



RP 32-2

SITE INSPECTION, TESTING AND PRECOMMISSIONING OF NEW PLANT

June 1992

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BP Group Engineering Standards Forum**

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SCOPE AND PURPOSE This Recommended Practice gives constructive guidance on the requirement for the Inspection, Testing and Precommissioning of New Plant. It purpose is to give guidance on those requirements considered essential for ensuring the integrity of equipment and systems, from which more specific requirements can be developed by site engineers.											
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FOREWORD

Introduction to BPGroup Recommended Practices and Specifications for Engineering

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

Value of this Recommended Practice

This document represents the accumulated practices of the BPGroup for ensuring a high standard of Site Inspection, Testing and Precommissioning of New Plant.

Application

'Specification' or 'Approval' actions are indicated by an asterisk (*) preceding a paragraph number.

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 Recommended Practice is a major revision of BPEngineering CP 20 which was last issued in January 1970 and reprinted with amendments in July 1987.

Feedback and Further Information

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

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



1. INTRODUCTION

1.1 Scope

BP Group RP 32-2 specifies all BP general requirements for site inspection, testing and pre-commissioning of new plant that are within the stated scope of each section, and is for use with a supplementary specification to adapt it for each specific application.

1.2 Quality Assurance

- * 1.2.1 The contractor shall operate a quality system to ensure that the requirements of this code are achieved. The contractor's quality management system may be based upon the principles of the quality standard [ISO 9000](#) or similar. BP will require demonstration of the management system, but this may be waived if the system has been verified recently by a Certification body acceptable to BP.
- 1.2.2 The implementation of such a quality management system will be subject to monitoring by BP and, in addition, may be audited following an agreed period of notice.
- 1.2.3 The level and extent of the assurance of quality required depends upon the application and criticality of the design, and will be determined by BP and/or BP's main contractors as appropriate

2. INSPECTION AND TESTING - GENERAL REQUIREMENTS

2.1 Test Dossier

- * 2.1.1 Construction contracts normally require the Contractor to establish a comprehensive documentation system. This may be done with advisory input from BP, and in all cases the system shall be approved by BP before implementation.
- 2.1.2 The system shall include a test dossier (or set of such dossiers). Compiled in the dossier shall be the specified site inspection and testing requirements for all installed systems, plant and equipment, and the records of the actual inspection checks and tests. Where prefabrication is carried out away from site, this shall also be included.

Model check/test record sheets and certificates are to be found in the various parts of GSCW: Their use is recommended.



- 2.1.3 The Contractor is responsible for carrying out all site checks and tests to the satisfaction of the Inspector and for completing the appropriate check sheets/certificates, cross referencing them with Vendor works tests where applicable. The Contractor shall further ensure that a fair copy of each certificate bearing original signatures is preserved for incorporation in the handover volume of the dossier (from which further copies may be generated as required).

2.2 Certification for Procured Items

- 2.2.1 This sub-section covers the certification of materials, plant and equipment provided by manufacturers, suppliers and/or inspection authorities in respect of material composition and properties, integrity tests and performance tests.

- 2.2.2 As early as possible following the receipt of items on site and prior to their erection, installation and/or site testing, the Inspector shall obtain or the Contractor shall make available to BP all required certification. The Inspector shall satisfy himself that certification packages are complete and that the certificates confirm conformance with the design specification. In the case of packaged units care must be taken to ensure that documentation is included for all items within that unit.

- 2.2.3 The required certificates shall be inserted in the dossier provided with the materials, plant or equipment delivered to site. The dossier may be shipped separately from the delivered items provided it arrives at the same time as the items. The Inspection plan for the items must indicate to whom documents need be sent.

- 2.2.4 Any item received at site without the required certification shall be quarantined. It shall not be issued for installation until the certification becomes available and the requirements of 2.2.2 are satisfied or until the Inspector gives express approval for installation.

2.3 Test Programme and Gear

- * 2.3.1 As part of his overall programme, the Contractor shall prepare and submit for BP's approval a Test Programme for all equipment. Test activities shall be scheduled so as to smooth resource requirements as far as is possible consistent with meeting the overall programme. Adequate notice shall be given to the Inspector of any changes in the Test Programme. Key dates shall be highlighted for third party inspections.

- 2.3.2 It is the Contractor's responsibility to prepare and offer to BP equipment for inspection and for the witnessing of pre-acceptance tests in accordance with the agreed programme. The Contractor shall



provide all the necessary facilities and test gear for the proper execution and witnessing of tests.

- 2.3.3 The Contractor shall not carry out tests during the hours of darkness or in inclement weather where these conditions could have an adverse effect on the test or test equipment or on the proper witnessing thereof, or on the safety of personnel.

2.4 Preliminary Checks

- 2.4.1 As soon as possible following receipt of an item (other than bulk materials) at site, Contractor shall check for transit damage. The thoroughness of the check should be determined by the complexity, criticality and fragility of the item. Contractor shall advise the Inspector of any damage found and the proposed corrective action. Alternatively the Inspector may choose to witness Contractor's checks or conduct his own.

- 2.4.2 The Inspector shall also check nameplates/tags to ensure the information thereon is complete and correct.

2.5 Preservation and Cleanliness

- 2.5.1 Contractor shall ensure and the Inspector verify that all project equipment, plant and materials are maintained to a standard of cleanliness and are preserved in a manner appropriate to their type and duty and to the climatic conditions of the site as specified by Project procedures. This requirement applies before, during and after erection/installation.

- 2.5.2 Consideration shall be given to the appointment by the Contractor of an engineer with overall responsibility for the preservation of project equipment, plant and materials. The engineer would be responsible for preparing preservation procedures and schedules where necessary, which would incorporate manufacturers' recommendations, and ensuring that these were followed.

- 2.5.3 More specific requirements for preservation are given in the sections dealing with the equipment concerned.

2.6 Material Identification

- 2.6.1 Scope and Applicability

This sub-section outlines the methods available for verifying conformance of metallic materials to specification. Such verification is required for pressure containment equipment and fittings (pressure



vessels, piping, valves etc.) and for structural members used in the construction of offshore structures.

2.6.2 Material Certification

- (a) As required by 2.2.2 the Inspector shall check material certificates for conformance with specification. This is particularly important where the material is for use in sour service, or is an 'exotic'. Whether positive tests need to be employed will depend on the 'criticality' of the item and the level of confidence - a subjective matter - in the accuracy of its certificate. For example, the level of confidence in certificates for pipe fittings, purchased from stockists is likely to be lower than for those purchased directly from a reputable manufacturer. Where full traceability is specified and there is doubt in the material conformance to specification, then positive tests should be employed
- (b) Absolute certainty of conformance with specification can only be obtained by destructive mechanical testing and chemical analysis. Destructive testing can be usefully employed on samples of relatively inexpensive items from the same batch. Again, there must be a high level of confidence that the items are actually from the same batch. This means reliance on certification, and after successful test of the sample, (re-) stamping in the presence of an authorised Inspector

2.6.3 Test Methods and Equipment

The methods and equipment listed below are either employable on site or are rapid laboratory techniques. Technical advice on the use of the more sophisticated techniques can be obtained from BPE and BPREsearch Centre Sunbury (RCS) who offer analytical services. Services may also be obtainable from specialist contractors. The techniques may be used in combination.

- (a) Basic sorting techniques:-
 - (i) Visual inspection.
 - (ii) Use of a magnet.
 - (iii) Chemical spot checks.
- (b) Chemical composition:-



- (i) 'Metascop' portable analyser (cannot detect Carbon, Phosphorus or Sulphur). More accurate laboratory-based equipment is also available.
 - (ii) X-ray fluorescence. A rubbing is taken on diamond paper and sent to RCS or a laboratory for analysis. Again, cannot detect C, P or S.
 - (iii) Portable XRF Analyser (Texas Nuclear Analyser or similar). A portable hand-held X-ray fluorescence device with the same limitations as (ii) above.
 - (iv) Leco Analyser. Laboratory-based. Burns sample (which can be as small as ca 0.1 gram) of material and analyses and computes % C and % C + S.
- (c) Mechanical properties:-
- (i) Hardness testing.
 - (ii) Plastic replication techniques - although more commonly used for assessing the significance of defects such as cracks, this technique can be used to give an indication of metallurgical structure and thus of mechanical properties.

2.7 Coatings and Coverings

2.7.1 Guidance on the preparation, at site, of metal surfaces for and application of coatings and coverings is given in the following publications to which reference should be made:-

BPGROUP RP 24-2	-	Passive Fire Protection of Structures and Equipment (see Note 1 below)
BPGROUP RP 52-1	-	Thermal Insulation
BPGROUP GS 106-2	-	Painting of Metal Surfaces
BPGROUP GS 106-3	-	External Coatings for Steel Transmission Pipelines (see Note 2 below)
EEMUA Publ. 142	-	Acoustic Insulation of Pipes, (Formerly Valves and Flanges OCMA Spec. NWG-5)

Notes:



- (1) Passive fire protection was formerly known as 'fireproofing' in BP Engineering Codes and Standards, a somewhat misleading term whose use has been discontinued.
- (2) Although this Recommended Practice excludes transmission pipelines, certain coating and wrapping techniques are applicable to buried lines.

2.7.2 The Inspector shall ensure conformance with the particular specifications for the surface preparation and materials application operations and for the materials themselves. Key check points are:-

- (a) Limiting ambient conditions (low temperature and/or high humidity) during painting and blasting operations
- (b) Time limit between surface preparation and painting operations, and surface finish compliance post surface preparation and immediately prior to painting
- (c) Total final dry film thickness.
- (d) Protection of cold insulation against moisture penetration
- (e) Proper fitting and sealing of cladding to protect thermal and acoustic insulation from (rain or deluge) water
- (f) Acoustic insulation to be placed over thermal insulation (where both are to be applied).

3. INSPECTION AND TESTING OF PIPING

3.1 Scope

- 3.1.1 The requirements of this Section apply to pipework within the scope of BP Group [RP 4-1](#) and [RP 42-1](#). Unless otherwise specified, the relevant provisions of this Section also refer to the complete piping systems of steam generating plants and power stations.
- 3.1.2 Cross-country and sub-sea pipelines are excluded from the scope of this Section as is structural pipework.
- 3.1.3 [GSCW](#) Pt B2 also refers.



3.2 Identification and Marking

3.2.1 Project should establish a single system for pipework identification to be used by all fabricators/construction sites. This is of particular importance in the offshore environment where confusion could result during the installation phase if individual yards have used different colour coding systems. Piping idents shall include isometric number and revision.

3.2.2 Spool pieces should be identified by hard stamping , preferably using low stress dot matrix stamps on the flange rim or by metallic label. Austenitic steels must not be hard stamped but can be electrically engraved instead.

3.3 Inspection During Pre-fabrication and Erection

Actions by the Inspector:-

3.3.1 Check material's conformance to specification and ensure any traceability requirements are complied with. Sub-section 2.6 refers.

3.3.2 Check dimensional accuracy of spool pieces (after PWHT) and that they are properly marked for identification.

3.3.3 Check erected pipework conforms to design requirements particularly with regard to fittings, connections, slope of lines, adequacy and positioning of temporary and permanent supports, location of vent and drain valves etc. On hot lines the locations and lengths of pipe shoes should be checked to ensure that as the lines expand on being warmed and taken into service, the pipe shoes will remain on the supports. These are to be rechecked as the system is warmed up and reaches operating temperature.

On lines where stress free installation is required eg. to pumps and compressors, check by release of appropriate joints that undue stress is not being applied by incorrectly installed piping.

On lines such as steam lines requiring 'pull up cold' check that correct pull up is applied.

3.3.4 Check cleanliness of erected pipework.

3.3.5 Visually inspect, as far as is practically possible, joints and linings of lined pipe as erection proceeds. Also check all flange faces are clean and undamaged including RTJ grooves.



- 3.3.6 Check that piping welds have been made in accordance with BPGGroup [GS 118-5](#), [GS 118-6](#) and [GS 118-7](#) or other specified standard and with the appropriate qualified procedure, and that all NDE, repairs and stress relieving requirements have been carried out. Also assure that an inventory of X-ray films is established. See also [GSCW Pt H: Welding](#).
- 3.3.7 Measure wall thicknesses as may be required for confirmation of compliance with specification and for base line data. Points chosen for base line data and subsequent periodic NDE should be agreed with the Operator's maintenance/inspection department.
- 3.3.8 Check that wall thickness measurement points in lagged lines are accessible by means of removable sections of lagging/cleaving or the provision of 'windows'.
- 3.3.9 Check that all in-line equipment - pumps, strainers, valves etc. - are installed correctly, including correct orientation for fluid flow.
- 3.3.10 Check whether all electrical bonding/earthing on cathodic protection requirements have been met.
- 3.3.11 Check that all valve operating systems (hand wheels, gear systems, control systems etc.) are in the correct position relative to the ball, gate etc, position. Check that spindle marking on ball valves correctly reflects the open/closed position of the ball.

3.4 Flushing and Preparation for Pressure Testing

- 3.4.1 All lines shall be cleared of debris by flushing with water or by blowing with steam or air, as appropriate, in accordance with Procedure PP.2, [GSCW Pt B2](#).
- 3.4.2 In advance of flushing and pressure testing, the sub-division of each system into test packs is to be agreed with Contractor, together with details of the requirements for equipment isolation and removal. A test pack line list should be completed (Form P-14, [GSCW Pt B2](#)).
- 3.4.3 Flushing is not to be carried out through machinery or equipment which may be damaged by such an operation.
- 3.4.4 Flushing with equipment, vessels and tanks on line is permitted provided the pressure and/or weight of the flushing medium can be tolerated and any internal instruments, fittings or other devices which would be subject to damage are removed.
- 3.4.5 Precautions are to be taken to ensure that debris is not flushed into vessels, equipment or dead ends.



