



Ministry
of Defence

Specialist Mechanical Works on Petroleum Installations on MOD Property

Practitioner Guide 04/12

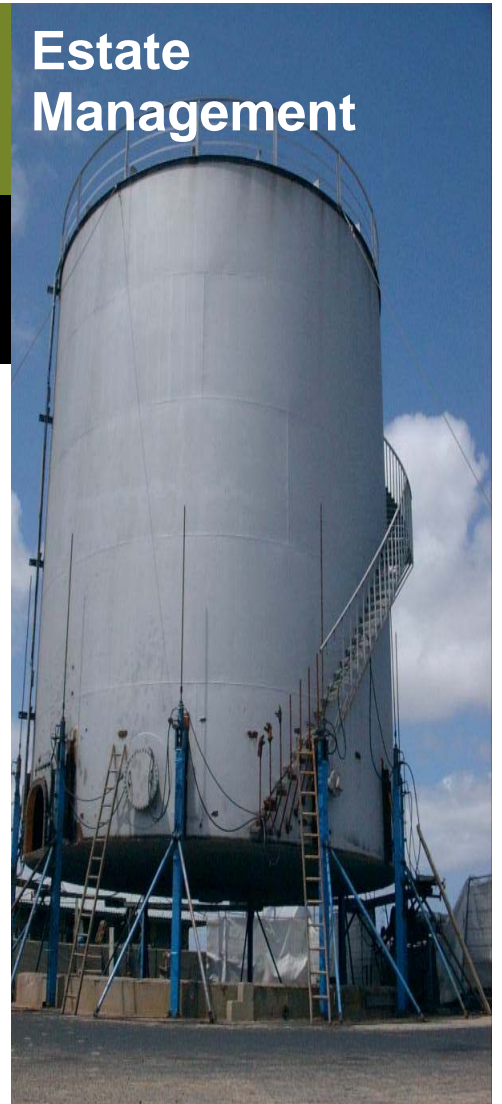
Estate Management

Document Aim:

This Practitioner Guide sets the Ministry of Defence (MOD) Standard for the construction, modification and repair of fixed mechanical equipment at 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 MOD estate. It is not a technical guide 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.



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26 November 2012	1.0	Mark Spooner	Document replaces DWFS 05.

Reference Documents

A	JSP 375 Volume 3 Chapter 5 – Petroleum
B	JSP 375 Volume 3 Chapter 2 – Petroleum
C	JSP 317 Safety Regulations for the Storage and Handling of Fuels and Lubricants.
D	Design and Installation Guide for Specialist Work in Petroleum Installations (Electrical). (DWFS 14)
E	Practitioner Guide Inspection, Maintenance and Testing of Equipment Installed at Petroleum Installations – Mechanical and Electrical
F	Specification 032 Internal Coating of Aviation Fuel Tanks
G	Specification 043 Pumps for Bulk Fuel Installations
H	Specification 044 Fuel Measurement
I	Specification 046 Aviation Fuel Filtration

FOREWORD

This Practitioner Guide here after known as the guide is published by Defence Infrastructure Organisation (DIO) for application across all areas of the MOD and replaces Defence Works Functional Standard 05. The Guide 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.

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PRACTITIONER'S GUIDE

ABBREVIATIONS

ANSI	American National Standards Institute
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
BASEEFA	British Approvals Service for Electrical Equipment in Flammable Atmospheres
BSI	British Standards Institution
BSCP	BS Code of Practice
BSEN	British Standard European Norm
DIN	Deutsche Institut für Normung (German Institute for Standardisation)
DE TA	Defence Infrastructure Organisation Technical Authority
EEMUA	Engineering Equipment and Materials Users Association
HSE	Health and Safety Executive
IGE	Institution of Gas Engineers
IP	Institute of Petroleum
ISO	International Organization for Standardization
PTFE	Polytetrafluoroethylene
P/V	Pressure/Vacuum
Ra	Arithmetical Mean Deviation of Surface Profile (BS1 134)
RF	Raised Face
SIS	Swedish Standard Institute
TS	DQA/TS Specification

Introduction

This Guide, has been issued to reflect; changes in standards, health & safety procedures and environmental constraints and to comply with current MOD requirements.

The Guide must be applied to petroleum related mechanical works associated with construction projects, modifications to existing installations and in maintenance replacement works by Project Managers, Estate Managers, Facility Managers and Specialist Petroleum Design Engineers.

The Guide covers material specifications and installation practices for equipment designed for working pressures up to and including 19.3 barg, for example ANSI class 150 flanges valves and fittings, that are found on the MOD estate, generally at the following installations:

Petroleum Supply Depots
Bulk Petroleum Storage Installations
Cross Base Pipelines
Hydrant Systems
Jetty Pipelines

The specification does not apply to:
Service Stations (Motor Transport (MT) Facilities)
Off base cross country pipelines.
Installations and equipment operating above 19.3 barg.

Fuel oil storage and handling facilities directly associated with heating and power generation plants. Whilst this Guide affords a high degree of guidance in the design and conduct of works on petroleum installations, it is essential that only appropriately qualified, experienced and equipped Designers and Contractors use the Guide. This is an essential requirement for works on petroleum installations to ensure that duty of care is exercised in view of the hazardous nature of the products handled by the installations. All works in petroleum hazardous areas must comply with JSP 375 Volume 3 Chapter 5 - Petroleum

Aim

The Guide:

Provides a consistent approach in the selection of materials and workmanship which will ensure similar designs being constructed throughout the MOD estate.

Ensures that the necessary quality requirements are obtainable.

Provides the correct approach in respect of safety, economy and environmental considerations necessary for the works application on the MOD estate.

Sets standards to which works activities can be inspected and audited.

Practitioner Guide Format

The Guide comprises the following main sections:

Section 1: General Requirements.

Section 2 to 15: Equipment, Materials and Workmanship.

Annex A - Schedule.

In Section 1, General Requirements, guidance is given on the scope and application of the Guide, together with a presentation of the definitions used, and the administrative and technical requirements of design and construction.

Each of the main sections of the Guide, (section 2 to 15), comprises general introductory paragraphs, in which the application of the equipment or the works activity is qualified, followed by equipment details and construction methods.

The Schedule at Annex A affords a simple means of specifying a design or construction task, and is for the use of the Project Manager or Designer in the preparation of the tender documentation.

Each section within the Guide has been prepared for use on a self contained basis. All necessary elements are contained within the section, thus minimising the need for cross referencing. This does mean that certain elements, for example welding, appear in several sections. In such cases, the general welding requirements are complemented by the specific requirements of the design under consideration.

Guidance

This Guide covers the majority of bulk petroleum storage tank applications.

Certain tank types are not covered:

Horizontal single skin steel tanks below ground.

Horizontal double skin steel tanks below ground.

Horizontal steel tanks > 90m³.

Horizontal double skin GRP tanks above and below ground.

Technical Authority

Technical advice and assistance on MOD Petroleum related matters can be obtained from DIO. Approaches may be through local DIO offices or directly to the DIO Petroleum Technical Authority:

Principal Mechanical Engineer
Mechanical and Fuels Infrastructure
Professional and Technical Services
Defence Infrastructure Organisation
Kingston Road
Sutton Coldfield
West Midlands
B75 7RL

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1 General Requirements

1.1 Scope

- 1.1.1 The Guide applies to the mechanical 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 Guide does not cover Motor Transport Facilities, Cross Country Petroleum Pipelines and Fuel Oil Storage and Handling Facilities directly associated with heating and power generation plants.
- 1.1.3 The Guide 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).
- 1.1.6 Where internal tank works has been undertaken, after twelve months from initial filling an internal tank inspection shall be undertaken to check the conditions of the interior coating and other internal components. Tank entry shall only be undertaken where safe access can be achieved and JSP 375 Volume 3 Chapter 5 applied. When tank access is limited, inspection shall be visually from the tank manhole.

1.2 Safety

- (a) 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 5.
- (b) The Authorised Person, AP Petroleum 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. 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 Petroleum.
- (c) Design or procedural changes, or equipment changes must not be initiated on any fuel facility without a recorded HAZOP (Hazards and Operability) study being 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.

1.3 Application of the Guide Elsewhere

1.3.1 USVF Bases

- (a) The guidelines given in this Guide 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 overseas the construction, modification and repair of equipment on fuel 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 Guide 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 CONDO¹ the guidance given in this Guide should be followed on permanent/semi-permanent deployed operating bases where practicable. The guide is not applicable for installations designed, executed and maintained by the Royal Engineers in an operational theatre designated as a Military Works Area².

1.4 Definitions

1.4.1 The terms used within this Guide 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 Guide) 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 100°C refer to appropriate section of ASME B 31.3
- (f) COMPLETE INSTALLATION shall mean not only major items of plant and equipment covered by this Guide, 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 Guide or the related documents.
- (g) CROSS COUNTRY PETROLEUM PIPELINES (not covered in this Guide): 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 (RAF) and are generally designed for pressures in excess of 19 barg.
- (h) 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.
- (i) DESIGN TEMPERATURE shall mean the temperature coincident with the design pressure.
- (j) 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. The types of fuel to be handled are shown in Annex A, Schedule.
- (k) HOLIDAY shall mean a fault in an internal or external coating where the metal surface is not fully covered by the coating system.
- (l) HOLIDAY DETECTION shall mean electrical inspection of the coating for the holiday faults.
- (m) INDEPENDENT WELDING INSPECTOR shall be an engineer, qualified to a recognised standard, employed by an Engineering Inspection/Insurance Company.
- (n) INDICATED as used in 'as indicated', 'where indicated', 'unless otherwise indicated' and like phrases, means indicated in Annex A, Schedule, of this Guide, or in the other related documents listed in the invitation to tender.
- (o) 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.

- (p) PETROLEUM SUPPLY DEPOTS (PSDs): Off-base Bulk Petroleum Storage Installations generally operated by Oil Companies on behalf of MOD (RAF). These installations are located off-airfields and normally supply on-base Aviation Bulk Fuel Installations by cross country pipelines.
- (q) 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.
- (r) PROJECT MANAGER is an official of the MOD or person employed in that capacity for the purpose of managing and administering the works covered within this Guide.
- (s) STAINLESS STEEL shall mean austenitic stainless steel of minimum chromium content 18%.
- (t) TONE DOWN: Colour painted on above-ground petroleum pipework and facilities when requested by the operating authority to make them less visible from the air (normally NATO green)

1.5 Related Documents

1.4.1 This Guide should be cited in the contract for works on bulk petroleum installations on the MOD estate. Any discrepancy between this Guide, the Conditions of Contract, the Contract Drawings or any other documents listed on the tender form shall be referred to the relevant person as soon as practicable during the pre-acceptance stage or to the Project Manager 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 stated in Annex A, Schedule, under the same conditions as those required by the tender documents.

1.7 Standards

1.7.1 Compliance with the current BS, BSEN and ISO or other standard or regulation published by the MOD/DE as listed, in Annex A, Schedule, and shall bring to the attention of the Project Manager any changes during the course of the Contract in the relevant standards and Codes of Practice.

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

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 reference with which they are to comply.

