



RP 30-1

INSTRUMENTATION AND CONTROL DESIGN AND PRACTICE

September 1993

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SCOPE AND PURPOSE This Recommended Practice provides guidance on the design and application of Instrumentation and Control Systems used for the protection, control and monitoring of production and process plant, storage facilities, pipelines and other installations handling flammable gasses and liquids. Its purpose is to provide design engineers and plant management with:- (a) guidance on the need and applicability of Instrumentation and Control Systems. (b) a basis for designing, evaluating and selecting types of Instrumentation and Control Systems for various duties. (c) guidance on health and safety aspects associated with the design, installation and operation of Instrumentation and Control Systems.											
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FOREWORD

Introduction to BP Group Recommended Practices and Specifications for Engineering

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

General

This is a revision of Part 2 of BP Code of Practice CP 18, previously issued in separate sections from April 1986 onwards. With its supplementary yellow pages it has been rationalised into a single document RP 30-1 composed of eleven sections:-

Section 1	Introduction
Section 2	Control Engineering Principles
Section 3	Selection of Instrumentation Equipment
Section 4	Instrument Installation
Section 5	Earthing and Bonding Systems
Section 6	Instrument Power Supplies
Section 7	Instrument Air Systems
Section 8	Hydraulic Power Systems
Section 9	Control Panels
Section 10	Control Buildings
Section 11	Instrument Database Systems

These Sections reflect the applicable previous sections generally retaining previous content but in some cases additional sections and sub-sections have been added (see cross reference list, page vi).

This document specifies all BP's general requirements for instrumentation and control systems that are within its stated scope and is for use with a supplementary specification to adapt it for each specific application.

Value of this Recommended Practice

This Recommended Practice gives the basis for the design of instrumentation, control and associated information systems. It has been developed from cross-Business experience gained during capital project developments, operations and maintenance; and from equipment developments and evaluations carried out under BP's Business and Corporate R&D programme.



The document covers the rapidly developing field of digital technology, and gives guidance on instrumentation and control system strategy, equipment selection and project development.

Where such codes exist for established elements of the technology, the document guides the user as to their correct application.

It is intended to review and update this document at regular intervals, because it is essential to maintain BP's commercial advantage from the effective deployment of the rapidly developing technology covered by this Practice.

Application

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

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

Principal changes to Sections Issued from March 1991:-

- (a) The Practice has been revised to the new format to rationalise the sections, and integrate the commentary into the main text.
- (b) The sections have been updated to include references to new standards and reflect changes in operating practices.
- (c) Section numbering has been amended to suit the applicable part.

The cross-reference table at the end of this foreword shows relationships between new documents and the old CP 18.

Feedback and Further Information

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

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



LIST OF SECTIONS CROSS REFERENCED TO CP 18

RP 30-1 TO RP 30-5

CP 18 PARTS AND SECTIONS

No equivalent in RP 3~X

Part 1 (Foreword and Introduction)

RP 30-1 INSTRUMENTATION AND CONTROL DESIGN AND PRACTICE

Part 2 Systems, Design and Practice

Section 1	Introduction	E Section 1	Introduction
Section 2	Control Engineering Principles	E Section 2	Control Engineering Principles
Section 3	Selection of Instrumentation Equipment	E Section 3	Selection of Instrumentation Equipment
Section 5	Earthing and Bonding	E Section 5	Earthing and Bonding
Section 6	Instrument Power Supplies	E Section 6	Instrument Power Supplies
Section 7	Instrument Air Systems	E Section 7	Instrument Air Systems
Section 8	Hydraulic Power Systems	E Section 8	Hydraulic Power Systems
Section 9	Control Panels	E Section 9	Control Panels
Section 10	Control Buildings	E Section 10	Control Buildings
Section 11	Instrument Database Systems	Section 11	Digital Systems (to RP 30-4 , Sect 2)
		+ Section 12	Advanced Control System (to RP 30-4 , Sect. 5)
		+ Section 13	Telecommunications (to RP 30-4 , Sect. 3)

RP 30-2 INSTRUMENTATION AND CONTROL SELECTION AND USE OF MEASUREMENT INSTRUMENTATION

Part 3 Measurement

Section 1	Introduction	E Section 1	Introduction
Section 2	Temperature Measurement	E Section 2	Temperature Measurement
Section 3	Pressure Measurement	E Section 3	Pressure Measurement
Section 4	Liquid Level Measurement	E Section 4	Liquid Level Measurement
Section 5	Flow Measurement	E Section 5	Flow Measurement
Section 6	Storage Tank Measurement	E Section 6	Storage Tank Measurement
Section 7	On Line Analytical Measurement	E Section 7	Measurement
Section 8	Automatic Samplers for Offline Analysis	E Section 8	Automatic Samplers for Offline Analysis
Section 9	Weighbridges and Weighscales	E + Section 9	Weighing Systems
Section 10	Environmental Monitoring		
Section 11	Instrumentation for HVAC systems		
Section 12	Drilling Instrumentation		

RP 30-3 INSTRUMENTATION AND CONTROL SELECTION AND USE OF CONTROL AND SHUTOFF VALVES

Part 4 Valves and Actuators

Section 1	Introduction	E Section 1	Introduction
Section 2	Regulating Control Valves	E Section 2	Regulating Control Valves
Section 3	Power Actuated Isolating Valves	E Section 3	Power Actuated Isolating Valves

RP 30-4 INSTRUMENTATION AND CONTROL SELECTION AND USE OF CONTROL AND DATA ACQUISITION SYSTEMS

Section 1	Introduction
Section 2	Digital Systems (new commentary added)
Section 3	Telecommunications
Section 4	Subsea Control Systems
Section 5	+ Advanced Control Systems

RP 30-5 INSTRUMENTATION AND CONTROL SELECTION AND USE OF EQUIPMENT FOR INSTRUMENT PROTECTION SYSTEMS

Part 5 Protective Systems

Section 1	Introduction	E Section 1	Introduction
Section 2	Protective Instrument Systems	E Section 2	Protective Instrument Systems
Section 3	Alarm systems	E Section 3	Alarm Systems
Section 4	Fire and Gas Detection and Control Systems	E Section 4	Fire and Gas Detection and Control Systems
Section 5	Pipeline Leak Detection	E + Section 5	Pipeline Leak Detection

E- equivalent (not identical)

+ - yet to be published



1. INTRODUCTION

1.1 Scope

1.1.1 This Recommended Practice specifies BP requirements for Instrumentation and Control Systems, Design and Practice. It contains sections that have general application to the provision of instrumentation, instrumentation systems, and control systems, including general principles, documentation and requirements for common systems.

1.1.2 Other related Recommended Practices to BP Group RP 30-1 specify BP requirements for specific equipment, i.e. Measurement, Valves and Actuators, Control and Data Systems and Protective Systems.

1.2 Application

1.2.1 To apply this Part, it shall be considered that Section 2, control Engineering Principles, Section 3, Selection of Instrumentation Equipment, and Section 4, Instrumentation Installation, have general application for all projects.

1.2.2 Reference is made in the text to British Standards. These standards are generally being harmonised with other European standards and will be allocated ISO/EN reference numbers. In certain countries, national Standards may apply. BP shall approve use of other standards.

1.3 Units

1.3.1 This Recommended Practice employs SI metric units.

1.3.2 Nominal pipe sizes (NPS) are ANSI or API designations which have not yet been metricated. However, metric DN numbers are given in brackets.

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

1.4 Quality Assurance

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



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

2. CONTROL ENGINEERING PRINCIPLES

This Section specifies BP general requirements for control engineering design.

2.1 Basis for Design

- 2.1.1 BP will specify the overall requirements for instrumentation and control applicable to a particular project. This will include the basis for design, planned manning levels and the locations and functions of manned control centres.

This design basis section is intended to give guidance to BP engineers on the areas to be addressed and issues which may be relevant to the overall scheme. The nature of plant and projects within the BP Group are many. Therefore, the user of this document must use his own judgement as to the relevance of any requirement to a particular job. Detailed guidance may be obtained from the custodian of this document.

The control system designer must consult with the end user when formulating the policy to be adopted for the control system for new, expanded or modified plant. The end user in this context is most commonly the operating management for a plant or complex. However, at the early design or concept stage of a grass roots project there may be no operating management and it is necessary to consult with the client's representative from the appropriate BP Business. It is essential to establish the responsible organisation or person and work closely with the end user when developing the outline control system philosophy since they will ultimately have to approve the approach adopted.

Standardisation of equipment and techniques should be addressed early on. Many aspects could be covered. However, the following are perhaps the more significant:-

- (a) Standardisation of equipment with some existing facility on site, or standardisation of equipment being supplied by different contracts for a project (e.g. distributed control system supplier).*
- (b) Standardisation of equipment numbering, units of measurement, documentation systems for operations and maintenance (e.g. computerised documentation).*
- (c) Any requirement for standard communication links to site-wide computer systems or a SCADA system. This could include data communications to third parties or via third party networks.*

The BP control engineer should review the whole of BP Group RP 30 series and indicate any amendment, exclusion and clarification of statements relevant to the project. This should include the job requirements for items to be specified by BP. Other Recommended Practices make reference to instrumentation and should also be reviewed;



notably BP Group [RP 22-1](#), [34-1](#), [42-1](#), [52-1](#), [44-1](#), [12](#), [4-4](#), [32-2](#), [32-3](#), [32-4](#), [32-5](#), [50-2](#).

It is often desirable to submit to the contractor an outline plan giving provisional locations of control and equipment areas.

2.1.2 The contractor will be responsible for the engineering development in accordance with contract documentation and BP Recommended Practice to ensure that the specified requirements for instrumentation and control are provided on the finished plant.

* 2.1.3 The contractor shall submit for approval by BP a document describing the 'Instrumentation, control and monitoring philosophy' for the project. The document shall as a minimum requirement include the following information:-

- (a) The principal responsibilities of the contractor, sub-contractors and suppliers for the correct design, supply, installation and testing of instrumentation and controls. This shall identify responsibilities for the correct provision of software.

It is essential that responsibilities for the provision of both hardware and software are clearly defined. Some flexibility in the contract, with agreed component costs and manhour rates for changes in scope, may prove beneficial.

BP is likely to provide some software packages to run in a computer system. Some estimate of machine loading and the facilities required to accommodate BP supplied software will have to be made early in project development to enable the contractor to firm up his specification on the supplier. Changes in software specification are certain to occur during development which may lead to contractors' claiming extra payment.

BP may separate the control system (or a computer system) supply contract from the main contract. In this case responsibilities for input/output listings (or communication link and loads) will have to be carefully defined. Again changes as the job develops may lead to claims as a result of extra work.

- (b) The control strategy for the plant, including the degree of information gathering and automatic operation necessary to meet the planned manning levels and operating efficiency targets specified by BP. This should include any hardware/software provision for use by plant managers, supervisors and maintenance staff.

The main control point for the plant must be defined at the pre-project stage since it potentially has a major impact on cost and engineering development. If it is unclear at the relevant contract stage, then the contractor should be asked to address the options versus cost; for BP approval of the ultimate design route.



Generally, large and complex plant is operated from control rooms within individual units from a control room for a group of units in the geographical area or from a central control room for the whole site or complex. Offshore, this may be one or more control rooms on one or more platforms with communications to one control centre (possibly onshore) for overall supervision.

BP should specify the degree of automation required at each location (e.g. how much field operation as opposed to control room operation is acceptable), taking into account the planned manning levels, the nature of the plant and the operating efficiency targets of the project.

- (c) The location of operator and supervisor control stations and the facilities thereon, including the methods of providing, displaying and accessing plant measurements and controls, alarm handling, and routine and on-demand reports.

