



RP 58-1

**NON-REFRIGERATED
PETROLEUM AND PETROCHEMICAL
STORAGE**

March 1998

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BP GROUP RECOMMENDED PRACTICES AND SPECIFICATIONS FOR ENGINEERING											
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PETROCHEMICAL STORAGE (Replaces BP Engineering CP 21)											
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SCOPE AND PURPOSE This Recommended Practice covers the bulk storage of crude oil, petroleum and petrochemical products in vertical cylindrical tanks in refineries, storage terminals, chemical plants and marketing installations.											
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CUSTODIAN (See Quarterly Status List for Contact) Tankage											
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FOREWORD

Introduction to BP Group Recommended Practices and Specifications for Engineering

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

Value of this Recommended Practice

This Recommended Practice covers the bulk storage of crude oil, petroleum and petrochemical products in vertical cylindrical tanks in refineries, storage terminals, chemical plants and marketing installations.

Application

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

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

Principal Changes from Previous Edition

This document is an update of BP Engineering Code of Practice CP 21 (July 1986.) No technical changes have been made, the update comprises only re-formatting into the Recommended Practice (RP) style. Users should be aware that this document retains the prescriptive requirements of BP CP 21.

Feedback and Further Information

Users are invited to feed back any comments and to detail experiences in the application of BP Group Recommended Practices, to assist in the process of their continuous improvement.

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



1. SCOPE

This Recommended Practice covers the bulk storage of crude oil, petroleum and petrochemical products in vertical cylindrical tanks in refineries, storage terminals, chemical plants and marketing installations.

The bulk storage of liquefied petroleum gases in pressure storage vessels is covered in BP Group [RP 46-1](#)

Petrochemicals covered by this RP are those classifiable within the provisions of the IP Model Code of Safe Practice in the Petroleum Industry, Part 3.

Vertical cylindrical welded steel tanks are limited to a design pressure up to and including 140 mbar(ga) and a minimum metal design temperature of 10°C.

The following are excluded from the scope of this RP:-

- (a) Vertical, cylindrical, flat-bottomed storage tanks containing refrigerated or cryogenic liquids.
- (b) Horizontal storage tanks to [BS 2594](#).
- (c) Underground or inground storage tanks.
- (d) Storage tanks constructed from alloy steel, stainless steel and non-ferrous materials (but see 7.4.1).
- (e) Spheroid and spherical storage vessels.
- (f) Mobile storage vessels.
- (g) Prestressed concrete vessels.
- (h) Rectangular steel tanks.
- (i) Inleg storage on offshore production platforms.
- (j) Non-metallic storage vessels.



2 **QUALITY ASSURANCE**

Verification of the vendor's quality system is normally part of the pre-qualification procedure, and is therefore not specified in the core text of this specification. If this is not the case, clauses should be inserted to require the vendor to operate and be prepared to demonstrate the quality system to the purchaser. The quality system should ensure the technical and QA requirements specified in the enquiry and purchase documents are applied to all materials, equipment and services provided by sub-contractors and to any free issue materials.

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

3. **ALLOCATION OF TANKAGE**

Crude oil, petroleum and petrochemical products shall be stored as follows:-

3.1 Floating Roof Tanks

Oils with closed flash points at or below 55°C, corresponding to IP Class I and Class II products (e.g. crude oil, gasoline, naptha and kerosine), shall be stored in floating roof tanks.

3.2 Fixed Roof Non-Pressure Tanks

Oils with closed flash points above 55°C, corresponding to IP Class III products (e.g. gas oils, diesel oils, lubricating oils, fuel oils and residues), shall be stored in fixed roof non-pressure tanks.

3.3 Fixed Roof Pressure Tanks

Products which for process reasons require storage under a gas blanket shall be stored in a fixed roof pressure storage tank of appropriate design (see 7.1).

It may not be practical or economically possible to provide a gas blanket, in which case an internal floating cover would be the best alternative.

Various designs of internal floating covers are available and before any final decision is made with respect to a supplier, an appraisal should be made of the latest designs.



3.4 Exceptions

3.4.1 Where adverse climatic conditions, such as heavy snowfalls, preclude the use of floating roof type tanks for Class I and II products, fixed roof low pressure (20 mbar(ga) max.) tanks to the requirements of 5.2 of this RP may be used.

- * 3.4.2 For environmental, product conservation and operational reasons, floating covers fitted in a fixed roof, non-pressure tank may be used, subject to BP approval. When using a floating cover in a fixed roof tank, venting of the space above the cover, as recommended in [BS 2654](#) Appendix E, shall be provided. When a floating cover is specified, an additional ullage, unavailable for storage, shall be provided to accommodate the circulation vents, located in the upper part of the shell. Floating covers shall conform to BP Group [GS 158-1](#).

The unusable ullage at the upper end of the shell must allow for the siting of the shell vents and the floating cover clearance.

- * 3.4.3 Where water ingress to the existing floating roof storage tanks has to be minimised for process or other reasons, a cone roof or a lightweight geodetic structure dome fitting over the entire tank may be used, subject to BP approval.

Light weight geodetic domes are often constructed of aluminium and the structural strength of such a dome would be low in a fire. In selecting a geodetic dome, designers should consider the effect of a fire on adjacent tanks or plant.

4. TANK DIMENSIONS AND CAPACITIES

4.1 Selection of Tank Dimensions

Tanks shall conform to the standard diameters listed in Table 9 of [BS 2654](#). Heights of tanks are not standardised and the heights shown in Table 9 of [BS 2654](#) are for information purposes only. In selecting tank dimensions, the highest tank compatible with permissible ground loading, economic fabrication, and local authority restrictions should normally be chosen.

Specific attention should be given to minimising the quantity of inaccessible oil in the tank when it is at its low working level.

An approximation of the working capacity of fixed roof tanks may be arrived at by assuming the dead space at the bottom will extend to 150 mm above the suction branch, with an ullage space of 150 mm. Consideration should be given to fitting a downturned suction nozzle inside the tank to minimise the unusable volume at minimum dip.



For a floating roof tank, when deciding on the volume required for storage, an allowance must be made for the unusable volume under the floating roof, when at its lowest operating level. This level normally varies between 1.0 m and 1.9 m above the shell to bottom junction. Operating above the minimum level ensures that the roof is not being grounded and that the roof vents (bleeder vents) are not opening. If it is an operational requirement to ground the roof frequently then the increased probability of roof metal fatigue and gas ignition must be considered in the tank design stage.

To diminish the unusable volume under the floating roof, the following must be considered during the design stage:

- (a) *minimising the operating height of the roof support legs.*
- (b) *use of smaller, multiple inlet/outlet nozzles or alternatively provision of nozzles fitted with a transition neck from round to low height section.*
- (c) *provision of mixer blade recesses in the floating roof.*
- (d) *provision of the internal guides at shell manholes to protect the roof seal.*
- (e) *minimising the space required for roof drainage piping.*
- (f) *provision of adequate horizontal clearance between any pantograph weights and shell penetrations.*

For slops tankage, e.g. light and heavy slops, recovered oil, tanker ballast and washings, and also fuel oil and bitumen tanks, the working capacity of each heated tank should be based on a minimum dip of 1 m above the steam coil.

4.2 Tank Height

In selecting the height of a tank, the tank base pressure shall not exceed the safe load bearing capacity of the ground. In calculating the base pressure, the weight of the product or test water capacity, whichever is the greater, shall be used (see 7.7).

5. DESIGN CODES

5.1 Statutory Requirements

For storage tanks, the design code must comply with the requirements of the national or local authorities, including any Customs and Excise requirements, of the country in which they are to operate. Any such requirements must take precedence wherever they are more stringent than those of this RP and the contractor must ensure that these requirements are met.