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 Current certificates of compliance shall be provided when required by the Project Manager Standards referred to in this Guide are as follows:

British Standards	
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 6651	Protection of structures against lightning
BS 7079	Preparation of steel before application of paints and related products.
BS 7159	Code of practice for design and construction of glass reinforced plastics (GRP) piping system for individual plants or sites.
BS 7430	Code of practice for earthing.
BS 8888	Technical products (TPS) specification
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 :
	Part 1 Technical conditions for inspection and delivery.
	Part 2 Tolerances on dimensions and form
BS EN 12476	Phosphate conversion coatings for metals: methods of specifying requirements.
BS EN 12285	Workshop fabricated steel tanks
	Parts 1 & 2: Horizontal cylindrical single skin and double skin tanks for the aboveground storage of flammable and non-flammable water polluting liquids
BS EN 13480	Metallic industrial piping
	Part 3 Design and calculations
BS EN 13636	Cathodic protection of buried metallic tanks and related piping
BS EN 13923	Filament-wound FRP pressure vessels: materials, design and testing
BS EN 14015	Specification for the design and manufacture of site built, vertical, cylindrical, flat -bottomed, above ground, welded, steel tanks for the storage of liquids at ambient temperature and above.
BS EN ISO 228	Pipe threads where pressure-tight joints are not made on the threads: dimensions, tolerances and designation.
BS EN ISO 1461	Hot dip galvanized coating on iron and steel articles.
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
PD 5500	Specification for unfired fusion welded pressure vessels
PD CLC/TR 50404	Electrostatics: code of practice for the avoidance of hazards due to static electricity.
BS 4C 14	Specification for aircraft pressure refuelling connectors
ANSI/ASME Standards	
ANSI/ASME	Pipe threads, general purpose

B1.20.1	
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
ASME VIII	Boiler and pressure vessel code
ASTM Standards	
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 Standards	
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)
ANSI/AWWA Standards	
C 203	Coal tar protective coatings and lining for steel water pipelines: enamel and tape hot applied
EI Standards	

	EI Measurement manual part 2
	EI Model code of safe practice for the petroleum industry: part 1 electrical safety code
DIN Standards	
DEF STAN	01-5 Fuels, lubricants and associated products
DEF STAN	49-4 Filter, Fluid, Pressure (coalesce) for gasoline and kerosene fuels
DEF STAN	49-5 Filter, Fluid, Pressure,(precoat) for aviation fluids
DIN 30670	Polyethylene coating for steel pipes and fittings: requirements and testing
MSS Standards	
MSS SP- 43	Wrought stainless steel butt welding fittings
EEMUA Standards	
EEMUA 153	Supplement to ASME B31.3
Institution of Gas Engineers	
IGE / TD / 1 Edition 4 Supplement 1	Handling, Transport and Storage of Steel Pipe, Bends and Fittings

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 Authorised Person Petroleum 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 Compliance with the 'Crown 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 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) Act and Regulations made there under
- (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 Project Manager should comply with the engineering drawing practice of BS 8888. All drawings submitted to the Project Manager shall be prepared on sheet sizes A0 to A4 as specified in BS 3429. All drawings should be submitted as required below to the Project Manager, 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 arrangements 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 foundation details
- (d) Drawings showing greater engineering detail if ordered by the Project Manager
- (e) Drawing required by any other documents referred to in this Guide.
- (f) Record drawings referred to in clause 1.9
- (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 as shown in Annex A, Schedule
- (i) Drawings shall be submitted to the Project Manager for approval within the time scale given in Annex A, Schedule.

1.10 Record Drawings

1.10.1 Record drawings shall be provided in a format as stated in Annex A Schedule. The drawings required for record purposes shall be as follows:

- (a) All drawings submitted for approval as described in clause 1.7.3, but amended as required by the Project Manager
- (b) All additional drawings required by the Project Manager as indicated in Annex A, Schedule

- (c) The number of copies of each drawing required for record purposes shall be as shown in Annex A, Schedule

1.10.2 Record drawings shall be marked as follows:

- (a) 'RECORD' or 'AS-INSTALLED' in block letters 19mm 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 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 and any special features
- (b) General instructions for dealing with fault diagnosis and remedial action
- (c) Details of all routine preventive maintenance requirements
- (d) Any precautions necessary for ensuring health and safety and avoidance of misuse
- (e) Any features required by any other documents referred to in this Guide

1.11.2 A full set of planned 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 Project Manager and in all cases the particular installations to which they relate shall be clearly identified in a manner approved by the Project Manager.

1.11.3 A comprehensive list of spares required for maintenance of the completed Works should be prepared. The list shall include spares that normally need to be replaced due to fair wear and tear including a statement of likely life for these items together with the 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 is indicated in Annex A Schedule.

1.11.5 Training for nominated site personnel on all new equipment, installations and systems should be provided

1.12 Materials

1.12.1 General: only new materials shall be used unless otherwise specified; where the Project Manager directs the use of existing materials, these shall meet the specification for new materials.

1.12.2 Equipment that will be used with aviation fuel must comply with the following requirements: 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 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 Project Manager 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 Pipework and Fittings

2.1 General

2.1.1 The pipework and fitting specifications detailed within section 2 are intended to be used at Petroleum Supply Depots, 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, 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 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
- (c) System 1 AC GRP Pipe

2.1.4 Selection of pipeline materials and system design shall comply with the guidelines of this Guide 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 6651
- (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 clauses as applicable within this Guide.

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

2.1.7 The Project Manager be given access to inspect all equipment including pipes before despatch to site. The Project Manager shall be informed before the date of despatch of all equipment including pipes. For details of timescale see Annex A, Schedule.

2.2 Stainless Steel Pipework and Fittings (System 1 AA)

2.2.1 This part of the Guide 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 as set out in Annex A, Schedule.

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 (material) BS 1600, Sch 80s (dimensions) Seamless - plain ends
	50 mm and above	ASTM A 312/A 312M type 316L (material) BS 1600 Sch. 10s (dimensions) Seamless or welded - bevelled ends
Pipe Nipples	Up to 40 mm	ASTM A312/A 312M type 316L (material) BS 1600 Sch. 80s Seamless - ends as required 50 mm and 100 mm long
Pulled Bends	Up to 40 mm	Minimum centre line radius - 5 x nominal diameter 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 or Screwed ends to ANSI B 16.11 as required ANSI B 1.20.1 threads. Elbows 45o and 90o long radius Tees: equal and reducing Couplings Swage nipples Caps Sockolets
	50 mm and above	ASTM A 403/A 403M , WP 316L Butt weld to ANSI B 16.9 or MSS SP-43-1982 Elbows 45° and 90° 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 raised face Socket weld or blind

	50 mm and above	ASTM A 182/A 182M-F 316L to BS EN 1759-1 Class 150, raised face Weld neck Slip on Blind
Gaskets	All	Rubber bonded jointing for industrial and aerospace purposes: specification 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	ASTM A 193/A 193M GR B7 stud bolts ASTM A 194/A 194M GR 2H heavy hex nuts. All to be Stainless Steel.
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)
)
STR	Socket weld tee reducing)
) ASTM A 182/A 182M F 316 L 3000lb forged steel
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 NOTES:

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

2.2.7 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 Guide 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 as set out in Annex A, Schedule.

2.3.3 Tolerances on diameter and wall thickness of linepipe 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 Project Manager, by a phosphate conversion coating: (See Annex A, Schedule).

2.3.5 Pipe stored in corrosive conditions, or for a long period, prior to fabrication.

2.3.6 Pipe which may release corrosion products upon commissioning with fuel.

2.3.7 Pipe which will convey water or other corrosive liquid and which cannot be internally lined.

2.3.8 Any other condition which exposes the internal surfaces of the pipe to corrosion.

2.3.9 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.

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

2.3.11 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.

2.3.12 A phosphate conversion coating shall not be applied to pipe which will be internally lined.

2.3.13 Piping materials shall be supplied in accordance with the Codes and Standards in Table 2.2. below:

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 (material and dimension) Sch 80 Seamless or ERW Plain ends
	50 mm and above	API 5L GR B (materials and dimensions) 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 Material as for pipe Ends plain
Branch fittings		See branch schedule at end of table
Fittings	Up to 40 mm	ASTM A 105/A 105M 3000lb forged steel Socket weld ends to ANSI B 16.11 or Screwed ends to ANSI B 16.11 as required ANSI B1.20.1 threads Elbows, 45o and 90o long radius Tees equal and reducing Couplings Unions Swage nipples Caps Sockolets
	50 mm and over	ASTM A 234/A 234M GR WPB Butt weld to ANSI B16.9 Wall thickness to match pipe Elbows 45° and 90° long radius only Tees, equal and reducing Reducers, concentric and eccentric
Flanges	Up to 40 mm	ASTM A 105/A 105M to BS EN 1759 - 2 Class 150, raised face Socket weld Blind

	50 mm and over	ASTM A 105/A 105M to BS EN 1759 - 2 Class 150, raised face Weld neck Slip on Blind
Gaskets	All	Rubber bonded jointing for industrial and aerospace purposes: specification 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	ASTM A 193/A 193M GR B7 stud bolts ASTM A 194/A 194M GR 2H heavy hex nuts All to be plated
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	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)
)
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)

2.3.14 NOTES:

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

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

2.3.17 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 Glass Reinforced Plastic (GRP) Pipework and Fittings (SYSTEM 1 AC)

2.4.1 This part of the Guide shall apply to those sections of pipework and fittings shown on the Drawings with line numbers ending in "... 1AC".

2.4.2 The process conditions for this system of piping shall be as set out in Annex A, Schedule.

2.4.3 All pipe and fittings shall be selected from a single manufacturer's range of products to ensure that the dimensions of joints for pipe and fittings are compatible.

2.4.4 Fittings shall be supplied with the same pressure rating as the pipe to which they will be attached to ensure that the inside diameter of the fittings spigots are compatible with the outside diameter of the pipe.

2.4.5 Piping materials and fittings shall be suitable for a design pressure of 19.3 barg.

2.4.6 All materials shall be MOD/DIO approved for use. Resins used for pipework, fitting construction and the adhesives used for pipework and fitting connection shall remain unaffected by both product and additives.

2.4.7 Piping materials shall be supplied in accordance with the codes and standards in Table 2.3. below:

Table 2.3 Pipework and Fittings, System 1AC: GRP

Pipe	All sizes	Designed and manufactured to withstand a minimum internal pressure of 19.3 barg Wall thickness and outside diameter to manufacturer's standard. Spigot and socket ends for adhesive bonding joint for long pipe runs. Plain ends for adhesive bonding joint for short pipe runs
Fittings	All sizes	Designed and manufactured to withstand a minimum internal pressure of 19.3 barg. Spigot and socket ends for adhesive bonding joint compatible with dimensions of plain ended pipe Elbows: 45° and 90° Tees, equal and reducing Coupler (to join two plain ended pipes) Adapter (to convert socket to spigot end) Reducing saddle (for small branches) Reducers, concentric and eccentric
Flanges	All sizes	Designed and manufactured to withstand a minimum internal pressure of 19.3 barg Socket ends for adhesive bonding joint compatible with dimensions of plain ended pipes Full faced flange drilled to suit BS EN 1759-1 class 150 Steel mating flange with raised face machined off and fitted with a full face gasket
Gaskets	All	Rubber bonded jointing for industrial and aerospace purposes: specification Oil resistant, non-graphitized to BS 7531. 1.5 mm thick Dimensions to ANSI 16.21 Table 6 class 150 full faced No jointing compound to be used.
Flange bolting	All	ASTM A 193/A 193M GR B7 stud bolts ASTM A 194/A 194M GR 2H heavy hex nuts Stainless steel
Material Resistivity	All	Generally pipelines and fittings shall be manufactured from antistatic or conducting materials i.e. a low resistivity material. The criteria for satisfactory earthing is that the resistance to earth at any point on a non metallic pipeline should be less than 10 Ω (ohms). The specific guidelines given in PD CLC/TR 50404 shall be applied

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 user. Details of type and size are given in Annex A, Schedule. 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 Steel

(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 threading
Use	For standard female hose couplings threaded to BS 2464, Appendix B, loose fit, straight
Manufacture	As pipe
Finish	Bare Steel

(c) Pipe Ends (for off load points and vapour recover connection)

Pipe ends shall be prepared for the connection of vehicle off load and vapour 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 Steel

(d) British / American Hose Adaptors

Adaptors shall be prepared, if required as shown in Annex A, Schedule, 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 Steel

2.5.2 Hose Connection Caps

2.5.3 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 calibration, 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 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 products. 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 compliance with this clause shall be provided.

3.1.3 Valves shall be closed by rotating hand wheel or levers in the clockwise direction and opened by movement in the anti-clockwise direction. The valve hand wheel 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 other Project Manager 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 hand wheel or lever irrespective of the size of the valve, where this can not 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 hand wheel or lever at the height as shown on the drawings. The hand wheel 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 Project Manager. 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 indicated by the Project Manager (see Annex A, Schedule)
Repair of Defective Castings	Obtain approval of the Project Manager 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, when required, is given in Annex A, Schedule.

3.1.12 Carbon steel valves shall be externally coated with a primer coat only. Finishing coats 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 Minimum dry film thickness – 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 Flanged valves for use on GRP piping systems (system 1AC) shall be supplied with Class 150 full faced flanges.

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

3.1.17 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.

3.1.18 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 paragraph 3.3.17 and the operational requirements of the system.