The nature of the control facilities and information displayed at any point will be related to the responsibilities of respective operations personnel and their ability to control or otherwise influence any situation which might arise.

Sometimes extra operator facilities (or at least space/means of access) may be necessary during start up or trouble shooting.

The locations and basic layout of the operator and supervisor control stations is an early decision for the project. It is preferable that the requirements are specified by BP at the outset. This would entail a decision on either:-

- (i) *Use of comprehensive video based distributed control or SCADA system, with some indication of the number of consoles, number of screens, facilities required (e.g. printers for reports and alarm/event recording, hard-wired shutdown panel, dedicated fire and gas screens), location of console or access for extra manning during start-up or trouble shooting.*
- or (ii) *Use of individual instruments located in panels at different locations. Extra facilities such as sequence control, or overall supervisory control by a computer or SCADA system should be identified.*
- (d) The physical distribution of main control equipment hardware and the method of data transmission between areas. This shall identify the interfaces between major system packages (e.g. distributed control system, emergency shutdown system, fire and gas system, programmable logic controllers, SCADA system, communications systems). Interfaces with such equipment supplied as part of sub-contracted plant packages shall be included.



The physical layout of the plant in relation to the operating policy will influence the options open to the control engineer when developing facilities. The ability to physically distribute modern control equipment over a wide area can be exploited to save the installed cost (and space and weight in the offshore scene). Offset against this may be the cost of providing a suitable environment and services for electronic equipment on or near the plant. (Refer also to 2.3.3).

- (e) The basis of design to meet electrical hazard classification (e.g. the use of intrinsically safe or other method of protection).

This shall include the policy to overcome the potential ignition hazard caused by batteries within equipment otherwise electrically isolated under abnormal plant conditions. This shall cover batteries supplied as an integral part of an electronic card or card file (e.g. for memory support). Examples where primary power may be isolated are on:-

- (i) Loss of pressurisation/purging of Ex (p) protected apparatus.
- (ii) Power down of equipment following detection of an unacceptably high flammable gas concentration in the surrounding area (e.g. offshore 'red' shutdown condition, gas release in analyser house).
- (iii) Power down of equipment following loss of purging/pressurisation of a room or enclosure which is maintained at a lower hazard classification than the surrounding area, by purging or pressurisation.

BP commissioned a study by Electrical Research Association (ERA Report No. 4120/06) which gives guidance on this issue. A copy and further advice may be obtained from the custodian of this document.

- (f) Every effort should be made to eliminate the requirement for Category 1 or Category 2A instrumentation systems from the overall design.

See BP Group RP 30-5 and BP Group [RP 30-6](#) for guidance on categorisation.

- (g) Levels of protection to be incorporated into the fire and gas/emergency shutdown systems (Refer also to BP Group [RP 30-7](#) and [RP 30-6](#)).

Independent documents covering the basis for design of protective instrumentation systems (including ESD) and, where applicable (e.g. offshore) fire and gas detection systems may be desirable. Note that for



some projects these have to be submitted to authorities for approval. Such documents should be developed under the authority of the safety or loss prevention engineer appointed to the project.

- (h) The interconnection of instrumentation forming part of a safety system (e.g. fire and gas monitoring) with the main plant instrumentation, control and display system.

Authority requirements for safety systems differ in different countries. Integration of any safety system into the main plant instrumentation system has to be carefully examined to ensure that neither the authority's nor BP's requirements are compromised. It is usually possible to display safety information via a distributed instrumentation or SCADA system provided that adequate availability can be demonstrated; and provided that the safety system itself is totally independent from the sensors through the logic system to the final actuating device. Sometimes special independent displays are necessary for fire systems (e.g. at an entry to a building/room). Reference should be made to BP Group RP 30-4 Section 2 and BP Group RP 30-5 Sections 2 and 4.

- (i) The interface with any external equipment (e.g. long distance radio or telecommunications system, data processing computers, management information system).

These interfaces could be non-standard necessitating 'special to project' software. Also the data is likely to be important to operation and management of the facility. Safe operation could be seriously impaired on loss of a critical communications link (albeit there would be redundancy) for an unmanned facility (e.g. to an unmanned offshore production platform).

Care needs to be taken to ensure that safety systems (e.g. emergency shutdown, fire and gas systems) can be accommodated without compromising their integrity. This is particularly important when addressing long distance links which may involve radio or other telecommunications networks.

- (j) Facilities provided to run plant optimisers, expert systems and other software packages as specified by BP.
- (k) The provision of uninterruptable power supplies and the distribution to equipment (Refer also to BP Group RP 12). An estimate of the connected loads shall be given.

Many otherwise well designed installations have been unreliable due to an inadequate power supply. Frequently this has been due to a mismatch between the instrumentation requirement and the UPS system. Common mode failures in the supply system have also been observed. Power supply load estimates need careful assessment as it is all too easy to 'play safe' and end up with significantly oversized battery or battery inverter systems (uneconomical and perhaps resulting in reduced performance from under-run inverters).

The power supply and instrument design engineers must evolve a common policy for the project. Refer also to BP Group RP 12.

- (l) Equipment and protocols for computer aided design and engineering to be used during project development and for hand over of documentation and data to BP.
- (m) Instrument numbering system.

- * 2.1.4 When a centralised control room is specified, any designed use of local control rooms as bases for field operators or for use during emergency, trouble shooting or start-up conditions may impact on the site manning levels. The contractor's proposals shall be subject to approval by BP.

Operations manning levels and availability of appropriately skilled operations staff may make local fallback control points impractical under difficult operating circumstances. The operating department's view should be sought.

- 2.1.5 Where existing instrumentation is to be incorporated as a whole or in part into a new or revised control system (e.g. re instrumentation projects or plant revamps), the contractor shall ensure that signal transmission, earthing practice and electrical safety of new and existing equipment is compatible. Particular attention shall be given where intrinsically safe equipment is involved on either the existing or new facility. e.g:-

- (a) Existing field instrumentation and associated cabling supplied and installed as intrinsically safe many years ago may not meet the system certification requirements of the new equipment.
- (b) Existing earthing policy for signals and signal cable screens may differ from the new equipment manufacturer's recommendation.

Advice should be sought from the control system supplier and, where necessary, electrical safety consultants (such as ERA, SIRA).

Experience has shown that existing plant has been built (and perhaps previously modified) to a variety of different standards. These can impact on the economic options open when connecting existing equipment into new electronic systems. Compromise is often necessary and well worth addressing before the design progresses in detail.

- * 2.1.6 BP will specify the basis of design for instrumentation to meet statutory fiscal and accountancy measurements.

BP, as the operator is responsible for all negotiations with customers, commercial partners, third parties and authorities. It is essential that those within BP responsible for such agreements are consulted to ensure that all measurements are identified and specified to the appropriate accuracy; and installed to ensure



adequate security of data, including data processing and readout. Reference should be made to the BP Measurement Guidelines (which are regularly amended) and to BP Group [RP 30-2](#) Sections 5 and 6.

Responsibilities of the parties involved should be clearly identified in project co-ordination procedures.

2.2 Function of Instrumentation

2.2.1 Instrumentation should be provided to satisfy the following requirements:-

- (a) Enable safe and convenient plant start up, uninterrupted operation, and controlled shut down.
- (b) Enable safe manually initiated emergency shutdown from agreed locations. Different levels of shutdown shall be provided when specified by BP. Refer also to BP Group RP 30-6.
- (c) Provide automatic protective action where deviation of plant variables could result in a hazard to personnel or equipment.
- (d) Provide information and controls to enable plant and utilities to meet the specified requirements for safety, product quality, throughput, efficiency and economic operation.
- (e) Provide local indication of plant variables at points which will allow local adjustment of control and bypass valves. Local indication of variables necessary at plant and equipment during start up, shutdown or during emergency conditions shall also be provided.

The requirements for these facilities will need to be identified by BP. It is unlikely that the contractor alone would have the knowledge of the plant or its operation to satisfactorily provide the full facility. BP directly or in consultation with the contractor or specialist consultant would develop the concept and engineer as the project proceeds.

Additional measurements over and above those necessary for basic plant operation will probably be required (e.g. for energy observation, advanced control, plant optimisation, oil loss or stock control, or management information schemes). Early specification of such measurement points (even if only in outline) could minimise any risk of project cost escalation and reduce the contractor's future scope for extras.

2.2.2 BP may specify additional instrumentation to satisfy the following requirements:-



- (a) Means of recording plant variables for fault diagnosis and for the prevention of unscheduled shutdown. This should include real time information on sequence of events and plant trips.
- (b) Information to enable early detection of any degradation of plant or equipment due to fouling, wear or other malfunction. This should be addressed as part of the overall condition monitoring and maintenance policy for the plant.
- (c) Means of processing and recording key information for plant operation and for plant efficiency monitoring.
- (d) Measurements, information processing, recording and automatic sampling for fiscal and accountancy purposes.
- (e) Measurements, information processing, recording and automatic controls for any emissions to atmosphere and discharges of liquid effluents which are necessary to enable legislative requirements to be adhered to.
- (f) Information processing, display, recording and reporting facilities for the presentation of processed measured data in a format suitable for management, operations, technical, commercial and maintenance personnel. Data links to plant-wide management information systems may be specified by BP.
- (g) General evacuation alarms with policy for activation and sound levels and frequencies in relation to surrounding plant.
- (h) Environmental and health monitoring systems.
- (i) Special regulations applicable to drilling areas on offshore platforms.

2.2.3

The function of key instrumentation may be subject to special regulations and codes which shall be identified during the appropriate stages of the engineering development. For example, these regulations and codes may be national authority, statutory or local for design and installation requirements and require independent or authority inspection.

The purchaser will specify any special regulation and applicable codes necessary for the provision of:-

- (a) Environmental, pollution, fire and gas monitoring and protection systems. The extent of the facilities provided and



automatic protective action incorporated, shall be subject to approval by the purchaser.

- (b) Instrumentation applicable to safety, legal and fiscal requirements.

2.3 Selection and Installation of Instrumentation

2.3.1 Equipment shall be selected in accordance with local and national regulations and installed to [BS 6739](#) and [API RP 550](#). It shall also satisfy the functional requirements stated in contract documentation and in this Recommended Practice.

2.3.2 Equipment shall be suitable for the environment in which it is to be installed and maintained. Selection shall take into account the following:-

- (a) Geographic location
- (b) Ambient temperature and expected variation
- (c) Area hazard classification (refer also to BP Group RP 12)
- (d) Atmospheric pollutants
- (e) Humidity
- (f) Dust
- (g) Vibration
- (h) Thermal and solar radiation
- (i) Lightning

Refer also to Section 3 of this Recommended Practice.

2.3.3 When the installed cost of signal transmission cable is high or when a control room or control centre is remote from the plant, the process interface, control and protective equipment modules should be located local to the plant with serial communication with operator facilities in the control room. The ultimate choice of location shall be based upon an overall economic assessment which shall include:-

- (a) The provision of all necessary operator facilities at the control room.
- (b) The provision of command and data communication (of adequate integrity) between local and control room located modules.
- (c) The provision of suitable environment, services and secure power supplies at the local level.



- (d) The provision of any additional facilities necessary for maintenance.
- (e) The impact (positive and negative) on other engineering costs such as civil, structures or building.
- (f) The impact of any requirement for flame retardant or fire resistant cables (refer to BP Group RP 12/[GS 112-12](#)).

Physical distribution of control and monitoring equipment may necessitate the purchase of more expensive hardware and may involve additional cost to install; notably the provision of a suitable environment (both ambient conditions and electrical safety classification), and services of adequate integrity at the different locations.