5.2 Selection of Design Code

All storage tanks shall meet the requirements of BP Group [GS 158-2 \(BS2654\)](#) and the following:

For design pressures between

- (a) 6 mbar(ga) internal vacuum and 56 mbar(ga) internal pressure, the design code should be [BS 2654](#).
- (b) 6 mbar(ga) internal vacuum and an internal pressure in the range 56 mbar(ga) to 140 mbar(ga), the design code should be [BS 2654](#) with the following additional requirements from [BS 4741](#):
 - (i) Shell design.
 - (ii) Tank anchorage.
 - (iii) Pressure and vacuum relieving devices.
 - (iv) Testing.

Note 1: Storage tanks to [API 620](#) or [API 650](#) are acceptable if such tanks are more economical.

Note 2: Above 140 mbar (ga), pressure storage vessels shall be provided, in accordance with the requirements of BP Group [RP 46-1](#).

* 5.3 BP Approval Requirements

The design code shall be subject to approval by BP before design and manufacture is allowed to proceed.

6. INSPECTION

* 6.1 Statutory Requirements

The inspection of all storage tanks must comply with the design code and any statutory requirements of the national or local authorities of the country in which the storage tank will be operated. The statutory requirements may require the use of a particular inspection authority.

When there is no statutory inspection authority and independent inspection is required, appointment of the independent inspecting authority shall be subject to approval by BP.



6.2 BP Requirements

Inspection shall meet the requirements of the vertical steel welded tanks section of BP Group [RP 32-1](#).

* 6.3 Additional Requirements

BP may specify additional inspection requirements to supplement statutory and code requirements.

7. MECHANICAL DESIGN

7.1 Design Pressure

Tanks are classified as non-pressure, low-pressure or high-pressure tanks. For a given duty, the appropriate class shall be selected to give a reasonable pressure margin above the operating pressure. Note that for internal pressures between 56 and 140 mbar(ga), additional design measures, detailed in 5.2(b) of this RP are required.

For tanks not designed to [BS 2654](#), the design pressure shall be selected to give a reasonable pressure margin above the operating pressure. To ensure complete pressure tightness of the pressure vent valve, the tank gas operating pressure should not be more than 75% of the valve set pressure.

7.2 Design Temperature

- * 7.2.1 The minimum design metal temperature shall normally not be lower than 10°C. When the shell temperature is controlled by ambient conditions and the ambient temperature is lower than 10°C, BP will specify any requirements with regards to notch toughness.

All tank materials must possess sufficient low temperature toughness to reduce a possibility of brittle fracture occurring during tank hydrostatic test and during operation. For a storage tank, the required toughness of the materials is chosen on the basis of two low temperature conditions:

- (a) *that existing during normal operation,*
- (b) *that existing during the first hydrostatic test.*

The lowest temperature permitted during normal operation is designated as the minimum design temperature and is the lowest of the product temperature and LODMAT+10°C in the UK or LODMAT+5°C elsewhere, where LODMAT cannot be established accurately (LODMAT =Lowest one day mean average temperature).

The lowest temperature existing during the hydrostatic test is the test water temperature.



Because the material toughness is improved during the tank's first hydrostatic test, the toughness requirement at lower design temperature may be less stringent than the toughness requirement at higher hydrostatic test temperature.

For this reason the basis of the material toughness testing must be considered, taking into account both environmental and process conditions and agreed with the contractor at the pre-contract stage.

- * 7.2.2 The maximum design metal temperature shall not exceed 150°C unless approved by BP. Full details of materials and design stresses shall be submitted at the tender stage. It should be noted that [BS 2654](#) requires consideration of the effect of the reduction of minimum yield strength, and the consequent reduction of the maximum allowable design stress, for temperatures above 150°C.

- * 7.2.3 Unless otherwise stated, BP will specify the maximum and minimum design metal temperature for all storage tanks.

7.3 Specific Gravity

A specific gravity of 1.0 or the product material specific gravity, whichever is the greater, shall be assumed for tank design purposes.

7.4 Material Selection

- * 7.4.1 The contractor shall select tank materials suitable for the product stored. Normally these materials will be carbon and carbon-manganese steels and shall comply with the requirements of BP Group [GS 158-2](#). When the contractor proposes materials other than carbon and carbon-manganese steels, e.g. stainless steels, the material specification and the design code to be used shall be subject to approval by BP.

On hazardous duties where stainless steel materials have been selected, consideration should be given to the use of butt welded bottoms and roofs rather than the more conventional lapped weld. In such instances the welds should be fully penetrated and welded from both sides. Details of the precautions the tank vendor intends to take to minimise distortion during fabrication should be obtained at the enquiry stage.

- * 7.4.2 Carbon and carbon-manganese steel plate shall conform to [BS 4360](#) with the grade not exceeding 50 unless otherwise approved by BP. This shall not preclude the use of alternative specifications, e.g. [ISO 630](#) or [Euronorm 25](#) when so approved by BP. The use of steels stronger than [BS 4360](#) grade 50 will normally be permitted only when Appendix A of BP Group [GS 158-2](#) is being applied.



- 7.4.3 For the storage of caustic soda solutions in carbon and carbon-manganese steels, the maximum design temperature shall not exceed the following depending upon the caustic soda concentration:

Concentration of Caustic Soda Solution % by weight		Maximum Design Temperature C
Up to	1	95
Up to	5	85
Up to	10	80
Up to	15	75
Up to	20	70
Up to	25	65
Up to	30	55
Up to	35	50
Up to	40	45
Over	40	43

When the maximum design temperature exceeds the above values it will be necessary to utilise other materials, e.g. stainless steel, or to apply special liners to the tank.

- 7.4.4 When the requirements of 7.4.1 to 7.4.3 of this RP have been considered, the contractor shall state the material selection in his storage tank data sheet.
- * 7.4.5 The tank fabricator, if different from the contractor, shall be permitted to propose alternative material specifications provided they have equivalent chemical compositions and mechanical properties. Any changes from the contractor's storage tank data sheet shall be subject to approval by BP prior to purchase and fabrication.

7.5 Corrosion Allowance

Unless statutory requirements of the national or local authorities, or experience of tanks in a specific duty dictate otherwise, corrosion allowance shall not be added to the minimum plate thickness specified in [BS 2654](#).

Provision of a uniform corrosion allowance for the roof, shell and tank bottom is both uneconomical and technically unsound. This is so, because the tanks corrode preferentially in selective areas and additionally, in those areas the form of corrosion is mostly by pitting. Therefore an addition of a uniform corrosion allowance of say 2 mm would not retard appreciably tank wall penetration by pitting.

The most suitable tank element for provision of a corrosion allowance is the roof support structure of a fixed roof tank. The increase of thickness of the roof support

steelwork is justified on the grounds of safety for the inspection personnel. Elsewhere, application of the following corrosion protection has been found effective:-

Roof	externally	-	paint
	internally	-	paint only if in water service.
Shell	externally	-	paint
	internally	-	paint only the lowest 1.5 m height or, where in light spirit service paint entirely floating roof tanks shells.
Bottom	externally	-	paint; where burned off by welding, rely on bitumen extruded from the foundation bitsand
	internally	-	paint or line with GRP.

7.6 Tank Roofs

- * 7.6.1 BP will consider all designs of fixed and floating roofs except pan type roofs, which are not permitted for use with an open top tank. Unless otherwise approved by BP, double deck floating roofs shall be provided for tanks over 84 m diameter, and for smaller tanks when specified by BP.

Double deck roofs should be considered for smaller tanks when the main disadvantages of a single deck roof - effects of wind induced loading and fire-fighting difficulties (see commentary to Section 11) - are not acceptable.

