walls
Existing storage tanks used to direct deliver aviation fuels	Lining of the tank bottom and the first 1.0 m of the walls. If not lined – OAs should consider upgrading as soon as practicable
Existing storage tanks that are to be repurposed to direct deliver aviation fuels	Lining of the tank bottom and the first 1.0 m of the walls
Existing storage tanks used to store aviation fuels but do not direct deliver	OAs should consider the benefits of lining

Note. The following non-ferrous materials must not constitute any part of the lining application:

(a) Zinc, zinc rich compounds and alloys containing zinc

(b) Lead and alloys containing lead

(c) Copper and alloys containing 4% and above copper

(d) Cadmium and its compounds

14.12.3 After tack welding of any backing strips, but prior to fitting and welding, the underside of the tank bottom plates and exterior surfaces of the sump shall be prepared and painted in accordance with the following requirements leaving unpainted margins at weld locations as necessary.

(a) The surfaces to be painted shall be clean, dry, and free from rust. A primer coat of zinc phosphate primer is to be applied, followed by two coats of High Build bituminous paint with a minimum DFT of 125 microns per coat.

14.12.4 After tank erection and satisfactory completion of tank testing, the exterior surfaces of the roof plates, shell plates and all associated external mountings, and other steelwork shall be prepared and painted in accordance with the following requirements:

Surface Preparation	Abrasive blast clean to BS 7079 Sa 2½
Primer coat	Alkyl Zinc Silicate Min DFT - 75 microns
Intermediate Coat	High build, epoxy sealer Min DFT - 75 microns
Finish Coat	High build, aliphatic polyurethane Min DFT - 75 microns
Colour	Specified by the PM

Note. Further guidance on appropriate external coating systems and coating repairs can be found in EEMUA 159 Section C5.

14.13 Cleaning

14.13.1 On completion of coating and other internal work, the interior of the tank shall be left clean, dry, free from foreign objects and in all other respects, fit to receive, store and direct deliver fuel.

15.0 Prevention of MATTE & Environmental Risk Tolerability Studies

15.1 Introduction

15.1.1 The root causes and lessons learned from the fire and explosion at Buncefield were documented extensively by the EA in 2008 and HSE in 2011. However, soon following the investigation into the incident, it become apparent that the subsequent implementation of enhanced control measures when upgrading existing petroleum terminals, refineries and storage depots, represented a significant cost to TLBs and chief executives.

15.1.2 The COMAH Competent Authority (HSE) felt that the matter of environmental risk tolerability was a fundamental issue that needed resolving. In that, when determining the SIL of an overfill protection system or considering the adequacy of combined primary, secondary and tertiary containment measures, there was a need to consider risk targets/tolerability when determining if sufficient work had been done to not only mitigate safety risks to ALARP, but also those that posed a major accident threat to the environment (MATTE).

15.1.3 The MoD is not regulated by the HSE regarding its compliance with COMAH; that responsibility is held by the Defence Ordnance, Munitions & Explosives (OME) Safety Regulator (DOSR). The DOSR TL's authority and responsibilities is delegated by the Director General of the DSA. DOSR regulates OME in the MoD in accordance with the Secretary of State's Policy Statement in order to maintain a regulatory regime based on compliance with the Major Accident Control Regulations (MACR) DSA 03-OME Part 4.

15.1.4 Effective from October 2019, DSA 03-OME Part 4 sets out the MACR requirements for the MoD. MACR implements arrangements to achieve results at least as good as those achieved by non-MOD COMAH sites. MACR discharges that policy in the context of prevention of a Major Accidents (MA) and the mitigation of consequences to human health and or the environment should one occur.