The potential benefits are high where individual signal transmission of variables over long distances would otherwise be necessary. On-shore there are savings in trenching, mounting cable tray, cable itself, marshalling boxes; much of which is labour intensive (particularly cable laying and making off) and disruptive to operations in the case of plant modifications.

Offshore there is, in addition, the potential to avoid masses of cabling and consequent congestion, savings in space and weight, and the capability for a higher degree of onshore completion and testing. BP Exploration have commissioned a number of studies which will lead to the publication of a series of design guidelines, including some for instrumentation.

The designer needs to look carefully at the relative benefits for the various options applicable to a particular plant and plant configuration in order to establish the overall optimum economic installed cost.

2.3.4 Control and equipment rooms shall be sized according to Section 10 of this Recommended Practice and the following minimum requirements:-

- (a) Access to equipment for operations and maintenance personnel, taking into account that operations personnel may need access during maintenance operations.
- (b) Space required for services and their distribution; including electrical power supplies and instrument air.
- (c) Space necessary for cables and services routed below Suspended floors and above false ceilings taking account of access to smoke detection sensors in these spaces.
- (d) Space for incoming and interconnecting cabling, including marshalling areas.

- (e) Space for control panels and equipment cabinets supplied with packaged plant.
- (f) Space for any special equipment or equipment required to meet national or local regulations, such as building controls, fire monitoring panels or communications equipment.

2.3.5 Communications facilities specified by BP (e.g. radio, telephone, telex, loudhailer) should comply with BP Group [RP 30-4](#) Section 5

Communications equipment which does not contribute to control or operation of plant is not within the scope of this Recommended Practice. Space required on operator stations and in equipment areas should not be underestimated.

* 2.3.6 Equipment shall normally be selected on the basis of both field proven ability for the application and manufacturer's support in the locality of the plant. The sub-contractors and vendors included on the tender lists for the supply of equipment and services shall be subject to approval by BP.

(a) *The proven support (project management, spares, servicing and technology) available from the manufacturer or his agent near the installation or main BP support base.*

(b) *The proven long term spare part availability. Some manufacturers have failed to support a product over a reasonable working life (say 15 years). This is particularly true for specialised equipment (e.g. process analysers) and for electronic systems. In some cases the local representative has found it uneconomic to continue support where initial sales (and hence spare part/service) demand was small. In other cases the manufacturer has been unwilling (or unable due to his sub-suppliers policy) to maintain support. Products have frequent updates and there have been instances of versions of a particular model being difficult to maintain only a few years after purchase.*

The main criteria relating to equipment is proof that the equipment (i.e. model numbers of the main elements on offer) is fully operational on a similar sized facility. Alternatively, if an updated version is offered and is advantageous, the designer should ensure that a proven fallback item is available and compatible.

Clearly there is a compromise between selecting well proven equipment with a very low risk to the project timetable and selecting less well established equipment with superior facilities for the operating company in the longer term. Specialist advice should be sought in case of doubt.

2.3.7 Equipment should be selected to keep the overall installed cost to minimum. Special attention shall be given to minimising the installed weight and space on offshore facilities and on packaged plant supplied in a modular form.



The business unit should advise whether the overall installed cost should be on a capital or whole life cost basis.

2.3.8 System components shall be selected such that the system will fail to a designated state on component or utility failure.

- * 2.3.9 On critical applications, the use of high reliability (e.g. redundancy techniques) in the equipment and the utility supply and distribution systems may be employed to achieve the required integrity but shall individually be subject to approval by BP. The submission to BP shall include the techniques employed, source data and the actual calculations.

Reference should be made to BP Group [RP 50-2](#) and BP Group RP 30-5.

For non critical applications, reliability analysis should only be provided where necessary to establish equipment test frequencies. These should be agreed with the Operator. Reference should be made to BP Group [RP 30-6](#) and [RP 50-2](#).

Any use of reliability techniques in support of high reliability applications of instrumentation must be analysed by persons familiar with this technology. A BP or an external specialist consultant should be employed where the BP office responsible for auditing the design is unfamiliar with the methodology.

2.3.10 Sequential and batch control equipment shall incorporate interrogation of plant conditions and equipment status to ensure that the correct sequence has occurred at each step. The position in the sequence and any malfunction shall be brought to the attention of the appropriate operator.

2.3.11 The accuracy of measurement shall be consistent with both an instrument's function on the plant and equipment commercially available. The accuracy and range of measurement required shall be stated on procurement documentation and shall take into account the range of measurement under normal operation (with expected variations), at start-up, and under emergency conditions.

Generally the more stringent the accuracy requirement, the more costly the equipment and installation. Too high a specification may limit the choice of measurement technology employed. Too low an accuracy requirement may result in the measurement being ineffective for its purpose. It is important to consider the overall system accuracy (including any manually input data/constants/assumptions) and not just a single item being purchased.

Accuracy should be stated in meaningful terms such as precision, repeatability, reproducibility and preferably using the terms in the applicable reference standard (e.g. [BS 1042](#) for flow measurement).



2.3.12 Main plant instrumentation should be electronic and contain facilities to serially communicate with a supervisory control system.

Electronic instrumentation is preferred due to its high reliability and ease of maintenance. More equipment is becoming available for use in harsh and hazardous areas.

Pneumatic instrumentation may be used for purely local controls and within local control rooms, provided that it is an economical installation and that measured data is not degraded outside specified accuracy for onward transmission to any data gathering system.

Compatibility of communications between new and existing instrumentation, and with the supervisory system, shall be demonstrated.

Most modern instrumentation, including 'single loop controllers' have considerable computing power for control and calculation (e.g. mass flow from several inputs). They are also readily interfaced with SCADA and communications equipment with no degradation of measurement accuracy either via a serial RS 422/RS 232 link and 'gateway', or using the I/O facilities of the DCS or SCADA system.

Pneumatic instrumentation still has the advantage of inherent 'electrical' safety, and may be more economic overall for small locally controlled plant (e.g. instrument air may be available, but not a power supply of adequate integrity). Some operations still consider that their available technicians can handle first line maintenance of pneumatics but not electronics. Pneumatics can never be as accurate as modern electronics and should be positively discouraged when any computation or complex control scheme is involved (e.g. when square root extractors, signal selectors, computing relays or similar devices) are necessary.

*

Optical transmission of data may be used provided that it forms a field proven feature of the manufacturer's data communications system. The use of non-standard systems and optically based measurement and control systems are subject to approval by BP.

Optical technology is becoming established in the data communications field, for analysers and for other specialist instrumentation and is generally acceptable, subject to 2.3.6.

The technology is currently making advances into primary measurement (e.g. pressure, temperature, pressure and level) but is by no means established. The use of such devices for primary plant control requires individual consideration at this time.

Any use of optical fibre transmission will inevitably lead to the laying, jointing/repair and testing of optical fibre cables. The techniques for this are evolving, but the end user company should be consulted in relation to the necessary skills or specialist contractors being available locally.



Optical systems may not automatically be considered to be inherently safe. To date (1993), certified equipment is not available.

2.3.13 Analogue signal transmission shall conform to [IEC 381](#) and [IEC 382](#). The following levels are preferred:-

- (a) Electronic signals should be 4-20 mA d.c.
- (b) Digital signals should be 24 volt nominal.
- (c) Pneumatic signals should be 0.2 - 1.0 bar (ga) (3-15 psig).

In the longer term, a specification 'Manufacturing Automatic Protocol' (MAP) for data communications at high levels of plant control and information systems, should be published by the International MAP Federation. At lower levels of plant control, BP is working to promote a 'Field Bus' standard. BP is also active in the European Manufacturer and User Group (EMUG) preparing a section covering process industry requirements. Advice on status can be obtained from the custodian of this Recommended Practice.

2.3.14 Serial transmission may be used between component parts of a proprietary control and information system for data gathering, operator commands and supervisory control. Except for digital communication with 'Smart' transducers forming part of a proprietary control system, serial transmission shall not form part of the basic level of control, or of any automatic shutdown initiation or actuation, unless approved by BP. Where used, a deterministic protocol based upon [ANSI/IEEE 802.4](#) is preferred.

Serial transmission is commonly used in distributed control and SCADA systems for data transmission, status information and operator commands to remote intelligent devices such as controllers or controller files; and is now the accepted method for major BP projects.

The use of a serial transmission link between the key elements in basic control or protection of the plant should be avoided. The design should include automatically initiated systems at the local level with commands (e.g. manual shutdown) only transmitted. Where serial transmission within a critical system cannot be avoided, a high overall system availability using redundant channels of communication is normally essential. Typical applications may be protection of pipelines or remotely operated satellite production platforms.

The use of serial transmission between 'Smart Transmitters and Valves' and process controllers must be carefully applied. Problems may occur with interference to other analogue loops in the same multicores, and there will be problems in obtaining alternate supplies with the same protocols. There are potential advantages in serial communications between 'Smart Transmitters' and flow computers as the errors associated with the additional DAC/ADC units within the transmitter and flow computer will be removed.

- * 2.3.15 The design of electronic equipment and its installation shall ensure that plant operation is not impaired by electromagnetic (EMI) interference. BP will specify the EMI frequencies and radiation levels to be expected. Instrument system design should minimise the necessity of hand-held portable radios for maintenance or operations in control equipment areas. (See also Section 3 of this Recommended Practice and BP Group [RP 30-8](#)).

- 2.3.16 Major items of control equipment should be subject the inspection at the manufacturers works before despatch. Inspection shall be under the direction of a BP nominated inspector engineer, and carried out in accordance with BP Group [GS 130-3](#). Reference should also be made to BP Group [RP 32-2](#).

When required, final inspection procedures and test programmes shall be submitted to BP for approval at least six weeks before testing and final inspection commences.

- 2.3.17 In offshore installations, area classification of modules may be achieved by pressurisation, or there may be special requirements to isolate electrical equipment should gas be detected. The contractor shall address the impact of such circumstances on networked cables (e.g. data highways) passing through such areas; isolation of which may stop operator communications with large sections of plant.

- * 2.3.18 Standard manufacturers products frequently have screwed connections to the process and to accessories, and sometimes vent valves. For high pressure hydrocarbon, hydrogen and noxious services these may be unacceptable. The contractor shall assess and issue a policy statement for approval by BP at an early stage of project development.

2.4 Instrument Numbering System

- * 2.4.1 The instrument numbering system used on any plant or plant expansion or modification shall be subject to approval by BP at an early stage of the contract. Each item of equipment shall be identified by a unique tag number. The method used shall be based on [ISA S5.1](#) but take into account:-

- (a) Constraints within the selected control system vendors display.

Some video based display systems have significant limitations as to the number of alpha-numeric characters used for tag number or descriptor. Likewise all combinations of letters and numbers may not be available. This is less of a constraint on modern systems; but should be checked before finalising a numbering system for a project, plant or site.



- (b) Existing practice and site preferences at the BP operating centre concerned.

Numbering systems used in higher level systems may be already established on site. Also, the method of presentation or data input may not be tag number based. Some consistency is essential to ensure all parts of the operation work to a common scheme (e.g. the laboratory, the operator and the operations controller). The overall method should be reviewed at the project SOR stage and written into FEED documentation.

- (c) Compatibility with higher level data processing, management information and maintenance systems.

Items of equipment not covered by [ISA S5.1](#) such as fire and gas systems, HVAC systems, power supply units, equipment racks and marshalling cabinets shall be identified using a similar method.

Utilities shall be identified as to service and function at the point of distribution (e.g. at power isolating switches and valves).

Reference should also be made to Section 11 of this Recommended Practice entitled 'Instrument Database Systems'.