3.1.19 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, 40mm 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 ANSI B1.20.1
Bonnets/Cover	Bolted
Material	Body – carbon steel
	Trim – Symbol 18-10-2 (Cr-Ni-Mo stainless steel)
Bellows seal	Not required
Operation	Hand wheel

3.2.3 Ends shall be as shown on the Drawings and in the Valve Schedules. (See Annex A, Schedule). 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, 50mm and larger, shall comply with the following requirements:-

Size	50mm and larger
Standard	BS EN ISO 10434
Class	150
Soft Seals	Not required
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 Tappings	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
Trim-symbol	18 10-2. (Cr-Ni-Mo stainless steel)
Other fluid contact materials to be compatible with the process liquid as agreed with the Project Manager	
Operation	Hand/Geared/Motorised as indicated in the Valve Schedule in Annex A Schedule.

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 40mm and smaller shall comply with the following requirements:-

Size	40mm 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
Materials	Body-carbon steel
	Ball/stern-BS EN 10222 -316

	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 Project Manager.
Operation	Hand-lever

3.3.3 Ends shall be as shown on the Drawings and in the Valve Schedules in Annex A, Schedule. 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 compliance with BS EN ISO 17292 and BS EN ISO 10497 unless otherwise agreed by the Project Manager.

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

Size	50mm and larger
Standard	BS EN ISO 17292
Class	150
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 Welded-on flanges not permitted
Drain Tapping	Not required
Ball Protrusion	Not acceptable
Materials	Body-carbon steel 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 permission of the Project Manager.
Operation	Hand/Geared/Motorised as indicated in the Valve Schedule in Annex A Schedule.

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

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, 40mm and smaller, shall comply with the following requirements:-

Size	40mm 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
Cover	Body – carbon steel
Material	Trim – symbol 18-10-2 (Cr-Ni-Mo stainless steel)

3.4.3 Ends shall be as shown on the Drawings and in the Valve Schedule in Annex A, Schedule. 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 to BS EN 1759 -1 RF class 150. Welded on flanges not permitted
Shell tapping	Drain to be threaded to BS 21 taper. No others required.
Soft seals	Not required
Cover	Bolted
Materials	Body carbon steel
Trim symbol	18-10-2 (Cr-Ni-Mo stainless steel)

3.4.6 A lever override shall be incorporated as called for in the Valve Schedule in Annex A, Schedule.

3.5 Double Block and Bleed Valves

3.5.1 Double block and bleed valves provide a means by which the operator can assess if the valve seat is not sealing. These valves are used when product segregation is required, for example multi product lines.

3.5.2 Double block and bleed valves are not to be used when positive isolation is required i.e. when tanks, pipework or equipment need to be isolated.

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

Size	50 mm and larger
Standard	ANSI/API 599 6th edition
Class	150
Type	Plug valve with lifting plug seats
Ends	Flanged to BS EN 1759-1 RF class 150 Welded-on flanges shall not be 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 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 Project Manager'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
Class	150
Type	Line spread (spill) or Line spread (non spill) or Non-spread (non spill)
Ends	Flanged to BS EN 1759-1 RF Class 150 Welded-on flanges not permitted or Butt weld ends
Spectacle plate	Stainless steel
Seal rings	Required
Materials	Body carbon steel Stainless steel

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	API Spec 6D
Class	150
Type	Full bore, with parallel sliding gate, sealing rings and raising stem
Ends	Flanged to BS EN 1759-1 RF class 150
Dimensions	"Face to face" to API 6D
Materials	Body - carbon steel 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 to a pressure 10% above the working pressure.

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 shown on the Relief Valve Schedule in Annex A Schedule
Standard	API RP 520 7th edition
Class	Determined by the valve set pressure
Type	Spring loaded, thermal relief
Ends	Inlet – 25 mm screwed female Outlet – 25 mm screwed female Threaded to ANSI B 1.20.1
Material	Body – carbon steel Internals – stainless steel to BS EN 10222-5
Set pressure adjustment	± 10%
Set pressure tolerance	± 3%
Maximum overpressure	10% during relief
Set point	As stated in Relief Valve Schedule in Annex A Schedule

Tests To be preset, tested and stamped at the manufacturer's works

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

Size	As shown on the Relief Valve Schedule in Annex A Schedule
Standard	API RP 520 7th 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
Material	Body – carbon steel Internals – stainless steel to BS EN 10222-5
Set pressure adjustment	± 10%
Set pressure tolerance	± 3%
Maximum overpressure	10% during relief
Set point	As stated in Relief Valve Schedule in Annex A Schedule
Tests	To be preset, 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 filter water separators
- (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

3.9.7 The valve type, function, set point, failure position and opening time, shall be as defined in the valve schedule in Annex A Schedule.

3.9.8 Valve bodies shall be carbon steel or aluminium as indicated in Annex A Schedule. Trim material shall be stainless steel to BS EN 10222-5

3.9.9 The pressure rating of the valve shall be 19.3 barg

3.9.10 All ancillary valves and pipework shall be in stainless steel

4. 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 in Annex A, Schedule.
- 4.1.2 Carbon steel equipment shall be externally coated with a primer coat only. Finishing coats 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
- 4.1.4 Surface preparation: Abrasive blast clean to BS 7079 Sa 2½ surface profile 50 – 75 microns.
- 4.1.5 Primer coat: Epoxy zinc phosphate
- 4.1.6 Minimum dry film thickness: 50 microns
- 4.1.7 Stainless steel and aluminium equipment shall be supplied uncoated.
- 4.1.8 All equipment shall be left uncoated internally except where indicated in Annex A, Schedule. Internal coating, where required, shall be in accordance with DW FS Specification 032 Internal Coating of Aviation Fuel Tanks.
- 4.1.9 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.
- 4.1.10 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 guide expressly permits otherwise
 - (iv) The express prior agreement of the Project Manager 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 Filter water separators for aviation fuels shall comply with DE Specification 046 Aviation Fuel Filtration

4.3 Fuel Monitors

4.3.1 Fuel monitors for aviation fuels shall comply with DE Specification 046 Aviation Fuel Filtration

4.4 Pre-Coat Filters

4.4.1 Pre-coat filters for aviation fuels shall comply with DE Specification 046 Aviation Fuel Filtration

4.5 Bulk Meters

4.5.1 Bulk meters for aviation fuels shall comply with DE Specification 044 Fuel Measurement

4.6 Pumps

4.6.1 Pumps for Bulk Fuel Installations shall comply with DE Specification 043 Pumps for Bulk Fuel Installations.

4.7 Sight Glasses

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

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

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

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

4.8 Flow indicators

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

Size	Up to 40mm
Ends	Screwed, female, to ANSI B1.20.1
Indicator Type	Bladed spinner
Materials	Body – carbon steel, to BS EN 10213 1-3 Viewing disc – toughened glass Seals – compatible with water and product Spinner – stainless steel
Orientation	Suitable for vertical or horizontal mounting

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

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

4.9 Basket Strainers

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

Size	25 mm and larger
Type	Inline type with internal, removable mesh basket and bolted top cover
Standard	PD 5500 or ASME VIII
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
Mesh Size	As stated in Annex A, Schedule

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

Size	25 mm and larger
Type	Inline type with internal, removable mesh basket and bolted top cover. The strainer shall include a change over 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.
Standard	PD 5500 or ASME VIII
Ends	25 mm – 40 mm screwed to ANSI B 1.20.1 50 mm and larger flanged to BS EN 1759 – 1 RF class 150
Materials	Body – carbon steel to BS 1504 – 161 grade 480 Basket – stainless steel
Mesh size	As stated in Annex A, Schedule

4.10 Pressure Gauges

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

Size	100mm diameter face
Standard	BS EN 837 - 1
Type	Bourdon Tube
Materials	Body – stainless steel Tube – stainless steel
Scale Range	So that normal operating pressure is halfway along range

The normal operating points, overpressure requirement and end fittings of pressure gauges shall be as detailed in Annex A, Schedule.

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

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

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 as detailed in Annex A, Schedule.

4.11 Loading Arms

4.11.1 Loading arms shall be of a proprietary manufacture, approved by the Project Manager, and shall include the following features:

- (a) Compatible for use with the vehicles or ships to be loaded taking into account 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 bar.

4.12 Pantographs

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

4.12.2 Compatible for use with aircraft or road vehicles to be loaded, taking into account the operating envelopes required.

4.12.3 Fully articulated in vertical or horizontal planes by means of low torque swivel joints.

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

4.12.5 Stainless steel or aluminium construction on all wetted parts.

4.12.6 Connection to hydrant pits as Annex A, Schedule.

4.12.7 Connection to aircraft or refueller vehicle as Annex A, Schedule.

4.12.8 To include a meter, venturi pressure sensor, flow control valve and dead mans handle as required, according to Annex A, Schedule.

4.13 Hydrant Fuelling Valves

4.13.1 Hydrant fuelling valves, a specialised form of line pressure actuated control valve, shall be a proprietary manufacture, approved by the Project Manager, 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 bar max.
- (d) Stone guard in inlet 4 mesh.
- (e) Outlet diameter 100mm for fuelling outlets, 65mm for defuelling 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.

4.14 Hydrant Fuelling Pits

4.14.1 Hydrant fuelling pits, to house the hydrant fuelling valves, shall be of proprietary manufacture, approved by the Project Manager, 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.

4.15 Self Seal Quick-Release Couplings

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

Size	65mm
Standard	BS 4C 14 (Aerospace Series)
Material	Stainless steel or aluminium as stated in Annex A Schedule.

4.16 Insulating Flange Joint

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

Size	50mm and above
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, 3mm thick

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

5 Fabrication of Pipework

5.1 General

- 5.1.1 All ferrous pipework, within installations (e.g. Bulk Petroleum Storage Installation) 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 ASME/ANSI/EE MUA standards (see Clause 1.2.1 a).
- 5.1.2 All GRP pipework shall be fabricated and installed in accordance with manufacturers recommended procedures.
- 5.1.3 All materials required for the completion of the Works shall be provided in accordance with the materials section of this Guide.
- 5.1.4 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.
- 5.1.5 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).
- 5.1.6 Conductive non-metallic pipelines shall be earthed so that the resistance to earth at any point should not exceed 10⁸ Ω (ohms).
- 5.1.7 Screwed, flanged or union joints shall not be buried. Where such joints are sited underground they shall be located in an adequately drained and accessible pit. Screwed joints shall not be back welded unless specifically indicated on Drawings or elsewhere in this Guide (see also Clause 5.2.10 below).
- 5.1.8 Paint or stencil identification marks shall be applied on pipelines, filters, pumps and other equipment as required by the Project Manager. Marks as letters, numerals, or coloured banding shall be in accordance with the Project Manager'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 50mm and larger shall be prefabricated to the maximum extent practicable to minimise in-situ welding. Class 150 pipework larger than 50mm shall be joined by butt welding or by flanged joints.
- 5.2.2 Piping 40mm 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 40mm 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 250mm nominal bore.
- 5.2.5 Contractor fabricated bends in pipe, if permitted, shall be produced by bending to radii as follows:-

- 5.2.6 Size 80 mm and under – not less than 3 x nominal bore of pipe
- 5.2.7 Sizes 100 mm to 250 mm – not less than 5 x nominal bore of pipe
- 5.2.8 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 nominal outside diameter of the pipe. Bends showing wrinkling characteristics shall not be installed. Mitre joints and gusseted or Mitre bends shall not be used.
- 5.2.9 Transverse segments cut from factory manufactured proprietary bends may be used on pipe sizes 100 mm and greater provided that the arc distance measured along the crotch is at least 50 mm.
- 5.2.10 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.
- 5.2.11 On pipe sizes 50 mm 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 Guide. Threaded joints shall be sealed with virgin PTFE tape.
- 5.2.12 When seal-welding is expressly permitted by the Project Manager, 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
- 5.2.13 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 Guide and the Contract Drawings. Ball valves shall be used for vents and drains and fitted with caps or plugs.
- 5.2.14 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 Project Manager 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.
- 5.2.15 In all cases support anchors and guides shall be in accordance with the following requirements:
- 5.2.16 All pipe supports shall be designed and constructed in accordance with BS EN 13480 part 3. Thermal expansion shall be taken up by changes of direction wherever practicable. Expansion loops or mechanical devices shall not be used without approval of the Project Manager. Any additional support required for constructional or testing purposes shall be provided and removed on the completion of testing.
- 5.2.17 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.