15.1.5 The Chemicals and Downstream Oil Industries Forum (CDOIF) was established in 1997 and its core aim is to inform regulatory and industry approaches to issues affecting the health and safety of people, sustainability and the environment. In 2010, CDOIF formed a WG, comprising industry leaders, engineering institutions and Regulators, which assessed potential MATTEs with the intention of developing an environmental risk screening tool. In brief, the work included:

(a) Developing an approach to classifying different levels of MATTE consequence based on extent, severity and duration of recovery

(b) Providing risk criteria to be used in assessing the tolerability of the environmental risk

(c) Developing guidance on how risks may be evaluated

15.2 CDOIF Guideline – Environmental Risk Tolerability

15.2.1 The guideline was published in 2013 and it sets out a screening methodology for assessment of environmental risk within the ALARP framework. In summary the guideline provides:

(a) A clear definition of the types of harm that should be considered in an environmental risk assessment, and how the harm should be characterised for the assessment

(b) A definition of the risk criteria to be used in assessing the tolerability of the environmental risk from an establishment and, where appropriate, individual scenarios

(c) Guidance on how risks may be evaluated

(d) Guidance on how to include the cost of environmental harm in a MAH cost benefit analysis

15.2.2 The CDOIF WG decided that the environmental risk tolerability should be based on the risk posed to a specific receptor from all MATTE scenarios at a single establishment that could impact that receptor. The assessment requires the identification of the hazards that will result in a MATTE and the process involves:

(a) Identification and evaluation of 'source-pathway-receptor' linkages for different credible scenarios. This includes demonstrating an understanding of the hazards of the establishment and the sensitivities of the environment

(b) Identification of tolerability criteria for relevant receptors, dependent on the receptor type and potential level of consequence to the receptor

(c) Evaluation of risks to the receptor, through examination of accident scenarios (their consequences and frequency) and comparing this to the tolerability criteria derived above

15.2.3 In summary the process adopted to produce the guideline has delivered guidance on many aspects including:

(a) A screening methodology, which can be used by operators, without the need for potentially expensive third-party input

(b) MATTE threshold definitions and a range of MATTE consequences based on extent/severity and duration of harm

(c) Details of risk assessment and CBA methodology, with greater clarity placed on the assessment of risk at new and existing establishments

15.2.4 It follows that for either new-build, refurbishment or remediation of petroleum installations on the MOD Estate, PMs and Contractors are to consider the environmental impact of their proposed works. Irrespective of whether or not the site is MACR designated, this requirement shall apply to all sites where petroleum products are stored in bulk.

15.2.5 As a minimum requirement for MACR designated sites, PMs and their Contractors should ensure that the guidance in DSA 03-OME Part 4 , Chapter 6, *Major Accident Control Regulations – Environmental Risk Assessment,* is followed when producing an environmental risk assessment associated with the carrying-out of works on petroleum installations located on the MOD Estate.

16.0 Overfill Protection

16.1 Layers of Protection and SIL Analysis

16.1.1 A Layers of Protection Analysis (LOPA) and Safety Integrity Level (SIL) Risk Analysis for overfill protection shall be conducted in accordance with the IEC 61511 standard.

The various measures for prevention and mitigation of major accidents may be thought of as 'layers of protection' (LOPs). These lines or layers serve to either prevent an initiating event (such as overfilling of a storage tank, for example) from developing into an incident (typically a release of a dangerous substance), or to mitigate the consequences of an incident once it occurs. An analysis of these LOPs should be conducted for each installation.

16.1.2 The results of the LOPA can then be used to assign a SIL rating. Each SIL is to be protected against by a Safety Instrumented Function (SIF) and is calculated without the beneficial risk reduction effect of the SIF. The unmitigated risk is then compared against a tolerable risk target. If the difference between the unmitigated risk and the tolerable risk is higher than tolerable, this must be addressed through risk reduction of the SIF. Each order of magnitude of risk reduction that is required correlates with an increase in one of the required SIL numbers.

16.1.3 Further guidance on the application of the LOPA process can be found in Appendix 2 of HSE Safety and environmental standards for fuel storage sites - Process Safety Leadership Group Final report.

16.2 Automatic Tank Gauging

16.2.1 Automatic tank gauging systems are installed at OFDs, PSDs and aviation BFIs. They comprise field and control room equipment to monitor fluid parameters to ensure that an accurate method of stock control can be achieved for accounting purposes and to give an early indication of loss of fluid through leakage.