- 2.4.2 P&I diagrams should show all items of instrumentation, each item being identified by its unique tag number. For diagram clarity, complex control systems should be identified on detail drawings, cross referencing between the master and detail.

- * 2.4.3 Documentation for batch and sequence systems shall include a logic diagram and a flow chart or a ladder diagram. The methodology and the symbols used shall be subject to approval by BP. Refer also to 2.7 of this Section.

Most reputable manufacturers and contractors have in their practices acceptable methodology to present batch and sequence information. A project policy should be agreed and applied to all contracts and purchases. It may, however, prove more economic to accept individual suppliers' standard methods.

2.5 Units of Measurement and Display

- * 2.5.1 BP will specify the units of measurement. These should follow [ISO 1000](#), but may be modified to comply with local or national variations or existing site practice.
- * 2.5.2 Readout of variables presented to control room operators should be in both digital form in engineering units and in analogue form as horizontal or vertical bars. Set point, measured value, controlled



output and controller status shall be displayed as a minimum requirement.

Most current single-cased electronic instrumentation is microprocessor based and capable of many functions in its operation and data display. However, not all instruments can display all information simultaneously in analogue and digital form. Some may only display some information in digital form (e.g. calculated values). Some information may only be available to the operator as a secondary level of readout via keys or similar means of access. Acceptability of any display should be agreed with the operating authority before procurement of any instrument system.

Symbols or VDU's should generally be to [ISO 3511](#), and [BS 1553](#) where applicable.

Readout of data presented on field instrumentation and local control panels may be in analogue or digital form. Selection for each type of application shall be subject to approval by BP.

The method of data displayed on video based systems shall be subject to approval by BP.

- 2.5.3 Indication of plant and equipment status should include the 'ON'/'OPEN', the 'OFF'/'CLOSED' and the transient state.
- 2.5.4 Refer to BP Group [RP 30-5](#) Section 2 for the requirements for alarm displays.
- * 2.5.5 Pressure at or above normal atmospheric should be displayed in gauge units. Pressure below atmospheric should be displayed directly in vacuum units. Any requirement for the display of pressure in absolute units shall be subject to approval by BP.
- 2.5.6 Temperature should be displayed directly in engineering units.
- 2.5.7 Rate of flow should be displayed directly in engineering units per unit of time. Display of data on simple analogue display instruments without a calculation or linearisation facility may be on scales of 0-10 square root or 0-100 linear with a multiplying factor.
- 2.5.8 Totalised flow readout shall be directly in engineering units. The display for fiscal or accountancy purposes shall comply with the requirements of BP Group [RP 30-2](#) Section 5.
- * 2.5.9 Level in plant vessels and equipment should be displayed in terms of 0-100% working range. BP will specify any requirement for readout in height, depth or volume.



- 2.5.10 Level in storage tanks shall be displayed in accordance with BP Group [RP 30- 2](#) Section 6.
- * 2.5.11 Presentation and readout of data for specialist instrumentation such as process analysers should be consistent with the display of other measurement information on the plant or complex.
- Refer to BP Group [RP 30-5](#) Section 4 for the requirements for the display of information on fire and gas systems.
- The form of presentation for each type of measurement shall be subject to approval by BP.
- 2.5.12 Recording of data and events should be provided by the use of a digital storage system which may stand alone or be integrated with a video based digital control or computer system. This shall include facilities for:-
- (a) Off line storage on diskette or similar permanent storage device.
 - (b) Display of real time and historical trend data at the operator's station, with data and time discrimination adequate for the dynamic changes anticipated on the plant concerned.
- Digital storage is normally available as a standard feature of most electronic systems. The facilities offered differ considerably and need to be addressed carefully, particularly the time discrimination, their ability to follow short term trends (many store and average information over a period and display the average over a time period as a bar) and the capacity for short and long term storage of information.*
- * 2.5.13 Paper chart analogue recording facilities should only be used for small systems where a digital storage system is uneconomic and for measurements displayed on pneumatic control panels.
- Field mounted recorders should be avoided. Their use for any individual application is subject to approval by BP.
- Recorder charts should be 0-10 square root or 0-100 linear as appropriate to the recorded signal. Multi-variable recording involving both types of scaling shall have charts with linear and square root graduations on alternate time segments. Strip charts of 100 mm (or 4 in) width and with 25 mm (or 1 in) per hour chart speed are preferred. Wider charts and faster chart speeds may be used when a higher level of resolution is necessary to effectively display the measurement.



Circular chart recorders should be restricted to field service. Chart rotation may be one revolution per day or per week as appropriate to the duty.

Paper chart recording is of limited value for post fault analysis unless regularly time checked. Maintenance and other attention may be high (mechanical parts, inking, clearing blocked pens, chart changing, keeping chart running cleanly on drive mechanisms).

2.6 Instrumentation Supplied as Part of Packaged Units and Modular Plant

2.6.1 Instrumentation supplied as an integral part of packaged units and plant modules shall comply with this Recommended Practice unless otherwise approved by BP.

Reference should be made to BP Group [GS 130-2](#), Instrumentation for Rotating Machinery, where applicable and to BP Group [RP 30-2](#) Section 11 and 12 for HVAC and Drilling packages respectively.

2.6.2 Instrumentation and control equipment should as far as possible be common across the complete facility. In particular, where modules and packages comprise the bulk of a facility (e.g. an offshore production platform), every effort shall be made to ensure that this policy is followed by the main contractor, the sub-contractors and fabricators.

In order to achieve these aims the bulk instrument item vendors should be selected on a general basis during the FEED process such that when the main module and package order are placed, the instrumentation vendors have already been selected. BP requirements for specific items of instrumentation equipment can be specified as part of the relevant specifications.

In particular, where packages are to be custom built, compliance with BP specified instrumentation equipment can be made a requirement. However, where manufacturers' 'standard' packages are to be supplied, care should be taken not to impose BP specific requirements where this may infringe the overall warranty given by that manufacturer or where it may lead to excessive costs or delivery.

Early project decision should be given to the policy for commonality of equipment between the main contractors design and packages, and also between packages from different vendors.

Most fabricators of custom packages can readily accommodate any suppliers' equipment without cost penalty, provided it is specified at the outset. Proprietary plant (e.g. Gas Turbine Units) produced to standard designs will incur a significant cost penalty if non-standard equipment (to them) has to be incorporated.



- 2.6.3 The design of modules shall minimise the degree of installation work, inspection and testing offshore/at site. The project timetable, component procurement programme and resources should ensure that the degree of mechanical completion and testing is maximised before despatch from the manufacturer's or fabricator's works.

Package units usually interface with the main plant instrumentation system and with other packages. It is essential that one party (typically the main contractor) has the clear responsibility to ensure compatibility between equipment supplied under different contracts/sub-contracts. This responsibility must cover safety aspects (e.g. loop certification requirement of intrinsically safe systems), maintenance aspects (e.g. safe isolation of remote connected equipment) and the provision of documentation (e.g. loop drawings) clearly defining the interface.

- 2.6.4 All external electric, pneumatic and hydraulic connections shall be terminated at marshalling boxes or cabinets.

- 2.6.5 For offshore applications, instrumentation and associated accessories, piping and cabling shall be contained within the main structural framework of a module. It shall be protected from mechanical and environmental damage during lifting, transport and installation.

- 2.6.6 Equipment and cables shall be identified in accordance with BP Group RP 30-1 Section 4.13

2.7 **Documentation**

- 2.7.1 Operating and maintenance manuals shall be provided for all plant and equipment, including that supplied by vendors and sub-contractors. Documents shall include a reference to the equipment tag number. Vendor documentation should include a reference to the contractor's and instrumentation supplier's order numbers. Manuals shall be supplied to BP prior to mechanical completion of the respective plant, plant section or module. They shall be updated to 'as built' status prior to commissioning.

Manuals shall include the following as a minimum requirement:-

- (a) Detailed description of the function of instrumentation provided.
- (b) P & I diagrams.
- (c) Instrument Index, with references to P & I diagrams and other key documents.



- (d) Logic diagrams, cause and effect charts, flow charts and ladder diagrams, together with written description of the operation and control functions.
- (e) Maintenance manuals for equipment supplied as part of packaged plant and for bought-in equipment.
- (f) Data sheets and requisitions/orders for instrumentation and accessories. These shall identify the manufacturer, model number, ranges, materials of construction, and (where appropriate) relevant process fluid data.
- (g) Schedule of all instrument calibrated ranges, and alarm, trip and control settings.
- (h) Plot plan showing the location of all major items of instrumentation.
- (i) Pneumatic, hydraulic and process piping hook-up drawings.
- (j) Loop and system wiring diagrams identifying all equipment, cables, junction boxes and terminals.
- (k) Instructions for software modifications (including system configuration) and maintenance. This shall include clear methodology for essential operations carried out with the system on-line; such as start-up of new plant connected to the system, re-calibration, hardware modifications and software modifications. Refer also to BP Group [RP 30-4](#) Section 2.
- (l) Power supply line diagrams showing sources of power supply and circuit protection, including individual ratings and discrimination between levels of protection.
- (m) Electrical safety dossier containing copies of all safety certificates and inspection documents, as required by [BS 5345](#).
- (n) A list of all batteries, as 2.1.3. (e), within equipment hazardous areas, and method of protection.
- (o) Calculations and supporting documentation.
- (p) A register of safety devices as 2.7.5.

Contract documents normally take precedence over Recommended Practice. Therefore, BP should specify the specific requirements for documentation within project contract documents.



Some sites have computerised documentation (e.g. Teroman) and CAD systems in service. The format of documentation received from contractors/vendors for such systems should be carefully specified.

See also Section 11 of this Recommended Practice on Instrument Databases.

2.7.2 Documentation relating to programmable devices shall be presented in written or typed form and also on disk, diskette or cassette, as appropriate to the equipment. It shall be provided at each of the following stages as a minimum requirement:-

- (a) As presented for factory acceptance testing.
- (b) As shipped from the vendor's factory.
- (c) As accepted by the client in the field.

2.7.3 Software documentation, both text and hard copy, shall be produced in triplicate. One reference copy of each issue shall be presented to (and retained in a secure manner by) each of the following:-

- (a) The equipment vendor.
- (b) The contractor.
- (c) The end user's nominated representative.

The three reference copies of any issue shall at all times be transported and stored separately, and clearly identified as to function, dates and times of writing and updating.

In the event of one reference copy being damaged or corrupted, another of the same issue may be used provided that the cause of the first copy being unusable has been removed and the second copy is copied and verified before or immediately after loading into the machine and then returned to its storage position.

In the case of 'tailor-made' systems, copies of the source software for equipment supplied shall be included in the documentation. This requirement shall be included in all orders and sub-orders for such equipment.

2.7.4 On completion of site acceptance tests, all three copies of software documentation shall be presented to the end users representative for secure storage and use, in accordance with site procedures.

For further advice on software documentation control procedures, refer to BP Group RP 30-4 Section 2 .

2.7.5 The vendor shall supply a register of safety related devices which shall include:-



- (a) Data pertinent to pressure let-down stations, including size, type and fully open flow coefficients of the limiting valves or orifices in every route between the high and low pressure systems.
- (b) High reliability trip system data. Each system should be separately documented with a schematic drawing. Every component shall be specified together with testing frequency and a reference to the study report which defined the system's reliability.
- (c) Where distributed control is employed, annotated diagrams showing the segregation which prevents common mode instrument component failures from producing unacceptable relief loads.
- (d) A list of control and protective instrumentation, the correct functioning of which has been taken into account when designing or sizing a pressure protection system (Refer to BP Group [RP 44-1](#)).