- 3.4.6 Separators, heat exchangers and similar vessels can be used as paths for flushing, but upstream piping must incorporate suitable metallic, permanent or temporary strainers; if not the lines must be flushed first with the equipment isolated.
- 3.4.7 The Operator's advice and agreement shall be obtained on the mesh size, type and location of temporary strainers and filters. A record of all such temporary devices should be kept to ensure they can be accounted for after removal. Also, they should have tabs which project at least 75 mm (3 in) beyond their retaining flanges so that they can be readily seen.
- 3.4.8 Vents shall be provided at high points to expel air, and drains shall be provided at low points.
- 3.4.9 All flushing outlet connections shall be provided with a basket for trapping debris.
- 3.4.10 Precautions shall be taken to ensure the water is safely drained away whilst flushing is being carried out. If air or steam blowing is to be carried out, the need for special precautions regarding the exhaust area and thrust on pipework must be considered and identified. Special attention is to be paid to ensure that electrical, electronic or any other equipment adjacent to or below, is not deluged.
- * 3.4.11 In certain cases chemical cleaning of systems (e.g. machinery seal oil or lubrication oil systems) may be specified. In these cases special procedures will be required for approval by BP.
- 3.4.12 Control valves and soft seated valves should be removed prior to flushing, but where this is not possible the internal fittings shall be removed.
- 3.4.13 All in-line valves shall be in the fully open position during the pressure test. Pressure tests shall not be made against closed block valves: blinds shall be used with valves open. Check valves shall have either the disc removed or be jacked open for flushing and pressure testing.
- Note: Some in-line valves, notably ball valves, must be tested with the valve half open to ensure that the seals are not exposed to excessive differential pressure and to allow the valve stem and body to be pressure tested.
- 3.4.14 All positive displacement meters (and their strainers), turbine meters, bursting discs, flow nozzles, orifice plates and safety and pressure relief valves are to be removed before flushing and testing. Temporary



spacers or spool pieces are to be fitted to complete the pipework. The temporary fittings must conform to the specification of the system being tested and be clearly identified for later removal.

- 3.4.15 The relevant requirements detailed in [GSCW](#) Pt B7 regarding relief valves are to be implemented.
- 3.4.16 Impulse piping to instruments is to be disconnected from the instrument downstream of the first block valve during flushing and testing of main process lines. Analyser sampling systems shall also be disconnected.
- 3.4.17 All sprinkler piping shall be flushed and then plugged for pressure testing; heads, rosettes and nozzles shall be fitted after pressure testing.
- * 3.4.18 All pipe supports and anchors should be fitted prior to flushing and pressure testing and any temporary supports required during fabrication and erection removed. In certain cases additional pipework supports may be required due to the weight of the testing medium; the design, position and loadings for both the supports and pipework must be approved by BP and the foundations designed accordingly.
- 3.4.19 Expansion joints of the sliding sleeve or bellows type and spring hangers should be provided with temporary restraints to limit lateral movement.
- 3.3.20 Piping systems in which vessels/heat exchangers are incorporated may be tested as a whole except where the vessel test pressure is less than that specified for the piping.
- 3.4.21 Vessels and heat exchangers may only be included in a system pressure test if the item has previously been pressure tested in accordance with code requirements to a test pressure not less than the piping system test pressure.
- 3.4.22 The Inspector shall verify that manufacturer or site pressure test certificates, endorsed by an Independent Inspectorate, are available on site for all vessels and heat exchangers before approval is given for the inclusion of such items in the system test.
- 3.4.23 Checks must be carried out to ensure that the system and all line items of equipment can safely withstand the specified system test pressure and weight when full of water. Particular attention must be given to the possibility and prevention of overstressing tubesheets which have been designed on a differential pressure basis.
- * 3.4.24 In the case of vessels so designed that they cannot support a full head of water, or where the foundations or supporting structures impose a



weight limitation, the vessel may be included in the test by partially filling with water and introducing an air/nitrogen blanket. A detailed procedure, including safety precautions to be taken, must be prepared by the Contractor and approved by the BPSpecialist Vessel Engineer in such cases. A relief valve must be fitted to protect the vessel during such a test and if one of the relief valves from the vessel is used for this purpose, a spring having the correct pressure range must be fitted for the period of test.

3.4.25 A tested safety valve set to relieve at a pressure marginally above the test pressure and of adequate capacity shall be fitted to any system being pneumatically tested.

3.4.26 All joints, including butt welds and welded attachments, shall be free from paint, dirt, grease and temporary protective coating and shall be left uninsulated for pressure testing. At the Inspector's discretion, this requirement may be waived, except for the closure welds/joints, in respect of prefabricated sections which have previously been pressure tested. Subsequent to pressure testing, field welds shall be coated in accordance with the relevant specification

3.4.27 Once the system is filled for testing, spring hangers and supports are to be checked and reset. Spring hangers shall be blocked when testing steam or gas lines with liquid

3.5 Pressure Testing

3.5.1 Procedure

- (a) All lines shall be pressure tested, the test witnessed by the Inspector and the results recorded on the appropriate form. Exceptions are noted in 3.5.4 and 3.5.5 below.
- (b) The test procedure shall be in accordance with [GSCW](#) Pt B2 section 7: PP3 or PP4 as appropriate.
- (c) A hydrostatic test using clean fresh water is the preferred option (but see 3.5.2).
- (d) Whenever possible, test limits should be defined to coincide with system completion and leak test requirements.

3.5.2 Constraints

The choice of testing medium and the type of test may be constrained by:-



- (a) shortage of fresh water (sea or brackish water may require to be inhibited)
- (b) deleterious effect of certain testing media on piping material (e.g. chloride ion on austenitic steels) or on operating fluid (e.g. water contamination of hydraulic oils or instrument air, or the danger of moisture in acid, ammonia, liquefied gas and catalyst services)
- (c) pipework configuration, which may preclude adequate draining and hence require a pneumatic test
- (d) cold ambient conditions, which may require anti-freeze additives or use of kerosine or gas oil.

There is also the danger of brittle fracture of notch sensitive ferritic steels if tested below 15°C (60°F).

Guidance is given in [GSCW](#) Pt. B2 section 7:PP3 (loc. cit.) and specialist advice should be sought if in doubt.

3.5.3 Test Pressure and Duration

The test pressure shall be in accordance with the code to which the piping has been designed (normally [ANSI B31.3](#)). The duration of the test shall be not less than 30 minutes from when the Inspector agrees that the test pressure has been attained. The minimum test pressure shall not normally be less than 100 psig

3.5.4 Pre-fabricated Pipework

- (a) Fully prefabricated pipework, complete with flanged ends, will not normally require to have a repeat test at full hydrostatic test pressure provided the following conditions apply:-
 - (i) A full hydrostatic pressure test has been carried out in the fabricator's works.
 - (ii) An approved test certificate is available to cover this test.
 - (iii) There is no statutory requirement for a repeat site pressure test.
- (b) A final test, see Section 13.3, to check for joint tightness is required in all cases.



- (c) The test certificate referred to in (ii) above shall refer to the line numbers, and suitable identification marks shall have been stamped on the flanges (but see 3.2.2).
- (d) Consideration should be given by the Inspector to imposing a requirement that the tightening of flanged joints not subject to a system pressure test be witnessed by him. This is particularly important for lines in critical service or where operating pressures exceed 20.5 bar (ga) (300 psig).

3.5.5 Closure Welds

Tests on closing welds in lines which have previously been tested in sections, or retests due to a cut-in to a line which has already been tested, may be waived at the Inspector's discretion provided that cases (a) to (c) below are satisfied and the results are to the Inspector's satisfaction.

- (a) Preparation and welding are carried out under the supervision of the Inspector.
- (b) Full (100%) radiography is carried out on closure welds.
- (c) Other NDE requirements imposed by the specifying authority and authorised by the Inspector are met.

3.6 Post-Test Reinstatement and Completion

3.6.1 On completion of pressure testing, the piping, and any vessels and/or equipment included in the test, shall be vented, drained and, where necessary, cleaned and dried by blowing through with oil free compressed air to the satisfaction of the Inspector.

If it has been necessary to use water to test systems in which moisture cannot be tolerated, special drying techniques may have to be employed, e.g. the use of hot dry air, and special attention should be paid to places where water may be trapped, such as valve bodies, low points and dead ends. The use of water in such situations can only be permitted in extreme cases where another medium is not available

3.6.2 Spades, blanks, temporary strainers and any other equipment installed for testing shall be removed on completion of testing. Permanent strainers shall be opened up and cleaned. Wherever a flanged joint is broken, joint rings or gaskets shall be renewed. The Inspector may witness the re-making of joints in critical/high pressure service (see 3.5.4(d)).



Any temporary bolting which has been used shall be replaced to the satisfaction of the Inspector and any temporary fitments which may have been installed to limit travel, e.g. in expansion joints and pipe hangers, shall be removed. Hangers shall be checked and reset as necessary.

Where necessary, valves are to be re-packed with the appropriate grade of material.

3.6.3 Pressure relieving devices shall be replaced to the satisfaction of the Inspector.

3.6.4 For further guidance see piping completion check procedures in the [GSCW](#) Pt B2, section 7: PP-5.

3.7 Drain Lines

3.7.1 Pressure Drains

'Pressure drains' refer to a closed drainage system designed in accordance with a recognised piping code, irrespective of the system operating pressure. Such systems shall be inspected and tested in accordance with the preceding paragraphs of this Section .

3.7.2 Closed Low-Pressure Non-Hazardous Drains

- (a) Low-pressure non-hazardous drains are those in non-flammable, non-toxic service operating between zero and 1 bar (ga) (15 psig).
- (b) Such drains shall normally be tested for tightness by filling the system with water. Alternatively, a smoke test may be carried out. The '1 1/2 times maximum operating pressure' criterion may be used, at the Inspector's discretion, to determine the test pressure of systems whose maximum operating pressures are 1 bar (ga).

3.7.3 Underground Sewers

- (a) Prior to testing, lines shall be checked to ensure that they are free from obstruction.
- (b) Underground pipework of cast iron or non-metallic materials together with manholes and similar underground chambers, shall be hydraulically tested in accordance with [BS 8805](#) Part 1 : Guide to New Sewerage Construction.



- (c) Where practicable, testing shall be between manholes. Short branches between manholes shall be tested as one system with the main drain; manholes shall be tested separately.
- (d) The soffit of the pipe shall be well supported during the test except at the joints; these shall be left clear to allow a hand check for leaks.
- (e) Invert levels and falls shall be checked prior to backfilling.
- (f) Where clayware or plastic pipes are to be tested at a hydraulic pressure in excess of 3 m head (0.3 bar (ga)), then a check shall be made on the suitability of the pipe to withstand the pressure.

4. INSPECTION AND TESTING OF UNFIRED PRESSURE VESSELS

4.1 Scope

The requirements of this Section apply to all unfired pressure vessels including heat exchangers (for which further specific requirements are given in Section 5 of this Recommended Practice) and pressure storage tanks.

4.2 Site Fabricated Vessels

4.2.1 General

The general requirements covering inspection of site fabricated vessels during the fabrication process and for pressure testing are as laid down in procedure No. 22 of BPGGroup RP 32-1 except that the Inspector shall undertake the duties of the 'Independent Inspection Authority' unless it is decided to employ such an inspectorate. Special requirements for site pressure testing are also given in sub-section 4.5 of this CP.

4.2.2 Pressure Testing

- (a) The requirements for pre-test cleaning and the constraints imposed on the choice of testing medium by ambient temperature etc., are given in sub-section 3.4.
- (b) The test pressure shall be in accordance with the specified design code.
- (c) Post-test venting, draining, drying, the remaking of broken flanged joints and fitting of pressure relieving devices shall be as per sub-section 3.6.



4.3 Bought-In Vessels

4.3.1 The Inspector shall thoroughly examine the vessel in accordance with the requirements of the relevant Sections of [GSCW](#) Pt B3 and Pt B5
Key check points are:-

- (a) conformance with specification (material and test certificates, nameplate, dimensions, adequacy of access) See also 2.4.2.
- (b) transit damage (especially to small nozzles, and vessel internals) See also 2.4.1.
- (c) general condition and cleanliness. See also 2.5.1.

The above shall equally apply to PAUs incorporating such vessels

4.3.2 Special attention is to be paid to refractory-lined vessels and reactors to ensure compliance with specification/design with regard to the refractory and method of attachment.

4.3.3 The Inspector shall also verify that any temporary attachments made to facilitate transport are removed and the welds ground flush and inspected by NDT. Such attachments must not be welded to the pressure envelope

4.4 All Vessels

Actions by the Inspector:-

4.4.1 Take base-line wall thickness measurements. Chosen points to be agreed with Operator as in 3.3.7 and 3.3.8. Also check that corrosion coupons where required are correctly installed.

4.4.2 Foundations and Supports

- (a) Check dimensional correctness of concrete foundations/supporting steelwork and holding-down bolts (diameter, length, spacing); check bolting material if considered necessary.
- (b) Check that provision has been made for drainage from within the vessel's skirt.
- (c) After installation, check the holding-down arrangements of horizontal vessels to verify any special design requirements for expansion are met.

- 4.4.3 Prior to final boxing-up for handover to Operator, conduct an internal inspection to ensure acceptable level of cleanliness and that all internal fittings are complete and properly and securely installed. The Operator may also wish to witness this and should be invited to do so.