16.2.3 Automatic tank gauging systems can be used for aboveground vertical and horizontal tanks, semi-buried (mounded) tanks and below ground tanks.

16.2.3 Automatic tank gauging systems shall comply with the requirements of API MPMS Chapter 3.1B.

16.3 High and High-High Level Alarms

16.3.1 Tank overfill protection instrumentation, associated alarms and safety mechanisms shall be fitted to all bulk fuel storage tanks. Consideration shall be given to the provision of emergency shutoff mechanisms, such as pump trips and valve closures upon activation of the High-High level instrument to ensure that the fuel level does not exceed the maximum capacity of the tank.

Figure 1 follows and outlines the basic principles and requirements for overfill protection systems.

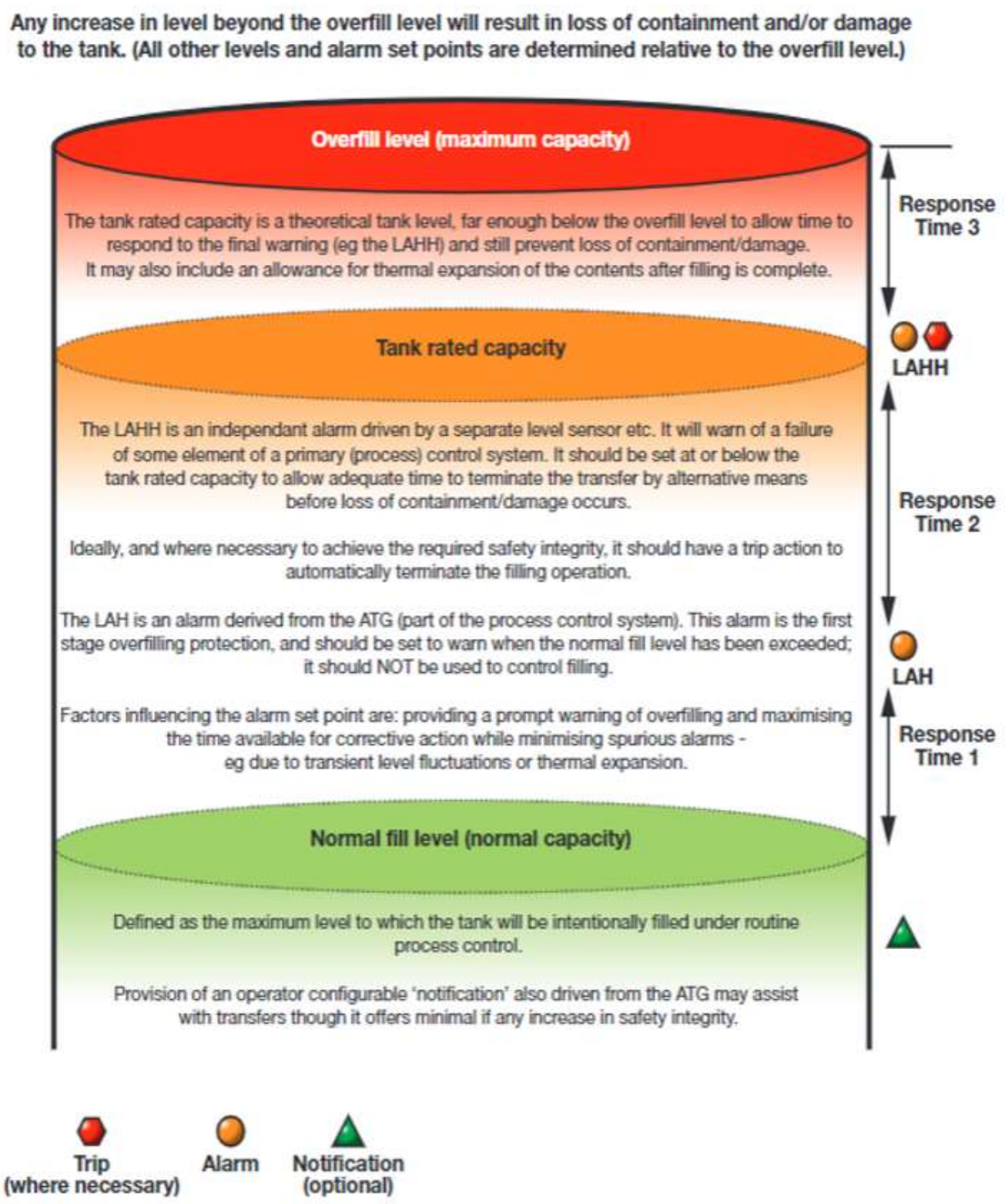


Figure 1: Overfill Protection - Tank Levels (based on API 2350).

16.3.2 Further guidance on the function and setting for high level alarms can be found in Appendices 3 & 4 of HSE Safety and environmental standards for fuel storage sites - Process Safety Leadership Group Final report.

17.0 Secondary and Tertiary Containment

17.1 Secondary Containment

17.1.1 The provision of secondary containment facilities for storage tanks and associated pipework should be provided wherever reasonably practicable, as per The Control of Pollution (Oil Storage) Regulations 2001.

17.1.2 Secondary containment facilities usually take the form of a bund, the volume of which should be capable of holding at least 110% of the largest tank capacity.

17.1.3 Further guidance on secondary containment can be found in CIRIA C736.

17.2 Tertiary Containment

17.2.1 The provision of tertiary containment should be considered based on environmental risk. A tertiary containment risk assessment should consider the prevention of all liquids (including fire-fighting water) leaving the site and therefore contaminating the ground, as per The Control of Pollution (Oil Storage) Regulations 2001.

17.2.2 Further guidance on tertiary containment can be found in CIRIA C736 and EI Guidance on risk assessment and conceptual design of tertiary containment systems for bulk storage of petroleum, petroleum products, or other fuels.

18.0 Tank Calibration

18.1 General

18.1.1 Tank calibration shall be carried out by an approved firm of specialist calibrators.