2.8 Instrument/Electrical MCC Interface

2.8.1 Many of the signals between the MCC and items of instrumentation equipment are status signals only. Wherever possible these signals should be sent via a serial link to the relevant instrument panel (e.g. Process Control System or Shutdown System) in order to remove the requirement for a large Interface Relay Panel. Where this is not practical, a hardwired link should be considered, fused to protect the instrument equipment input card.

As a further space and cable saving measure, the remaining interface relays that are required for hardwired signals should be included as a separate section or bay of the MCC.

2.8.2 There should be no pump or motor sequencing or standby start logic within the MCC. This should generally be done in the distributed control system or by local pump/motor logic boxes. The only non-status signals to the MCC should then be the pump stop and start commands and the hardwired signals from the Shutdown Systems and from the Emergency Stop Push-buttons.

The MCC cubicles should thus have no logic and could all be of the same standard design.

Note that care should be taken to ensure that MCC initiated machine trips are considered within logic design.



3. SELECTION OF INSTRUMENTATION EQUIPMENT

This Section specifies BP general requirements for the selection of electrical and pneumatic instrumentation equipment.

3.1 Selection of Electrical Instrumentation Equipment

3.1.1 Equipment shall be selected in accordance with the general principles detailed in Section 2 of this Recommended Practice.

3.1.2 Equipment for use in potentially hazardous atmospheres should be selected in accordance with [BS 5345](#).

BS 5345 gives guidance on the selection, installation and maintenance of electrical equipment for potentially hazardous atmospheres. It is a British Standard Recommended Practice and therefore applicable in the United Kingdom. However, many other countries have their own standards or codes of practice. Where electrical equipment is installed in these countries, the relevant standards and codes of practice should be used.

* 3.1.3 The types of protection selected shall be subject to approval by BP.

In any hazardous zone, more than one type of protection may be used, provided all types used are suitable for the hazard classification.

When using intrinsically safe equipment, special care should be taken with segregation of the circuits, earthing and interfaces with other electrical equipment.

3.1.4 'Ex N' equipment should be selected for use in Zone 2 areas only. 'Ex N' is only a National (UK) certification. Therefore for non UK projects this type of protection should only be used if it has been approved by the relevant national certifying authority.

* 3.1.5 The use of 'Ex p' shall be subject to approval by BP

It should also be noted that some manufacturers claim 'Ex N' classification for their equipment without the certification to prove this. Due care should be taken in this respect.

'Ex e' is the BP preferred method of protection for Zone 1 areas and is equally preferred with 'Ex N' in Zone 2 areas. It is preferred on the grounds of being generally lightweight, easy to maintain and of simple construction. Note that there is no requirement to use 'Flameproof' cable glands or even glands labelled 'Ex e'. The only requirement is to maintain the IP 54 rating of the enclosure and to maintain the resistance to the 7 NM impact test.

Where 'Ex e' or 'Ex N' certified equipment is not suitable or available as methods of protection in Zone 1 and Zone 2 areas, 'Ex d' certified equipment may be used.



Note that the environmental protection for 'Ex d' may not be as good as 'Ex e', i.e. there is no requirement for IP 54 rating. However, this rating may be achieved by the use of suitable sealing gaskets, provided that these are approved as part of the 'Ex d' certification.

Note that the 'Ex d' protection is normally item certified only. Therefore a modification to the 'system' inside the 'Ex d' enclosure may require re-certification.

'Ex de' is a hybrid protection method that is suitable for Zones 1 and 2. It is generally used where the main equipment is enclosed in an 'Ex d' enclosure with an 'Ex e' terminal box attached. This method of protection is perfectly acceptable to BP.

'Ex p' can be used in both Zone 1 and Zone 2 areas. In effect a localised non-hazardous area is created by an 'Ex p' enclosure. However, for Type 'p' enclosures, associated instrumentation is required to monitor the air purge and over-pressure. Type 'p' equipment also tends to be purpose built, expensive and requiring of significant maintenance. Therefore, type 'p' equipment should not be used where a viable alternative exists.

Intrinsic Safety (I.S.) method 'Ex ia' is the only protection method suitable for use in Zone 0 areas. Intrinsic Safety method 'Ex ib' can be used in Zone 1 areas and below. Intrinsic Safety is the only protection method that does not rely on mechanical integrity to ensure safety from causing ignition. Both Intrinsic Safety methods are acceptable to BP.

Things to be considered when planning to use I.S. are that often additional associated equipment is required, that there is general lack of understanding of I.S. equipment and that the maintenance procedures and documentation necessary to maintain the system integrity are demanding.

'Ex o', oil Filling and 'Ex q', Sand or Power Filling are not used commonly and in the UK are currently only Certified for use in Zone 2 areas. If possible one of the other methods of protection should be used in preference.

'Ex s', Special protection is a useful protection method to use for applications where no other protection method is available or where the requirements cannot be met in another way. This method of protection is normally acceptable for use in Zones 1 and 2 and is perfectly acceptable to BP.

The protection method of Encapsulation is a Certifiable method of protection in its own right, ('Ex m') and is perfectly acceptable to BP.

3.1.6

The use of equipment within the EC for applications where European certified equipment is not available shall be subject to approval by BP. Where necessary, such equipment shall be submitted for independent assessment before approval. A document of conformity shall be prepared which details the considerations made in assessing the safety of the equipment.

This refers to the use of equipment with certification not of EC origin, such as UL in the United Kingdom or special equipment which has not been certified. Where this type of equipment is used, the engineer should satisfy himself that it is safe. It



may be necessary to submit it to a suitable authority (e.g. BASEEFA or SIRA Safety Services Ltd.) for certification to be obtained.

- 3.1.7 Certification of equipment shall be by a nationally recognised body, acceptable to the local or national authority of the country of installation.

The certificate for a given item of equipment will have a certificate number. Where CENELEC certifying bodies are concerned there may also be a letter at the end of the certificate number. A 'U' indicates that the certificate is a component certificate only, 'S' that special conditions apply to the use of the equipment. Due care should be taken to ensure that the certification does not preclude the mode and conditions of operation intended.

3.2 Cables

* 3.2.1 Cable Construction

Instrument signal cables for field installation not requiring fire resistance or flame retardance should be constructed in accordance with [BS 5308](#), and selected according to [BS 6739](#), except as noted in this Section. On applications in environments which are aggressive to PVC or polyethylene, materials for insulation and sheathing shall be subject to approval by BP.

Generally, cables to BS 5308 : Part 1 are used where polyethylene insulated cables are required. BS 5308 : Part 2 covers PVC insulated cables. In some cases, special cables may be required (e.g. mineral insulated cables in hot areas). In such cases the L/R ratio and voltage rating as defined in BS 5345 shall be met.

When the use of fire resistant or flame retardant cables has been specified, reference shall be made to BP Group [GS 112-12](#).

Fire resistant cables should be used in special fire risk areas, as determined by BP, on those circuits whose continuous operation, for a period of time during a fire, is essential for safe shutdown of the process plant or installation. Flame retardant cables are used offshore and for some land based applications where some fire resistance is required, but not so great as for fire resistant cables.

Where there is a probability of hydrocarbon liquid spillage, underground cable shall be lead sheathed.

In locations where cables may be subject to damage, they shall be protected by an overall armour. Steel wire armour is preferred. Steel braid may be used where there is a requirement to minimise weight (e.g. offshore) or where small bending radii or flexibility is of importance.

Traditionally, wire armouring has been used for all field installations. Section 4 of this Recommended Practice requires that cable be installed in such a way that it is



not subject to damage. The need for armoured cable throughout a project should be carefully considered.

Colour coding of insulation and sheathing for instrument cables may be in accordance with [EIC Spec CCI P/4](#). Alternatively a single outer sheath colour may be used for all instrument cables provided that suitable colour banding is applied at cable ends wherever the service of that particular cable is not immediately obvious from junction box or termination marking. In this latter case the outer sheath colour chosen for instrument cables shall be different than that for electrical power cables.

Conductors shall be sized to provide a loop resistance within that required for the application. The minimum conductor size shall be 0.5 mm² (16/0.2 mm) for stranded cables or 1.0 mm² for solid conductors.

3.2.2 Cable Selection

Signal categories are detailed in this Sub-Section. [BS 6739](#) defines three cabling categories. Only signals of the same signal and cable category shall be contained in the same multicore cable.

(i) High Level Analogue Signals (4-20 mA, 5-50v d.c.)

Individual circuit cables should consist of a twisted pair with tape screen. A multipair cable should have only a collective overall screen.

(ii) Low Level Signals (below 5v d.c.)

Individual circuit cables should consist of a twisted pair with tape screen. A multipair cable should have individual pair screens.

This category can include shutdown initiating services.

These circuits shall be run in separate multipair cables.

(iii) Resistance Thermometers

4 wire cables should consist of 2 twisted pairs of conductors laid in quad formation around a central dummy and have an overall screen.

3 wire cables should be uniformly twisted together and have an overall screen.

Multi-circuit cables should have individually screened quad or triple conductors.

(iv) Thermocouples

Individual cables should consist of a twisted pair with tape screen. A multipair cable shall have individual pair screens.

Materials of construction for conductors shall be in accordance with BP Group [RP 30-2](#) Section 2.

(v) Shutdown Circuits

Twisted pair cables should be used for this service. Where volt drop is excessive for the apparatus connected, and the installation is not required to be intrinsically safe to [BS 5345](#), then non-twisted pair cable to [BS 6346](#) (except as noted in this Section) may be used.

Screening is not normally required for these cables.

Screening is not normally required for shutdown circuits as the power level is usually higher than other types and the equipment is not so susceptible to pick-up.

(vi) High Level Digital Signals

Twisted pair cables should be used for this service. Where volt drop is excessive for the apparatus connected, and the installation is not required to be intrinsically safe to [BS 5345](#), then non-twisted pair cable to [BS 6346](#) (except as noted in this Section) may be used.

Screening is not normally required for these cables.

*

(vii) Data Transmission

Cable type and specification shall be approved by vendor(s) of the equipment to be connected.

Individual twisted pair cables used for data transmission shall be screened. Multipair cables carrying audio and data transmission shall have individually screened pairs to avoid cross-talk.

Extended frequency circuits should be carried on twisted pairs in a multicore cable with individual screens.



Signal levels on adjacent cables in the same frequency band shall be similar to minimise cross-talk.

Insulation for non-IS system cables shall conform to [IEC 92](#) for spark, voltage and insulation testing.

Co-axial signal cables shall comply with the system vendor's requirements.

Double screening shall be provided where additional protection from noise is necessary for long co-axial cables.

System design shall be subject to approval by BP.

(viii) Intrinsically Safe Circuits

Intrinsically safe circuits shall be grouped into the categories listed.

All conductors forming part of intrinsically safe circuits shall be contained in multicore cables reserved solely for intrinsically safe circuits.

Cable sheath may be coloured blue to [IEC 304](#) or [BS 6746C](#). Alternatively blue banding of standard instrument cable following the guidelines of section 3.2.1 may be used provided that this is accepted by the relevant national authority.

Cabling shall conform to the requirements of [BS 5345](#).

(ix) Telecommunication Cables

Cables for telephone systems shall have cores identified with the standard colour coding for telephone cable in the country of use. For UK duty refer to British Telecom Specification 1308A, Telephone Cables 2000 series.

3.2.3 Cable Installation Requirements

Cable installation requirements are generally covered in Section 4 of this Recommended Practice and BP Group RP 12. The following factors, however, may guide selection of equipment used in installation:-

- (a) Cables should not be run in conduit. Exceptions may be around machinery, where special cables such as vibration probes need to be protected. Armoured cables are preferred.