- 7.6.2 BP do not consider that provision of a frangible roof to shell joint is an adequate measure to ensure emergency venting of storage tanks which are less than 20 m in diameter. For these storage tanks, the provision of emergency venting capacity shall be determined on the assumption that there is no frangible roof to shell joint, and emergency venting methods shall be in accordance with Appendix F of [BS 2654](#).

- * 7.6.3 When an internal floating roof within a fixed roof tank is specified by BP (see 3.4.2), it shall comply with the requirements of BP Group [GS 158-1](#).

Internal floating covers may be specified by BP in cases where excessive external loading on the roof occurs e.g. due to snow, and a conventional floating roof could not perform satisfactorily.

- 7.6.4 For fixed roof design, attention is drawn to the requirement of [BS 2654](#) for the roof supporting structure to be designed in accordance with [BS 449](#).



- * 7.6.5 Floating roofs shall be provided with drains to discharge rain water, any condensation water and fire fighting water to the outside of the tank unless specified otherwise by BP. In addition to normal roof drains, double deck roofs shall be fitted with emergency drains, capable of discharging rainfall in excess of design directly into the product. Single deck roofs shall not be fitted with emergency drains.

One additional roof drain line over and above the number required to discharge the design rainfall shall be provided.

Floating roof drains shall be articulated pipe drains fitted with flexible joints using antifriction bearings or using steel bellow flexible joints. Flexible hoses shall be used for floating roof drains only when approved by BP.

Drain pipes shall be located so that they are not affected by the forces generated by the flows from mixers and inlets.

The roof drain lines shall be valved at the tank and at the drain pit. The first (tank shell) valve shall be locked open.

Types of flexible joint used by BP are the Chicksan (antifriction bearings) and the Pivot Master (steel bellows).

Roof drain lines should be valved individually at the tank so that any roof drain can be isolated in the event of failure of the pipe inside the tank. Provision of an additional roof drain line is also proposed for this reason. Downstream of the tank valves, the drain lines may be combined into a single line valved at the oily water sump.

In the case of single deck floating roof tanks in situations where the oily water sump is located inside the bund close to the tank, consideration should be given to the installation of a second common drain line bypassing the sump and valved outside the bund. This second line would enable fire fighting water to be safely drained from the tank roof during a fire, when it may not be safe to approach the tank or oily water sump. Failure to drain water from the tank roof in this situation increases the risk of sinking the roof and escalating the fire.

- 7.6.6 The method of drainage of tank roof water and internal entrapped water to the outside of the bund shall be in accordance with BP Group [RP 4-1](#).

* 7.7 **Foundations**

BP or its appointed designer will supply the tank fabricator with details of the foundation design when placing enquiries. The design shall be in accordance with BP Group [RP 4-3](#) and subject to approval by BP.



*** 7.8 Tank Bottom**

For earth mound foundations, the tank bottom should be coned upwards with the angle of slope to the foundation design. For other types of foundations, flat or coned bottoms shall be used as specified by BP or its appointed designer.

When it is required to empty a tank completely and frequently and where contamination between successive tank contents cannot be tolerated, a cone downwards bottom can be installed with a centre drain/pumpout. The pump-out line will extend from the tank shell to a centre sump with a turn down into the sump.

7.9 Tank Anchorage

7.9.1 Under certain loading and test conditions, the tank shell and bottom plate local to the shell may tend to lift off its foundation. All storage tanks shall be checked to prevent this phenomenon occurring and the tanks shall be anchored as necessary. In checking for tank uplift, the weight of any insulation shall not be taken into account.

7.9.2 As a minimum requirement, both the tank design pressure and 100% design wind loading shall be considered to act simultaneously whilst the tank is empty.

7.10 Wind Loading

* 7.10.1 Wind loading for UK sites shall be in accordance with [BS CP 3: Chapter V: Part 2](#). The design wind speed and the factors on basic wind speed shall be detailed on the contractor's storage tank data sheet and shall be subject to approval by BP.

* 7.10.2 For sites other than in the UK, design wind speeds and wind pressures shall be obtained from national standards. Full details of the national code and description of the design wind speed shall be subject to approval by BP. If no national standard exists, wind loading shall be subject to approval by BP.

7.10.3 The above wind speed shall also be used in wind girder calculations in [BS 2654](#), except that a minimum of 45 m/s shall be assumed.

* 7.10.4 The design of primary wind girders shall be subject to approval by BP when $D \times V$ is greater than 4500 or when V is greater than 45.

Where D = tank diameter (m)
 V = design wind speed (m/s)

7.10.5 In areas where high winds frequently occur, the effect of wind-induced oscillation and flexing shall be taken into account in a floating roof design.



7.10.6 Rolling ladders when required, shall be designed to resist wind loading and wind induced vibrations. They shall be fitted with anti-derailment devices which are adequately designed for the maximum wind speed without locking or causing permanent distortion.

Note: It should be assumed that the worst conditions of 7.10.1 to 7.10.6 above will also apply during erection.

7.11 Earthquake Loading

* 7.11.1 Storage tanks shall be designed for seismic loading when this is a statutory requirement or when specified by BP.

* 7.11.2 The design method to determine seismic loadings on storage tanks shall be subject to approval by BP.

7.11.3 Unless otherwise stated, seismic loading and wind loading are not to be considered to act simultaneously.

7.11.4 The contractor shall provide, prior to the award of contract, the additional vertical forces at the shell arising from the seismic overturning moment to enable the design of the tank foundation to be assessed.

7.12 Testing

7.12.1 Normally, fresh water should be used for the water test. For austenitic stainless steel tanks, the chloride content of the test water shall not exceed 30 ppm. For carbon steel tanks when fresh water is not available in sufficient quantities, salt water may be used. When using salt water, the tank should be washed down immediately after the test with fresh water.

7.12.2 On floating roof tanks, there shall be sufficient clearance between the gauger's platform and the roof in its highest position during the water test. The roof will be immersed less in the water than in the stored product. Tank design should be based on the use of salt water for test purposes.

* 7.12.3 When the product to be stored has a specific gravity greater than 1.0, special attention should be given to the method of testing, to ensure that the shell is sufficiently overloaded above the normal operating load. The test procedure shall be subject to approval by BP.

Laboratory tests carried out on the wide plate specimens prove that the initial preloading of steel by at least 10% improves steel toughness on subsequent applications of stress. Preloading of structures at relatively warm temperature has



therefore a beneficial effect and diminishes the probability of brittle failure occurring during operation at lower temperature.

Because BP standards for tanks demand the design to be based on the maximum sp. gravity of 1.0, the tanks for most hydrocarbons (whose sp. gravity is usually below 0.85) receive an effective preloading during the full height hydrostatic test.

Other products, whose sp. gravity is greater than 1.0 do not receive this preloading and are therefore less protected against brittle fracture than the tanks storing products of sp. gravity lower than 1.0.

Therefore in the cases of tanks storing products of sp. gravity greater than 1.0, consideration should be given to provision of shells 10% higher than those required for product storage or alternatively to the use of material for the tank construction of higher toughness than normally demanded by the standards for tanks storing products of sp. gravity equal to 1.0 or less.

- * 7.12.4 During the initial filling of floating roof tanks with the product, the BP operational centre will check pontoon compartments and decks for any leaks.

'Because of the danger of gassing, no person is allowed to descend on to the floating roof of a tank in service unless that person is wearing a breathing apparatus and a life line which is under the constant supervision and control of at least two persons on the dipping platform. Where the floating roof can be raised to the rim of the tank, thus obviating pockets of gas, breathing apparatus may not be necessary, but the precise working conditions must be specified.' Extract from BP Model Code of Refinery Safety Regulations, Section 7.01(k).