- 5.2.18 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 1.0m generally
 - (b) Minimum 1.2m under roads, hardstanding for vehicles and aircraft pavements or taxiways and for 6m either side of this.
 - (c) Minimum 1.2m 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 Project Manager. The maximum value shall apply only where necessary to take account of minor variations in contour.
- 5.2.19 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.
- 5.2.20 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.
- 5.2.21 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.
- 5.2.22 Following completion of backfilling the necessary restoration of the top soil 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 Project Manager.
- 5.2.23 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.
- 5.2.24 The design and location of vent points and drain points, complete with associated valves shall be shown on the Drawings.
- 5.2.25 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.
- 5.2.26 Additional vents and drain points shall be located in positions agreed with the Project Manager.
- 5.2.27 The line pipe shall be delivered, stored and handled on site in accordance with the following requirements:
- 5.2.28 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.
- 5.2.29 On completion of loading, the pipes shall be made secure in a manner as to prevent damage to the protective pipe wrapping during transportation.

5.2.30 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 clause. In order 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:

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

5.2.31 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.

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

5.2.33 The pipes shall be strung out so as 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.

5.2.34 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 as a result 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.

5.2.35 Protection to the ends of the pipes shall be retained for as long as practical, before incorporation of the pipes into the works.

5.2.36 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.

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

5.2.38 Contractor field fabricated/formed bends shall not be used unless it is shown on the drawings.

5.2.39 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 D (where D is the outside 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

5.2.40 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.

- 5.2.41 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 to ensure that the wall thickness is not less than 98% of the original wall thickness at the points checked.
- 5.2.42 The field bending procedure shall be amended if the above requirements cannot be met and the bending radii given above shall be increased until satisfactory bends are produced.
- 5.2.43 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 40D (where D is the outside diameter of the pipe).
- 5.2.44 After fabrication of the bends or other special pipes, the coating shall be made good.
- 5.2.45 Installation of transverse segments cut from Contractor field fabricated/formed bends will not be permitted.
- 5.2.46 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, to be agreed with the Project Manager.
- 5.2.47 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.
- 5.2.48 Fabricated lengths of pipework shall be laid in accordance with the following requirements:
- 5.2.49 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 special precautions during lowering. The pipework shall not be over stressed during installation.
- 5.2.50 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 outside diameter.
- 5.2.51 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.
- 5.2.52 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 Project Manager who will require adequate protection of the pipeline. Failure to comply with this Clause may render the Contractor liable to re-test the section of pipeline affected, at his own expense.
- 5.2.53 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.
- 5.2.54 The Project Manager will give details of any lettering required on the slabs.
- 5.2.55 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.
- 5.2.56 Unless otherwise indicated, after testing, the pipework shall be finally cleaned as followed:

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- 5.2.57 Remove all items of equipment likely to be damaged by the flushing process.
- 5.2.58 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.
- 5.2.59 Flush lines for 2 hours using the process fluid at the normal operational flow rate, as agreed with the Project Manager.
- 5.2.60 After 2 hours examine the strainers and if found clean, the flushing may be considered complete. If not clean, flushing shall continue, with the strainers being examined every 2 hours until clean.
- 5.2.61 When clean, the system shall be thoroughly drained, temporary spools and connections shall be removed and equipment under (a) above replaced.

5.3 GRP Pipework

- 5.3.1 All pipework and fittings shall be joined using adhesive bonding. Joints shall be socket/spigot or plain ended pipe with loose couplings. Jointing adapters shall be used, as required, to convert socket ends into spigot ends.
- 5.3.2 Flanged joints shall be used when joining GRP pipework to ferrous pipework or ferrous valves. The GRP flange, which shall incorporate an appropriate socket end, shall be joined to the plain ended GRP pipe using an adhesive bond. The GRP flange shall be full faced and drilled to match the bolt holes of a BS EN 1759-1 class 150 ferrous flange. The ferrous flange raised face shall be skimmed to make a flat face flange and the joint shall be completed using a full face gasket.
- 5.3.3 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.
- 5.3.4 Branch connections shall be made using equal or unequal tee joints, as appropriate. The tees which shall incorporate socket ends shall be joined to plain ended GRP pipe using an adhesive bond.
- 5.3.5 Bends shall be made using elbow joints incorporating socket ends suitable for adhesive bonding onto plain ended GRP pipe.
- 5.3.6 Adhesive bonded joints shall be made in accordance with the GRP pipework manufacturer's instructions. Recommendations for material handling and storage, bonding temperature, joint preparation and cleanliness shall be followed in full. All bonded joints shall be made suitable for a pipe system design pressure of 19.3 barg at the design temperature specified for the fittings in section 2.4.1 of this Guide.
The depth of buried pipelines shall be as shown on the drawings and shall be such that cover to the pipe is as follows:

Minimum 1.0 m generally

Minimum 1.2 m under roads and hard-standing for vehicles and for 6.0 m either side of this.

Maximum cover not to exceed minimum cover by more than 500 mm except as indicated on the drawings or as agreed by the Project Manager. The maximum value shall apply only where necessary to take account of minor variations in contour.

- 5.3.7 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 underground pipework shall be provided with a bedding and surround of 200 mm pea shingle, free from harmful substances and foreign matter, over the full width of the trench.
- 5.3.8 Installation and backfilling of trenches shall be undertaken in accordance with GRP pipework manufacturers recommended practice. In a typical installation, the pea shingle 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.
- 5.3.9 On completion of the initial backfill with pea shingle 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.
- 5.3.10 Mechanical rammers shall not be used until the pipework is covered by at least 600 mm of selected excavated materials and thereafter only with proper care.
- 5.3.11 Following completion of backfilling the necessary restoration of the top soil layer or; where applicable, surface reinstatement shall be carried out to the satisfaction of the Project Manager.
- 5.3.12 Piping shall be kept clean and free of all dirt, debris and foreign materials, during fabrication, construction and erection, 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.
- 5.3.13 Unless otherwise indicated, after testing, the pipework shall be finally cleaned as follows:
- 5.3.14 Remove all items of equipment likely to be damaged by the flushing process.
- 5.3.15 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.
- 5.3.16 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.
- 5.3.17 Flush lines for 2 hours using the process fluid at the normal operational flow rate, as agreed with the Project Manager.
- 5.3.18 After 2 hours examine the strainers and if found clean the flushing may be considered complete. If not clean, flushing shall continue with the strainers being examined every 2 hours until clean.
- 5.3.19 When clean the system shall be thoroughly drained, temporary spools and connections shall be removed and equipment removed under (a) above, replaced.

6 Welding of Ferrous Pipework

6.1 General

- 6.1.1 This section of the Guide is applicable to the welding of all ferrous pipework, both carbon steel and stainless steel, within installations (e.g. Bulk Petroleum Storage Installation) 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 Project Manager 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 used and the standard of workmanship comply with the standards specified in this section.
- 6.1.4 Only qualified craftsmen shall be employed to perform all aspects of the work including testing where required. Any craftsmen considered by the Project Manager and the independent welding inspector to be unsuitable shall be removed.
- 6.1.5 The Project Manager 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 clauses of this section.
- 6.1.7 This section shall be read as supplementary to the indicated British Standards such that clauses within this section 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 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 radiographed and the pipeline hydraulically tested.

6.2 Welding Procedures

- 6.2.1 Welding procedures shall be proposed to suit the range of materials, 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).
- 6.2.4 Details of timescale and the number of copies of procedures that are to be submitted for approval are detailed in Annex A, Schedule.
- 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 or the weather conditions are unsuitable for welding.

6.2.6 Tools and equipment shall be provided in good operating condition and of a capacity suited for the work.

6.3 Documentation

6.3.1 Prior to commencement of inspections, documentary evidence of the independent welding inspector qualifications and details of his employing Engineering/Insurance Company shall be submitted to the Project Manager 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 Project Manager. See Annex A, Schedule.

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 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 ASME B31.3 shall apply except as augmented or modified within this section of the Guide.

6.5.2 Butt joints shall be full penetration and line-up clamps shall be used for all butt welds in piping 80mm 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
- (b) permanent backing rings
- (c) copper backing bars
- (d) peening
- (e) flame gouging
- (f) arc-air gouging

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 300mm 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:
- 6.5.14 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.
- 6.5.15 Before performing qualification tests preliminary approval shall be obtained for the proposed procedures and shall arrange for witnessing by the Project Manager and the independent welding inspector.
- 6.5.16 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.
- 6.5.17 Welding procedure approval shall be carried out in accordance with BS 2633 or BS 4677 as applicable.
- 6.5.18 Approval of welders shall be in accordance with the following requirements:
- 6.5.19 Only welders who have been approved specifically for the Contract shall carry out welding.
- 6.5.20 All welder approval tests shall be witnessed by the Project Manager and his authorised welding inspector.
- 6.5.21 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 Project Manager.

- 6.5.21 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.
- 6.5.22 Welder approval shall be carried out in accordance with BS 2633 or BS 4677 as applicable.
- 6.5.23 Rectification of welds shall be in accordance with the following requirements:
- 6.5.24 Welds which do not comply with the standard specified in this section of the Guide shall be rectified such that they are brought into compliance.
- 6.5.25 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.
- 6.5.26 Cutting out of a weld containing unacceptable defects shall be effected by removing a suitable length of pipe containing the weld in all cases.
- 6.5.27 Full records of welding defects and all repairs to welds shall be maintained in a form approved by the Project Manager.
- 6.5.28 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.

6.6 Weld Testing

- 6.6.1 The requirements of BS 2633, BS 4677 and ANSI B31.3 shall apply except as augmented or modified by this section of the Guide.
- 6.6.2 Each completed joint shall be cleaned using power driven wire brushes and otherwise prepared as necessary for visual examination and non-destructive testing.
- 6.6.3 The site activities shall be coordinated so that visual examination by the Project Manager and the independent welding inspector and all necessary inspections by the Contractor are carried out before the weld areas are painted or otherwise covered.
- 6.6.4 The Contractor should carry out all specified non-destructive testing.
- 6.6.5 The Project Manager and the independent welding inspector shall:
- 6.6.6 Witness all welding procedure and welder approval tests including the mechanical testing of specimens prepared from test welds.
- 6.6.7 Be satisfied that the correct welding equipment, materials and techniques are being employed and that the specified standards of workmanship are being achieved.
- 6.6.8 Be satisfied that the specified non-destructive testing of test welds and production welds is being carried out satisfactorily.
- 6.6.9 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.
- 6.6.10 Visually examine all completed test and production welds.

- 6.6.11 Visually examine all specimens prepared from test welds including specimens specially prepared for macro-examination and specimens before and after mechanical testing.
- 6.6.12 Visually examine all radiographs of test and production welds.
- 6.6.13 Witness the appropriate final pressure test.
- 6.6.14 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 Project Manager for examination.
- 6.6.15 X-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 Project Manager.
- 6.6.16 The Contractor should carry out all other non-destructive testing and shall submit copies of fully detailed test reports to the Project Manager for examination.
- 6.6.17 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.
- 6.6.18 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. Techniques shall be to BS EN 10160. A laminar defect shall not be accepted if it exceeds 25 mm in any direction.
- 6.6.19 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 1290.
- 6.6.20 A radiographic procedure accompanied by radiographs of sample welds shall be submitted to the Project Manager and the independent welding inspector for approval. Approval of the radiography procedure shall be obtained before the commencement of production welding.
- 6.6.21 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.
- 6.6.22 Radiography for production welds shall be in accordance with the following requirements:
- 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
 - (e) Welds in any special sections of pipework as indicated in Annex A, Schedule
 - (f) Welds in fabricated fittings and manifolds

- (g) Welds at joints between components such as pipes or pipe fittings of different material grade or wall thickness
- (h) The first two welds made by each welder (or welding team)
- (i) The first weld made by each welder (or welding team) after changeover to a different welding procedure.
- (g) 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 a. above. The particular welds to be radiographed shall be selected by the Project Manager and the independent welding inspector following visual examination. Radiography carried in accordance with c. below shall be disregarded for the purposes of this paragraph.
- (k) In addition to the radiography called for in a and b above:
- (l) All repaired butt welds and all butt welds required as a consequence of the cutting out of welds containing unacceptable defects shall be subjected to radiographic examination.
- (m) In the event that an unacceptable defect in a weld is revealed by radiography carried out in accordance with b two further butt welds produced on the same day by the same welder (or welding team) shall be radiographed. Selection of the particular welds to be radiographed shall be made by the Project Manager 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.
- (n) Welds subjected to radiographic examination in accordance with a, b and c above shall be radiographed over the full length of the weld in every case.