- (b) Glands and cable fittings shall be suitable for the cable type and certified for hazardous areas where applicable.
- (c) Stopper boxes shall be used on flameproof installations as required by certification.

3.3 Earthing and Bonding Systems

For details of earthing and bonding systems see, Section, 5 of this RP.

3.4 Marshalling and Junction Boxes

- 3.4.1 Marshalling and junction boxes for both shutdown and intrinsically safe circuits shall be separate from those on general instrument measurement and control duty.

Separate marshalling and junction boxes are only necessary for intrinsically safe and shutdown applications. Other circuits may use the same box, but the different signal types should be segregated within the box by grouping and spacing or physical barriers.

- 3.4.2 Marshalling and junction boxes shall be sized to permit termination of all cores and screens, including spares, without the need for more than one core per terminal. In addition, a minimum of 10% spare terminals shall be provided.

- 3.4.3 Clamp type terminals with slot headed screws should be used for all connectors. The screws shall not be in direct contact with the conductor.

While clamp type terminals are preferred, other types of terminal may be used provided the form of clamping does not damage the conductor.

- 3.4.4 Cable entries should not be at the top of boxes unless installed in a fully weather protected environment.

- 3.4.5 The degree of protection of marshalling and junction boxes should be a minimum of IP 54 as defined in Appendix A of [BS 5345 : Part 1, \(IEC 529\)](#) unless installed in a fully weather protected environment. A higher category of protection may be necessary for areas where water hosing operations are likely.

- 3.4.6 Where aggressive ambient conditions are encountered, e.g. offshore, stainless steel boxes should be specified.

- 3.4.7 Marshalling and junction boxes used on intrinsically safe circuits shall be and clearly labelled as containing intrinsically safe circuits.

3.5 Cable Tray and Racking

3.5.1 Cable tray or racking should be constructed of heavy duty, hot dipped galvanised steel. End cuts shall be sealed immediately after cutting.

* 3.5.2 Where galvanised steel tray is unsuitable for the environmental conditions to be encountered, stainless steel or glass reinforced plastic tray may be used subject to approval by BP.

Stainless steel and glass reinforced plastic cable tray should only be used for corrosive atmospheres (e.g. platforms and areas of acid spillage) as both types are expensive. Additionally, for glass reinforced plastics, the engineer should satisfy himself that the surface resistivity is suitable for the installation (i.e. no static charge build up). PVC coated tray has been found to be unsuitable for use on external applications due to water ingress on cut ends.

3.5.3 The use of PVC coated tray is not permitted.

3.6 Selection of Pneumatic Instrumentation Equipment

3.6.1 Pneumatic equipment shall be limited to simple equipment as described in Section 2 of this, Recommended Practice

3.6.2 For related air supply and tubing specifications, (e.g. supply pressure, materials, bore and tube lengths etc.) refer to Sections 4 and Section 7 of this Recommended Practice).

Volume or signal boosters can be used to extend the distance of transmission. Tubing diameters should be kept to a minimum, reducing the volume in the tube and so minimising lag time. Consideration should be given to calibration errors introduced by the booster.

Larger tubing may be required where actuator sizes are large, or two or more actuators are connected in parallel. The speed of response of the equipment may otherwise suffer.

3.6.3 Signal ranges should be from 0.2 to 1.0 bar (3 to 15 psi).

3.6.4 Equipment should operate from a clean dry air main supply, reduced as required via a suitable regulator to a pressure not less than 1.5 bar(ga) 20 psig).

Equipment can sometimes be operated from the process fluid and is especially useful at remote locations with no electricity supply.

Non-bleed relays should be provided to minimise venting of a hazardous fluid.

Vents from power cylinders, solenoids etc., should be piped to a safer location.



* If instrument air is not available, the following may be used as the pneumatic supply; subject to BP approval:-

- (a) Bottled air or bottled nitrogen for simple low consumption applications. Life of a standard cylinder charge shall be stated to the approver.
- (b) Bulk nitrogen provided that safe practice can be assumed, and the service is clearly identified by labels at all maintenance points.

* The use of hydrogen gas (or other process medium) is a non-preferred option as a source of pneumatic supply. It may only be used provided that:-

- (i) Safe practice can be assured.
- (ii) It is environmentally acceptable at the location.
- (iii) It's use is approved by BP for each and every individual application

3.6.5 Each pneumatic instrument shall be fitted with a gauge to indicate supply pressure and control signal. Additional gauges may be required to indicate diaphragm pressure, balance signals etc.

4. INSTRUMENT INSTALLATION

This Section specifies BP general requirements for instrument installation. It should be read in conjunction with [BS 6739](#) and [API RP 550](#) which give general guidance on instrument installation design and practice.

4.1 Location, Mounting and Accessibility

4.1.1 Instruments shall be installed in accordance with the design specification, equipment specification, relevant approved drawings and the manufacturer's specification. Minor items not included such as local cable and tray routes, small bore pipe runs and instrument layout shall be agreed by BP and the main contractor prior to fabrication and installation.

4.1.2 Instruments shall be located in accordance with instrument location diagrams and be mounted so that they may be easily removed for maintenance.



- 4.1.3 Instruments should be located away from potential fire risk and spillage areas, hot or exposed environments, sources of vibration, and process vents and drains. The location of instrumentation impulse pipe runs, vents and cable trays shall not obstruct access, walkways or plant which may require regular attention.
- 4.1.4 Bracket and support materials shall be resistant to atmospheric corrosion. Painting or other coating protection shall be subject to approval by BP.
- 4.1.5 Instrumentation requiring operator access shall be mounted at a height of between 1.4 m (4 ft 6 in) and 1.6 m (5 ft 3 in) from grade or platform. Other instrumentation should be mounted between 0.7 m (2 ft 3 in) and 1.6 m (5 ft 3 in).
- 4.1.6 Indicators shall be readily visible from operating positions and under the normal (natural or artificial) lighting levels at the location. Special attention shall be given to the readability of liquid crystal displays (LCD's).
- 4.1.7 Manufacturers' data plates, zero and span adjustments and manifold valves (where fitted) shall be accessible. Data plates shall not be painted over.
- 4.1.8 Instruments and their displays should be installed in the vertical orientation by bracket or post mounting. They shall not be supported on handrails.
- 4.1.9 Instruments shall not be supported by process lines unless specifically designed for direct mounting and capable of withstanding line induced vibration, e.g:-
- (a) pressure gauges (refer also to 4.3.),
 - (b) local direct reading bi-metallic temperature indicators and
 - (c) low mass sensors
 - (d) low mass transducers.
- 4.1.10 Direct mounting of other types of instrumentation shall be subject to approval by BP at an early stage of the design.

Low mass instruments may be direct mounted on to process lines or equipment provided the following conditions are met:-

- (a) *They are not subject to vibration in excess of the manufacturers stated maximum.*
- (b) *The normal working temperature limits of the device will not be exceeded due to conducted heat from hot lines, etc.*



- (c) They are provided with adequate line isolation and vent facilities.
- (d) They are located such that they are unlikely to be damaged due to operations or maintenance staff standing or climbing upon them.
- (e) Cabling to them is suitably supported and routed and/or a suitable local junction box is provided to terminate those provided with 'flying leads'.

Close coupling of differential pressure transmitters to orifice plates in certain applications may be used to minimise the length of impulse lines. This method may be used to reduce leakage at fittings (e.g. for toxic or harmful fluids such as hydrofluoric acid), where viscous fluids are being measured, or where condensate formation may cause errors in measurement. Additionally, on some steam service or air flow measurements the installation may be simplified by close coupling the transmitter and orifice plate.

A differential pressure transmitter which is not close coupled should not be supported by its process pipework. If supported by a manifold, then the manifold should be firmly clamped and supported by a post or to an enclosure.

- 4.1.11 Instruments shall be installed such that, in service, the operating temperature is within the manufacturers' specified limits; subject to an overall maximum limit of 70°C (158°F).
- 4.1.12 Where instruments are direct mounted on process lines that are heat traced and lagged or lagged only, the mounting shall allow for removal or maintenance of the instrument without removing the lagging or heat tracing. The mounting arrangement must protect the instrument from excessively high or low temperatures through conduction or radiation.
- 4.1.13 Instruments should be specified with enclosures of classified protection levels in accordance with [IEC 529](#) and suitable for the environmental conditions in which they are to be located.
- 4.1.14 Where it is not possible to obtain such equipment, or where there is a significant cost or operational advantage in using equipment of a lower protection level, additional protective enclosures which meet the requirement should be used. Where numbers of these instruments are at one location, they should be grouped together within the same protective enclosure, with sufficient space for maintenance.
- 4.1.15 The cabinet should be provided with a clear window to allow indicators to be read without exposing the equipment to temperature variations.

Care should be taken to ensure that too high a level of protection is not unnecessarily specified, e.g. many suppliers may construct to IP 53 requirements, but only one to IP 54 which could incur a cost penalty. [IEC 529](#) defines the IP levels of protection.



Where a certain protection level is required, say IP 55, but only IP 44 is available, the lower category enclosure may be used with an additional mounting box which itself meets IP 55.

It should be noted, that grouping equipment into one large enclosure can be cost effective and give operational and maintenance advantages. Typically, grouping of analysers into a centralised house is beneficial in comparison to the use of individual enclosures for each analyser.

This section refers only to environmental protection. It is essential that the engineer ensures that the installation meets the hazardous area requirement for electrical apparatus.

- 4.1.16 Where weather protection is required for both instruments and personnel, a protective cabinet or shelter shall be provided; with sufficient space for both operational access and maintenance.

4.2 Instrument Piping

- 4.2.1 Impulse pipework and fittings up to and beyond the first block valve from the process line or vessel, shall be in accordance with BP Group [RP 42-1](#) and BP Group [GS 142-6](#).
- 4.2.2 Impulse piping should be installed in accordance with [BS 6739](#) and [API RP 550](#) Part 1.
- 4.2.3 Impulse lines shall be kept to a practical minimum length.
- 4.2.4 Pipework shall be adequately supported and clamped to metal tracking or structural members. Pipework shall not be supported on handrails
- 4.2.5 The design shall include allowance for any differential movement between the tapping point and the instrument due to thermal expansion or vibration of the main plant pipework.
- 4.2.6 Where instruments are installed on immiscible fluid service the impulse lines shall be installed horizontally. In all other applications impulse piping shall be sloped to ensure self-venting or self-draining as appropriate to the application.
- 4.2.7 Where instruments contain large inventories of process fluid (e.g. level transmitters), or where frequent blowdown of impulse lines is envisaged, vents and drains shall be in accordance with BP Group [RP 42-1](#). For all other instrumentation, small volumes of non-toxic process fluid (less than 2 litre) may be vented and drained to atmosphere provided that safe disposal can be assured. Special care is necessary where the installation is above grade and where hot, flammable or toxic materials are involved.

Generally, pressure gauges, pressure and differential pressure transmitters can be considered as small volume devices, but in specifying vent and drain requirements, the engineer should carefully consider the position of isolation valves, length of impulse lines and potentially hazardous nature of the fluid and its process condition, i.e. temperature and pressure. If in any doubt, the requirements of BP Group [RP 42-1](#) should be met.

The vent and drain requirements on non-hazardous duties can often be simplified by installing integral valve manifold blocks, which allow maintenance checks to be carried out with the minimum venting of process fluid.

Care should be taken to specify manifolds for the maximum pressure and temperature they are likely to encounter. For example, on steam duty, the manifold should meet the steam specification not just the condensate.