18.1.2 Tanks shall be calibrated when empty and after final site testing.

18.1.3 Unprotected vertical tanks shall be calibrated in accordance with the Institute of Petroleum Measurement Manual Part II Section 1 (IP 202/69) using the procedure specified as method 1 – Calibration of Vertical Cylinders by 'Strapping'.

18.1.4 Protected vertical tanks shall be calibrated in accordance with the Institute of Petroleum Measurement Manual part II, Section 1 (IP 202/69), using the procedure specified as method 2 - Calibration of Vertical Cylinders by Internal Measurement.

18.1.5 Horizontal tanks shall be calibrated in accordance with the Institute of Petroleum Measurement Manual part II, Section 2 (IP 202/72) – Calibration of Horizontal and Inclined Cylindrical Tanks using the internal measurement method (IP Tank Calibration Method No 3) unless otherwise indicated.

18.1.6 Buried or mounded tanks without concrete encasement shall be calibrated after back-filling and, if required after mounding has been completed.

18.1.7 Protected concrete encased tanks shall be calibrated after encasement has been completed and allowed to cure for at least 7 days.

18.1.8 The following items shall be provided to the PM in respect of each tank:

(i) One copy of the measurement data and calculations
(ii) Three copies of the basic 'metric' calibration tables in individual clear plastic envelopes
(iii) Basic calibration tables shall be in litres at 15˚ C standard temperature
(iv) The particular hatch to which the calibration data applies shall be clearly and permanently marked

18.2 Calibration Tables

Calibration tables shall be prepared in the standard format indicated below:

HEADING										
Tabulation Nominal 200,000 litres at 15 °C	LOCATION									
	TANK NUMBER									
	NOMINAL CAPACITY (LITRES)									
	NOMINAL HEIGHT (METRES)									
	NOMINAL DIAMETER/LENGTH (METRES)									
	INSTALLATION NUMBER									
	CALIBRATION PROCEDURE									
	CALIBRATION DATE									
	DEPTH IN MILLIMETRES (MM)									
		0	1	2	3	4	5	6	7	8	9
	0										
	10										
	20										
	etc										

Nominal capacity 200,000 litre and over (capacity in litres at 15˚C)

DEPTH IN MILLIMETRES (MM)										
	0	1	2	3	4	5	6	7	8	9
0										
10										
20										
etc.										