4.5 Site Pressure Testing

4.5.1 Scope

The requirements of this sub-section apply to vessels undergoing, for whatever reason, individual pressure tests on site. The inclusion of vessels in piping system pressure tests is covered in Section 3.

4.5.2 When Required

Bought-in vessels constructed in accordance with a recognised pressure vessel code (which implies their having undergone a properly certified shop pressure test) will not require individual pressure tests at site except in the following cases:-

- (a) Vessels whose condition resulting from transport, storage, handling or for any other cause is suspect in the opinion of the Inspector.
- (b) Vessels which have had any site modification or repair which in the opinion of the Inspector necessitates a site pressure test or are necessitated by statutory requirements.
- (c) Vessels which have been constructed or assembled on site (see sub-section 4.2).
- (d) Vessels which may already have been tested in manufacturer's works but which are required to be re-tested on site after installation to satisfy statutory requirements.
- (e) When manufacturers' certified test certificates are not available.

4.5.3 Test Constraints

The constraints outlined in para 3.5.2 are equally applicable to pressure vessel testing.

4.5.4 Witnessing

Pressure tests shall be witnessed by the Inspector.



4.5.5 Test Pressure and Duration

The test pressure and duration shall be agreed with BP when it is proposed that these differ from Code requirements.

4.5.6 Preparation for Testing

- (a) Vessel relief valves must be removed or positively isolated.
- (b) All plugs are to be removed from tell-tale holes in reinforcing rings/pads.
- (c) All joints shall be free from paint, insulation or other covering/coating.

* 4.5.7 Pneumatic Testing

- (a) In the case of vessels so designed that they cannot support a full head of water, or where the foundations impose a weight limitation, a pneumatic or a combined hydrostatic and pneumatic test may be necessary. The procedure, including safety precautions to be taken in such cases, must be submitted to BP for approval.
- (b) When vessels are pneumatically tested or are given a combined hydraulic and pneumatic test, a relief valve must be fitted to protect the vessel during the period of test.
- (c) If one of the relief valves from the vessel is used for this purpose, attention is drawn to the necessity for fitting a spring having the correct pressure range and retesting the valve on the re installation of the original spring.

4.5.8 Foundations - Precautions

- (a) Where a tower is to be subjected to a full hydrostatic test or to a combined hydrostatic-pneumatic test, the Contractor (or other authority responsible for the design of the foundation) shall specify the maximum wind speed that can be tolerated with the vessel full (or part full) of water.
- (b) Base level readings on hortonospheres or any other large vessels which are to be tested in the field, are to be taken on each supporting column before, during and after filling with water and emptying.



4.6 Fractionation Columns

4.6.1 This sub-section covers additional tests required for trayed and packed columns. Tests shall be witnessed by the Inspector.

* 4.6.2 Trayed Columns

(a) Tolerances. The following shall be checked against the specified tolerances:-

- under downcomer clearance
- weir height
- tray levelness.

Unless specified otherwise the tolerance given in BP Group [GS 146-1](#) para. 2.11 shall apply.

(b) Leak Tests. The following leak tests shall be performed with the liquid level at the top of the risers. BP will specify the category of test to be applied.

For accumulation trays:-

Category	Typical Application	Max Acceptable Rate of Level Drop
1	Vacuum towers - lowest distillate draw	10 mm/h
2	Vacuum towers - except Cat. 1	50 mm/h
3	All other towers	200 mm/h

For bubble cap trays:-

Use the rate given for Category 3.

Drain holes shall be plugged where necessary.

(c) The replacement of tray manways shall be witnessed by the Inspector and the Operator invited to attend.

4.6.3 Packed Columns

(a) Gravity Distributors. The distributor level shall be checked against design tolerances. Unless specified otherwise, a tolerance of 2 mm maximum difference from high to low point shall be used. Where the distributor design is such that



individual components are levelled separately, the above tolerance shall apply to each component and to all the components collectively.

- (b) Pressure Distributors. All flange bolts shall be checked for tightness. Spray nozzles shall be installed after the distributor has been assembled in the column. The nozzles shall be checked for tightness.

5. INSPECTION AND TESTING OF HEAT EXCHANGE EQUIPMENT

5.1 Scope

This Section covers the particular requirements for the inspection and testing of all types of heat exchange equipment.

5.2 Requirements

- 5.2.1 The requirements for the inspection and testing of unfired pressure vessels, Section 4 of this Recommended Practice shall apply to heat exchange equipment as is appropriate to the particular type of heat exchanger and to its foundations/supporting structure.

- 5.2.2 Tubulars inserted into process towers or vessels shall be considered as forming part of that tower or vessel and subject to the same inspection and testing requirements, in addition to the more stringent requirements which may be applicable to the tubular.

- 5.2.3 Dismantling should not be required as a routine, but if required in individual cases, bolted bonnets and channels should be removed or the end covers or manhole covers removed from fixed tube-plate exchangers; new joints shall be fitted on re-assembly. Special care must be taken where expansion bellows are involved to ensure guide rod settings are checked after testing

- 5.2.4 Inspection and test requirements for any machinery associated with heat exchangers (e.g. cooler fans and drivers) shall be in accordance with the Section of this Recommended Practice appropriate to the particular type of machinery and its control equipment.

5.3 Site Pressure Testing

- 5.3.1 Heat exchange equipment may be included in the testing of the piping system of which it forms part. Requirements, limitations and precautions are covered in Section 3 of this Recommended Practice. Exchangers with mild steel tube should be protected to avoid corrosion

after wetting (see 5.4.2). Site pressure testing is required only in the circumstances stated in para. 4.5.2.

5.3.2 Site pressure testing of heat exchangers may be carried out individually or in groups/banks of similar exchangers on the same duty.

5.3.3 The general requirements of paras. 4.5.3 to 4.5.6 shall also apply.

5.3.4 Particular attention is drawn to the need in all testing operations to prevent overstressing tube sheets which have been designed on a differential pressure basis. The appropriate design code shall be followed.

5.4 Post-Test Remedial Work/Reinstatement

5.4.1 Leaks between tube and tubesheet may be remedied by re-rolling. Advice on the appropriate parameters governing the re-rolling operation should be obtained from the tubular manufacturer. Such repairs should be carried out to an approved procedure and should be documented.

5.4.2 Particular attention is to be paid to ensuring that the equipment is thoroughly dried out to prevent scaling or corrosion of tubes before commissioning.

5.5 Air Coolers

Procedures for site performance testing of air coolers will have previously been agreed with Contractor/supplier and will depend on the extent to which the coolers have been tested prior to delivery. The important test parameters are thermal performance, air flow rate, structural stability, vibration and electrical power consumption. Guidance on performance testing is given in BPGroup [GS 126-2](#).

6. INSPECTION AND TESTING OF FIRED HEATERS

6.1 Inspection of Tubes and Headers Before and During Erection

6.1.1 Heater coils with welded-on headers or return bends are the more common type of installation. The alternative is where the tubes are expanded into the headers.

In 6.1.2 through 6.1.4 below, where applicable, crossovers and crossover connections shall be treated in the same way as tubes and headers.



6.1.2 General Requirements

Actions by the Inspector:-

- (a) Check that materials for tubes, headers and return bends conform with specification (see also sub-section 2.6).
- (b) Ensure all required measurements are correctly taken and recorded. Chosen points for base-line data, eg. Creep measurement datums, should be agreed with the Operator as in 3.3.7. Baseline ultrasonic thickness measurements are required:-
 - (i) at intervals along tubes
 - (ii) along the outer radii of return bends.

6.1.3 Heater Coils with Welded-On Headers or Return Bends

- (a) Prior to being placed in position, each tube end and header or return bend shall be examined for weld preparation, cleanliness and freedom from defect such as lamination or porosity.
- (b) Tube ends and headers or return bends shall be measured for wall thickness and ovality prior to assembly. The Inspector shall verify that the measurements are within acceptable tolerances to permit fit up for welding.
- (c) Preparation, welding, post-weld heat treatment (where applicable) and radiography shall comply with BP Group [GSS 118-5, 118-6 and 118-7](#).
- (d) Where multihole, internal tube headers are fitted, the wall thicknesses and sizes of such header bodies and end caps shall be measured and recorded.

6.1.4 Heater Coils with Tubes Expanded into Headers

- (a) Prior to being placed into position, each tube end and header shall be examined for cleanliness, damage to header landings and other defects. Each tube end shall be free from pitting, lamination, flats or millscale.
- (b) Each tube end and its mating header shall be measured after the tubes have been threaded through the tube support sheets. The ID, OD and average wall thickness of the tube end and the ID of the header lands shall be measured and recorded.



- (c) Two expansion tests on each size of tube shall be carried out using the BPro rolling chart (BPStandard Drawing S-2032), or other similar chart as may be agreed with BP, and using the actual expanders proposed. Test expansion stub tubes and header shall be of the same material as to be used for the coil, and the final expanded ends shall be sectioned by Contractor.
- (d) The Inspector and Contractor will mutually agree on the amount of expansion required in each case and the modifications required (if any) to the tube rolling chart. The required expansion and the actual expansion after rolling shall be recorded.
- (e) On completion of expansion, the tubes shall be measured internally for ID at the roll and at 300 mm (1 ft) along the tube.
- (f) On convection bank tubes which are not externally accessible, the bore of the tubes shall be measured along their length by calipers and the sizes recorded.
- (g) Where tube ends are to be seal welded after expansion, the tube ends shall be fly cut in accordance with BPStandard Drawing S-1088 except in those cases where the Inspector considers that the tube ends are in a sufficiently satisfactory condition that fly cutting may be omitted.

Prior to seal welding, the tube ends shall be thoroughly cleaned and all traces of oil or grease removed.

The seal welds are to be examined for cracks, porosity or other defects with dye penetrants or other means agreed with BP.

6.1.5 Header plugs and seat screws shall be treated with anti-scuffing compound prior to assembly as required by BPGroup [GS 122-1](#).

6.2 Pressure Testing

6.2.1 On completion of erection, heater coils shall be subjected to a hydraulic pressure test which shall be witnessed by the Inspector. The test pressure shall be in accordance with the appropriate design code.

* 6.2.2 A test procedure shall be prepared by Contractor and submitted for BP's approval. The procedure shall cover (not by way of limitation) flushing, testing (including the duration of the test and the test medium) and post-test reinstatement (including any requirements for drying out).



Guidance on these matters is given in sub-sections 3.4 through 3.6 of this Recommended Practice.

- 6.2.3 Heater coils should be spaded at inlets and outlets (heater side of valves where fitted) and provision made for the venting of air and for draining.
- 6.2.4 Heater coils designed to operate under vacuum should, after the hydraulic test, be subjected to a pneumatic leakage test at 1 bar (ga) (15 psig) with a suitable gas using a liquid detergent solution as a detector.
- 6.2.5 On heaters which have seal welded expanded tubes, the pressure test shall be carried out after completion of seal welding.
- 6.2.6 The heater will be subjected to a further tightness test during pre-commissioning (see Section 13.3).

6.3 Heater Linings, Air Preheaters, Ducts and Stacks

- 6.3.1 A special examination for compliance with the specifications and drawings shall be made during construction of the refractory linings in heaters, ducts and stacks.

Particular attention is to be given to the allowance for expansion, and checks made to ensure that sufficiently heavy reinforcement has been used for the refractory linings, that the reinforcement has been securely attached and that the reinforcement will remain at its correct distance from the casing throughout the subsequent refractory gunning operation.

A check shall also be made to ensure that any paint which has been specified for the internal corrosion protection of lined casings and ductwork has been applied and that expansion joints in refractories are of the required number and width and are fitted with the specified materials.

- 6.3.2 Dampers and operating mechanisms shall be checked for free action through full travel and to ensure that they fail safe in the open position; the mechanism should be match marked in this position and checked to ensure that it indicates the true position of the damper.

Air motors when provided should also be checked that they develop sufficient power to operate the dampers with the normal air pressure available at the point of application.

- 6.3.3 Immediately following erection, the alignment and verticality of the stack is to be verified and recorded.



- 6.3.4 The heater enclosure and flue gas ducting shall be smoke bomb tested in accordance with BPGroup [GS 122-1](#). The combustion air side of a flue gas/air heater shall be smoke bomb tested to at least 25 mm (1 in) w.g.

6.4 Burners

- 6.4.1 Burner swirlers, quarls, dampers, gas guns/rings and oil guns shall be visually examined for signs of damage or blockage.
- 6.4.2 The burner installation shall be inspected to ensure that all the setting dimensions and tolerances meet the requirements as shown on the manufacturer's drawings.
- 6.4.3 Burner air registers or dampers shall be checked for free action through their full travel and to ensure that the external position indicators show the true position of the register/damper.
- 6.4.4 Where forced draught burners are installed, the flow rate of combustion air to each burner shall be checked to ensure that it is within $\pm 3\%$ of the calculated average air flow rate per burner.

7. INSPECTION AND TESTING OF PRESSURE RELIEF VALVES AND BURSTING DISCS

7.1 Scope

The requirements of this Section apply to pressure relief valves (including pilot-operated relief valves) and bursting discs where these are installed to protect a system against over-pressure by discharging fluid from the system to atmosphere or to a disposal system. The requirements do not apply to actuator-operated valves whose action is controlled by pressure-limiting instrumentation nor to small relief valves discharging back into the system (e.g. on engine lube oil systems or bypass relief valves on pumps).