- 4.2.8 Vents and drains may be omitted for instruments on non-hazardous service as defined in BP Group [RP 42-1](#) provided that the operating pressure is low [e.g. below 1.5 bar (ga) (22 psig)].
- 4.2.9 To minimise release on element failure, impulse lines to pressure and differential pressure instruments on LPG and LNG services should have a 1.4 mm dia. restriction orifice fitted. These should be located between flanges immediately downstream of the main isolating valve.
- 4.2.10 Impulse pipework shall be lagged, or heat traced and lagged, where the process liquid would otherwise condense, solidify or be otherwise adversely affected by low or high ambient temperatures. Lagging shall also be provided to protect personnel from high or low temperature impulse lines.
- 4.2.11 Breakable connections shall be provided adjacent to the instrument to facilitate instrument removal.

4.3 Pressure Instrument Installations

- 4.3.1 Refer to BP Group [RP 30-2](#) for BP general requirements for pressure measuring instruments.
- 4.3.2 Gauges and indicators shall be positioned to be easily read.
- 4.3.3 Gauges up to and including 150 mm (6 in) dial size may be close coupled and supported by their own connections if the impulse piping is flanged or welded (refer also to 4.1.1).
- 4.3.4 Where pressure instruments are installed on a condensable service a manufacturers' standard or pigtail syphon should be used.



- 4.3.5 Where a pressure instrument is located more than 2.5 m (8 ft) from the primary block valve or where this valve is inaccessible an additional block valve should be installed near the instrument.
- 4.3.6 Pressure gauges shall be installed so that their blow-out protectors are not obstructed. Protectors shall face away from the operator.
- 4.3.7 Low range equipment shall be installed such that gravitational effects on the sensing element do not cause calibration errors or induce noise due to vibration. Impulse piping design should generally comply with that for differential pressure flow instruments (see 4.6).
- 4.3.8 Where pulsation dampers are used, they shall be installed close to the measuring element. The use of partially closed isolating valves is not permitted.
- 4.4 Level Instrument Installations**
- 4.4.1 Refer to BP Group [RP 30-2](#) for BP general requirements for liquid level instruments.
- 4.4.2 On steam duties, condensation chambers may require to be lagged for personnel protection.
- 4.4.3 Level gauges shall be installed such that the indicator is visible from grade or platform.
- 4.4.4 General site lighting shall allow any level within the range of the gauge to be seen at all times. Integral illuminators shall be provided for through vision gauges.
- 4.4.5 To facilitate removal of direct mounted level instruments for maintenance, adequate overhead lifting clearance shall be provided.
- 4.4.6 On internal installations, displacers and floats shall be restricted by cages or alternative protection to retain the displacer should it become detached.
- 4.4.7 On liquid/liquid interface service, the top vessel connection shall be submerged in the lower density fluid under all operating conditions.
- 4.4.8 Displacer chambers connected to vessels employing steam as a stripping medium shall be provided with a gas purge into the vapour connection.



- 4.4.9 Displacer chambers connected to vessels containing slurries and highly viscous liquids shall be provided with a liquid purge into the liquid connection.
- 4.4.10 On applications where purged impulse lines or dip legs are provided, non return valves should be fitted upstream of the purge controller.
- 4.4.11 Due consideration should be given to the effects of the environment on field mounted instrumentation, including localised regions of high temperature on electronics.
- * 4.4.12 When installed in a hazardous service as defined in BP Group [RP 42-1](#), specific measures shall be taken to ensure that any emission caused by damage to the level installation is minimised. These measures shall be subject to approval by BP.

Elimination of the risks inherent in hazardous service conditions is of prime importance. Close coupled instruments should be provided wherever possible. If separately mounted differential pressure instruments are necessary for the process conditions, the installation should be protected from external damage by the use of metal or strong plastic sheeting. A bound around the vessel, and the provision of motorised isolation valves should also be considered.

4.5 Temperature Instrument Installations

- 4.5.1 Refer to BP Group [RP 30-2](#) for BP general requirements for temperature measuring instruments.
- 4.5.2 Sensing elements shall be in good thermal contact with thermowells.
- 4.5.3 Where capillary systems are used, they shall be continuously supported and protected, and any excess length neatly coiled, clipped and supported. The installation shall not introduce standing errors.
- 4.5.4 Clearance and sufficient cable or capillary slack shall be provided to allow element removal from pockets without disconnecting termination's or unclipping cable/capillary from supports.
- * 4.5.5 Where it is impractical to mount a temperature sensing device in a thermowell, each and every application shall be subject to individual approval by BP. Such installations shall be clearly labelled to identify to maintenance personnel that no thermowell has been installed.

The most common application of sensors fitted without thermowells are skin thermocouples on heater-tubes, bearing temperatures and fast response measurements on gas turbines etc. Apart from such accepted applications, temperature devices should be installed without thermowells only in exceptional circumstances, usually for reasons relating to speed of response or severe space limitations. The utmost care must be taken in the design to prevent accidental



removal. Clear, permanently affixed labels must warn of the need to depressure the line or vessel before removal.

- 4.5.6 Specific attention shall be given to ensure motor and generator winding temperatures are segregated from other instrument sensing applications via galvanic isolators. The integrity of the hazardous area shall be protected against insulation failure or induced voltages.

It would be advisable to connect winding temperature inputs to a separate system from DCS or PLC input cards. The outputs connected into DCS via volt-free contacts or galvanic isolators. This system should be clearly labelled that no IS systems should be connected, even via safety barriers.

- 4.5.7 When two thermocouples or RTD's are in the same pocket, their terminals shall be clearly marked as to their function.

- 4.5.8 Thermowells should be mounted into a pipe, rather than a process vessel, unless the measurement would be adversely affected.

4.6 Flow Instrument Installations

Refer to BP Group [RP 30-2](#) for requirements of flow measuring instruments.

- 4.6.1 Orifice Plate Installations
General requirements for installing differential pressure instruments are given in Figure No. 4-3, 4-4 and 4-5.

Spare tappings on orifice flanges shall be blanked or plugged.
Tappings at 45 degrees may be used on orifice flanges to permit closer spacing of adjacent pipework.

The two impulse lines for a differential pressure instrument should be run together to maintain both at the same temperature and to facilitate heating and lagging.

- * 4.6.2 Metering Installations

In-line devices, such as turbine meters and positive displacement meters, shall be installed in accordance with BP Group [RP 30-2](#) and manufacturers' recommendations. Isolation and depressuring valves shall be provided for equipment removal and safe maintenance.

Where parallel runs are employed, elbows and isolation per BP Group [RP 42-1](#) shall be provided at each end of the meter runs to facilitate removal of one run whilst the other is in service.



The problem of removing meter runs, control valves, ball valves etc., while the other streams are still in service, can be exasperated by using ring type joints. If the meter runs are above the inlet and outlet headers and isolation valves, they could be connected via elbows. The elbow can be removed, the valve blanked allowing the meter run to be dismantled

Where in-line proving of liquid meters is required, and facilities are provided for connection to an external prover or master meter, provision shall be made for security of measurement, adequate drainage or containment of spillage, access for connection and adequate weather protection.

Drip trays of adequate capacity can be used provided chemical drainage is available. If not then sand could be used to collect liquids and disposed of into chemical waste.

Location of pressure relief valves shall be such that proving accuracy is not reduced by minor leakage's. Locations shall be subject to approval by BP.

Adequately sized weather protected facilities shall be provided for equipment and personnel to facilitate proper calibration of Class 1 and Class 2 metering.

Impulse piping on Class 1 and Class 2 metering shall be as short as possible.

Post mounted flow computers shall be protected by individually mounting in a GRP enclosure with suitable access; or in groups can be located in a shelter.

Solar or battery powered installations may be considered where no power is available and telemetry is not required.

Generally, flow computers connected to and incorporating telemetry systems, standby streams, printers, recorders etc., should be mounted in a heated/air conditioned room.

4.6.3

Variable Area Flowmeters

Variable area flowmeters shall be installed vertically with sufficient clearance to permit tube and float removal. The piping installation shall not put undue stress on flowmeter bodies.

4.7

Analyser Installations

*

4.7.1

Although the following items give BP's general requirements for analyser installations, the detailed housing requirements specified in BP Group [RP 30-2](#) Section 7 shall be observed. Reference should also be



made to [EEMUA Publication No. 138](#) for additional general information. All installations shall be subject to approval by BP.

- 4.7.2 All analysers should be protected against adverse ambient conditions, and be installed in a temperature controlled environment.

Analysers are generally delicate, sensitive devices which should be protected against the elements. It should be borne in mind that during maintenance, internal components will be exposed to the elements, and that environmental protection should be adequate for maintenance and calibration.

- 4.7.3 Analysers fitted with sample systems and requiring gas bottles should be installed at ground level in a designated analyser house.

Gas bottle racks are commonly picked out in safety reviews as being inadequate. All bottles should be secured in an upright position.

- 4.7.4 Transportation should be via purpose built trolleys. Rolling of gas cylinders along the ground is potentially hazardous.

- 4.7.5 To minimise the quantities of hazardous materials inside the analyser house, gas bottles and sample systems should be located outside.

- 4.7.6 Adequate access shall be provided for bottle or chemical replenishment.

- 4.7.7 Electrical distribution boards should be located outside the analyser house.

- * 4.7.8 Electrical supplies should be from a source approved by BP. Lighting within the analyser house should be from a separate source. Emergency lighting may be required.

- 4.7.9 Chemical stores shall be separated from the analyser house, and well ventilated.

- 4.7.10 BP will specify personnel safety equipment to be provided (e.g. monitoring of toxic releases, safety showers, eyewash facility).

- 4.7.11 Equipment containing flammable fluids, including carrier gases, or which is to be located inside analyser houses located in a hazardous area should be specified for Zone 2 as a minimum.

4.8 Control Valve Installations

- 4.8.1 Refer to BP Group [RP 30-3](#) for BP general requirements for regulating control valves.



- * 4.8.2 Clearance shall be provided above and below the valve so that its internals and actuator may be removed. Where this is not feasible and the valve is flanged, it may be swung on a bolt axis to provide access. This method shall be subject to approval by BP.
- Swinging of valve bodies on a bolt axis to provide access to the valve trim, although commonly carried out on site when no other method is available for valve inspection, often requires the springing-apart' of the pipe flanges to allow gasket renewal. Special care should be taken to minimise the need for swinging a valve, especially where ring type joint flanges are used.*
- * 4.8.3 Control valves shall be installed such that they and their associated equipment and valves are accessible for maintenance and manual operation. Access may be from grade or a platform. Alternative safe means of access may be permitted subject to approval by BP.
- Alternative means, refer to permanently installed walkways or accessways that afford adequate personnel protection with respect to hand railing kick plates, non-slip flooring, etc.*
- 4.8.4 The valve should be capable of being maintained and operated from these access areas, within comfortable arms reach set by the physical constraints of the handrailing, etc.
- 4.8.5 To facilitate maintenance, access to permit the use of lifting equipment shall be provided.
- 4.8.6 Sufficient access shall also be provided for welding and heat treatment of valves welded into the process line.
- 4.8.7 Control valves for volatile liquids shall not be installed adjacent to hot equipment.
- 4.8.8 Diaphragm and piston actuated valves should be installed with their stems vertical.
- 4.8.9 Butterfly valves shall be installed with their shafts horizontal unless a different orientation is approved by the manufacturer.
- 4.8.10 Electro-pneumatic converters shall be mounted close to the valve. They should not be mounted directly on the valve.
- 4.8.11 To facilitate local manual operation, the local indication of a process variable associated with a control valve should be clearly visible from that valve.