- * 7.12.5 Small vertical cylindrical tanks that are shop fabricated shall be tested in the shop. Any subsequent site test, to ensure no damage during transit has occurred, shall only be required when specified by BP.

7.12.6 All water testing shall be done before any painting is carried out.

7.13 Protective Systems

7.13.1 External Protection

7.13.1.1 Shop and site painting of storage tanks shall be in accordance with Schedule A of BP Group [GS 106-2](#).

7.13.1.2 The underside of floor plates shall be blast cleaned and primed prior to laying.

One recommendation for the treatment of the underside of floor plates prior to tank construction would be to blast clean to near white metal and paint both sides with a red oxide twopack epoxy primer to 25 microns d.f.t. The paint should be left 50 mm short on all edges to avoid inclusions in welding. The sole purpose of this treatment would be to remove millscale and present a reasonably even surface condition to the bitsand base on laying the plate. Damage to the primed underside in laying out the plate would be anticipated. Should corrosion occur, this condition of surface presents the best chance of corrosion taking place evenly overall rather than pitting



corrosion developing. We would place most reliance on the quality of the bit and base to prevent underside corrosion.

- 7.13.1.3 Site painting should be performed under favourable painting conditions, as required by BP Group [GS 106-2](#)

Application of some paint systems in the UK during winter conditions may give rise to considerable delays whilst waiting for favourable painting conditions and curing time, etc.

7.13.2 Internal Protection

- * 7.13.2.1 Partial or full protection of internal surfaces of storage tanks from corrosion and stress corrosion cracking may be specified by BP.

- 7.13.2.2 BP Group [GS 106-2](#) details certain types of tanks that require internal protection e.g. crude oil tanks, flow tanks, ballast tanks, emulsion break tanks. Although BP Group [GS 106-2](#) allows shop surface preparation, reblasting of the floor area shall be carried out following water testing of the tank.

- * 7.13.2.3 Certain tanks may require internal protection depending upon the product stored. When required, the paint or lining shall be fully resistant to all substances that the tank is specified to contain during operation. The choice of lining will be specified by BP.

7.14 Insulation

- 7.14.1 To prevent any external corrosion of the shell occurring on insulated storage tanks, specific attention shall be given to ensure that water cannot penetrate the insulation. Attention is drawn to the requirements of [BS 2654](#) Appendix B.

- * 7.14.2 Attention is drawn to BP Group [GS 158-2](#) for the need for BP to approve the method of attaching the painters' trolley gear. The normal method of providing holes in the top curb angle on non insulated tanks shall not be employed for insulated tanks.

- 7.14.3 Tanks intended to be partially insulated shall be checked to ensure that the resulting thermal stress is within the allowable.

* 7.15 Documentation

The contractor shall provide with his tender a completed storage tank data sheet for each tank, which should contain all the information required for appraisal of the mechanical design by BP, as listed in the data sheet contained in BP Group [GS 158-2](#). On the contract completion, the contractor shall supply all tank design and fabrication



drawings including floating roof seal drawings and all welding procedures. The contractor's tank drawings shall include a general arrangement drawing stating the tank principal dimensions, the materials used, the nozzle sizes and the orientations and elevations of all fittings. BP may require copies of all design calculations, including floating roof stress analysis.

8. TANK FITTINGS

8.1 General

8.1.1 The orientation of the roof and shell fittings should permit the installed equipment to work accurately and effectively. For example, the flow from a mixer should not be hindered unduly by the siting of heaters. The dipping and level gauge tubes should be located in the least disturbed areas and be readily accessible from the gauger's platform. Customs and Excise requirements must be taken into account when grouping dip tubes.

Careful consideration should be given to the relative orientation of nozzles and fittings to maximise the overall efficiency of the operation. General guidelines are given below, although conflicting requirements may require compromise solutions to be adopted in some cases.

- (a) *Where separate inlet and outlet nozzles are required, these should be located well away from each other.*
- (b) *In general, mixers used for blending purposes should be located in the shell adjacent to the inlet nozzle where the most effective blending is accomplished during the filling of the tank. Multiple mixers on blending duty are generally located on the same side of the inlet nozzle.*
- (c) *For crude tank bottom sludge and water duty, the mixers should be located diametrically opposite the suction nozzles which has the effect of keeping the suction nozzle clear of sludge.*
- (d) *Where installation of more than one mixer is proposed by the manufacturer (see 8.6.1), he will normally also recommend their relative locations. It is generally accepted that where several mixers are needed, these should all be installed on one side of the tank within an arc in the range 45-120 degrees. The recommended angle separation between individual mixers varies from one manufacturer to another, but this is probably not critical.*
- (e) *A mixer should not be installed near to equipment which would either hinder the flow or be affected by the flow from the mixer. The floating roof drain pipes should be located so that they are not affected by the forces imposed by the operation of the mixers or the tank inlet flow.*

8.1.2 The recommendations of the IP Measurement Manual Part V shall be followed for the installation of automatic liquid level and temperature measuring instruments on storage tanks.



8.1.3 Branches for instruments and the liquid level indicator still pipe shall be in accordance with the instrument design.

8.1.4 Special fittings for internal floating roofs when fitted in fixed roof tanks shall meet the requirements of BP Group [GS 158-1](#).

8.1.5 Connecting pipework to the tank shall conform to the requirements of BP Group [RP 42-1](#). Pipework shall have the required flexibility to allow for the design differential settlement between the tank and the piping, for any thermal expansion of the piping, and for the movement resulting from tank shell dilation due to pressure.

For seismic loading, the effect of dynamic interaction between the piping and the tank shall be allowed for.

8.1.6 A list of appropriate BP Standard Drawings for tank fittings is in Appendix C.

* 8.1.7 A check list for tank shell fittings which may be required is given in Appendix D. The number, type, size and location of fittings will be specified by BP.

Fittings will normally be listed either on a separate data sheet or included on a drawing showing the orientation of the fittings around the tank.

The information should include size and rating of nozzles, the height of the nozzle above the tank bottom and the projection from the tank shell. The latter will normally be dimensioned such that flange faces of a group are in the same plane.

Small diameter nozzles, i.e. NPS 1/2 to 1 1/2 (DN 15 to 40) should be avoided if possible on shop-fabricated tanks due to the possibility of damage during transit. In general, nozzles should be a minimum of NPS 2 (DN 50).

8.1.8 Details of floating roof fittings that are to be supplied are given in Figure 7 of BP Group [GS 158-2](#).

8.2 Manholes

8.2.1 Manholes must satisfy the statutory requirements of the country in which the storage tank will operate. Requirements for the number, sizing and location of manholes shall be as BP Group [GS 158-2](#).

8.2.2 Flush type clean-out doors should not be fitted on tanks of shell thickness exceeding 20 mm. When they are required, on tanks of shell thickness exceeding 20 mm, the flush type clean out doors shall be in accordance with [BS 2654](#).



8.3 Branches and Flanges

8.3.1 Storage tanks shall be fitted with standard flanged branches for connection to pipework and fittings.

8.3.2 Studded connections are not permitted.

8.3.3 Flanges, bolting and gaskets shall be in accordance with BP Group [RP 42-1](#), BP Group [RP 42-2](#) and BP Group [GS 142-7](#) respectively.

- * 8.3.4 Tank branches shall not be overstressed by loads resulting from connected equipment such as piping, valves and mixers. Where necessary, suitable supports shall be provided for tank valves and mixers. The tank vendor shall submit with his tender the maximum loading acceptable to the branches, for use in the design of the pipework.

When specified by BP, calculations for local loadings on the shell shall be submitted for approval.

8.3.5 When shell plates with openings require post-weld heat treatment, the branches should be grouped in as few plates as possible in order to reduce costs, but within the positioning constraints of 8.1.1.