7.2 Storage, Handling and Identification

- 7.2.1 Attention is drawn to the requirements of sub-sections 2.4 and 2.5. Precautions shall be taken to prevent the ingress of dirt into relief valves which together with bursting discs and their carriers should be stored indoors prior to installation.
- 7.2.2 Each relief valve shall be identified by a unique tag number which shall be hard stamped, using low stress round nosed type steel stamps, either



on its body or on a metal label securely attached to the body. A relief valve schedule should be kept (see 7.4.3).

7.3 Initial Temporary Installation

7.3.1 Relief valves and bursting disc carriers may be temporarily fitted in position to facilitate pipework erection. Bursting discs shall not be fitted in their carriers during such temporary installation. The use of temporary dummy pieces instead of the actual relief valves is preferred.

7.3.2 Upon completion of pipework erection and prior to flushing and pressure testing, all relief valves and bursting disc assemblies shall be removed. See also 4.5.6(a).

7.4 Cleaning, Testing and Setting

7.4.1 Following their removal from the erected pipework, relief valves and bursting disc carriers should be dismantled and thoroughly cleaned. Relief valves not installed during pipework erection need not normally be stripped down unless there is evidence of damage or unsatisfactory operation during test.

7.4.2 Just prior to start up and in all cases not more than 60 days prior to commissioning the system in which it is to be installed, each relief valve shall be set and tested to the satisfaction of the Inspector to ensure that it lifts and reseats at the specified pressures within the tolerances allowed. A leak test may also be required if specified or at the Inspector's discretion.

7.4.3 Test results for each valve shall be recorded and included in the test dossier. A schedule of relief valves indicating system, valve tag number, location by P&ID reference, date sent for calibration, date returned and date installed must also be maintained. Examples of model forms are contained in [GSCW Pt B 2](#), section 9.

7.4.4 Immediately following testing, valve inlet and outlet branches shall be covered to prevent ingress of dirt and a seal affixed to the valve. Covers should not be removed until the valve is being installed.

7.5 Final Installation

7.5.1 Following system pressure test and immediately before installation of relief valves and bursting discs, the connecting inlet and outlet lines are to be checked for cleanliness and to ensure there is no blockage or partial restriction. Such lines are to be in good condition, suitably supported and rain flaps where fitted, free to operate.

7.5.2 The Inspector should check each valve after it has been re-installed to ensure that it is correctly located and that its seal is intact. Insulation is not to be applied to any such valve until the Inspector has carried out his check.

The Inspector should, at the same time, check that drain holes have been provided at the base of outlet piping discharging to atmosphere and that their location does not constitute a hazard.

7.5.3 The installation of bursting discs in their carriers should take place as late as possible in the construction stage to avoid corrosion or other possible damage.

The final installation should be checked by the Inspector to ensure that the correct mounting and the correct disc have been installed. Once installed, discs should be inspected regularly (usually every 2 days) and renewed if any evidence of deterioration is evident.

8. INSPECTION AND TESTING OF TANKAGE

8.1 Scope and Applicability

8.1.1 The requirements of this Section cover atmospheric storage tanks of steel construction for:-

- (a) non-refrigerated petroleum and petrochemical liquids, in accordance with BS 2654 as supplemented by BP Group [GS 158-2](#).
- (b) refrigerated liquefied gases, in accordance with [EEMUA Publication No. 147](#).

8.1.2 Sub-section 8.2 General Requirements covers all tanks, although particular sub-clauses of 8.2.4 may apply only to certain types of tank as is obvious from the wording. Again, the requirements for testing outlined in 8.3 are generally applicable to all tanks but there will be additional special requirements for tanks in refrigerated service. Reference should be made to the publications listed above for more detailed guidance on inspection and testing.

8.2 General Requirements

8.2.1 Materials

All materials used in construction shall have passed inspection following receipt at site. The Inspector shall check all relevant certification for conformance with material specification. This is



particularly important in the case of material for tankage in refrigerated service. Attention is also drawn to sub-section 2.6 of this Recommended Practice.

8.2.2 Foundation Pads

Prior to the commencement of erection, foundation pads shall be inspected and the finished top of foundation levels checked for conformance with design.

8.2.3 Welding

The Inspector shall check that all the necessary requirements with regard to the operations listed below are performed in accordance with the specification:-

- welder qualification
- welding procedure qualification
- plate alignments/nozzle fit-ups
- sequence in which joints are welded
- stress relieving/PWHT
- NDE (examination and interpretation of results) repairs etc.
- NDE technicians qualifications (if not previously confirmed)

8.2.4 Erection

The Inspector shall check, as applicable to the particular type of tank:-

- (a) adequacy of protection of the shell against wind damage during erection
- (b) positioning/orientation of nozzles and fittings
- (c) that shell and floating roof tolerances are within specified limits
- (d) that tank roof weak weld joints have been tested ([API 650](#))
- (e) that welding has been performed in accordance with the approved welding sequence drawings
- (f) floating roof seal is properly fitted; shunts correctly installed with continuity between roof and shoes; roof support legs are all adjusted to the same specified height
- (g) heating coils, internal pipework mixers etc. are properly supported and aligned.

8.2.5 Insulation

Where insulation is to be placed, this shall be done after the water test (see 8.3.3). The Inspector shall check the adequacy of surface preparation and also that the insulation, vapour barrier (refrigerated service) and cladding are properly installed and fitted so as to avoid water/water vapour penetration.

8.2.6 Safety Devices

Prior to their installation, pressure and vacuum breakers are to be checked, tested and set in the workshop as for pressure relief valves (see 7.4). Testing and setting shall be witnessed by the Inspector.

8.3 Testing

8.3.1 Scope of Tests

The test methods specified in the design code for the shell, floor plates (vacuum box test), roof, roof drains, heating coils etc., shall be followed in accordance with the particular test procedures (see 8.3.4). Internal pipework shall be inspected and tested in accordance with Section 3.

8.3.2 Test Medium

Normally, fresh water should be used for the shell test. For austenitic 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, brackish or salt water may be used subject to BP agreement. Where this is done the tank should be washed down with fresh water immediately after the test to the Inspectors satisfaction.

8.3.3 Pre-Test Cleaning

Before testing, the tank is to be cleaned and roof drains and heating coils flushed, all to the satisfaction of the Inspector. Testing must be completed before painting or the application of any protective coating or insulation.

8.3.4 Test Procedures

- (a) Comprehensive test procedures shall be specified and agreed between BP and Contractor. The test procedure will include maximum filling rates, hold periods, normal and emergency emptying procedures, method of measuring settlement, limits for differential and maximum settlement of the foundations,



minimum water temperature, water quality and any need for inhibitors etc.

- (b) The Inspector shall ensure that the procedure as specified is rigorously followed. He shall witness and verify Contractor's measurements of settlement and maintain an independent record of the same.
- (c) Although this will have been taken into account in preparing the procedure, particular care shall, nevertheless, be taken during both the filling and emptying operations to ensure that there is adequate venting to avoid (fixed) roof damage.
- (d) Similarly, when the inner and outer steel tanks of a double or full containment liquefied gas tank are hydro-tested simultaneously, great care shall be taken with the removal of the water to prevent damage to the inner tank. The liquid level in the annular space shall always be kept equal to or lower than that of the inner tank to prevent compressive stresses in the inner tank shell or bottom uplift. The bottom insulation of the inner tank shall be adequately protected against the danger of liquid penetration during testing and tanks properly dried on completion of the test in accordance with the specification.

9. INSPECTION AND TESTING OF MACHINERY

9.1 Scope

The requirements of this Section apply to all rotating and reciprocating machines and their drivers: pumps, compressors, electric motors (other than for electrical inspection/tests), steam and gas turbines, diesel and gas engines etc. The requirements do not apply to small ancillary units (e.g. a lube-oil pump on a larger machine, a refrigerant compressor-motor unit in an air conditioner, very small electric motors for instrument clocks etc.). Such equipment should, nevertheless, be checked to ensure that it is in working order.

9.2 Certification/Preliminary Inspection/Preservation

- 9.2.1 Attention is drawn to the requirements of sub-sections 2.2, 2.4 and 2.5 of this Recommended Practice.
- 9.2.2 During the storage and installation periods, all inlet and outlet connections - main process/service, lube-oil, seal oil, cooling water etc. - shall be blanked off to prevent ingress of dirt. The Inspector may, at



his discretion, require Contractor to open up any machine for inspection and to carry out necessary remedial cleaning.

- 9.2.3 All machines shall be regularly hand or bar rotated throughout the storage and post-installation periods in order to protect the bearings. Advice on the frequency of this operation shall be obtained from the machine manufacturer. A rotating record for each machine shall be maintained by Contractor and verified by the Inspector.

9.3 Foundations/Supporting Steelwork

Concrete foundations/supporting steelwork shall be examined and checked against erection drawings for dimensional accuracy before any machine is landed.

9.4 Installation

The Inspector shall witness/verify the following requirements:-

- * 9.4.1 Any special installation and/or alignment procedures specified by the machine manufacturer or by BP shall be followed by the Contractor. For large, complex or highly specialised machines, the manufacturer may provide an installation engineer whose instructions shall be followed by Contractor.
- 9.4.2 Initial alignment of the machine shall be carried out before primary process/service pipework is connected. A trial pipework fit should then be carried out, before final alignment. The Inspector shall satisfy himself that piping alignment is satisfactory.
- 9.4.3 Bedplate flatness, inclination to the horizontal plane (measured in two mutually perpendicular directions) and level (above datum), and shaft alignment and end float are all to be checked before grouting. For reciprocating machines, crankshaft deflections should also be checked and recorded.
- * 9.4.4 The grouting material shall either be specified by the machine manufacturer and/or approved by BP. The material shall be non-shrinkable.
- 9.4.5 During the grouting operation, adequate air vents must be provided and the grout properly vibrated to avoid air entrapment particularly in holding-down bolt pockets. Unless otherwise specified, fabricated box-type bedplates shall be completely filled with grout. For large machines or machines with large out-of-balance forces, placing of grout may need to be supervised by a qualified representative of the machine manufacturer.



- 9.4.6 After grout curing, the machine bedplate top membrane is to be sounded to detect the presence of any voids. If voids are discovered, a test hole 1/8 inch diameter is to be drilled in the void area to ascertain its volume as a preliminary assessment for possible remedial action.
- 9.4.7 All machine frame bolting is to be checked for tightness to ensure that transit vibration has not produced machine bolt slackness and to ensure that the bolts conform to the specification.
- 9.4.8 Alignment of driver to driven machine is to be carried out after the grout has adequately cured. The general requirements for the alignment operation are covered in [GSCW](#) Pt B4-sections 2 and 3; model certification forms are contained in section 5 of Pt B4. Dial gauge readings shall be recorded. Manufacturers' particular alignment requirements shall take precedence over those in the [GSCW](#). Lasers may be used at the discretion of the Inspector.
- 9.4.9 After the permanent pipe supports have been fitted and the pipework connected, the Inspector shall re-confirm that piping alignment is satisfactory and pipe loads at machine flanges are within specified tolerances. A final alignment check shall then be carried out.
- 9.4.10 The Inspector shall check that all ancillary systems, appurtenances and enclosures are complete and properly installed and connected: lube-oil, seal oil, cooling water, vent and drain piping and valves, including relief valves; instrumentation, electrical and control devices and trips; coupling guards, access ladders and walkways (on large machines); weatherproof/noise attenuating enclosures; etc. Ancillary piping shall have been properly flushed and cleaned prior to installation (see also 9.5).
- 9.4.11 If couplings are to be removed following alignment, they shall be properly marked/tagged to ensure identification.

9.5 Preparation for Running Tests

The preparation and cleaning procedure prior to initial lubrication and the requirements for packing of glands shall be carried out to the satisfaction of the Inspector. Where mechanical seals are fitted, a special inspection must be carried out to ensure that any ancillary pipework and fittings are correctly installed.

The cleanliness of oil systems should be based on the appropriate scale in [ISO 4406](#)



9.6 No-Load Running Tests

- 9.6.1 No-load running test procedures shall be agreed between BP and Contractor. Manufacturers' advice shall be obtained where necessary. The Inspector shall ensure that the agreed procedures are followed in every case.
- 9.6.2 All electric motors shall be checked for direction of rotation, generally in the uncoupled condition. Certain units such as fractional HP motors driving dosing pumps should not be uncoupled.
- 9.6.3 Drivers, together with their ancillaries, should be run, uncoupled, at their full operational speed for a period of at least 4 hours.
- 9.6.4 Driven equipment with their auxiliaries should also be run at full operational speed, initially at no-load, for at least 4 hours. Bearing temperatures should be monitored throughout the test

This shall be done only if the equipment is not liable to suffer damage when run in this condition. Certain equipment (e.g. submersible pumps and dosing pumps) can only be safely run dry for a few seconds and this would normally be done for the direction-of-rotation check (9.6.2).

Where for operational or other reasons it is not possible to carry out an initial no-load running test, this shall be combined with the performance test (see 9.7).

9.7 Performance Tests

- 9.7.1 The procedures for performance testing of machines requiring such tests shall be agreed between BP and Contractor/Supplier.
- The requirement for performance testing and the range of operating conditions to be covered in the test are normally specified by the Operator, being determined by such factors as the criticality of the service and the extent of testing at the manufacturer's works. In general, equipment is to be tested to ensure that, as a minimum requirement, its performance meets the specified duty. However, the Operator may wish to obtain an indication of performance in conditions different from those specified.
- 9.7.2 Performance testing including noise and vibration tests will of necessity usually take place during pre-commissioning or during the initial stages of commissioning. Witnessing of such tests may involve Third Parties in addition to BP/Operator.