7 Pressure Testing of Pipework

7.1 General

7.1.1 This section of the Guide applies to the pressure testing of all pipework, ferrous and GRP.

7.1.2 Ferrous pipework, shall be pressure tested at the full test pressure using water as the test medium unless this is specifically prohibited as detailed in the Annex A, Schedule. 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.

7.1.3 GRP pipework shall undergo a preliminary leak test using air, followed by a full pressure test using the process liquid as the test medium.

7.1.4 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.

7.1.5 A schedule of operations should be submitted as detailed in Clause 7.1.4 including preliminary leak testing if this is required, to the Project Manager 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. For details of timescale and the number of schedules required see Annex A, Schedule. Project Manager's approval should be provided for the complete test procedure in advance of the first test of any description taking place. The programme shall take into account the position of test fluid sources and the sequence of operations, and provide for the possibility of failure requiring additional test fluids.

7.1.6 The full pressure test should be carried out by a specialist sub-contractor approved by the Project Manager. 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 testing operations.

7.2 Preliminary Leak Testing

7.2.1 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 Project Manager provided that the tie-in welds have been 100% radiographed.

7.2.2 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.

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

7.2.4 Safety with air testing: When air is used as the test medium the requirements of H&SE Guidance Note GS4 – Safety in Pressure Testing shall be met. Before the pressure is raised the Contractor shall inform the Project Manager of the safety precautions taken.

7.2.5 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 Project Manager.

7.3 Full Pressure Testing

7.3.1 The pressure for the full pressure test shall be as follows:

For ferrous pipework	29.0 barg (1.5 x design pressure (Class 150))
For GRP pipework	1.5 times the normal operating pressure (See Annex A, Schedule)

7.3.2 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.

7.3.3 Where tees, elbows, reducers and other fittings are welded into existing pipework, the Project Manager 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 7.2 are applied. This shall be followed by a hydrostatic test of the pipework at its normal operating pressure as stated in Annex A, Schedule, as agreed by the Project Manager.

7.3.4 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 every 15 minutes.

7.3.5 Should any failure occur during hydrostatic testing this shall be rectified and repeat the test to the satisfaction of the Project Manager. Where fuel is used as the test medium this shall be

drawn off for reuse and gas free the pipework before repairs are executed. Works shall be undertaken in accordance with the JSP 375 Volume 3 Chapter 5 - Petroleum for Work on Petroleum Installations.

- 7.3.6 The sections to be hydrostatically tested shall be fitted with the liquid test medium. The air shall be eliminated through vent valves at all high points in the pipeline. The temperature of the product in buried sections shall be monitored and if in the opinion of the Project Manager 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, to prevent the formation of air pockets.
- 7.3.7 The pressure shall be raised to 7 barg and the volume of product 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 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.
- 7.3.8 If the air content is satisfactory the test pressure shall be raised at a uniform rate of 0.5 bar/min to the test pressure. The test pressure shall be held for 2 hours.
- 7.3.9 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.
- 7.3.10 Written acceptance is required from the Project Manager 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.
- 7.3.11 Records shall be maintained to the satisfaction of the Project Manager, 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.

7.4 Test Instruments

- 7.4.1 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 Project Manager. Current test and calibration certificates for the dead weight testers and associated instruments shall be available on site for inspection by the Project Manager and shall include copies of all such certificates in the pressure test records.

8 Protection of Ferrous Pipework

8.1 General

- 8.1.1 This section of the Guide applies to the protection, both internally and externally, of all ferrous pipework.
- 8.1.2 Fully-detailed data sheets and certificates of conformity with the relevant standards in respect of all materials 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 Project Manager.

8.2 Internal protection

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

8.2.2 The internal surface of all carbon steel pipework and fittings shall be left as bare metal unless otherwise stated in Annex A Schedule. Sections which are to be treated internally shall be coated in accordance with DW FS Specification 032 Internal coating of Aviation Fuel Tanks

8.3 External Protection - Above Ground Pipework

8.3.1 The external surface of all above ground stainless steel pipework shall be to the following requirements:

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

8.3.3 All associated valves, equipment and carbon steel pipe supports shall be prepared and painted in accordance with the requirements specified in Clause 8.3.2 below.

8.3.4 When tone-down is specified in the Annex A, Schedule, 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	See Annex A Schedule

The external surface of all above ground carbon steel pipework, fittings supports, valves and equipment shall be protected in accordance with the following requirements, as directed by Annex A, Schedule.

	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 50 microns Min	Epoxy Zinc Min DFT : Rich DFT : 75 microns
Intermediate	Epoxy, Micaceous Iron Oxide Iron Oxide	Epoxy, Micaceous Min DFT : 100 microns Min DFT : 125 microns
Finish	Recoatible polyurethane Min DFT : 50 microns	
Colour	See Annex A Schedule	

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 above ground carbon steel pipework, fittings, supports, valves and equipment where the Project Manager determines abrasive blast cleaning is not appropriate, shall be painted in accordance with the following requirements, as directed by Annex A, Schedule.

Normal Atmosphere	Saliferous Atmosphere	
Surface preparation	Mechanical preparation to BS 7079 Sa 3 standard	
Primer	Surface tolerant high build epoxy mastic Min DFT : 75 microns	
Intermediate	Surface tolerant High build epoxy build epoxy mastic Min DFT : 75 microns	Surface tolerant High build epoxy mastic Min DFT : 125 microns
Finish	Recoatible polyurethane. Min DFT 50 microns	
Colour	See Annex A Schedule	

The external surface of all above ground, trace heated carbon steel pipework, fittings, valves and equipments 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 Inorganic Zinc Silicate	DFT 60 microns (-0 + 15 microns)
Cure	Cure strictly in accordance with Manufacturer's instructions

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

8.4.1 The external surface of all buried stainless steel pipework and fittings shall be left as bare metal.

8.4.2 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 below and as directed by Annex A Schedule:

8.4.3 Extruded Polyethylene

8.4.4 The 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.

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

Except where the reinforced thickness coating is specified in Annex A, Schedule, the standard thickness coating shall be provided. The coating thicknesses shall not be less than the minimum permissible values indicated in the following:

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

- 8.4.6 Surfaces to be coated shall be free of all oil, grease 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.
- 8.4.7 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.
- 8.4.8 The adhesive shall then be applied by extrusion to the Manufacturer's recommended thickness.
- 8.4.9 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 an homogenous sheathing.
- 8.4.10 The adhesive and polyethylene coating shall terminate 125 ± 25 mm from each end of the pipe.
- 8.4.11 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.
- 8.4.12 All other testing and inspection of the coating shall conform to the requirements of DIN 30670.
- 8.4.13 In the event that 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.
- 8.4.14 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 file.
- 8.4.15 Repairs are to be made by means of a repair procedure approved by the Project Manager 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.

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

- 8.5.1 The external surface of all buried stainless steel pipework and fittings shall be left as bare metal unless otherwise indicated in Annex A, Schedule.
- 8.5.2 The external surface of all buried carbon steel pipework and fittings, 80mm diameter and less, shall be protected in accordance with the following requirements:
- 8.5.3 The surface shall be protected using a PVC/Laminate tape protection system.
- 8.5.4 Surfaces shall be wire brushed to remove all rust, millscale, weld spatter, dirt and other loose or deleterious matter:
- 8.5.5 Where applicable, factory coating ends shall be wire brushed for a minimum distance of 150mm, ensuring coating ends are bevelled.
- 8.5.6 Primer shall be applied immediately following completion of surface preparation in accordance with Manufacturer's recommendations.

8.5.7 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 re-priming or stripping and re-priming will be required.

8.5.8 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.

8.5.9 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 1.1mm minimum and the thickness of the PVC backing shall be 0.3mm minimum, unless a fabric reinforcement is provided in the bituminous resin, in which case thickness of the PVC backing shall be 0.1mm minimum.

8.5.10 Tape width shall be suitable to conform to the size and shape of the structure being wrapped.

8.5.11 Primer shall be that which is recommended and manufactured by the Tape Manufacturer and be a fast drying compound, suitable for cold application by spray or brush.

8.5.12 The applied tape shall be inspected to confirm that an effective bond is formed between the pipe surface and the tape. This inspection shall be carried out no less than 24 hours after application.

8.5.13 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:

8.5.14 Three layers of tape shall be applied on the pipe to form a patch.

8.5.15 The centre of the tape patch shall be punctured with a sharp instrument.

8.5.16 The voltage of the holiday detector shall be just high enough to register the puncture in the three tape layers.

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

8.6 Wrapping Field Joints and Repairs to Factory Wrapped Pipe Lengths

8.6.1 All field joints of factory-wrapped pipework shall be in accordance with Clause 8.5.2 above.

8.6.2 Coating repairs to factory-wrapped pipework shall be in accordance with Clause 8.5.2 above.

8.7 External Protection - Pipework in Pits

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

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

8.7.3

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

8.8 Cathodic Protection of Pipework

8.8.1 A professional investigation is necessary to ascertain the need for, type of and extent of the cathodic protection system required. The investigation shall take into account all local corrosion influences and effect on existing buried structures and services.

8.8.2 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, shall be designed in accordance with the specification listed in Annex A, Schedule.

8.8.3 General designs should be for 30 years life.

9.0 Tank Fittings

9.1 General

9.1.1 Tanks shall be provided with fittings as indicated on the Drawings.

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

9.1.2 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

- the ferrous materials are hot-tinned
- the ferrous materials are epoxy coated
- this Guide expressly permits otherwise
- the express prior agreement of the Project Manager has been obtained

9.1.2 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:

- zinc (including all zinc coatings), zinc compounds and alloys containing zinc;
- lead and alloys containing lead;
- copper and alloys containing 4% and above copper (unless specifically stated as being allowed in individual equipment specifications);
- cadmium and its compounds

9.1.3 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 will highlight this.

9.1.4 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).

Selection of equipment, materials and system design, shall comply with the guidelines of this Guide 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 6651
- (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

9.2 Tank Manholes

9.2.1 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 manhole diameters are given below unless otherwise indicated in Annex A, Schedule. The minimum requirement for tank entry by personnel is two manways.

Tank type:	Manhole Internal Diameter (mm)	Minimum number
Horizontal < 15 m ³	800 mm	1
Horizontal > 15 m ³	800 mm	2
< 30 m ³	800 mm	2
Vertical < 10 m Diameter	1000 mm	2
Vertical Tank > 10 m Diameter	1000 mm	3

9.2.2 Manholes are sized to assure safe entry and exit to tanks for personnel using breathing apparatus and personnel protective equipment.

9.3 Pressure/Vacuum Valves

9.3.1 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 6mm.

9.4 Free Vents

Size	As shown on the Drawings; usually at least as large as the incoming fill pipe to act as an overflow in case of tank overflowing.
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 6mm. Screen on aviation tank vents does not have to conform to 9.1.2.

9.5 Emergency Venting

9.5.1 The venting arrangements described in (9.3 and 9.4) are designed to cope with pressure fluctuations during normal operations. Additional pressure relief is necessary for above ground tanks to cope with possible fire engulfment. The emergency vent shall be in accordance with API 2000.

9.6 Dip and Sampling Hatches

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

Size 100mm (4")

Type Self closing with provision for padlock.

Material Cast Aluminium

9.7 Combined Dip and Vent Fittings

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

Size Vent size as shown on Drawings; 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.

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

9.7.3 Screen on aviation tank does not have to conform to 9.1.2.

9.8 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.

9.9 Dipstick

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 – 4m max length.

Markings Engraved (one face only). Installation and tank identification (in a form approved by the Project Manager) to be included.

Graduations Required along entire length of dipstick as indicated below:

Nominal capacity of Tank (litre	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

9.9.7 Graduation marks together with corresponding capacity in litre units to appear at main divisions.

9.9.8 Graduation marks alone to appear at sub-divisions.

9.10 Dip Tape

9.10.1 Spring steel with stainless steel dipping weight generally as illustrated in the Institution of Petroleum Measurement manual. To be graduated in millimetres.