The axis of grouped branches should be parallel with each other to facilitate the arrangement of the connecting pipework.

8.3.6 In order to avoid generating a static charge by splashing, inlet branches (other than for foam) should be positioned so that liquids are introduced below the lowest working liquid level. Where a branch jet is on a line which can be used for filling purposes, a second unrestricted branch should be fitted in the tank shell for low-level filling.

Where jet or propeller mixing facilities are fitted to fixed roof tanks containing refined Class I or II products, they should not be used when the tank liquid depth is below 3 m. A period of at least 30 minutes should elapse after the mixing has been stopped before manual dipping or sampling, irrespective of liquid level. This is to allow any static charge that may have accumulated on the liquid to dissipate.

- * 8.3.7 Where specified by BP, base foam injection facilities should be provided on fixed roof tanks (not fitted with internal floating covers) using dedicated shell nozzles and pipework. Alternatively, subject to approval by BP, base foam injection may be made by connecting the injection system into tank suction or filling pipework.

Where a decision has been taken to provide fixed fire protection on fixed roof tanks not fitted with internal floating covers, a base foam injection system is the preferred method of protection. The decision whether to install fixed fire protection should be made after considering the volatility of the material stored, the propensity of the



stored material to form a hot zone beneath a burning surface (such as crude oil, fuel oil), adjacent risks (other tankage, process plant), topography of the storage site, and investment value of stored material. Advice on the installation of these facilities should be obtained through the Custodian of this document.

Base foam injection should not be considered for fixed roof tanks fitted with internal floating covers because of the uncertainty of how the floating cover may perform in a fire or explosion. If the cover remains intact, it will prevent foam from reaching any burning surface above the cover; if it sinks, it would render the base foam injection facility ineffective. Top foam pourers should therefore be fitted where fixed fire protection is judged necessary for this type of tank.

8.3.8 Pumpout connections for emptying tanks shall be of dished sump type to Figure 33(b) of [BS 2654](#). Bottom outlet connections shall not be used.

For pumpout connections, the branch should be located next to the main outlet branch so that the pumpout may be connected conveniently into the outlet piping downstream of the tank valve. The branch should be sized to suit the required pumpout rate, and as a guide the following nominal branch sizes are suggested:-

- | | | | |
|-----|---------------------------------|---|-----------------------------|
| (a) | Tank diameter less than 20 m | - | NPS 4 (DN 100) |
| (b) | Tank diameter 20 m to 50 m | - | NPS 6 (DN 150) |
| (c) | Tank diameter greater than 50 m | - | NPS 8 to 12 (DN 200 to 300) |

Pumpout branches may be used for water draw-off. For tanks where uneven settlement of the foundation may occur, additional NPS 4 (DN 100) water draw-off branches should be provided as follows:-

- | | | |
|-------|---------------------------------|--------------|
| (i) | Tank diameter 15 m to 30 m | 1 additional |
| (ii) | Tank diameter 30 m to 45 m | 2 additional |
| (iii) | Tank diameter greater than 45 m | 3 additional |

The additional water draw-off branches may be fitted with dished sumps to [BS 2654](#) Figure 33(b) or terminate internally a short distance above the bottom plate in accordance with Figure 9 of BP Group [GS 158-2](#).



- 8.3.9 For floating roof tanks, the inlet branch should be extended into the tank to prevent any adverse effect from entrained gas and liquid turbulence on the roof and seal.

When separation of gas occurs in a floating roof tank inlet pipe, sufficient turbulence may be created, local to the inlet branch of the tank, to cause damage to the tank roof seal and to the floating roof itself. In cases where severe gas separation in the tank inlet lines is probable, consideration should be given to provision of an internal extension of the inlet branch, designed so that the turbulence caused by the discharged gas is dissipated away from the roof seal area and over a large area inside the tank.

- * 8.3.10 Where drip trays are specified by BP to be fitted under the tank branches, it may be necessary to increase the height of any minor branches in order to give adequate clearance for the tray.

Drip trays are installed to collect drips from valves to prevent contamination and spoiling of the surrounding area. The contents of the trays can be piped to a drainage sump (see BP Group [RP 4-1](#)). For liquids liable to solidification, a light product, e.g. gas oil, can be fed to the tray as a diluent. In some cases where solidification is unavoidable without heat, e.g. bitumen spillages, the trays can be made removable for transporting to a cleaning installation where heat is applied for the cleaning process.

- * 8.3.11 Where the design proposes a nozzle larger than NPS 30 (DN 750), this shall be subject to approval by BP, as smaller, multiple nozzles may be preferred (see commentary to 4.1).

8.4 Valves and Tank Isolation

- 8.4.1 Every shell nozzle shall have a valve mounted directly on the nozzle, fitted with a spectacle blank located on the tank side of the valve.

- 8.4.2 In order to be able to effect rapid shutoff in the event of equipment failure, the following may be provided:

- (a) motor actuators on valves on pump suction lines.
- (b) non-return valves on filling lines of diameter greater than NPS 8 (DN 200).

The actuators and any associated cabling should have remote activation capability from a safe area, and be fire protected in accordance with BP Group [RP 24-1](#).

- 8.4.3 A block valve with an automatic drain valve, or alternatively two block valves, may be provided on all tank water drain lines terminating at open drains, to prevent uncontrolled loss of tank contents should a



single valve fail in the open position. One of the valves should be installed at the tank and one at the oily water sump (see also 7.6.6).

Where two block valves are installed, one of the valves should be of the quick-acting type.

In cases where large crude oil tanks, such as at Milford Haven in 1982, have suffered a full surface area fire, a phenomenon called 'boilover' has occurred when the heat wave travelling down through the tank contents has reached the water bottoms. The resultant rapid boiling action has ejected large quantities of burning oil over the rim of the tank into the bund, thus creating the possibility of rapid escalation. In order to reduce the possibility of this happening it is suggested that tanks, especially those fitted with emergency roof drains are provided with separate water bottom drains routed outside the bund to allow water to be safely drawn off during such a fire.

Consideration should be given to the installation of automatic or semi-automatic water drain valves in situations where a manual system requires a great deal of operator attention if a significant breakthrough of oil is to be prevented. Satisfactory performance has been reported with a number of different types of valve which operate through differences in the density, conductivity or capacitance between water and oil.

Two valves which have performed well in some applications in BP installations are Sysco and Belfield decantation valves. Both of these valves employ an internal float which sinks and seals off the outlet when the density of the liquid passing through it falls. The Belfield valve, for example, was installed on two drain lines on each tank at the Forties crude oil export terminal at Dalmeny in Scotland. After two years of experience, during which the valves operated efficiently, it was decided to install them on all four drain lines on each tank.

The valve needs to be primed each time it is used in order to remove oil remaining in the valve after automatic closure following previous use. The valve should be located close to the tank.

A less satisfactory performance has been reported with these valves on heavier oils due to the high viscosity, smaller density difference or presence of suspended solids.

8.5 Earthing and Bonding

8.5.1 Tanks up to 30 m diameter shall be provided with two, and tanks over 30 m diameter shall be provided with three, equally spaced earthing bosses. The bosses shall be positioned near the base of the tank and be in accordance with BP Standard Drawing S-0596M.

* 8.5.2 All tank internals, e.g. floating covers, mixers, gauge floats and sling arms, shall be bonded to the tank shell at one or more locations depending on the size of the internal object. The method of bonding shall be subject to approval by BP.

* 8.5.3 On floating roof tanks, multiple shunt connections comprising stainless steel strips 50 x 0.6 x 400 mm long, shall be provided between the floating roof and the tank shell at about 1.5 m intervals around the roof



periphery. Alternatively the manufacturer's normal arrangement for discharging static may be provided, subject to approval by BP.