9.8 Site Test Certification

Test results shall be recorded and inserted in the appropriate test dossier.

10. INSPECTION AND TESTING OF LIFTING EQUIPMENT

10.1 Definition

Lifting equipment means any device used for or in the lifting of persons and/or things. The term includes (though not by way of limitation):-

- passenger lifts (elevators)
- cranes
- winches
- hoists
- drilling derricks
- lifeboat davits
- runway beams
- pad eyes
- skips, cradles
- hooks, lifting beams, wire rope slings, fibre slings, shackles, eyebolts and flow booms
- lifting blocks, ropes, chains, pulleys.

10.2 Scope

10.2.1 The requirements of this section apply to all lifting equipment being erected or installed at site as a permanent feature or associated with plant and equipment being so erected/installed.

10.2.2 The requirements do not apply to lifting equipment, normally owned and operated by Contractor, used to facilitate the construction process. It is Contractor's responsibility to comply with the statutory regulations applicable to such equipment. For reasons of safety, the Inspector should, nevertheless, verify Contractor's compliance with such regulations.

10.3 Statutory Requirements

10.3.1 The Inspector shall ensure that all lifting equipment is inspected and tested in accordance with the applicable statutory requirements or Plant Inspection Branch recommendations regarding items not covered by statutory requirements. In countries where there are no statutory requirements or where the requirements are less onerous than the UK regulations, the latter should be observed.



10.3.2 The Inspector shall also ensure that manufacturers' recommendations with regard to inspection and testing are followed.

10.3.3 Tests may be required to be witnessed by a representative of the Insurers of the facility being built or, in certain countries, by a representative of the Statutory Authority.

10.4 Reference Codes and Regulations

10.4.1 The principal UK statutory regulations governing lifting equipment (as herein defined) are:-

- (a) [The Docks Regulations](#) 1934 (SR&O 1934 No 279).
- (b) [The Factories Act](#) 1961 (as amended by the various repeals/modifications regulations).
- (c) [The Offshore Installations](#) (Operational Safety, Health and Welfare) Regulations 1976 SI 1019.

10.4.2 Reference should also be made to:-

- (a) [GSCW](#) Pt B6 Mechanical Handling.
- (b) BPGROUP [RP 32-3](#), relevant Section on Lifting Appliances.

10.5 Identification, Registration and Certification

The Inspector shall verify the following:-

10.5.1 Each item of lifting equipment shall be given an identification number which shall be clearly marked thereon and which shall be quoted in all certificates and documents in which reference to the item is made. Identification numbers should be agreed with the Operator and comply with the overall sequence for the site.

10.5.2 Its safe working load shall also be clearly marked on lifting equipment.

10.5.3 Manufacturers' and site test certificates shall be compiled in the appropriate dossier. Examples of model certificates are contained in [GSCW](#) Pt B6 - section 6.

Dossiers must be made available to the Operator prior to the commencement of Commissioning.



10.6 Inspection and Test

- 10.6.1 UK statutory regulations require visual examination and testing to be carried out by a 'competent person'. In this sub-section of this Recommended Practice, the term 'Inspector' shall be construed as being synonymous with 'competent person'.
- 10.6.2 The Inspector shall verify that lifting equipment is free from damage/defects and correctly installed. The settings and functioning of all safety devices shall be checked and proved.
- 10.6.3 Drivers and ancillary equipment shall be inspected and tested in accordance with the appropriate section of this Recommended Practice.
- * 10.6.4 (a) A proof load test must be carried out with certified test weights in accordance with the governing regulations prior to an item being taken into service. Proof load tests will have been carried out at the manufacturer's works and these may be acceptable in lieu of tests at site. Tests at site will be carried out either if required by statutory regulations or if specified by BP. This includes testing of damaged/repared items.
- (b) Records of the test shall be entered in the appropriate certificate (see 10.5.3) as shall the records of any remedial work carried out before or after the test.
- 10.6.5 Lifting appliances such as cranes and lifts shall undergo tests to verify that they operate satisfactorily. Testing requirements will normally be agreed between BP and the manufacturer.

11. INSPECTION AND TESTING OF ELECTRICAL EQUIPMENT

11.1 Scope

- 11.1.1 This Section covers the site inspection of electrical equipment and the inspection and testing of installed equipment and circuits before and after initial energisation and is complementary to Part D of [GSCW](#).
- 11.1.2 Referring to [GSCW](#) D1.2, precommissioning is not applicable to electrical systems since once inspected and tested after installation, the equipment and circuits are ready for electrical commissioning which is outwith the scope of this Recommended Practice.
- 11.1.3 Equipment and circuits will normally include but not be limited to the following:-



- (a) Power generation and distribution systems at all voltages.
- (b) All cabling systems for electrical power and control systems. Cabling systems associated with Instrumentation and Telecommunications systems may be included.
- (c) DC equipment and power supplies including batteries.
- (d) AC and DC electrical motor and associated switchgear and control equipment.
- (e) Lighting and small power systems.
- (f) AC and DC actuators and associated control equipment may be included.
- (g) Navigation, safety and warning systems (such as sirens and flashing beacons).
- (h) All earthing and bonding systems. In addition to that for electrical systems, this will normally include those for:-
 - (i) instrumentation and telecommunication systems, both intrinsically safe and non-intrinsically safe.
 - (ii) mechanical equipment, PAU's vessels and piping systems.
 - (iii) structural systems.

11.2 Inspection and Testing Requirements by Third Parties

- 11.2.1 Where there is an involvement with an Independent Certification Authority or other Statutory body then early discussion is advisable to ensure that its full requirements for inspection, testing and any witnessing are agreed. In addition the discussions should establish the extent and programme for any inspections and tests that can be carried out for final acceptance prior to final installation (such as at vendors works or during module or PAU fabrication) so that they do not need to be repeated on site. Electrical Zone classifications should be confirmed and a check made to ensure that all electrical equipment , including any testing equipment or means of communication such as portable radios or telephones is appropriate to the Zone classification in which it is to be utilised
- 11.2.2 Other parties such as Supply Authorities, Commissioning or Operators may have specific requirements for inspection, testing and witnessing.



11.3 Vendors

11.3.1 As referred to in Section D.1.5 of [GSCW](#), for special electrical equipment, Vendors will normally be required to carry out final inspections and testing at site after installation. Such final testing may include full function and load tests.

* 11.3.2 The extent of such site inspection and testing should take into account documented work already carried out in the vendor's works together with any additional requirements dictated by third parties in 11.2 above. Inspection and Test Certificates shall be prepared by the vendor and approved by BP prior to use.

11.3.3 All major Electrical equipment and preassembled electrical installations should be examined on delivery to site by the BP Engineer or Inspector so that agreement can be reached with the vendor for the early completion of outstanding or defective work.

11.4 Definitions

11.4.1 Section D2 of [GSCW](#) covers general definitions and Part A of [GSCW](#) recommends the general contents of Fabrication and System Test Dossiers for Electrical Installation.

* 11.4.2 Fabrication and System Test Dossiers will normally be compiled by each Contractor and Vendor based on Quality Plans previously submitted to and approved by BP. Such Quality Plans should clearly identify all inspection and testing procedures and proforma certificates to be used together with witness points and approved signatories.

Overall System Dossiers for each system will then be compiled by BP to include all individual Contractors' and Vendors' Dossiers covering all disciplines.

11.4.3 Inspection and testing requirements particular to the Project will normally have been reviewed and defined in a Project Certification and Test Manual. In the absence of such a document the BP Site Electrical Engineer shall define the electrical requirements. In either case the contract shall require the Contractor to comply with such requirements (see also Section 11.6 below).

11.4.4 Fabrication Dossiers

The parts of the Fabrication Dossier relevant to the Electrical discipline will consist of all the information necessary to record the condition and



the 'as-built' status of the Electrical installation; the results of testing will be included in the System Test Dossier.

In addition to BPapproved certification, this Dossier should contain indices of all drawings, schedules, tagged items by system, engineering queries and non-conformance requests.

Vendors recommendations for maintenance and preservation together with records of work carried out should also be included.

As-built drawings as deemed necessary should also be included.

Copies of all approval certificates (issued by BASEEFA, PTB etc.) or all equipment located in hazardous areas shall be obtained from the suppliers and made available to the Contractor for cross referencing and inclusion in the dossier. The contractor shall identify any special installation requirements necessary to comply with the approval certification and record in the dossier that these have been satisfied.

11.4.5 System Test Dossiers

The parts of the test dossier relevant to the electrical discipline will consist of the results of all tests carried out at site to show that a piece of equipment or circuit is ready for commissioning. Any results of tests carried out by Vendors' representatives will be included but not the results of Vendors' works tests, which will be held in Vendors' dossiers.

All electrical equipment and associated cabling shall be indexed and allocated to a process system from the system register which normally forms part of the project specification.

Power generation and distribution systems at the different operating voltages, earthing, lighting, small power, public address systems etc., will all normally themselves be discrete process systems. Outgoing circuits e.g. for motors, and associated equipment will normally be allocated to the process system they serve e.g. instrument air, gas compression etc.

Where multicore cables serve more than one system, for inspection and testing purposes they should be included in whichever of those systems has the highest priority.

The dossiers shall include all BPapproved certification and as-built records as necessary.



11.5 Installation, Pre-Acceptance, Energisation and Commissioning

Section D3 of [GSCW](#) gives guidance on the above.

The BPSite Electrical Engineer shall have total responsibility for all electrical activities of vendors, contractors and suppliers through from receipt of equipment and materials to final acceptance for commissioning of all electrical installations and equipment. There shall be adequate engineering, inspection and supervisory staff to carry this out.

Further considerations should be given as follows in 11.5.1.

* 11.5.1 Installation - Reference Section D.3.1 of [GSCW](#)

11.5.1.1 Electrical equipment and electrical content of mechanical packages (Section D.3.1.3 of [GSCW](#)).

It should be borne in mind that such equipment can be in BPstorage for considerable periods between delivery and erection. Early site inspection at the storage location by the BPSite Electrical Engineer will identify outstanding, additional or remedial work necessary before acceptance for commissioning. These should where necessary be followed by site meetings with vendors to agree responsibility and programme for additional work. This work should be completed as soon as possible prior to erection to prevent future delay. In addition the BPSite Electrical Engineer shall ensure that adequate preservation and maintenance are provided during the storage period prior to issue to contractors for erection on site.

11.5.1.2 Compliance with good engineering practice and contractual requirements.

The contractual requirements will be defined in the project specifications and drawings. Where interpretation is necessary the BPSite Electrical Engineer shall establish with the contractor at an early stage what is acceptable as 'good engineering practice' and ensure that the criterion used is 'fit for purpose'. This is particularly important for site run installations. Answers to queries from the contractor shall be recorded in writing at all times by means of engineering queries, site instructions or other means as covered in project and contract co-ordination procedures. Specifications for material and equipment purchased by the contractor for the permanent works shall be approved by BPand project requirements for inspection and certification shall be adhered to.



11.5.1.3 Supervision of contractors activities for preparation of final documentation.

The BPSite Electrical Engineer shall be responsible for ensuring that all the necessary documentation included in fabrication and system test dossiers is complete.

The content and number of copies of as-built drawings/data to be provided by the contractor will normally be detailed in the contract documentation. As a minimum, the as-built status of all schematics, control logic and protection data shall be included together with details of any modifications to wiring and cable connections. In addition to those included in the dossiers, sufficient copies shall be provided in marked up form to allow commissioning and the subsequent safe operation of the installation to proceed prior to the original drawings being revised and re-issued. The responsibility for revision of the original drawings will normally be with the design contractor and vendors and be supervised by the BPproject engineer.

All dossiers and as-built information will refer to work completed and it will be necessary for any outstanding works within the contractors' scope to be identified together with material status for their completion by others. The BPSite Electrical Engineer shall agree outstanding work lists with the contractors and ensure that they are comprehensive and include both unstarted work and any incompleted work including outstanding punchlist items.

11.5.2 Pre-Acceptance Procedure - reference Section D.3.2 of [GSCW](#)

Pre-acceptance covers all the activities from the time the contractor offers an installation as complete to BPthrough to the point where all inspections and tests are completed and have been accepted by the BPSite Electrical Engineer and Energisation and Electrical Commissioning can commence. The installation will normally be completed by system or part system in a sequence linked to the commissioning programme.

The BPSite Electrical Engineer shall also consider the early energisation of systems for limiting the requirement for temporary systems during construction such as lighting and/or small power and welding supplies. The programme for some testing e.g. motor 4 hour runs may require switchboards to be temporarily energised from temporary generators. In addition to this, insulation resistance and HV pressure testing will impose voltages on equipment and cabling. The BPSite Electrical Engineer shall be fully responsible to ensure that no danger is caused and that all necessary safety precautions are taken by contractors, vendors', BPand any other personnel involved in electrical



matters. (See 11.5.4 Safety Procedures and Client's 'Permit to Work' below).

Further consideration should be given as follows:-

Section D.3.2.1 Co-ordination and planning of inspection and testing.

The co-ordination of the contractors' and vendors' inspection and testing activities to meet agreed programmes together with liaison for third party involvement (e.g. witnessing by supply or certification authorities etc.) shall be the responsibility of the BP Site Electrical Engineer.

The requirements for inspection, testing and witnessing by BP or others will normally be defined in the contractors' and vendors' approved quality plans (see 11.4.2 above) and any deviation from this will need to be agreed in writing.

In addition, interfaces with other disciplines, particularly with instrumentation and mechanical, during electrical testing must be carefully considered and co-ordinated within the testing programme by the BP Site Electrical Engineer.