Notes to calibration table including instructions to user, particulars of related dip points, particulars or reference dip heights, maximum level to which the tank should be filled, standard temperature at which the calibration table is correct, and any other relevant information.

Certification

Signature and identity of authorised calibrator.

19.0 Commissioning

19.1 General

19.1.1 The term 'commissioning' shall refer to operation of all the constituent functions of the completed works using fuels and all other working media, as far as possible, under actual operating conditions. The contractor shall comply with JSP 375, Vol 3, Chap 5 - Petroleum from the time that fuel is introduced to the works. During commissioning all necessary steps shall be taken to reduce accidental loss of fuel or other petroleum products to a minimum and contain any such leakage.

19.1.2 Any spills of fuel or other petroleum product shall be cleaned up immediately they occur and any remediation carried out to the ground that may be required.

19.1.3 The disposal of fuel after commissioning shall be as directed by the PM.

19.2 Pre-Commissioning

19.2.1 All works covered by this specification shall be completed and any other associated works that can be completed prior to the introduction of fuel into the system.

19.2.2 A commissioning schedule shall be prepared detailing the tests to be carried and the programme and procedures. Reference must be to JSP 375 Volume 3 Chapter 5 - Petroleum. The schedule must incorporate the proposed emergency procedures that will be undertaken in the event of a site spillage.

19.2.3 The commissioning schedule shall be submitted to the PM for approval before commissioning is due to commence.

19.2.4 The PM shall specify the time scale and number of copies required.

19.2.5 The PM shall be notified in writing of the proposed fuel quantities needed for commissioning or testing before they are required. The final requirement for fuel supplies shall be confirmed to the PM before the fuel is required at the site.

19.2.6 Fuel shall not be introduced into the equipment, pipelines, work, or installation until the following have been completed satisfactorily:

(a) The testing of all electrical installations and bonding, earthing and lightning protective systems

(b) The issue to the PM of test certificates in respect of the testing referred to '18.2.6 (a); these are to include copies of all appropriate BASEEFA certificates

(c) The execution of alignment checks on all major items of plant and equipment such as pumps, pump motors and filters; and availability of certificates relating to performance and pressure test

(d) Tank calibration data is available and calibration charts prepared.

(e) The successful testing of fuel storage tanks; with certification

(f) The successful testing of all piping; with certification

(g) The execution of checks for completion on all plant, equipment, controls, automatic gauging and alarm systems and inclusion of all seals, cartridges, and all other internal items

(h) All identification, markings and danger/warning notices positioned

(i) Internal probes and level switches are installed and tested

19.2.7 Written confirmation shall be provided to the PM that the above checks have been undertaken and that the installation is in a suitable and safe condition to receive fuel.

19.2.8 Prior to fuel being introduced into the installation, approval must be sought from the OA, who will initiate the licensing actions.

19.2.9 The PM shall determine and advise the method of compliance with JSP 375 Volume 3 Chapter 5 - Petroleum, for work on petroleum installations prior to fuel being introduced into the installation. The introduction of fuel will be conditional on the Safety Rules and Procedures compliance method being in place, and the agreement by the OA for fuel to be introduced in accordance with Joint Service Regulations for the Storage and Handling of Fuels and Lubricants (JSP 317).

19.3 Acceptance Testing

19.3.1 Full working tests of all aspects of the installations covered under this specification shall be carried out in accordance with the approved commissioning schedule.

19.3.2 Major contamination shall be removed from fuel using temporary strainers before insertion into filters of fine filtration elements.