8.5.4 When a rolling ladder is fitted, a flexible copper bonding conductor of 35 mm shall be applied across the ladder hinges, between the ladder and the tank top, and between the ladder and the floating roof.

* 8.5.5 When a rolling ladder is not fitted to a floating roof tank, one or more (depending on the size of the tank) flexible copper bonding conductors of 35 mm shall be applied between the tank shell and the floating roof. The bonding conductors should either follow the roof drain or be arranged so that they cannot form re-entrant loops. The disposition of the conductors shall be subject to approval by BP.

8.6 Jets and Mixers

* 8.6.1 When specified by BP, jets or mixers, or both, shall be installed for blending products or crude oils, to ensure that blends are homogeneous and to prevent crude oil sludge deposition.

Usually the mixer manufacturer will recommend the number and size of mixers required for a given tank size and duty. For this purpose the Tank Mixer Specification Sheet, a copy of which is included in BP Group [GS 134-2](#), should be completed as far as possible and forwarded with the enquiry.

For product blending it is normal to install fixed angle mixers. For crude tank bottom sludge and water (BS&W) duty, the swivel angle type are usually preferred due to their ability to reduce the sludge more evenly over the tank bottom, and to a greater extent, than fixed angle mixers.

* 8.6.2 Unless otherwise specified by BP, the jets and mixers shall be located in the shell nozzles or manways.

For large mixers intended to be mounted in tank standard manways, the manway may be strengthened by the provision of a class 150 flange.

8.6.3 Mixers shall be in accordance with BP Group [GS 134-2](#). Bearing failure or mechanical seal leakage warning devices, or both, shall be installed, especially where mixers are unattended for long periods.

The provision of warning devices for mixers is especially important for crude and product tanks located in remote areas, and when the mixers are equipped for remote operation not enquiring regular attendance for starting and stopping. The warnings should be given at a location regularly attended by operators.

A contributory factor, and possibly the prime cause, of bearing failure is the failure of the mechanical seal. It is recommended, therefore, that whatever the situation for the mixers i.e. location or attendance, all mixers should be fitted with mechanical seal leakage warning devices.



8.6.4 When a recess in the floating roof pontoon is required to provide clearance for the mixer, the roof sealing arrangement should be suitably modified to ensure that an effective seal between the roof and shell is maintained.

8.6.5 Low level mixer cut-outs and alarms should be installed to prevent damage to the mixer and floating roof at low liquid level operation.

Low level mixer cut-outs and alarms should be provided to activate at a predetermined low liquid level to prevent damage to the floating roof, if provided, and damage to the mixer due to operation with insufficient head. The minimum allowable liquid operating height above the mixer will be given by the mixer manufacturer. Jet or propellor mixers should not be used on floating roof tanks when the roof is landed or where because of low level the liquid movement may cause damage to the roof and its fittings.

8.7 HEATERS

* 8.7.1 The heating medium shall normally be steam, condensate or water. Electrical heating may be used as an alternative to steam or water, subject to approval by BP. If electrical heating is used, reference should be made to the BP Group [RP 12 series](#) of RPs.

8.7.2 When internal tank heaters are installed, internal flanged joints should be avoided and all-welded construction should be employed wherever possible to reduce the possibility of heating medium leaking into the tank. The design of the heater should allow for the predicted bottom settlement with respect to condensate drainage and allowable stresses. A means of positive isolation of the heating medium lines at the tank shall be provided.

For slops tank heaters, it is necessary to ensure a positive shut off of steam when required, to prevent overheating.

8.7.3 The heaters should be sized to ensure that, apart from making good the heat loss from the tank, the capacity is adequate to warm up the tank contents in accordance with operational requirements, e.g. from ambient temperature to design temperature in one week for heavy gas oil and two weeks for residues.

8.7.4 Where heaters consist of separate sections, these should be arranged in two separately supplied groups so as to provide flexibility of operation and protection against failure of any one group. Serpentine-type heaters should be similarly arranged where their size permits. For particularly viscous liquids, one section of the heater should be near to the tank outlet, to facilitate pumping.

8.7.5 When heating is required for slops tankage, it shall be supplied via steam coils sized in accordance with 8.7.3 of this RP. The steam inlet



shall be fitted with double block valves with bleed in between and the bleed piped to a safe point. Live steam injection is not permitted. The heating area may be broken up into coils of different sizes for flexibility. Coils should be close to the bottom of the tank, preferably in a single layer.

8.8 Vents and Relief Valves

- 8.8.1 The number and size of normal and emergency vents provided should be based on the venting capacity obtained from [BS 2654](#) and should be sufficient to prevent any accumulation of pressure or vacuum (including that arising from inert gas blanketing) exceeding the design conditions. (See also 3.4.2.)
- 8.8.2 For fixed roof tanks, attention is drawn to 7.6.2 of this RP to the BP requirement for determining the emergency venting capacity for tanks less than 20 m in diameter. The venting capacity shall be determined on the assumption that there is no weak roof-to-shell attachment.
- * 8.8.3 When protection against overpressure caused by an explosion within the tank is required, the method of relieving such a pressure and the design checks on the tank shall be subject to approval by BP.
- * 8.8.4 For floating roof tanks, the number of rim vents to be fitted shall be specified by the tank fabricator and subject to approval by BP.
- 8.8.5 Where a significant amount of process gas is present in a product, additional venting capacity shall be provided for its release.
- In certain cases, e.g. gasolines from sweetening processes, free process gases such as oxygen and nitrogen may be present in the rundown product. These gases must be released as they could subject the floating roof to excessive loadings. Most probably, this release would not be possible via the normal floating roof rim venting facilities. The gases would tend to rise towards the roof centre and one recommendation is the provision of a gas collection dome fitted at the roof centre, sized according to the quantities of gas involved, piped to a discharge vent near the roof rim.*
- 8.8.6 Automatic bleeder vents on crude oil tanks should be made in austenitic stainless steel.
- The tank fabricator will be informed of the maximum flow rates into and out of the tank, to allow him to determine the size and number of bleeder vents required.*
- * 8.8.7 For fixed roof tanks containing low flash point material, a pressure and vacuum type breather valve of a design approved by BP should be provided. This valve should be fitted with a screen with a mesh of open area adequate for the venting requirements.

The purpose of the screens for P/V valves and free vents is to prevent the ingress of birds, foreign matter and debris. In an endeavour to eliminate the possibility of blockage of these screens due to ice, waxy deposits, etc. in the absence of proper regular maintenance, the mesh should be sufficiently coarse and a 2 x 2 x 18 swg mesh is recommended which has a clean free area of approximately 81%.

It should be borne in mind that the effective venting capacity i.e. allowing for the mesh wire area, must satisfy the requirements of [API Std 2000](#).

The additional cost involved for a larger vent than is strictly necessary is very small compared with the overall cost of the tank. On this premise when sizing vents fitted with screens, it is recommended in view of the possibility of partial blockage, that the calculated venting capacity be increased and as a general rule a figure of approximately 50% overcapacity should be aimed at.

The use of flame arrestors on vent nozzles is not recommended because this could well lead to plugging of the vent.

- * 8.8.8 For fixed roof non-pressure tanks containing high flash point material that is never heated above the flash point, free vents of a design approved by BP should be provided. These free vents should be fitted with screens with a mesh of open area adequate for the venting requirements. If however the contents of a fixed roof tank are liable to be heated above the flash point, pressure and vacuum valves should be fitted complete with screens as in 8.8.7 above.

See commentary to 8.8.7

- 8.8.9 Safe access for inspection and maintenance should be provided to the roof vents.