Section D.3.2.2 Actions after completion of inspection and testing.

Once the installation is handed over by the Contractor and accepted by BP, the BP Site Electrical Engineer shall ensure all safety precautions have been taken and isolation completed and that no further work is carried out until commencement of commissioning.

11.5.3 Energisation and Electrical Commissioning - reference Section D.3.3 of [GSCW](#)

Whilst this is outwith the scope of this Recommended Practice, commissioning requirements will dictate the sequence and programme for electrical testing. The BP Site Electrical engineer shall be responsible for liaison with commissioning to achieve an integrated programme.

Handover for commissioning will normally be by system or part system as defined by the commissioning group. These definitions may, in some circumstances, differ in some detail from those of the design contractors, and the BP Site Electrical Engineer shall be responsible for agreeing precise system limits with commissioning prior to commencement of testing.



* 11.5.4 Safety Precautions and Clients 'Permit to Work' - reference Sections D.3.4 of [GSCW](#)

The BPSite Electrical Engineer shall be responsible for establishing safe procedures for all testing activities with vendors and contractors and ensuring that only suitably qualified and experienced personnel carry out such work.

The BPSite Electrical Engineer shall also be responsible for ensuring that no danger is caused and that all due safety precautions have been taken prior to commencement of and during such work. In this respect it will be necessary to implement a Permit to Work system prior to commencement of testing to ensure, in particular, that prior to any test, the necessary isolations have been completed, safety barriers erected, and that while testing is in progress no explosion nor fire hazards nor cause for danger to personnel occurs.

Ultimately the Client's Permit to Work system will apply but until this is appropriate the BPSite Electrical Engineer shall agree an interim system with all interested parties and implement that system prior to commencement of testing and until the clients system becomes operational. Such a system shall normally be in accordance with BP's Health and Safety at Work Advice and Information Manual, and take full cognisance of any Client's Safety Regulations etc., applicable to the site or location and any permanent or temporary hazards that may exist at the time.

Personnel authorised to carry out isolation or switching shall be identified and, where necessary, approval obtained (e.g. for HV switching) from the Supply Authority and/or the Client as appropriate.

Any test equipment for use in hazardous areas shall be fully certified and approved by the BPSite Electrical Engineer prior to use. Vendors and Contractors should maintain a log of all such equipment and the relevant approval certificates and calibration records shall be available to BPat all times.

* 11.6 **Electrical Procedures - reference Section D.4 of [GSCW](#)**

Detailed model procedures for electrical inspection and testing are included in Section D.4. of [GSCW](#) as follows:-

- 4.1 EP.1 Power and Control Cables
- 4.2 EP.2 witchboards and Busbars
- 4.3 EP.3 Circuit Breakers
- 4.4 EP.4 Contactor Starters
- 4.5 EP.5 Fused Switches



- 4.6 EP.6 Power Transformers
- 4.7 EP.7 Motors
- 4.8 EP.8 Batteries and Battery Chargers
- 4.9 EP.9 U.P.S.
- 4.10 EP.10 Lighting and Small Power Distribution
- 4.11 EP.11 Navigation Aids (Nav aids)
- 4.12 EP.12 Neutral Earthing Resistors
- 4.13 EP.13 Trace Heating Tapes and Circuits
- 4.14 EP.14 Earthing/Bonding
- 4.15 EP.15 Apparatus for Use in Hazardous Areas
- 4.16 EP.16 Oil Insulation Tests
- 4.17 EP.17 Drying of Electrical Rotating Machinery
- 4.18 EP.18 Current Transformer Magnetising Curves
- 4.19 EP.19 Junction Boxes
- 4.20 EP.20 Testing of Protection and Meter Circuitry

Proforma for electrical inspection and testing are included in Section D.5 of [GSCW](#).

On large projects specific procedures and proforma will normally be developed based on the models above and incorporated into the Project Test and Certification manual produced by the Project QA Manager in conjunction with the BPProject Electrical and/or Site Electrical Engineers.

In the absence of such a document the BPSite Electrical Engineer shall define the electrical requirements. Where possible BPmodel outline procedures and inspection and test proforma as detailed in Sections D4 and D5 of [GSCW](#) should be used in their original form. Modifications or additions as necessary may need to be made to cover other equipment/systems not listed above, different operating voltages or conditions and, in locations outside the UK, local statutory or other requirements.

It is advantageous for all Contractors to use BPproforma (provided by BP) for both inspection and testing so that the scope of inspection and testing is standardised and all information is recorded in the same format.

Any detailed or special procedures and method statements developed by contractors or vendors shall be approved by the BPSite Electrical Engineer prior to implementation as required in Section D1.3 of [GSCW](#).



*** 11.7 Temporary Installations**

The BPSite Electrical Engineer shall be responsible for ensuring that all temporary installations required for construction power supplies and lighting are installed and operated in a proper and safe manner.

In this respect he shall approve all Contractors' designs and equipment specifications. The installation shall be in accordance with good engineering practice and adequate inspection and testing shall be carried out and approved by the BPSite Electrical Engineer to ensure safe operation.

Particularly in future hazardous locations, the contractor shall maintain full as-built records of all temporary works to facilitate their complete removal prior to introduction of hydrocarbons etc.

Temporary installations in operating hazardous areas shall be subject to the same inspection and testing requirements as permanent works or be strictly in accordance with any conditions required by permits to work.

12. INSPECTION AND TESTING OF INSTRUMENTATION AND CONTROL SYSTEMS & EQUIPMENT

12.1 Scope

The requirements of this Section apply to all instrumentation and Control Systems including but not necessarily limited to the following:-

- Analysers, sampling and conditioning systems and associated systems,
- Alarm annunciator systems,
- Blending systems,
- Drilling systems,
- BOP control systems,
- Wellhead control systems,
- Computers,
- Controllers,
- Control panels,
- Control valves and motorised valves,
- Data collection systems,
- Distributed Control Systems
- Emergency shutdown systems,
- Emergency shutdown valves,
- Environmental monitoring systems,
- Fire and gas detection system,
- Flare gas metering system,



- Indicators,
- Instrument cabling of all types,
- Instrument piping, tubing and fittings (see also Sect. 3),
- Liquid level gauges,
- Machinery and condition monitoring equipment,
- Meter proving equipment,
- Orifice plates and all other flow element measuring types,
- Pressure gauges
- Pressure relief valves (see also Sect. 7),
- PD meters and strainers,
- Programmable Logic Controllers
- Resistance temperature detectors,
- Recorders,
- Scada and DCS systems,
- Solenoid valves,
- Subsea control systems,
- Switches (e.g. temperature, pressure etc.),
- Thermocouples,
- Thermometers,
- Transducers,
- Turbine meters and strainers,
- UPS systems associated with instrumentation.

12.2 Reference and Design Documentation

- 12.2.1 Instrumentation and control systems will have been designed and equipment specified in accordance with BP Group [RP 30-1](#) Instrumentation and BP Group [RP 30-2](#) Protective Instrumentation Systems, and any relevant national/statutory requirements.
- 12.2.2 The Inspector shall ensure compliance with all design/purchasing specifications.
- 12.2.3 Reference should also be made to [GSCW](#) Pt. E and [BS 6739](#) for further guidance.

12.3 Certification

- 12.3.1 Attention is drawn to the general requirements of sub section 2.1 and 2.2. of this Recommended Practice..
- 12.3.2 An agreed documentation system shall be prepared by the contractor for approval by the Inspector for use during the construction and pre acceptance phases. Detailed test plans for alarm and shutdown systems, interlock, sequential and pump-start systems shall form part of this documentation system.

12.3.3 Any equipment which is delivered without the specified certification will be quarantined and not issued for installation until the specified certification is available on site.

12.3.4 Model testing record forms and certificates are contained in [GSCW PT. E9](#).

12.4 Inspection and Storage of Procured Instrumentation

12.4.1 Attention is drawn to the general requirements of sub section 2.4 and 2.5 of this Recommended Practice.

12.4.2 Immediately upon their arrival on site, all materials and equipment shall be placed in storage in their original packings, suitably protected from the weather and/or under controlled ambient conditions as may be required by the nature of the instrument (see 12.4.5).

12.4.3 As soon as possible after receipt, they shall be unpacked and inspected by the Contractor and a record made of any damage during transit, shortages and the condition of the packing. This record will be passed to the Inspector, with a note of any corrective actions taken/required.

12.4.4 Equipment items shall be examined to confirm that they are correctly tagged and in accordance with design specifications and purchase orders. Particular regard shall be paid to ensuring suitability for the specified hazardous area classification for the location in which the items are to be installed.

* 12.4.5 After inspection, equipment shall be returned to weather protected storage with shipping stops and other devices for protection against damage whilst in storage. Computers and delicate electronic equipment shall be stored in a properly controlled air-conditioned environment where so specified by the supplier/manufacturer. Exceptions to all the above will be permitted only on the expressed written authorisation of the Inspector.

12.4.6 Modular and packaged equipment shall also be inspected to confirm that the structure, cable and piping runs do not conflict with equipment on adjacent modules or units. Access for commissioning and maintenance shall be checked.

12.5 Calibration and Testing (Pre-Installation)

12.5.1 To detect possible defects early, all instrumentation shall be tested and calibrated as soon as is practicable following receipt and initial inspection.



- 12.5.2 Calibration shall wherever possible be carried out in a suitably equipped workshop. Where instruments form part of a pre-assembled integrated system (e.g. a control panel on a packaged unit) which has previously been tested and accepted in the supplier's works, calibration may be carried out in situ. In situ calibration is also permitted for large control or motorised valves, turbines and PD meters. All such exemptions shall be authorised by the Inspector.
- 12.5.3 The calibration workshop shall be subject to approval by the Inspector. It shall be of sufficient size and have the necessary resources to accommodate the planned workload within the given time scale. The following features are an essential minimum:-
- (a) A clean, dry, well-lit environment.
 - (b) A clean, dry, instrument air supply to the maximum required pressure.
 - (c) All necessary electrical power supplies: 110 V-AC, 24 V-DC etc.
 - (d) Precision test equipment of sufficient accuracy, with current valid test certificates endorsed by an independent authority. Such equipment will include - deadweight testers - manometers, standard test pressure gauges, thermometers, potentiometers, ammeters, voltmeters etc.
 - (e) A temperature-controlled bath for resistance bulbs, filled systems etc.
- 12.5.4 A comprehensive documentation system shall be set up and maintained to provide a log of all instruments calibrated and a record of appropriate data. Model forms are contained in [GSCW](#) Pt. E - section 4. A complete set of vendor manuals/instruction books must also be available in the calibration workshop.
- 12.5.5 In preparing an instrument for calibration, all shipping stops shall be removed in accessories (e.g. charts, lubricants) installed.
- 12.5.6 The requirements, precautions and procedures governing pre-installation testing and calibration are detailed in [GSCW](#) Pt. E - section 2 and [BS 6739](#) Sect. 1..
- 12.5.7 The instrument to be tested shall be mounted in the correct plane on a rigid and vibration free stand or structure.

- 12.5.8 When testing has been completed, instruments process connections shall be drained and dried by blowing through with dry instrument air. All entries and connections shall be sealed against moisture and dirt ingress and the shipping stops replaced. Instruments shall be tagged to indicate 'calibrated' status and returned to suitable storage. Calibrated and un-calibrated instruments should be segregated.

12.6 Mechanical Installation

The Inspector shall check that the following requirements are complied with.

- 12.6.1 All local instruments, gauges, control valve stems, nameplates etc., shall be protected during installation and construction activities from physical damage and overpainting. There shall be no overpainting of manufacturers' finishes on any instrumentation without express written permission of the Inspector.
- 12.6.2 Instruments shall be located away from potential fire risk and spillage areas, sources of vibration and process vents and drains.
- 12.6.3 Instrumentation shall be examined to confirm that all equipment is in accordance within location drawings and that all components are correctly connected and installed.
- 12.6.4 The location of impulse pipework, vents, drains, cables, cable trays and any other accessories shall not cause a hazard either to personnel or equipment. Vents, drains and sample injection or withdrawal points shall conform with sub section 322.8 of BP Group [RP 42-1](#) - Piping Systems.
- Impulse pipework shall, in general, conform with BP Standard Drawing S-2025 and [API RP 550](#), and be self-draining/venting, according to application. Drain and vent valves shall be properly supported.
- 12.6.5 Field-mounted instruments shall be installed so that manufacturers' data plates, zero and span adjustments and isolation and manifold valves are accessible. They shall be installed in a true vertical plane, using bracket or post mountings. Supporting by process pipework or hand railings is not acceptable. Instruments shall be mounted between 1.4 and 1.6 metres above grade or permanent platform in order to be both readily maintainable and readable (where appropriate). Exceptions to this will only be granted by express written permission by the Inspector.
- 12.6.6 Instruments shall be securely tagged, with the full plant tag number engraved or stamped on a permanent stainless steel label.