19.3.3 The tests shall include pumping trials with all eventual operating permutations, valve operation checks, equipment pressure drop checks, equipment flow capacity checks, safety device checks, level gauge checks, flow meter checks and other instrument checks.

19.3.4 The contractor should provide all testing equipment except fuel quality sampling equipment and obtain approval of the satisfactory completed tests and accept this approval as a requirement for final completion of the Contract.

19.3.5 The PM will plan to check that the final fuel quality has not been impaired by contact with completed work.

19.4 Handover

19.4.1 The contractor must give the PM all test certificates, including works test certificates, of

all pressure vessels, valves, radiography records, NDT records, completed commissioning schedules and any other documents requested before handover.

19.4.2 The full set of ‘as installed’ drawings, in the required format with the correct number of copies, must be submitted, together with operation and maintenance manuals of all equipment in scope, prior to handover.

Annex A - Management of Change – Review and Action Plan

Change Manager:	Name:		Position:		Review Date:	
Review Team:	Name:		Position:			
	Name:		Position:			
	Name:		Position:			
Description of Change:						

Note: If the change is a result of a project, Quality Assurance documentation, revisions to existing drawings and snagging should be completed by the project.

Area of Review	Identify new requirements, existing systems effected or state 'no effect'	Required Action	Action Party	Planned Date	Date Completed
Risk Assessments					
Hazard and Operability Analysis (HAZOP - new/revised)					
Safety Surveys (noise, light, asbestos etc.)					
Safety Systems (SIL systems, effect on layers of protection etc)					
Security and Alarm Systems					
Emergency Plans					
Licensing Implications					
Operational Procedures					
Staff Training					
Plant Maintenance					
Third Party Consultation (Fire Service, EA etc.)					
Fuel Quality effects					
Aviation EI/JIG 1530 (section 3.3)					
Hydraulic Analysis (effect on system hydraulics)					
DSEAR (ATEX equipment)					
Other					
Final Review: I am satisfied that the above actions have been implemented and the management of change process completed. Signed (Appointed Change Manager)				Date:	

Annex B - Torque Specification of Bolted Flange Joints

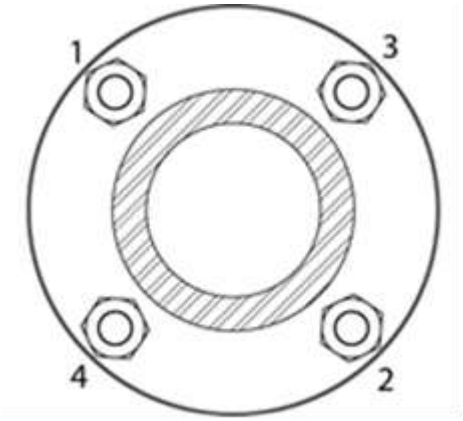
1. When making bolted flange joints on the MOD's ANSI/ASME Class 150 petroleum installations, the correct material and rating of bolts, studs and nuts shall be used. Details of the correct material grade and rating can be found in the earlier sections of this technical standard.
2. When making bolted flange joints on the MOD's ANSI/ASME Class 150 petroleum installations, the correct torque loading shall be applied using a calibrated torque wrench via the method outlined in the following instructions.

   Note. Lubrication reduces the coefficient of friction (CoF) and results in less torque needed to achieve a given tension. It also improves the consistency of achieving bolt to bolt loading and aids in the disassembly of the fasteners.
3. Before the lubricant is added, ensure that the nuts run freely by hand to where they will rest after tightening.
4. Ensure that the correct gasket has been fitted and insert the bolts/studs in the flange. Check that they are the correct length and will have between three to five complete threads showing when fully tightened.
5. Apply the lubricant (e.g. Rocol J166 Anti-Seize Compound, with a CoF of 0.15 or similar product) to the nut contact faces and the bolt/stud threads where the nut will run.
6. Number the location of each bolt on the flange. The use of masking tape around the flange may make it easier to number the locations – see below for an example.