9.11 Flame Arrestors

9.11.1 Safety device to prevent the propagation of a flame through a flammable vapour into the tank. Normally only applicable to Class I product tanks.

9.11.2 Capacity To be at least 300% of associated free vents or PV valves.(reference items 9.3 and 9.4)

9.11.3 Type Tube Bank with capability of sealing flame arrester with tube bank removed. If “dummy” tube banks are required for this they are to be clearly marked as such.

9.11.4 Body Materials Carbon steel or cast iron

Tube Bank Materials 18/8 stainless steel

Inspection and Maintenance Tube banks to be readily removable without dismantling the flame arrester;

Atmospheric Openings To be fitted with a 6mm x 6mm stainless steel mesh screen only.

9.12 Floating Suction

9.12.1 General

9.12.1.1 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.

9.12.1.2 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.

- 9.12.1.3 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.
- 9.12.1.4 The overall dimensions, movement envelope and general arrangement of each floating suction unit shall be designed to suit the particular 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.
- 9.12.1.5 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.
- 9.12.1.6 The nominal diameter of each floating suction unit shall be as indicated on the Drawings.

9.12.2 Materials of Construction

- 9.12.2.1 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.
- 9.12.2.2 Non-machined surfaces of aluminium alloy castings shall be lightly abraded to remove all traces of moulding sand and loose metal.

9.12.3 Components and Accessories

- 9.12.3 (a) 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.
- 9.12.3. (b) 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.
- 9.12.3 (c) 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.

- 9.12.3 (d) 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.
- 9.12.3 (e) 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 so as 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 Project Manager.
- 9.12.3 (f) Unless otherwise indicated, an external indicator designed to show the position of the suction arm within the tank, shall not be provided.

9.12.4 Pressure Tests

- 9.12.4 (a) 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.
- 9.12.4 (b) 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.
- 9.12.4 (c) Throughout the specified test periods there shall be no evidence of any leaks, undue distortion or other defects.
- 9.12.4 (d) Certified fully-detailed records of the pressure tests carried out shall be supplied to the Project Manager.

10. Horizontal Steel Tanks

Up to and including 90m³ Capacity for Installation above Ground

10.1 Design and Manufacture

- 10.1.1 This Guide deals with single skin steel tanks up to 90m³, specification as BS EN 12285 - 2. For specification details of tanks larger than 90m³, contact DE TA.
- 10.1.2 For details of tank fittings including tank manhole requirements see Section 9.
- 10.1.3 The tanks shall be designed and constructed to BS EN 12285 -2 except as modified by or augmented in this Guide and the Drawings.
- 10.1.4 The density and vapour pressure of the product and the design temperature will be as stated in Annex A Schedule.
- 10.1.5 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.

- 10.1.6 Tanks shall be designed to resist loading due to self weight, wind and hydrostatic testing and where applicable, external loading.
- 10.1.7 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 note the inflow and outflow rates as stated in Annex A Schedule, when determining the size of vents.

10.2 Shell Plate Arrangement

- 10.2.1 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 clause 4.5 of BS EN 12285 -2.
- 10.2.2 The shells shall be fabricated using an approved number of rings each rolled from a single piece of plate or from not more than 2 plates welded together.
- 10.2.3 No 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°.
- 10.2.4 Where an end plate is made up from 2 smaller plates, the welded joint between them shall lie at or above the centre of the tank end.

10.3 Fabrication Drawings

- 10.3.1 Fabrication drawings for the tanks shall be prepared and submitted to the Project Manager before starting fabrication. For details of timescale and number of drawings required see Annex A, Schedule. 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 of manholes.
- 10.3.2 Welding procedures complying with all relevant requirements of BS EN 1011 parts 1, 2 and 3 shall be submitted to the Project Manager at the same time as the fabrication drawings detailed in Clause 10.3.1.

10.4 Earthing Fittings

- 10.4.1 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 Guide and the following standards:
- 10.4.2 Code of practice for Control of Undesirable Static Electricity PD CLC/TR 50404
Protection of structures against lightning; BS 6651.
Code of Practice for Earthing BS 7430
Cathodic Protection of Buried Metallic Tanks and Related Piping BS EN 13636
Model Code of Safe Practice for the Petroleum Industry Part 1 Electrical Safety Code.

10.4.3 Each tank shall be provided with 2 welded on earthing bosses, 30mm x 45mm 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.

10.5 Welding procedure

10.5.1 Welding procedures shall be qualified to BS EN 15607 and welders to BS EN 1011 parts 1, 2 and 3

10.5.2 Welding shall be in accordance with BS EN 1011 -1. Butt welding shall be used on shell and dished ends.

10.5.3 The Contractor shall supply all the specialist personnel and equipment required to carry out the welding, inspection and weld tests specified.

10.5.4 All welds shall be visually examined to the requirement of BS EN 12285 -2

10.6 Tank Testing

10.6.1 A team of specialist testers shall be employed to carry out all tank testing.

10.6.2 Testing shall be in accordance with BS EN 12285.

10.6.3 All tests will be carried out hydrostatically using clean fresh water.

10.6.4 Any faults identified during the tests shall be repaired to the satisfaction of the Project Manager, the tank retested.

10.6.5 Pressure test certificates shall be supplied to the Project Manager. The Project Manager may appoint an inspector to witness any or all of the tests.

10.7 Painting/Protection

10.7.1 Internal surfaces of the tank shall be left clean, dry and bare except where an internal coating is required as stated in Annex A, Schedule. The internal coating where required shall be in accordance with DW FS Specification 032 Internal coating of Aviation Fuel Tanks.

10.7.2 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 Minimum dry film thickness - 50 microns
Intermediate coat	Epoxy micaceous Iron Oxide Minimum dry film thickness - 100 microns
Finish coat	Recoatable Polyurethane Minimum dry film thickness - 50 microns
Colour	See Annex A, Schedule

10.7.3 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 in Annex A, Schedule.

10.7.4 Nameplate

A brass template 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

11 Horizontal GRP Tanks for Installation Above Ground

11.1 Design and Manufacture

11.1.1 This Guide 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.

11.1.2 For details of tank fittings including tank manhole requirements see Section 9.

11.1.3 The design and detailing of these Glass Reinforced Plastic (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.

11.1.4 The tanks shall be designed and constructed in accordance with BS EN 13923.

11.1.5 The use of storage tanks completely fabricated from high resistivity materials, such as synthetic polymers and glass reinforced plastics having a volume resistivity greater than $10^8 \Omega \cdot m$ and/or a surface resistivity greater than $10^{10} \Omega \cdot m$ 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 earth. The conduction element shall be compatible with the aviation product.

11.1.6 Full details of the product to be stored including its density and vapour pressure together with the design temperature shall be as stated in Annex A Schedule.

11.1.7 Above ground GRP tanks are restricted to use on non-aviation Class III and Unclassified products.

11.1.8 Tanks shall be designed to resist loading due to self weight, hydrostatic testing and any other external loads.

11.1.9 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.

11.2 Fabrication Drawings

11.2.1 Fabrication drawings for the tanks shall be prepared and submitted to the Project Manager before starting fabrication. See Annex A, Schedule for 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 of manholes

11.3 Tank Testing

11.3.1 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.

11.3.1 Tanks shall be hydrostatically tested at the factory and a factory test certificate issued to the Project Manager.

11.3.1 Tanks shall be hydraulically tested once installed on site to a pressure as per Clause 13.3.1.

11.3.1 The supply of clean fresh water for testing shall be made available.

11.3.1 Any faults identified during the tests shall be repaired to the satisfaction of the Project Manager and the tank retested.

11.3.1 Pressure test certificates shall be supplied to the Project Manager on completion of site testing. The Project Manager may appoint an inspector to witness any or all of the tests.

11.3.1 After testing the tank is to be emptied and internally dried out and cleaned and water disposed of in accordance with current regulations.

11.4 Installation

11.4.1 The tank shall be installed on prepared foundations/piers as indicated on the Drawings.

11.5 Earthing

11.5.1 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 Guide 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 6651.
- (c) Code of Practice for Earthing – BS 7430
- (d) Model Code of Safe Practice for the Petroleum Industry: Part 1 Electrical Safety Code

11.6 Material Compatibility

11.6.1 All materials shall be subject to approval by DE TA. 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.

12 Semi-Buried, Concrete Encased, Vertical Steel Tanks

12.1 Design and Manufacture – General

- 12.1.1 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.
- 12.1.2 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 Guide or on the drawings.
- 12.1.3 The density and vapour pressure of the product and the design temperature shall be as stated in Annex A Schedule.
- 12.1.4 The tank shall be designed as a low pressure tank in accordance with BS EN 14015.
- 12.1.5 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 Chartered Engineer.
- 12.1.6 Copies of the design calculations and a certificate of structural adequacy in a form approved by the Project Manager, and signed by the above Chartered Engineer, shall be submitted to the Project Manager before tank fabrication commences
- 12.1.7 The number of copies and lead time prior to fabrication shall be as defined in Annex A, Schedule.

12.2 Tank Bottom Design

- 12.2.1 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.
- 12.2.2 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.
- 12.2.3 Unless otherwise indicated in Annex A, Schedule, the floor plates shall be lap welded throughout with the exception of 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.
- 12.2.4 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 Project Manager before construction of the screed commences. The number of copies and lead time prior to construction shall be as defined in Annex A Schedule.

12.3 Tank Roof Design

- 12.3.1 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.

- 12.3.2 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.
- 12.3.3 The tank roof columns shall be circular in cross section. Columns shall not be out of plumb by more than 6mm – i.e. no point on a line on a column intended to vertical to be more than 6mm away from a true vertical line.
- 12.3.4 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.
- 12.3.5 All hollow columns shall be filled with grade C25 concrete leaving no voids..The specification for the concrete is available as shown in Annex A, Schedule.

12.4 Tank Wall Design

- 12.4.1 Tank walls shall be designed to withstand all concrete and earth pressures.

12.5 Connections and Attachments

- 12.5.1 The tank shall be provided with nozzles as shown on the Drawings.
- 12.5.2 All nozzles and openings shall be reinforced in accordance with BS EN 14015. All nozzles shall be extended to pass through the concrete encasement.
- 12.5.3 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.
- 12.5.4 For details of tank fittings including tank manhole requirements see Section 9.

12.6 Earthing

- 12.6.1 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:

Electrostatics: Code of Practice for Avoidance of Hazards due to Static Electricity – PD CLC/TR 50404

Protection of structures against lightning: BS 6651.

Code of Practice for Earthing: BS 7430

Cathodic Protection of Buried Metallic Tanks and Related Piping: BS EN 13636

Model Code of Safe Practice for the Petroleum Industry: Part 1. Electrical Safety Code

12.7 Workmanship – Preparation of Plate and Members

- 12.7.1 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.
- 12.7.2 External protection shall be applied to the underside of all tank bottom plates prior to assembly.

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- 12.7.3 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.
- 12.7.4 Approval for manual cutting of edges to be welded shall be obtained from the Project Manager.
- 12.7.5 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.
- 12.7.6 A marking drawing shall be prepared and all steel marked to indicate its position in the structure to assist erection.
- 12.7.7 A weld sequence shall be prepared for butt joints in base plates and submitted to Project Manager for approval.
- 12.7.8 All burrs and sharp edges shall be removed by grinding.

12.8 Workmanship – Tank Floor

- 12.8.1 The internal drainage fall to the centre sump shall not be impaired and should this occur proposals shall be submitted to the Project Manager for correcting such faults.
- 12.8.2 The drain sump shall be shop fabricated and shop tested to the satisfaction of the Project Manager.
- 12.8.3 Shop testing shall include subsection of all welds to dye penetrant examination.
- 12.8.4 The bottom plates shall not be bolted or otherwise permanently fixed to the concrete floor slab.

12.9 Workmanship – Tank Roof

- 12.9.1 Internal supports shall be pre-loaded as required by the Project Manager to ensure that base plates under supports are in direct contact with concrete screed below.
- 12.9.2 Plate laps and nozzles shall be seal welded on the underside of the roof before applying either internal or external surface treatment.

12.10 Workmanship – Tank Walls/Encasement

- 12.10.1 The Project Manager shall be furnished with full details of the proposed methods for protection of the shell during erection, prior to the commencement of construction.
- 12.10.2 All temporary works necessary to support the steel tank during casting of the concrete jacket shall be designed and provided.
- 12.10.3 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 3 days following pouring of concrete.