- 12.6.7 Impulse lines shall be kept to a minimum practical length and shall contain the minimum number of fittings consistent with the ability to remove instruments or components for maintenance. Provision shall be made in the configuration of the impulse piping for differential movement between the instrument and its associated tapping point.
- 12.6.8 Impulse pipework shall be properly supported and clamped to metal tracking or structural members. Handrails will not be used for this purpose. For 12 mm O.D. stainless steel tubing, the maximum distance between supports shall be 1 metre.
- 12.6.9 Non-weatherproof instruments shall be mounted in cabins or protective 'instruments housings' with sufficient space for maintenance.
- 12.6.10 Where a blind transmitter (non-indicating) is used, or where an indicating transmitter/controller is not visible from the required operating position, (e.g. control valve) means of indicating the process variable shall be provided. This is not required however in general for thermocouples or resistance bulb applications.
- 12.6.11 Instrument air tubing shall be run on metal tracking or trays, routed away from areas where there is a risk of its suffering damage from mechanical vibration or other causes. It shall not be run on the same tray as power cable.
- 12.6.12 Instrument air supply and signal tubing shall be deburred and blown through before installation. Immediately prior to making final connections, air supply and signal tubing shall be thoroughly cleaned with clean, dry oil-free air.
- 12.6.13 Control panels and consoles shall be fully protected against damage during all installation in the control room or other remote associated equipment rooms.
- 12.6.14 Pressure instruments shall be installed with blow-out protectors unobstructed and directed away from personnel attending to these instruments. Where the instrument is more than 2.5 metres from the primary isolation block valve an additional local block valve shall be installed. Pressure gauges up to 150 mm diameter can be directly mounted if the associated pipework is flanged or welded.
- 12.6.15 Level instrument connections shall be direct to vessel or vessel bridles (standpipes), not to associated vessel pipework. Such connections shall use straight-through full-bore isolating valves. Bridles, if used, shall be directly connected to the vessel (i.e. without block valve). There shall be no U-bends between the instrument and the vessel, either in the piping or the bridle.



External level chambers shall have bottom entry lower connections and side entry upper connections, both connections being side-mounted to the vessel or bridle. Sufficient headroom shall be provided for the removal of top mounted displacers/floats.

12.6.16 Level gauge glasses shall be installed with quick-acting shut-off valves on both top and bottom mounting entries, and a full-bore drain valve. Safety shut-off ball valves shall be fitted to vessel nozzles. Level gauge glasses shall be easily readable from grade or platform.

12.6.17 Flow orifice installations shall be in accordance with BPStd Drg. S-1357M. Installations shall be checked to ensure:-

- Orifice plate is flat and concentric with pipe,
- Orifice is correct I.D. with a sharp upstream edge,
- No internal weld protrusions,
- Orifice taps are clear,
- Spare taps are plugged and seal welded.

The orifice plate (flow element) shall not be installed before flushing and pressure testing (see 3.4.14 of this Recommended Practice). The flange bore shall be recorded (see also 12.11.5 orifice plate checking).

12.6.18 Variable Area Flow Meters

The tube shall be checked for damage and that the scale range and float are in accordance with the data sheet which should show the gas with which the instrument has been calibrated. Manufacturer's calibration certificates are required for applications with varying temperature or specific gravities/densities.

12.6.19 Positive Displacement and Turbine Meters

Prior to installation of the meter casings, measuring elements of P.D. meters shall be removed. The elements shall be protected from mechanical damage, tagged and stored in a dry location. Alternatively, meters may be replaced with spool pieces; site to determine as found necessary.

Empty casings may remain in the line for pressure testing providing they are of adequate strength to withstand the line test pressure. In the case of turbine meters where it is not possible to remove the internal rotors, the meter shall be replaced with a spool piece.

Temporary strainers should be installed in front of PD and turbine meters. These temporary strainers should have a coarser mesh than



that of the permanent strainers but they may be installed in the same housing. They should be inspected at frequent intervals depending on quantity passed, before installation of the permanent line strainers.

The meter, or meter internals, as applicable, shall only be installed after the permanent line strainer is installed. Line flushing with water is found unsatisfactory and inadequate; process liquid at operational velocities should be used.

The installation shall be checked to ensure that the meter and strainer are easily removable and are not subject to pipeline stresses. The complete system shall be inspected to ensure that all components are correctly installed. These components include filters, vapour traps, drains, thermowells, pressure gauge trapping and switches. Manufacturers data on meter characteristics in accordance with BPGROUP [RP 30-1](#) Part 3 - Section 5.

12.7 Electrical Installations

- 12.7.1 Electrical connections and associated wiring shall be clearly and securely marked with the identification number as shown on the approved electrical hook-up schematic.
- 12.7.2 Junction boxes shall be weatherproof and certified for the hazardous area in which they are installed. They shall be mounted vertically. Additional protection should be afforded for adverse weather conditions in exposed areas to prevent ingress of water. Unused entry holes shall be properly blanked.
- 12.7.3 Cabling for thermocouples or resistance bulbs, used for control circuits, or any type of shutdown wiring shall be clearly and, unambiguously marked at each junction in order to guard against inadvertent disconnection.
- 12.7.4 Computer-quality cabling shall be specifically checked to ensure conformity with equipment manufacturer's requirements, particularly in regard to earthing of screening and armouring and separation and segregation from other cable types.
- 12.7.5 Each instrument cable shall be supported and clamped on a tray over its full length. Cable routes shall be in accordance with the approved drawings, away from areas of high fire risk and potential hazards. Cables shall not be bent to a radius of curvature less than that specified by the manufacturer. Cables shall not be installed or unreeled from drums when the ambient temperature is below limits specified by the manufacturer.

- 12.7.6 Only circuits of one class (e.g. 110 V-AC, 24 V-DC, ESD circuits) shall be contained within a multicore cable and a junction box. Intrinsically safe circuits shall be segregated from non-intrinsically safe circuits. Intrinsically safe circuits shall be suitably identified from other circuits. Power, control and shutdown circuits shall be similarly segregated and grouped (i.e. physical separation) not only within cabling trays and junction boxes, but on cable runs above and below ground. Where cross-overs are unavoidable, signal and power cable shall be so arranged as to cross at right angles, and separation shall be maintained by positive means.

12.8 Cable Testing

- 12.8.1 Before loop testing, all cabling shall be disconnected from equipment terminals at both field and panel ends, and checked for continuity from end to end. To avoid accidental contact between cable cores and terminals causing damage to electronic components, terminals shall be suitably protected. Cabling shall also be checked for insulation resistance from core to core, core to screen and screen to armour and the values suitably recorded.
- 12.8.2 Where required, tests on instrument cables for intrinsically safe circuits for loop impedance, inductance, capacitance etc., should be carried out in accordance with [BS 5345](#): Part 4.
- 12.8.3 Coaxial data highway cables and other computer quality cables shall be tested in accordance with the manufacturers' requirements, and shall include earthing resistance valves.
- 12.8.4 Termination of instrument cables and earth bonding of armour and screens shall be in accordance with BP Standard Drawings S-0596M, S-1998 and S-2019. Resistance to earth shall be measured to ensure acceptability and recorded. Earthing of intrinsically safe systems shall be in accordance with [BS 5345](#) Part 4.
- 12.8.5 Test data found shall be recorded on the appropriate form (see [GSCW](#) D or E for model format).
- 12.8.6 Testing programmes shall be agreed to meet systems completions priorities and multicore cables shall be allocated for this purpose to the highest priority system served by the cable.

12.9 Flushing and Preparation

- 12.9.1 The precautions to be taken for the protection of instrumentation during pre-test flushing/blowing through of pipework are included in

sub section 3.4 (in particular, paras 3.4.4, 3.4.10, 3.4.12, 3.4.14 and 3.4.16) and para 7.3.2 of this Recommended Practice.

12.9.2 All instrument air tubing between instrument and header or sub-header isolating valve shall be disconnected prior to any air blowing operation.

12.9.3 Where vessels are to be included in a piping system pressure test, displacement-type level transmitters and float switches shall be isolated prior to testing.

12.10 Pressure Testing and Post-Test Reinstatement

12.10.1 Instrument air headers, sub-headers and branch lines up to and including the isolation valves to individual instruments shall be pneumatically tested in accordance with procedure PP4, [GSCW](#) Pt. B2. The test pressure shall be in accordance with the applicable piping design code and maintained for a minimum period of 10 minutes. Tests shall be witnessed by the Inspector and the results recorded on the appropriate certificate (see [GSCW](#) Part E/Form I.1).

12.10.2 Instrument air tubing downstream of isolating valves shall be leak tested after the headers and sub-headers have been air-blown and the tubing reinstated.

12.10.3 Testing of instrument air piping with liquids is not permitted.

12.10.4 Process impulse piping to instruments may be pressure tested with the process piping (see also 3.4.16), but this is not preferred. Considerable damage could be suffered if certain instruments are over pressured. Pressure transmitters may be left installed for such tests provided it is confirmed to the Inspector that the pressure is within the range of the transmitter; for differential pressure transmitters the equalising valve shall be left open during test.

12.10.5 On completion of pressure testing all instrumentation equipment and impulse piping left in situ during the test shall be thoroughly checked, cleaned and dried, and any fittings, plugs etc. removed for the test reinstated, following post-test reinstatement of the pipework (see 3.6). All instrumentation etc. removed for the test shall also be reinstated for inclusion in the final process system leak test.

12.11 Testing and Instrumentation 'Loop' Checking

12.11.1 A loop will be defined as a combination of one or more instruments arranged to measure or control process variables or both.

12.11.2 A loop shall be termed ready for checking when:-



- (a) The appropriate pre-installation instrument calibration testing has been completed as per [GSCW](#) Pt. E - section 2 and recorded on form I-2.
 - (b) Process/pneumatic line pressure testing has been performed and recorded on form I-1.
 - (c) All cabling and wiring has been installed, tested and results recorded on the appropriate cable test certificate/form.
 - (d) All field instrumentation in the loop has been checked against the area classification to ensure that it suitably complies for use in that area (see para. 12.4.4).
- 12.11.3 A loop check is defined as being complete when a full response/functional test of all components within that loop has been conducted, found satisfactory and results recorded on form I-4.
- * 12.11.4 Testing and checkout requirements for the majority of instrumentation are described in principle below. For items not listed the methods of testing shall be submitted to the BPInspector for approval.
- 12.11.5 Orifice Plate Checking
- Before installation the BPInspector shall check the orifice plate for correct tag number, orifice bore size, location of vent/drain holes and record details on the form I-3.
- The orifice plate shall be inspected to verify plate physical conditions for flatness and upstream sharpness. Orifice flanges shall have been inspected to ensure freedom from burrs or obstructions in pressure tapping holes and also that the holes are positioned as per specification. (See also 12.6.17 - Mechanical Installation).
- 12.11.6 After installation, all instrument loops (individual temperature/pressure gauges excepted) are to be checked/calibrated to the satisfaction of the BPInspector.
- Only where a satisfactory 'response' calibration cannot be achieved will it be necessary to fully check the individual component in accordance with the manufacturer's specifications, for tolerance at zero, full scale range and intermediate points for ascending and descending scale.
- 12.11.7 In certain cases it may be necessary for the instrument manufacturer/supplier to check out specified instruments on site prior



to and following installation. This will be co-ordinated at site between the BPInspector and the contractor.

- 12.11.8 All calibration 'test' equipment used for loop checking shall be of a superior standard to equipment under test and appropriate to the Zone classification in which it is to be utilised. All test equipment shall be numbered and a record shall be maintained of routine testing/re-calibration of all testing equipment.

The BPInspector will advise the frequency of such re-calibrations as found necessary against the type/model of test equipment in use by the contractor.

- 12.11.9 Flow Measurement (Including Low Differential Pressure)

- 12.11.9.1 It is preferable that calibration be carried out with the instrument manifold attached to the instrument (i.e. low differential instruments).

Calibration shall normally be achieved using an air supply. The equalising valve shall be checked for leakage by isolating the input source and observing any fall in pressure.

- 12.11.9.2 Process Pressure and High Differential Measurements

These instruments shall be calibrated using compressed air and a test gauge/dead weight tester (as appropriate to the instrument range). All pressure gauges used in conjunction with controls and all special purpose gauges shall be included.

For the remaining gauges, only a random selection by the BPInspector shall be checked.

Pressure gauges used on oxygen service shall not be tested with oil.

- 12.11.10 Temperature Measurements

- 12.11.10.1 Filled Systems

All instruments of this type shall be given a functional check and critical instruments shall be calibrated. A temperature controlled bath or equivalent equipment shall be used for calibration against a mercury in glass thermometer having a National Physical Laboratory, Sunbury or other such equivalent certificate.



12.11.10.2 Thermocouples, Resistance Thermometer (RTD's) and Extension Leads

All thermocouple and resistance thermometer circuits shall be checked for polarity, continuity and correct material specification by inspection or testing as appropriate.

All circuits shall be tested by applying a known input at the junction between the thermocouple and extension leads and observing the panel mounted instrument indication. It should be noted that this is not intended as a calibration check of the instrument but a check that there are no defects such as polarity errors or the use of incorrect compensating leads; consequently this should be carried out after the indicating or recording instrument has been calibrated. The thermocouple or resistance bulb shall be inspected to ensure contact between the sensor (element tip) and the bottom of the pocket.

Receivers should be disconnected during insulation checks to avoid any possible damage.

Insulation of all leads shall be checked and rejected if less than 5 mega ohms using a 500 v insulation tester. Acceptance of valves less than 5 mega ohms is at the discretion of the BPInspector.

12.11.10.3 Industrial Thermometers

A random selection of thermometers shall be checked in the same manner as filled systems. The selection shall be made by the BPInspector.

12.11.10.4 Thermometer Pockets and Thermowells

These shall be checked to ensure there is no obvious error in the depth of immersion ('U' dimension), that the sensor/sensitive portion of the measuring device will be fully immersed in the line or vessel and that adjacent piping or equipment does not interfere with the withdrawal of the thermal element.

When pockets are fitted in the vertical position, action should be taken to prevent the ingress of water.

Where vessels or lines are insulated, the element head shall be clear of the insulation and any cladding.

Thermowells should also be checked by sample radiography or other approved method where appropriate to ensure that there are no forging defects.