8.9 Sample and Dip Hatches

- * 8.9.1 For fixed roof tanks, one NPS 6 (DN 150) hatch for dipping and sampling should be provided. A manufacturer's combined dip and vent fitting may be provided; the vent providing part of the capacity referred to in 8.8.1 of this RP. Outside the UK, some Customs and Excise authorities require extra dip hatches and the number required should be checked. For low pressure type 20 mbar(ga) gas blanketed tanks a 'slot dipping device' shall be used to permit dipping and sampling without venting gas to the atmosphere.

All of the above fittings shall be of a design approved by BP.

- * 8.9.2 For floating roofs the following shall apply:

A tube NPS 6 (DN 150) shall be located at the gauging platform, for the combined purposes of roof guide and dipping.



A separate sample hatch NPS 8 (DN 200) shall be provided. This should comply with BP Standard Drawing S-1147M or alternative approved by BP, located in the roof directly below the gauger's platform.

When specified by BP, a NPS 12 (DN 300) still well tube for auto level indication shall be located at the gauger's platform (see also 8.11.2.1).

The still well for the auto level indicator must be plumb vertical and a reference plate is required at the bottom of the tube.

Slots must be provided over the whole length of the tube, located on alternate sides, to ensure that there is no differential between the liquid levels inside and outside of the tube.

If required by local management, and to enable the level gauge tube to be used for manual dipping from the gauger's platform should the auto gauge not be working, a spool piece complete with a gauge hatch can be fitted between the tube and the auto level gauge. The hatch should be supplied with an easily removable cover for use by operators.

8.10 Liquid Interface Detection

On tanks where liquid interfaces have to be determined, sample points shall be installed, at appropriate vertical intervals terminating in shut off valves operable from ground level. Adequate support upstream of these valves shall be provided, to prevent mechanical failure of these small lines. The sample points should discharge into a common drain and, where necessary, the system shall be heat traced to prevent plugging.

8.11 Control Instrumentation

Requirements for equipment for the continuous measurement of liquid level and temperature in storage tanks are given in the BP Group [RP 30 series](#) of RPs (refer to document Custodian).

8.11.1 Temperature

8.11.1.1 For heated tanks a multipoint high temperature (remote) alarm shall be provided, with 6 sensing points at suitable vertical intervals, the lowest being 750 mm above the steam coil. The alarm shall operate in a permanently manned control room.

On heated tanks, an additional temperature sensing element to the multipoint shall be provided on the opposite side of the tank. This should be located 750 mm above the steam coil, linked with the steam supply control and shut off valve. A separate thermowell with local temperature indicator shall also be provided at this point.



- * 8.11.1.2 For all unheated tanks, one local temperature indicator shall be provided, the position being subject to approval by BP.
- 8.11.2 Level
- 8.11.2.1 A local level indicator shall be provided, and where required by the type of installation, shall in addition give remote indication.
- 8.11.2.2 A high level alarm shall be provided, preferably operating in a permanently manned control room.
- 8.11.3 Steam Supply
- 8.11.3.1 Means shall be provided to prevent the tank heating coil being uncovered by the stored liquid whilst steam is flowing.
- This could be achieved by warning lights at the tank outlet valve, so that the steam supply is off before emptying the tank, or by a low level alarm.*
- 8.11.3.2 For heated tanks where water is likely to be present in addition to oil, e.g. ballast tanks, recovered oil tanks and emulsion break tanks, there shall be no valved by-pass around the steam inlet control valve.
- This is to prevent possible overheating of the tank contents with manual control of the steam supply, when water bottoms could flash to steam resulting in a violent eruption within the tank, or froth over.*
- 8.11.3.3 Provision shall be made to enable the steam control valve to be serviced and to enable the tank to be positively isolated from the steam supply when heating is not required.
- For most tank duties the positive steam isolation would be by double block and bleed.*

9. STAIRWAYS, GANGWAYS AND HANDRAILS

9.1 General Requirements

In addition to the requirements given below, stairways, gangways and handrails shall comply with the requirements of BP Group [RP 4-3](#) and BP Group [GS 158-2](#).

9.2 Stairways

- 9.2.1 Where two or more tanks are sited in one bund and the distance between tank shells exceeds 10 m, each tank shall be provided with a separate stairway.



9.2.2 Stairways may be radial, tangential, spiral or any combination of these types. Radial and tangential stairways should be designed so that their support foundations are placed clear of the tank foundation. Supports should be designed to allow for differential settlement between the tank and the support foundation.

* 9.2.3 Stair treads and platform grating should be of the open grid type with 'visible edges' and may be either welded rectangular pattern complying with [BS 4592](#) or of pressed steel and, unless otherwise specified, shall be hot dip galvanised in accordance with [BS 729](#). The width of any opening should not exceed 25 mm and rectangular pattern tread with main bearing bars 5 mm minimum thickness is preferred.

9.2.4 For tanks designed to [BS 2654](#), where the nominal shell thickness exceeds 13 mm and for insulated tanks, the type of spiral staircase that requires welding treads to the tank shell shall be avoided. The radial or tangential type stairway is preferred in these cases, although spiral stairways with double stringers having a minimum of support brackets welded to the shell may be used.

9.3 Landings

Intermediate landings shall be provided at approximately 10 m vertical intervals for all types of stairway, or as required by the local authorities.

9.4 Vertical Ladders

9.4.1 On tanks 3.5 m or less in height, vertical ladders conforming to the requirements of BP Group [RP 4-3](#) may be fitted instead of stairways, except where stairs are necessary to give access to sampling points.

9.4.2 Attention is drawn to the requirement in BP Group [GS 158-2](#) for a vertical escape ladder for tanks 48 m diameter and over. The ladder shall be suitably supported from the shell and terminate at ground level.

9.4.3 When vertical ladders are required, a safety gate or bar shall be fitted conforming to BP Standard Drawing S-1969.

9.5 Gangways

9.5.1 Tank gangways which extend from one part of a tank to any part of an adjacent tank, or to ground, or to other structures shall be supported so as to permit free, relative movement of the connected structure. The design of gangways between tanks shall make provision for differential tank settlement.

See Commentary to 9.5.2.



- 9.5.2 Where two or more tanks are grouped within one bund, and the distance between tank shells is less than 10 m, gangways may be fitted between the tank roofs, served by stairway(s) common to several tanks, so arranged that an escape route is available from any one tank without crossing the roof of another. Wherever a common gangway services a number of tanks, additional means of escape in an emergency shall be provided. Vertical ladders are acceptable for this purpose.

To provide easier access to the tank stairway from outside the bunded area and at the same time facilitate escape in an emergency, a gangway may be provided from the top of the bund wall direct to the bottom of the stairway. Steps from the gangway for access into the bunded area may be provided.

9.6 Platforms

- * 9.6.1 Gauger's platforms are required for both floating and fixed roof tanks and shall be located near the main access stairway unless otherwise specified by BP. The platforms shall be suitable for the maintenance of installed instrumentation and equipment.

Normally all operational activities on the tank roof will, for safety reasons, take place at the gauger's platform which is located near the main access stairway for quick escape in an emergency.

These activities will include tank sampling, tank dipping and local reading of the auto level gauge equipment.

The platform is normally supplied by the tank contractor and located in accordance with instructions given by the engineer to suit the layout of the tankage area.

- 9.6.2 When a dip hatch, sample hatch or other fitting requiring operational access is located at the centre of the roof, bar treads shall be provided between the gauger's platform and the centre of the roof. In the case of a domed or coned roof, where the slope exceeds 15° or where the tank roof is insulated, or both, stair treads shall be provided instead of bar treads. A single handrail to the centre and a handrail around the periphery of the tank shall be required in such cases.

See commentary to 9.6.1.