12.11 Workmanship – Welding

- 12.11.1 This section of the Specification shall be read as supplementary to BS EN 14015 such that clauses within this Specification form additions to the requirements.
- 12.11.2 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.
- 12.11.3 A competent representative shall be designated, with whom the Project Manager 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.
- 12.11.4 Only qualified craftsmen shall be employed to perform any aspect of the work including testing were required. Any craftsman considered by the Project Manager to be unsuitable shall be removed.
- 12.11.5 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 Project Manager 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.
- 12.11.6 The Project Manager and the independent welding inspector shall be informed before making any repairs to welds where defects have been found.
- 12.11.7 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.
- 12.11.8 Unless approved otherwise by the Project Manager, 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 non-destructive testing (visual, radiographic, ultrasonic and magnetic particle)
- 12.11.9 See Annex A, Schedule, for 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

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- (c) Tools and equipment shall be provided in good operating condition and of a capacity suited for the work.
- 12.11.10 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 Project Manager. See Annex A, Schedule, for number of copies required.
- 12.11.11 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.
- 12.11.12 Welding Standard shall be in accordance with BS EN 14015 and as augmented in the Specification.
- 12.11.13 Qualification of Welding Procedures shall comply with the following requirements:
- (a) Details of procedures shall be provided in a form approved by the Project Manager.
 - (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 detailing clearly the sequence in which the joints are to be welded. Once approved this sequence shall be strictly adhered to.
- 12.11.14 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 Project Manager 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. 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.

12.11.15 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

12.11.16 Following Tank Production Welding all manual oxygen cut edges shall be dressed to a smooth clean profile by grinding. Undercuts for horizontal butt joints or fillet welds shall not exceed 0.5mm.

12.11.17 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.

12.11.18 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 Project Manager 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.

12.11.19 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 using power driven wire brushes.

12.11.20 The Project Manager and the independent welding inspector will carry out the interpretation of non-destructive testing (NDT) work covered by this subsection. of.

12.11.21 Such facilities and attendance will be provided (including affording adequate prior notice) as may reasonably be required to enable the Project Manager 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) Satisfy himself 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

12.11.22 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 Project Manager and the independent inspector and 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 non-destructive 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.

12.11.23 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 Project Manager 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.

12.11.57 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.

12.12 Tank Testing

- 12.12.1 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
- 12.12.2 The vacuum box method shall be used for testing the tank bottom weld seams.
- 12.12.3 Fresh clean water shall be provided for the purpose of testing, maintain the water supply in a clean and un-contaminated condition within tanks during testing and make all necessary provisions for the safe disposal of the water on completion.
- 12.12.4 The Contract programme should take into account 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.
- 12.12.5 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 $\frac{3}{4}$ 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.
- 12.12.6 Detailed hydrostatic test procedures before any testing operations are started shall be provided to the Project manager.
- 12.12.7 At least eight 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 Project Manager
- 12.12.8 Levels shall be recorded at each reference point against a known datum during each stage of filling and shall be submitted to the Project Manager for approval.
- 12.12.9 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.
- 12.12.10 In the event of uneven settlement or leakage occurring, the water filling shall be stopped immediately and reported to the Project Manager. With the Project Manager's approval the emergency procedures shall be implemented.

12.13 Paintings/Coatings

- 12.13.1 Internal surfaces shall be left clean, dry and bare, except where internal epoxy coating is required as stated in Annex A, Schedule.
- 12.13.2 The internal coating, where required, shall be in accordance with DWFS Specification 032 Internal Coating of Aviation Fuel Tanks.
- 12.13.3 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.

- 12.13.4 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.
- 12.13.5 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.
- 12.13.6 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.

12.14 Cleaning

- 12.14.1 On completion of coating and other internal work, the interior of the tank shall be left clean, dry, and free from foreign objects and in all other respects fit to receive fuel.

13 Unprotected 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 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.
- 13.1.2 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.
- 13.1.3 The density and vapour pressure of the product and the design temperature shall be as stated in Annex A Schedule.
- 13.1.4 The tank shall be designed as a low pressure tank in accordance with table 3 of BS EN 14015
- 13.1.5 Design calculations shall be prepared for the tanks. Design calculations in a form approved by the Project Manager shall be supplied. The number of copies and lead time prior to fabrication shall be as defined in Annex A, Schedule.

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.
- 13.2.1 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.
- 13.2.1 A central sump shall be incorporated in the tank bottom to facilitate water draw-off and be designed in accordance with figure 0.5 a – alternative arrangement: BS EN 14015.

13.3 Tank Roof Design

- 13.3.1 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.

The roof shall be designed as a self supporting structure.

13.4 Connections and Attachments

13.4.1 The tank shall be provided with nozzles and openings as shown on the drawings.

13.4.2 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.

13.4.3 For details of tank fittings including tank manhole requirements see Section 9

13.5 Earthing

13.5.1 The number of earthing bosses required shall be as indicated in Annex A, Schedule, and these shall be spaced symmetrically around the tank shell.

13.5.2 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).

13.5.3 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 6651
- (c) Code of Practice for Earthing – BS 7430
- (d) Cathodic Protection of buried Metallic tanks and Related Piping BS EN 13636

13.6 Workmanship – Preparation of Plate and Members

13.6.1 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.

13.6.2 External protection shall be applied to the underside of all bottom plates prior to assembly.

13.6.3 All burrs and sharp edges arises shall be removed by grinding.

13.7 Workmanship – Tank Floor.

13.7.1 The internal drainage fall to the centre sump shall not be impaired and should this occur, proposals shall be submitted to the Project Manager for correcting such faults.

13.7.2 The drain sump shall be shop fabricated and shop tested to the satisfaction of the Project Manager.

13.7.3 Shop testing shall include subsection of all welds to dye penetrant examination.

13.8 Workmanship – Tank Roof

13.8.1 Plate laps and nozzles shall be seal welded on the underside of the roof before applying either internal or external surface treatment.

13.9 Workmanship – Tank Shell

13.9.1 The Project Manager shall be furnished with full details of his proposed method for the protection of the tank shell during erection. The following factors shall be taken into account 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

13.9.2 The use of steel wire guys or cables may not be necessarily be adequate and consideration should be given to the use of temporary wind girders.

13.10 Workmanship – Welding

13.10.1 This section of the specification shall be read as supplementary to BS EN 14015 such clauses 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 Project Manager 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 Project Manager to be unsuitable, shall be removed.
- (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 Project Manager 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.

13.20.02 The Project Manager and the independent welding inspector shall be informed before repairs are made to welds where defects have been found.

- (a) Procedure and welder qualification tests shall be carried out in accordance with the clauses which follow:
- (b) 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.

13.10.03 Unless approved otherwise by the Project Manager, 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 and of a capacity suited for the work.

13.10.04 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.

13.10.05 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 Project Manager. (See Annex A, Schedule)

13.10.06 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.
- (e) Electrodes shall be supplied in clearly identified hermetically sealed containers.

13.10.07 Welding standards shall be in accordance with the requirements of BS EN 14015 as augmented in the specification.

13.10.08 Qualification of welding procedures shall comply with the following requirements:

- (a) Details of procedures shall be provided in a form approved by the Project Manager.
- (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 procedure, detailing clearly the sequence in which the joints are to be welded. Once approved this sequence shall be strictly adhered to.

13.10.09 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 Project Manager 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.
- (e) 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.

13.10.10 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.

13.10.11 Following tank production welding, all manual oxygen cut edges shall be dressed to a smooth clean profile by grinding. Undercut for horizontal butt joints or fillet welds shall not exceed 0.5 mm.

13.10.12 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.

13.10.13 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.

13.10.14 Before inspection, each completed joint shall be thoroughly cleaned using power driven wire brushes.

13.10.15 The Project Manager and the independent welding inspector will carry out the interpretation of non-destructive testing (NDT) work covered by this sub-section. The

contractor shall carry out all specified NDT work.

13.10.16 Inspection by the Project Manager 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.

13.10.17 The contractor shall provide such facilities and attendance (including affording adequate prior notice) as may reasonably be required to enable the Project Manager and the independent welding inspector to:

13.10.18 Carry out their inspection duties as described in this sub-section

- (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

13.10.19 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 Project Manager 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.

13.10.20 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 Project Manager 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

13.11 Tank Testing

- 13.11.1 A comprehensive hydraulic test procedure shall be provided by the contractor and agreed with the Project Manager.
- 13.11.2 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.
- 13.11.3 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.
- 13.11.4 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.
- 13.11.5 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.
- 13.11.6 If the ambient temperature is equal to or below 0° C, the necessary measures are to be taken to avoid freezing.
- 13.11.7 The contract programme shall take into account the time required for tank filling.
- 13.11.8 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 $\frac{3}{4}$ 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
- 13.11.9 At least eight 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 Project Manager.
- 13.11.10 Levels shall be recorded of each reference point against a known datum during each stage of filling and shall be submitted to the Project Manager for approval.
- 13.11.11 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.
- 13.11.12 In the event of uneven settlement or leakage occurring, the water filling shall be stopped immediately and reported to the Project Manager. Previously agreed procedures shall then be put into operation.
- 13.11.13 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.

13.12 Painting/Coating

13.12.1 Internal surfaces shall be left clean, dry and bare, except where internal epoxy coating is required as stated in Annex A, Schedule.

13.12.3 The internal coating, where required, shall be in accordance with DWFS Specification 032 Internal Coating of Aviation Fuel Tanks.

13.12.4 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.

13.12.5 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 Dry Film Thickness of 125 microns per coat.

13.12.6 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
Surface profile 50 – 75 microns

Primer coat Epoxy zinc phosphate
Minimum dry film thickness 50 microns

Intermediate coat Epoxy micaceous iron oxide
Minimum dry film thickness 100 microns

Finish coat Re-coatable polyurethane
Minimum dry film thickness 100 microns

Colour See Annex A, Schedule

13.13 Cleaning

13.13.1 On completion of coating and other internal work, the interior of the tank shall be left clean, dry and free from foreign objects and in all other respects, fit to receive fuel.

14 Tank Calibration

14.1 General

14.1.1 Tank calibration shall be carried out by an approved firm of specialist calibrators.

14.1.2 Tanks shall be calibrated when empty and subsequent to final site testing.

14.1.3 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’.

14.1.4 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.

14.1.5 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

14.1.6 Buried or mounded tanks without concrete encasement shall be calibrated after back-filling and, if required after mounding has been completed.

14.1.7 Protected concrete encased tanks shall be calibrated after encasement has been completed and allowed to cure for at least 7 days.

14.1.8 The following items shall be provided to the Project Manager in respect of each tank:

- One copy of the measurement data and calculations
- Three copies of the basic 'metric' calibration tables in individual clear plastic envelopes
- Basic calibration tables shall be in litres at 15° C standard temperature
- The particular hatch to which the calibration data applies shall be clearly and permanently marked

14.2 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										
NOMINAL HEIGHT										
NOMINAL DIAMETER/LENGTH										
INSTALLATION NUMBER										
CALIBRATION PROCEDURE										
CALIBRATION DATE										
DEPTH IN MILLIMETERS										
	0	1	2	3	4	5	6	7	8	9
0										
10										
20										
etc										

capacity below
(capacity in litres)

Nominal capacity 200,000 litre and over (capacity in litres at 15° C)

DEPTH IN MILLIMETERS										
	0	1	2	3	4	5	6	7	8	9
0										
10										
20										
etc										

Notes:

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.

15 Commissioning

15.1 General

15.1.1 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 Volume 3 Chapter 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 oils to a minimum and contain any such leakage.

15.1.2 Any spills of fuel or oil shall be cleaned up immediately they occur and any remediation to the ground that may be required.

15.1.3 The disposal of fuel after commissioning shall be as directed by the Project Manager.

15.2 Pre-Commissioning

15.2.1 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.

15.2.2 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.

15.2.3 The commissioning schedule shall be submitted to the Project Manager for approval before commissioning is due to commence.

15.2.4 See Annex A, Schedule for time scale and number of copies required.

15.2.5 The Project Manager shall be notified in writing of the proposed fuel quantities required for commissioning or testing, before they are required. The final requirement for fuel supplies shall be confirmed to the Project Manager before the fuel is required at the site.