12.11.10.5 Protecting tubes for heater tube skin temperatures shall be tested for leakages using air at 7 bar (100 lbf/IN²).

12.11.11 Level Indicators

12.11.11.1 Level Displacement Types

External types shall be calibrated by using water in displacer chamber.

Internal displacer types shall be inspected and, response tests carried out by moving the displacer weights could be used for a dry test but calibration and further functional checks shall be carried out during the process system test.

The displacer cages and standpipes are to be vertical, the displacer is to hang free from its hanger bar and it is not to foul the bottom of the chamber.

External displacer chambers are to be installed with the mid range mark at the correct elevation.

Standpipes on internal levels shall be checked to ensure they are open at top and bottom and are perforated for interface duty.

12.11.11.2 Differential Types

The installation shall be checked to ensure correct siting, range suppression or elevation and that the correct sealing fluids are used. The instrument shall be calibrated as detailed in para 12.11.9.1

12.11.11.3 Float Actuated Types

These are to be correctly mounted on the vessels and at the specified height. The float is to be securely attached to the shaft and is to move freely on its axis over the whole range.

12.11.12 Controllers

Controller alignment shall be checked to ensure that any output change on adjustment of prop. band is within manufacturer's tolerances.

The operability of the loop shall be checked by varying the output and observing the control valve.



A functional check of the controller adjustments (Prop. band + integral + derivative) desired value, auto-manual and cascade switches is required.

The Controller action shall be set as specified and pneumatic controllers shall be leak tested in the seal position.

12.11.13 Control Valves

The installation shall be checked to ensure that:-

- (a) Valves are installed correctly in the line relative to flow direction.
- (b) Adequate clearance has been provided above the top works and below the base flange for maintenance requirements.
- (c) The valve action on air-failure is correct.
- (d) Where and when specified, tight shut off is achieved.
- (e) Valve stem is not bent.
- (f) Grease gun assembly, where specified, is provided and fitted.
- (g) Valve strokes smoothly with correct packing fitted and is correctly calibrated.
- (h) Valve positioner (where fitted) is correctly calibrated (there should be no by-pass to the positioners on split range duty).
- (i) Check for hysteresis with positioner by-passed.
- (j) Check valve plug seats correctly.
- (k) The handjack is accessible and operates freely.

Self operated valves should be tested for stroking by the application of pressure to the diaphragm.

Solenoid valves should be energised and de-energised to check the operation.

3-way valves require careful installation and inspection, and reference should be made to piping and instrument sheets for direction of flow through each port.

12.11.14 Electrically Activated Valves

Where actuators have not been tested with valve bodies in the valve manufacturer's works, testing the combined valve and actuator unit shall be carried out to demonstrate that the actuator will open the valve with the specified differential pressure in the associated pipework.

Initial testing shall be undertaken by winding the valve by hand to the mid position before operating the actuator to check that the motor phase rotation is correct, noting that incorrect rotation will damage the valve.

The setting of torque and limit switches, valve position indicators, indicating lights and remote/local controls shall be checked by a full operational test using both the medium and low voltage supplies.

Where more than one electrically operated valve is associated with a system of interlocks, all valves shall be operational to ensure that the required valves only are affected.

12.11.15 Alarm and Shutdown Systems

Testing of these systems shall ensure that they operate as specified. Final checking must include a test of the complete system under actual or simulated operating conditions. Although individual sections of a system may be checked for convenience, it is not permissible to assume from checking each section that the system as a whole is acceptable.

The setting of all alarm and shutdown devices shall be tabulated.

Alarm and trip devices should have their reset differentials checked and recorded to ensure reset is within working range of device.

12.11.16 Sequential Interlock and Automatic Pump Start-Up

Sequential, interlock and pump start-up and change-over systems shall be checked to establish that all operating conditions are met.

In some cases it will be possible to test these systems by simulating operating conditions, but it is emphasised that each system must be tested as a whole.

During the tests the Inspector shall also check that there is no interaction between systems.

12.11.17 Instrument Panels

For panels which are supplied complete with the instruments, tests will normally have been carried out at the manufacturer's works in accordance with BP Group [GS 130-3](#), for electrical and pneumatic instruments respectively, and these tests should not require repeating at site.

For panels supplied incomplete and where instruments are installed at site, further testing shall be necessary to the respective BP Standard on site.

* 12.11.18 Other Equipment

The testing and acceptance procedure for equipment which is not classified under Clause 12.11 shall in all cases be submitted for approval by BP.

12.12 Post Loop Test Reinstatement

During testing of various logic, sequential and shutdown systems, temporary 'links' or in the case of electrical control switch gear 'jumbo'/test leads are deployed as necessary to simulate operational conditions; these devices shall be recorded in a Log retained in the Control Room.

It is essential that on completion of testing all such devices are systematically removed and the Log endorsed accordingly.

13. PRE-COMMISSIONING

13.1 Scope

13.1.1 This Section describes the requirements for the preparation of a process unit up to the stage where processing can be commenced. See also para. 2.1.

13.1.2 This work should only be undertaken after the requirements of the preceding sections have been satisfied.

13.2 Heaters

13.2.1 If for operational reasons valves have been provided at the heater outlet, a pressure test utilising oil as the test medium should be carried out at the shut-in head of the heater feed pump. The procedure should be similar to that described in Section 6.2.



- 13.2.2 The heater refractory including that of the chimney should then be dried.

The procedure should normally be that recommended by the supplier but it must be thorough enough to ensure that the heater can be brought on stream immediately at the end of the pre-commissioning period.

A typical programme for a heater with a design heat release of about 30 MW (100,000,000 BTU/hr) would be as follows:-

- (a) Pass steam or oil through coils. If steam raising coils are fitted, feed water should be circulated through them and steam through superheaters.
- (b) Purge the heater combustion space with steam until steam has issued from the top of the chimney for 15 minutes.
- (c) Commence drying action by any convenient means, e.g. portable warm air fans, bottled gas burners. Allow the chimney base temperature to rise steadily, reaching about 120°C after 24 hours. The main burners may be lit when required for this purpose.
- (d) Thereafter raise the temperature by 25°C increments at 12 hour intervals up to 260°C. Maintain this temperature for 24 hours.

13.3 Final Pressure Test

- 13.3.1 A final pressure test with a test medium as specified on the line list should be carried out to prove the tightness of all piping and equipment joints.
- 13.3.2 For the purpose of this test the unit pipework, vessels, heat exchangers, etc. should be linked up by opening appropriate valves, except that:-
- (a) Pump suction and discharge valves should be closed.
 - (b) Pressure gauges and instruments unsuitable for the test pressure should be isolated.
- 13.3.3 Systems for steam, air fuel oil, fuel gas and water should be separately tested.
- 13.3.4 If any part of a unit is to work under sub-atmospheric pressure conditions an additional test (by vacuum) should be applied. This test should commence at maximum vacuum and continue over a period of 6



hours during which the loss of vacuum should not exceed 15 mbar (10 m (Hg) pr hour.

A vacuum test should also be carried out when it is necessary to evacuate for purging purposes. On catalytic units equipped with ejectors where the catalyst can be damaged by cold oil, water or steam, a vacuum test of the heater and reactors should be carried out. This test should commence at maximum vacuum and the loss of vacuum should not exceed 35 mbar (25 mm Hg) per hour.

Catalytic units not so equipped should be pressure tested with nitrogen.

13.4 Machinery Running Tests

- 13.4.1 Pumps will be required to run for 24 hours and a specified liquid should be introduced for this purpose.

During this period strainers (see BP Group [RP 42-1](#), Clauses 5.2 and 5.6.9) will be opened for cleaning as required.

- 13.4.2 Running tests on other types of machinery should be as specified.

13.5 Instrumentation

- 13.5.1 Instrumentation systems should be verified as ready for use by means of appropriate testing and calibration procedures, except where these can only be carried out during commissioning.

13.6 Drainage System

- 13.6.1 Each leg of the system is to have a flushing test.

In this test the water flowing into the receiving manhole may require to be disposed of with a portable pump.

- 13.6.2 When these tests are completed the system should be connected to the refinery main.

13.7 Catalyst

- 13.7.1 Catalyst carriers, catalyst, raschig rings and similar loose bulk items should be loaded into their appropriate vessels.



- 13.7.2 They should be carefully handled to minimise breakage and where necessary chutes or socks should be provided for this purpose. Where practicable, raschig rings should be floated in.

13.8 Utilities Systems

- 13.8.1 Steam, water, air and gas systems should be brought into service gradually.



DEFINITIONS AND ABBREVIATIONS

Definitions

Standardised definitions may be found in the BPGroup RPSEs Introductory volume.

Inspector	The BPEngineer responsible for monitoring/overseeing the inspection and testing of equipment. The 'Inspector' may be a Construction Engineer, Plant Inspector, Welding Inspector or an authorised Agency Inspector.
Operator	The department responsible for final acceptance and subsequent operation of the plant or equipment installation.

Abbreviations

BASEEFA	British Approvals Service for Electrical Equipment
BOP	Blow Out Preventer
BPE	BPEngineering (BPInternational Limited)
DCS	Distributed Control System
EEMUA	Engineering Equipment and Material Users Association
ESD	Emergency Shut-Down
GSCW	Guide to Site Construction Work
Hg	Mercury
HP	Horse Power
NACE	National Association of Corrosion Engineers
NDE	Non-Destructive Examination
PAU	Pre-Assembled Unit
PD	Positive Displacement
PTB	Physikalisch - Technische Bundesanstalt (German Equivalent to BASEEFA)
PWHT	Post Weld Heat Treatment
RTJ	Ring Type Joint
UPS	Un-Interruptible Power Supplies



LIST OF REFERENCED DOCUMENTS

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

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

[The Docks Regulation 1934](#) (SR & O 1934 No. 279)

[The Factories Act 1961](#)

[The Offshore Installations](#) (Operational, Safety, Health and Welfare) Regulations 1976-SI 1019

ANSI/ASME B31.3	Chemical Plant and Petroleum Refinery Piping
API RP 550	Manual on Installation of Refinery Instruments and Control Systems
ISO 4406	Hydraulic Fluid Power - Fluids - Methods for Coding Level of Contamination by Solid Particles
API 650	Welded Steel Tanks for Oil Storage
BS 2654	Specification for Manufacture of Vertical Steel Welded Storage Tanks with Butt-Welded Shells for the Petroleum Industry
BS 5345: Part 4	Installation and Maintenance Requirements for Electrical Apparatus with Type of Protection 'i'. Intrinsically Safe Electrical Apparatus and Systems
BS 6739	Code of Practice for Instrumentation in Process Control Systems: Installation Design and Practice
BS 8805: Part 1	Guide to new Sewerage Construction
BPGroup GS 106-2	Painting of Metal Surfaces (was BPStd 141)
BPGroup GS 106-3	External coatings for Steel transmission Pipelines (was BPStd 144)
BPGroup GS 118-5	Fabrication of Pipework to ANSI B31.3:- Carbon and Carbon-Manganese Steel Pipework (was BPStd 167 Part 1)
BPGroup GS 118-6	Alloy Steel Pipework



	(was BPStd 167 Part 2)
BPGroup GS 118-7	Austenitic and Duplex Steel Pipework, Cupro-Nickel and Nickel Base Alloy Pipework (was BPStd 167 Part 3)
BPGroup GS 122-1	Fired Heaters to API 560 (was BPStd 162)
BPGroup GS 126-2	Air-Cooled Heat Exchangers (was BPStd 161)
BPGroup GS 130-3	Testing and Inspection of Instrument Panels for Electronic Instruments (was BPStd 130)
BPGroup GS 146-1	Distillation, Absorption and Extraction Column Internals (was BPStd 168 December 1988)
BPGroup GS 158-2	Vertical Tanks for Non-Refrigerated Fluids Part 1: Tanks to BS 2654 (was BPStd 163)
BPGroup RP 4-1	Drainage Systems (was BPCP 5)
BPGroup RP 24-2	Passive Fire Protection of Structures and Equipment (was BPCP 16)
BPGroup RP 30-1	Instrumentation (was BPCP 18)
BPGroup RP 30-2	Protective Instrumentation Systems (was BPCP 48)
BPGroup RP 32-1	Inspection Procedures - New Equipment in Manufacture (was BPCP 51)
BPGroup RP 32-3	Inspection and Testing of Plant in Service (Mechanical Equipment & Piping) (was BPCP 52 Sections 8-25)
BPGroup RP 32-4	Inspection and Testing of Plant in Service (Electrical) (was BPCP 52 Sections 26-34)
BPGroup RP 32-5	Inspection and Testing of Plant in Service (Instrumentation)



BPGROUP RP 42-1	Piping Systems to ANSI B31.3 (was BPCP 12 April 1989)
BPGROUP RP 52-1	Thermal Insulation (was BPCP 13)
GSCW	Guide to Site Construction Work
EEMUA Publ. No. 142	Acoustic Insulation of Pipes, Valves and Flanges
EEMUA Publ. No. 147	Recommendations for the Design and Construction of Refrigerated Liquified Gas Storage Tanks.
BP Standard Drawings	
S-0596M	Earthing Electrodes for Use in All Areas and Typical Earthbar Joints and Fixings
S-1357M	Connections to Orifice Flanges, Gas Condensable or Liquid Service
S-1088	Heaters - Rolled Tube Connections with Seal Welding
S-1998	Typical Earthing Diagram for Scada and Computer Type Equipment
S-2019	Typical Installation Detail for Cable Termination and Earth Bonding
S-2025	Pressure Instrument Hook-Up General Principles
S-2032	Tube Rolling Chart