Note. The correct numbering of bolts should result in the odd-numbered bolts being around one side of the flange and the even-numbered bolts being around the other side.

7. The correct sequence for numbering the bolt locations is in a diagonal fashion, see the following diagrams for typical examples.

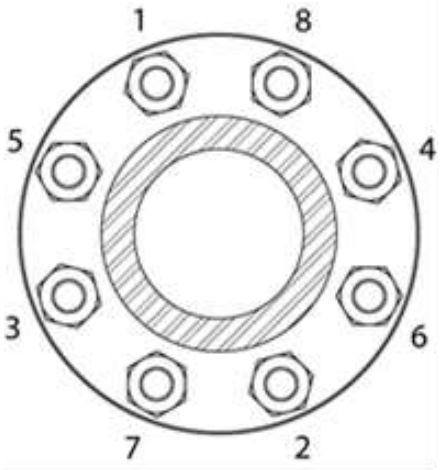
(a) 4-Bolt Flange - Bolting Pattern



Once marked-up the bolt numbers should read as follows in the clockwise direction:

1 – 3 – 2 – 4

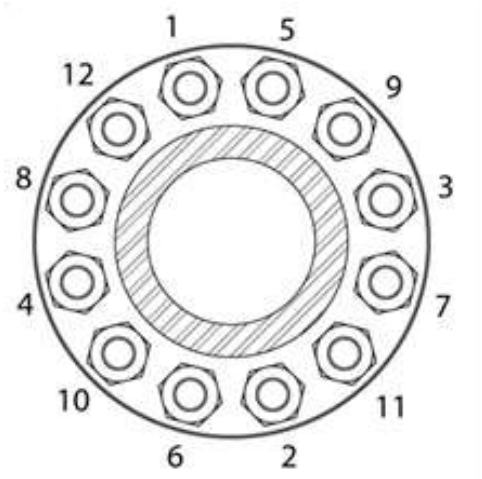
(b) 8-Bolt Flange - Bolting Pattern



Once marked-up the bolt numbers should read as follows in the clockwise direction:

1 – 8 – 4 – 6 – 2 – 7 – 3 – 5

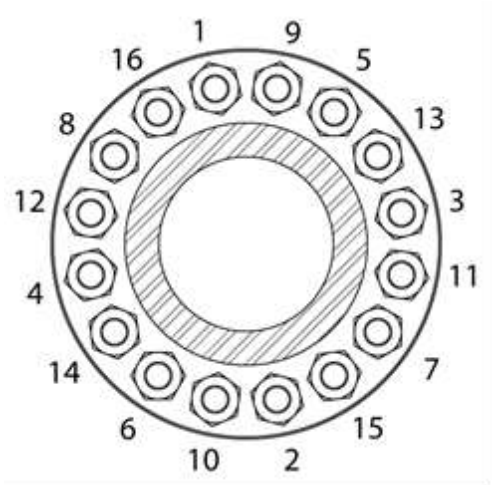
(c) 12-Bolt Flange – Bolting Pattern



Once marked-up the bolt numbers should read as follows in the clockwise direction:

1 - 5 – 9 – 3 – 7 – 11 – 2 – 6 – 10 – 4 – 8 – 12

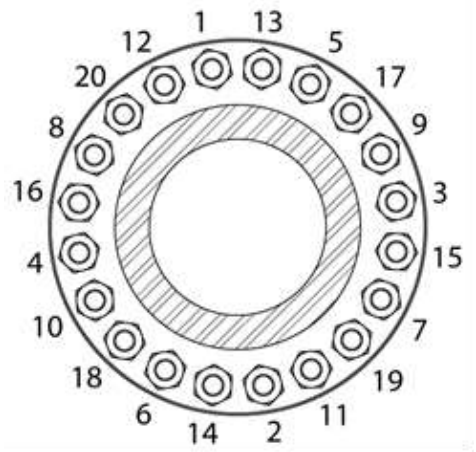
(d) 16-Bolt Flange - Bolting Pattern



Once marked-up the bolt numbers should read as follows in the clockwise direction:

1 - 9 - 5 - 13 - 3 - 11 - 7 - 15 - 2 - 10 - 6 - 14 - 4 - 12 - 8 - 16

(d) 20-Bolt Flange - Bolting Pattern



Once marked-up the bolt numbers should read as follows in the clockwise direction:

1 - 13 - 5 - 17 - 9 - 3 - 15 - 7 - 19 - 11 - 2 -14 - 6 - 18 - 10 - 4 - 16 - 8 - 20 - 12

8. Tightening shall be carried out in the following manner using a calibrated torque wrench:
    1. Before starting, hand tighten and check that the bolts fit snugly.
    2. First Pass: tighten the nuts/bolts/studs to 30% of the required final torque setting following the correct sequential order (e.g. 1, 2, 3….).
    3. Second Pass: tighten the nuts/bolts/studs to 60% of the required final torque setting following the correct sequential order (e.g. 1, 2, 3….).
    4. Third Pass: tighten the nuts/bolts/studs to 100% of the required final torque setting following the correct sequential order (e.g. 1, 2, 3….).
    5. Final Pass: tighten the nuts/bolts/studs to 100% of the required final torque setting following the rotational order.
    6. Leave for four hours and repeat the Final Pass until all nuts/bolts/studs will no longer move when the torque application equipment is applied to them.

9. The final torque settings for the correct fasteners* to be used on the MOD's ANSI/ASME Class 150 petroleum installations (see below), as referenced in Technical Standard - Petroleum 01, are shown in Table 1.

Carbon Steel Pipework: Bolts = ASTM A 193/A 193M GR B7 Stud Bolts

Nuts = ASTM A 194/A 194M GR 2H Heavy Hex Nuts

Stainless Steel Pipework: Bolts = ASTM A 193/A 193M GR B8M Stud Bolts

Nuts = ASTM A 194/A 194M GR 8M Heavy Hex Nuts

*Important Note. Hot dip galvanized or coated studs, bolts, washers, and nuts are not to be used as the coating will degrade in service and have an impact on maintaining the final torque loading figure. All fasteners used on these systems are to be bare metal.

Notes:

1. The settings in Table 1 are only to be used when the following parameters are followed.
2. Lubricant to be used on bolts and threads to have a CoF = 0.15 (copper anti-seize should not be used on stainless steel as this will create inter-crystalline corrosion which can cause parts to crack or break when under heavy loads)
3. Gaskets are to be spiral wound.
4. Flanges are to be ANSI B16.5.

Note. It is important that these settings are only used for the bolt materials and lubricants shown. Different bolt materials and lubricants will affect the torque values.

Size	Nominal Bolt Stress (lbf/in^2)	Torque (lbf)	Thread Size (UNC)	Min Bolt Length	Qty	Spanner Sizes	
						A/F Metric	A/F Imperial
½"	-	46	1/2"	2.1/4"	4	22 mm	7/8"
¾"	-	46	1/2"	2.1/4"	4	22 mm	7/8"
1"	-	46	1/2"	2.1/2"	4	22 mm	7/8"
1½"	45000	52	1/2"	3"	4	22 mm	7/8"
2"	45000	102	5/8"	3.1/2"	4	27 mm	1.1/16"
3"	50000	113	5/8"	4"	4	27 mm	1.1/16"
4"	45000	102	5/8"	4"	8	27 mm	1.1/16"
6"	50000	199	3/4"	4.1/2"	8	32 mm	1.1/4"
8"	50000	199	3/4"	4.3/4"	8	32 mm	1.1/4"
10"	40000	255	7/8"	5.1/4"	12	37 mm	1.7/16"
12"	45000	287	7/8"	5.1/4"	12	37 mm	1.7/16"
14"	45000	380	1"	6"	12	41 mm	1.5/8"
16"	40000	428	1"	6"	16	41 mm	1.5/8"

Table 1. ANSI/ASME Class 150 Flanges: Torque Loading Values