9.7 Handrails

- 9.7.1 Handrailing for stairways shall be of 30 mm diameter solid steel bar. Handrailing for platforms, gangways, etc. may be of any suitable solid steel section.
- 9.7.2 Roof edge handrails shall be provided, to extend 3 m on both sides of the gauger's platform on fixed roof tanks.

See also 9.6.2 and 9.8.1 of this RP.



9.8 Additional Requirements for Floating Roof Tanks

9.8.1 Floating roof tanks 48 m diameter and above shall be provided with access around the tank at the top of the shell for inspection and maintenance purposes. Where statutory regulations demand, on tanks below 48 m diameter, an outer handrail around the entire periphery of the wind girder and an access stairway from the gauger's platform to the wind girder must be provided. It is recommended that whenever a handrail is required the wind girder flange be 'toed-up' to form a kick plate and drain holes provided in the wind girder.

* 9.8.2 When rolling ladders are specified by BP, standard rolling ladders may be provided for tanks whose height to diameter ratio does not exceed 1.0. Above this ratio, the rolling ladder design shall be subject to approval by BP.

When a rolling ladder is provided, it is possible for an operator to have access to a floating roof when the roof is in the low position in the tank and therefore in an emergency he may not be in a situation for easy escape.

For this reason, access to floating roofs has been restricted by the requirements of 8.7 of BP Group [GS 158-2](#) to when the roof is in the high position.

This provision may be over-ruled by local management who may specifically request a rolling ladder.

10. TANK SPACING AND BUNDING

10.1 Minimum Requirements

Tank spacing and bunding for Class I, II and III flammable materials and unclassified materials shall be in accordance with BP Group [RP 44-7](#).

10.2 Bunding

10.2.1 Bunding shall be designed in accordance with BP Group [RP 44-7](#) and constructed in accordance with BP Group [RP 4-3](#).

10.2.2 Access shall be provided to the bunded area, for the handling of equipment and for general maintenance. Pipework should be designed to facilitate this access.



11. FIRE PROTECTION SYSTEMS

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The requirements of BP Group [RP 24-1](#) shall be met for both fixed roof and floating roof storage tanks. BP will specify the fire protection system to be employed.

Floating roof tank fires usually occur at the tank rim and at that stage can be successfully fought and extinguished, irrespective of the tank size, using fire fighting gas discharged from fixed nozzles or by the manual and automatic application of water foam, poured between the tank shell and roof foam dam.

If a fire escalates to a full roof fire, then on tanks greater than 48 m diameter it may be difficult or impossible to extinguish the fire.

In the case of a single deck type roof in a full roof fire, the fire water flow may be beyond the roof's ability to drain. This could result in the roof sinking and further escalating the fire.

The double deck roof, on account of its stiffness and ability to dump the excess water through the emergency drains directly into the product, is unlikely to be damaged by the weight of the fire water, even when the main rainwater drains are not functioning. The double deck roof is expected to continue to float and hence limit the fire to the rim space originally sealed by the roof seal.

Therefore in circumstances where a tank fire would be a particular hazard, consideration should be given to the provision of a double deck roof on tanks greater than 48 m diameter (see 7.6.1). The additional benefit of a double deck roof is its superior resistance to wind induced loading which can cause roof cracking and leakage of product.



DEFINITIONS AND ABBREVIATIONS**Definitions**

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

Abbreviations

API	American Petroleum Institute
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
BS	British Standard
DN	Nominal diameter
IP	Institute of Petroleum
ISO	International Organization for Standardization
LPG	Liquefied petroleum gas



LIST OF REFERENCE DOCUMENTS

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

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

International Standards

[ISO 630](#) Structural steels

European Standards

[Euronorm 25](#) General structural steels

British Standards

[BS 449](#) The use of structural steel in building

[BS 729](#) Hot dip galvanized coatings on iron and steel articles

[BS 2594](#) Carbon steel welded horizontal cylindrical storage tanks

[BS 2654](#) Vertical steel welded storage tanks with butt welded shells for the petroleum industry

[BS 4360](#) Specification for weldable structural steels

[BS 4592](#) Industrial open type metal flooring and stair treads

[BS 4741](#) Vertical cylindrical welded steel storage tanks for low-temperature service. Singewall tanks for temperatures down to 50°C

[BS CP 3](#) Code of basic data for the design of buildings. Chapter V: Part 2 Wind loads



American Standards

API 620	Rules for design and construction of large, welded low-pressure storage tanks
API 650	Welded steel tanks for oil storage
API Std 2000	<i>Venting atmospheric and low pressure storage tanks</i>

BP Group Documents

BP Group RP 44-7	Plant layout
BP Group RP 4-3	Foundations and general civil works
BP Group RP 4-1	Drainage
BP Group RP 46-1	Unfired pressure vessels
BP Group RP 42-1	Piping systems
BP Group RP 24-1	Fire protection-onshore
BP Group RP 12 series	Electrical systems and installations
BP Group RP 30-2	Instrumentation. & Control - Selection and Use of Measurement Instrumentation
BP Group RP 32-1	Inspection and Testing of New Equipment in manufacture
BP Group GS 134-2	Side entry impeller mixers for vertical storage tanks
BP Group GS 106-2	Painting of metal surfaces
BP Group GS 158-1	Internal floating decks for storage tanks
BP Group GS 158-2	Vertical steel welded tanks for storage of non-refrigerated liquids at low pressure
BP Group GS 142-7	Supply of Gaskets and Joint Rings for Bolted Flanged Joints
BP Group RP 42-2	Bolting for flanged joints
BP Standard Drawing	S-1969 Safety Gates and Bar for Vertical Ladders.



EEMUA and Other Documents

IP Model Code
Of Safe
Practice:
Part 3

Refining safety code. Being Part 3 of the
Institute of Petroleum model code of safe practice in
the petroleum industry.

IP Petroleum
Measurement
Manual:

Part V Automatic tank gauging.



BP STANDARD DRAWINGS FOR TANK FITTINGS

C1 The following drawings are mandatory:-

- | | |
|---------|---|
| S-0596M | Earthing electrodes for use in all areas |
| S-1147M | Fittings for Vertical Tanks 200 mm Dip Hatch Hinged Cover for Floating Roof |

C2. The following drawings are not mandatory, but may be used for guidance:-

- | | |
|---------|---|
| S-1132M | Welded Vertical Storage Tanks - Gaugers Platform |
| S-1135 | Fittings for Vertical Tanks - 24" dia. Roof Manhole |
| S-1138M | Fittings for Vertical Tanks - Dipping Platform |
| S-1139M | Fittings for Vertical Tanks - Fixed Roof Handrailing |
| S-1150M | Fittings for Vertical Tanks - 150 mm Rim Vent |
| S-1152M | Fittings for Vertical Tanks - Drain Plug |
| S-1167M | Foam Dam Details for Pontoon and Double Deck Roofs only |
| S-1171 | BP Radiographic Record Chart |



CHECK LIST FOR VERTICAL CYLINDRICAL TANK SHELL FITTINGS

D1. Branches for Tank Contents

Inlet (with internal extension for floating roof tanks as specified by tank manufacturer)
Outlet (the inlet and outlet may be combined where advantageous)
Gas blanket
Pumpout (to empty tank completely)
Water draw-off
Jetting
Mixers

D2. Branches for Services and Maintenance

Steam or water, with weld end internal extension
Foam for fire-fighting
600 mm dia. shell manholes
Flush type clean out doors
Non-flush clean out doors

D3. Branches for Instruments

Level alarms, high and low positions
Mixer cut-out float switches
Thermowells as required

D4. Brackets and Supports

Mixer support stays
Stairway
Escape ladder on tanks 48 m diameter and over
Insulation
Pipes, e.g. for foam (dry risers) water sprays and gas blanket
Instrument piping and conduit
Lighting and conduit.