15.2.6 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 Project Manager of test certificates in respect of the testing referred to in the foregoing item 'a' ; these 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.
- 15.2.08 Written confirmation shall be provided to the Project Manager that the above checks have been undertaken and that the installation is in a suitable, safe condition to accept fuel.
- 15.2.09 Prior to fuel being introduced into the installation, approval must be sought from the Operating Authority, who will initiate the licensing actions.
- 15.2.10 The Project Manager will 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 Operating Authority for fuel to be introduced in accordance with Joint Service Regulations for the Storage and Handling of Fuels and Lubricants (JSP 317).

15.3 Acceptance Testing

- 15.3.1 Full working tests of all aspects of the installations covered under this specification shall be carried out in accordance with the approved commissioning schedule.
- 15.3.2 Major contamination, shall be removed from fuel using temporary strainers, before insertion into filters of fine filtration elements.
- 15.3.3 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.
- 15.3.4 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.
- 15.3.5 The Project Manager will make arrangements to check that the final fuel quality has not been impaired by contact with completed work.

15.4 Handover

- 15.4.1 The contractor must give the Project Manager all test certificates, including works test certificates, of all pressure vessels, valves, radiography records, completed commissioning schedules and any other documents requested before handover.
- 15.4.2 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, prior to handover.

Annex A

Schedule

A.1 General

A.1.1 The following Schedule, 20 pages in total, affords the Project Manager and Design Engineer the means of providing information to prospective contractors prior to return tender submissions.

A.1.2 It is intended that the Schedules are completed by the Project Manager or Design Team and are included with the tender package provided by the Project Manager to potential contractors.

A.1.3 Generally the schedules provide:

- (a) Details of the petroleum products to be handled and any special considerations/requirements.
- (b) Specific design information required by the contractor.
- (c) Specific actions required to be undertaken by the contractor, for example requirements for approval drawings, maintenance document requirements, timescales.
- (d) Provide a checklist for the Project Manager and Design Team.

Location:

Date:

Issued to:

.....

Issued by:

.....

Page	Continuation Page(s)	Issued (Yes/No)
1		
2		
3		
4		
5		
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19		

Information to be Supplied to the Tenderer

Clause	Item	Requirement

1.1.4 Comprehensive planned preventative maintenance : Required*
Not required*

1.15 12 month Internal tank inspection Required*
Not required*

1.2.1 j Types of fuels to be handled :
Section of pipework where this fuel is used :

1.4.1 Period of Proven performance :

1.5.1 Standards referred to for this Contract :
:
:
:

Standards continuation provided : Yes*
No*

Schedule – Page 2 of 20

For use with DIO Practitioner Guide Specification for Specialist Works on Petroleum Installations – Mechanical

*Delete as necessary

Information to be Supplied to the Tenderer

Clause	Item	Requirement

- 1.7.3 Number of copies of all drawings required to be submitted to the Project Manager :
- For approval of detail :
- For approval of record drawings :
- For issue of approved drawings for site control purposes :
- Other issues (specify) :
- Requirements for issue of drawings for approval to the Project Manager :
- a) For drawings required by other documents referred to in the Specification : As specified in those documents
- b) For installation drawings prior to ordering materials or commencement of work, whichever is earlier :

Information to be Supplied to the Tenderer

Clause	Item	Requirement
--------	------	-------------

1.7.5 cont c)	For drawings showing relationships between disciplines prior to ordering materials or commencement of work, whichever is earlier	: Weeks
d)	For general arrangements of equipment, prior to ordering that equipment	: Weeks
e)	For drawings showing greater engineering detail if ordered by the Project Manager	: Weeks
f)	For Record Drawings, prior to Schedules completion of Contract	: Weeks
g)	For Planometrics, prior to scheduled completion of Contract	: Weeks
1.8.1	Format for Record Drawings	: Opaque Paper* Translucent Paper* CAD Disc* Other (specify)*

Information to be Supplied to the Tenderer

Clause	Item	Requirement
--------	------	-------------

1.8.2	Record drawings to be supplied in addition to those required by Clause 1.8.1 (a)	:	
1.8.2	Number of copies of each drawing required for record purposes	:	
1.9.4	Number of copies of the spares list required	:	
	Time period required, prior to completion of the Contract, for submission of the Maintenance and Operating documents and spares list	:	Months
1.9.5	Training for site personnel		Required* Not required*

Information to be Supplied to the Tenderer

Clause	Item	Requirement

- 2.1.7 Prior notification to Project Manager of date of materials
dispatch : Days
- 2.2.1 Process conditions for system 1AA pipework : Not required*
 - Process liquid :
 - Normal Operating Pressure
 - Design pressure : (19.3 barg max)
 - Design temperature :
- 2.3.1 Process conditions for system 1AB pipework : Not required*
 - Process liquid :
 - Normal Operating Pressure :
 - Design pressure : (19.3 barg max)
 - Design temperature :
 - Phosphate conversion coating for carbon
steel line pipe : Required*
 - : Not required*

Information to be Supplied to the Tenderer

Clause	Item	Requirement

2.4.1 Process conditions for system 1AC pipework : Not required*

- Process liquid :
- Additives :
- Normal Operating Pressure :
- Design pressure :
- Design temperature :

Note: Check these conditions against the requirements as set out in Schedule. Clause 7.3.1. b)

2.5.1 Hose coupling type for dispense point : BS EN ISO 228*
 BS 2464 *
 Not required *
 Size

2.5.1 Hose coupling type for slops point : BS EN ISO 228*
 : BS 2464 *
 Not required *
 Size

Hose coupling type for off load point : BS EN ISO 228*
 Not required *
 Size

2.5.3 British / American hose adaptor : Required*
 Not required *
 Size

*Delete as necessary

Information to be Supplied to the Tenderer

Clause	Item	Requirement

Environmental conditions for valves located outside

Temperature range :
 Humidity range :
 Location :

Valve testing – inspection at works Required *
 Not required *

3.1.11 Motorised actuator Specification :

3.2 to 3.7 Valve schedules – Attached at :

3.8 Relief valve schedule – Attached at :

3.9.2 Line pressure actuated control valve schedule
 Attached at :

3.9.3 Line actuated control valve material : Carbon steel*
 : Aluminium *

Information to be Supplied to the Tenderer

Clause	Item	Requirement
--------	------	-------------

4.1.1	Reduced design pressure	:	Applicable *
		:	Not applicable *
	Sections where reduced design pressure is applicable	:	
	Reduced design pressure	:	
4.1.4	Internal coating of equipment	:	Required *
			Not required *
	Equipment requiring internal coating	:	
4.9.1	Mesh size	:	
4.9.2	Mesh size	:	

*Delete as necessary

SCHEDULE

CONTRACT NO

Information to be Supplied to the Tenderer

Clause	Item	Requirement

4.10.1 Pressure gauge schedule attached at :

4.10.2 Differential pressure gauges

Normal operating point :

Range :

End fittings :

Pantograph requirements

Hydrant pit connection type & size :

Aircraft / vehicle connection type & size :

Meter on pantograph : Required *
Not required *

Venturi pressure sensor on pantograph Required *
Not required *

Flow/Pressure control valve : Required *
Not required *

Maximum flow rate limited to :
Maximum skin pressure limited to :
Flow/pressure control valve type :
Dead man's handle : Required *
Not required *

4.15 Body material : Stainless steel *
Aluminium alloy *

Schedule – Page 10 of 20

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*Delete as necessary

SCHEDULE

CONTRACT NO

Information to be Supplied to the Tenderer

Clause	Item	Requirement

6.2.1 Number of weld procedures for approval: Copies

 Number of Non-destructive test reports : Copies

6.6.13(a) (6) Special sections of pipework
 requiring radiographic examination
 of all included welds : Copies

Information to be Supplied to the Tenderer

Clause	Item	Requirement

Pipework sections where water is the pressure test medium : All sections *
List *

Pipework sections were the process liquid is the pressure test medium : Not applicable *
List *

Process liquid used for the fully pressure test when water is prohibited :

7.1.5 Works schedule : Copies
Timescale : Days
(prior to testing)

7.3.1 (b) Normal operating pressure facility *
Test pressure for facility : *

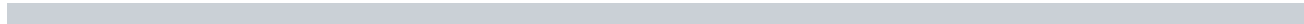
Not applicable *

7.3.3 Normal Operating Pressure at tie in points : *
Not applicable *

Information to be Supplied to the Tenderer

Clause	Item	Requirement
--------	------	-------------

8.2.2	Internal coating of carbon steel pipework: fittings to DW FS Specification 032 : Internal coating of Aviation Fuel Tanks :	Required * Not required *
8.3.1 (c)	Tone down to stainless steel pipework : Colour of tone down, where required :	Required * Not required *
8.3.2	Type of atmosphere, for painting : Colour of final coat :	Normal * Saliferous *
8.4.2	Type of external coating for buried : carbon steel pipework, larger than : 80mm diameter :	Reinforced coal tar Enamel * Extruded Polyethylene *
8.4.2.1	Minimum coating thickness for Polyethylene : System : :	Standard * Reinforced * Not required *
8.5.1	Buried stainless steel pipework : : Type of coating, if required :	Bare metal * Coated *
8.8.2	Cathodic protection system : Specification for CP system : - Available at	Required * Not required *



Defence Infrastructure Organisation

SCHEDULE CONTRACT NO

Information to be Supplied to the Tenderer

Clause	Item	Requirement

9.2.1 Number of manholes :
 Internal diameter of manhole : mm

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*Delete as necessary



Information to be Supplied to the Tenderer

Clause	Item	Requirement
--------	------	-------------

10.1.4	Product density	:	kg/l
	Product vapour pressure	:	bar
	Design temperature for tank	:	° C
10.1.7	Tank inflow rates	:	m3/hr
	Tank outflow rates	:	m3/hr
	Fabrication drawings shall be submitted to the PM (prior to commencement of fabrication)	:	Days
10.7.1	Internal coating for tank	:	Required *
			Not required *
	Exterior primer coat applied in factory, top coats applied on site	:	Required *
		:	Not required *
	Colour of final coat	:	

Information to be Supplied to the Tenderer

Clause	Item	Requirement
--------	------	-------------

11.1.7	Product density	:	kg/l
	Product vapour pressure	:	bar
	Design temperature for tank	:	° C
11.1.9	Tank inflow rate	:	m3/hr
	Tank outflow rate	:	m3/hr
	Fabrication drawings required	:	Copies
	Days (prior to commencement of fabrication)		
11.3.4	Provision of water for testing	:	By Contractor *
			By others *
11.3.7	Disposal of testing water	:	By Contractor *
			By others *

Information to be Supplied to the Tenderer

Clause	Item	Requirement
--------	------	-------------

12.13	Product density	:	kg/l
	Product vapour pressure	:	bar
	Design temperature for tank	:	° C
12.1.5	Design Calculations – Number of copies	:	
	Lead time prior to fabrication for submission of calculations	:	Weeks
12.2.1	Floor plate joint type	:	Butt weld *
	Other (specify) *		
12.2.2	Detail tank bottom drawings – number of Copies	:	
	Lead time prior to construction for submission of drawings	:	Weeks
12.3.5	Specification of concrete defined in	:	
12.10.3	Water for tank filling	:	By Contractor *
	By Others *		
12.11.2	Welding procedure drawings	:	Copies
			Days
			(prior to fabrication)
12.11.3	Non destructive tests	:	Copies
12.13.1	Internal coating of tank	:	Required *
			Not require *

Defence Infrastructure Organisation

SCHEDULE

CONTRACT NO

Information to be Supplied to the Tenderer

Clause	Item	Requirement
--------	------	-------------

13.1.3	Product density	:	kg/l
	Product vapour pressure	:	bar
	Design temperature for tank	:	° C

13.1.5 Design calculations – number of copies :
Lead time prior to fabrication for submission of calculations: Weeks

13.5.1 Number of earthing bosses required :

13.10.4(b) Non destructive tests : Copies

13.12.1 Internal coating of tank
Required *
Not required *

13.12.3 Colour of final coat :

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Property

*Delete as necessary

Information to be Supplied to the Tenderer

Clause	Item	Requirement

Commissioning schedule required for approval : Copies

Timescale : Days (before commissioning)

15.2.3 Fuel requirement : Provided by contractor *
provided by *

Notification of fuel quantity : Days (before commissioning)

Final notification of fuel requirement: Days (before commissioning)