4.9 Instrument Air Systems

- 4.9.1 Refer to Section 7 of this Recommended Practice for BP general requirements for piping, tubing, valves, fittings and accessories for instrument air systems. Refer to Fig. 4-1 for a typical air header arrangement.
- 4.9.2 The connection between an individual instrument air supply isolating valve and the associated filter-regulator should be by rigid pipework with a union fitting for disconnection. Alternatively, the filter-regulator may be independently supported and the connection made with tubing arranged in a 'swan neck' to facilitate disconnection.
- 4.9.3 Where plastic sheathed tubing is used, the sheath shall continuously cover the tube and be terminated at a seal incorporated within the compression fitting.
- 4.9.4 PTFE tape shall not be used on screwed fittings downstream of the filter regulator.
- 4.9.5 Connections to instruments shall have sufficient flexibility to facilitate disconnection.
- * 4.9.6 Provision shall be made for any differential movement between tubing supports and connected equipment. Refer also to 4.2.
- 4.9.7 Where there is insufficient freedom of movement in standard tube, and provided that the air flow is not restricted, short lengths of flexible armoured tube may be used.
- 4.9.8 Long runs of tubing shall be continuously supported and mechanically protected.
- 4.9.9 Tubing run together shall be installed vertically one above the other. More than three runs shall be supported on a tray. Any joints which may be necessary shall be staggered.
- * 4.9.10 Transmission distance should not exceed 100 m (328 ft). Volume boosters may be used to give the required response over greater distances provided that other control characteristics are not down graded.

On signal tubings, it is desirable to limit the volume of the tube to ensure that lags in transmission are minimised. Volume boosters may be used to reduce lags, alternatively smaller diameter tubing or preferably an electronic transmission system should be considered.



- 4.9.11 Tubing should not be run in hot environments or designated high fire risk areas. Tubing should be located away from places where it may be subjected to mechanical damage, spilt liquids or corrosive gases.
- 4.9.12 Tubing should be run such that it does not interfere with access to or removal of plant equipment.
- 4.9.13 Multi-tube should be laid in sand filled trenches. When a trench also contains electrical cables, multi-tubes shall be grouped together and clearly identified.
- 4.9.14 Multi-tubes shall be terminated and identified generally as shown in Fig. 4-2.
- 4.9.15 Multi-tube installation should generally comply with the requirements for electrical cables in 4.13.

4.10 Hydraulic Systems

- 4.10.1 Refer to Section 8 of this Recommended Practice for BP general requirements for hydraulic power supplies to instrument and control systems.
- * 4.10.2 The special requirements for subsea systems will be specified by BP.
- * 4.10.3 Long distance transmission of hydraulic supplies or control signals should be avoided. Local generation is preferred, unless uneconomic. The policy for each application shall be subject to approval by BP.
- 4.10.4 Materials and installation of piping, tubing and fittings shall be in accordance with Section 8 of this Recommended Practice unless otherwise specified or approved by BP. BP may specify more cost effective engineering solutions (e.g. armoured plastic umbilicals, pickled carbon steel pipe) when long transmission distances are involved.
- 4.10.5 Each individual user shall be provided with isolation valves in both the hydraulic supply and return lines. These shall isolate the control equipment and all accessories, including filters.
- 4.10.6 The supply and return pressure shall be indicated locally. Common headers may be used when several users are at the same location; e.g. control panel.
- 4.10.7 The supply to each individual user shall incorporate a filter and, where necessary, a pressure reducing valve in accordance with the connected



equipment manufacturer's specification. A pressure gauge shall be fitted downstream of the reducing valve.

- 4.10.8 A non-return valve shall be installed in the return line from each user. This shall be arranged to protect the control equipment from contamination due to a reverse flow of hydraulic fluid under fault conditions.
- 4.10.9 Tube and fittings used for control lines, for the hydraulic fluid supply between the filter and the user, and for lines between the user and the non-return valve shall be in accordance with Section 8 of this Recommended Practice. The use of PTFE tape and jointing compound is not permitted on screwed fittings within hydraulic systems.
- 4.10.10 Depressuring and drain valves shall be provided at each user. A tundish or similar should be provided for the safe disposal of hydraulic fluid.
- 4.10.11 Provision shall be made for any differential movement between piping and tubing and connected equipment. Where there is insufficient movement in standard tube or pipe, short lengths of flexible armoured tube may be used. The final filter shall be downstream of the flexible section.

4.11 Control Panels

- 4.11.1 Refer to Section 9 of this Recommended Practice for BP general requirements for control panels.
- 4.11.2 Control panels shall be installed in true vertical orientation.
- 4.11.3 Locally mounted panels shall be located as far as practicable from sources of harmful matter and vibration. If the area requires hosing down, the panels shall be mounted on a plinth approximately 130 mm (5 in) high, and be rated to IP 55.
- 4.11.4 The space in front of a panel shall be as stated in Section 10 of this Recommended Practice.
- 4.11.5 Readability of instrument displays shall not be impeded by reflections caused by natural or artificial light. Panel mounted annunciators shall be clearly visible under all lighting conditions.
- 4.11.6 Temporary protection shall be provided to prevent damage to panels during shipment and installation.



4.12 Labelling

4.12.1 All field instrumentation shall have a permanently affixed stainless steel label which is stamped with the full instrument tag number.

4.12.2 All indicating and controlling instruments and control valves shall have a clearly visible label adjacent to them giving the tag number and a brief process description.

4.12.3 They should be made from white/black/white laminated plastic with the exception of shutdown service which shall be made from red/white/red laminated plastic.

4.12.4 All equipment that forms part of a shutdown system shall be clearly labelled with a permanently affixed red plastic label marked 'TRIP'.

The English language shall be used but local or national alternatives may also be required to clearly identify the 'TRIP' function.

4.12.5 Labels should be fixed with screws or bolts to a permanent part of the plant structure that would not be removed when maintaining or removing equipment. Labels shall not be fixed to cladding.

4.12.6 Cable numbers shall be visible at the instrument.

4.13 Electrical Installations

4.13.1 General Requirements

Electrical instrumentation, equipment modules, control panels ancillaries and cables shall be installed in accordance with Sections 3 and 5 of this Recommended Practice and the following:-

[BS 5345](#)

[BS 6739](#)

[API RP 550 Part 1](#)

BP Group [RP 12](#)

BP Group [GS 112-1](#)

The method of cable and core identification marking shall be in accordance with BP Group [GS 112-1](#).

The system of identifying cables and junction boxes shall be in accordance with [EIC Spec. CCI P/7](#).

* 4.13.2 Terminations and Jointing



Only one core shall be used in each termination. Common connections shall be made using the terminal manufacturers' standard bridging arrangement.

Crimped connections with sheath retaining clip shall be used for stranded conductors.

Flat-form connectors shall be used in spring-loaded terminals. In other cases, spade or pin form connectors should be used as appropriate to the terminal design.

All crimping wire wrap or other termination, shall be carried out using a tool approved by the connector manufacturer.

Cable glands on outdoor service shall be shrouded. In outside locations, cables shall enter and exit junction boxes via the bottom or side. Where side entry is used, the cable shall be looped down to minimise the possibility of water ingress.

Sufficient cable slack shall be left at junction boxes, at instruments, and at individual core terminals to allow for remaking connections.

Where continuous uninterrupted multicore runs are not possible, cables should be jointed in junction boxes. Where this is not practical, in-line joints may be used subject to approval by BP.

* 4.13.3

Cable Installation

Cable installation instructions shall include any handling limitations imposed by the manufacturer, and shall meet BP Group [GS 112-1](#). In particular, minimum handling temperature and minimum bending radius shall be identified.

Overhead cables shall be supported by tray, racking or channel. Cable tray and ladder racking shall be positioned in the vertical plane. Where this is not possible or where cables are exposed to possible physical damage, trays with covers should be used. The cable should be routed away from potential hazards (e.g. spilt liquids and falling debris etc.).

Routing of multicore cables should be economic but avoiding areas where they could be exposed to fire, excessive temperature, mechanical damage, corrosive or solvent agents.

Redundant channels of voting systems which form part of an emergency shutdown or other safety systems shall be routed via different cables and by different routes. Where separate routing over

all or part of the run is not practical or economic, the routing shall be subject to approval by BP.

Separate routing of emergency shutdown voting circuit cables shall be maintained wherever practical. Separate routing is not obtained by running cables in separate cable trays in the same access duct, separated by only a metre or so. If true segregation of cables (i.e. running by different routes) cannot be achieved over a significant length or through high fire risk areas, additional methods should be considered to increase system reliability, e.g. the use of fire resistant cabling or running cables in fire resistant cable ducts or trays.

Redundant data highway cables for distributed control systems shall be run by separate routes unless otherwise approved by BP.

In distributed control and information systems, the security of information and control is dependent on one or more data highways. Generally, system manufacturers provide two channels per highway to allow a different route to be used for each channel, such that the loss of one channel does not impair operation.

It is important to carefully consider routing to minimise the risk of simultaneous failure of both channels due to mechanical damage, fire or similar.

Method of installation also needs to be considered early in the design, since long lengths may be involved (1 km) and some manufacturers cable requirements create difficulties in laying (e.g. minimising number of connections and non-flexible coaxial cable). It is often easier to lay the cable in trenches or on cable trays than to pull through conduits (e.g. under pipe tracks or roads).

4.13.4 The following minimum spacings between instrument and power cables should apply:-

Power Cable Rating Instrument Cable Separation Distance

125 V or 10 A	250 mm (10 in)
250 V or 50 A	500 mm (20 in)
440 V or 200 A	750 mm (2 ft 6 in)
5 kV or 500 A	1250 mm (4 ft)
11/33 kV or 800 A	2000 mm

In some installations, particularly offshore, the cable segregation as shown either cannot physically be achieved or causes unacceptable penalties due to space and weight constraints. In these instances the optimum arrangement should be designed by:-

- (a) *Keeping parallel runs of power and instrument cables as short as possible.*
- (b) *Ensuring all instrument cables are screened and earthed correctly.*
- (c) *Routing instrument cables least susceptible to 'pick-up' interference (e.g. 4-20 and contact alarm signals), closest to the power cables, whilst keeping low level and data transmission cables as far away as practical.*

In cases where a spacing of only 50% or less of the recommended distance is achievable, instrument and power cables should be separately routed.

All crossovers that bring power and signal cables into close proximity shall be made at right angles. The cables should not touch at the crossover.

The cable spacings listed above may be relaxed at entries to instruments and associated housings, or where parallel cable runs are of less than 30 metres (98 ft) in length and where due to physical constraints these spacings cannot practically be achieved. All such instances, where relaxation of these requirements are proposed shall be highlighted in design documentation and shall be subject to approval by BP.

For offshore installations, where such universal constraints may impose a significant installed cost penalty, policy for cable spacing should be established on an individual project basis.

Instrument cable categories shall be separated as defined in Section 3, para 3.2.2 of this Recommended Practice. Instrument power supplies above 10 amps shall be treated as power cables and segregated as this section.

Special cables, (e.g. data highways), shall be installed in accordance with the control equipment manufacturers' recommendations.

Where multicore cables pass through floors, or rise through covered trenches, they shall be provided with adequate mechanical protection in the form of metallic sleeves or kick plates projecting not less than 75 mm (3 in) above floor level. Kick plates shall not constitute a trip hazard.

Where multicore cables pass from one area to another the transit should be sealed. This is of particular importance where the dividing wall or bulkhead separates a hazardous area from a non-hazardous area, different hazardous area zone rating, or where the bulkhead is of a specified fire rating. In these cases multi-cable transits of a suitable accepted design shall be used.

Equipment trays, saddles and strapping shall be installed in accordance with BP Group [GS 112-1](#).

Removable gland plates shall be furnished for cable access into panels and equipment enclosures.



4.14 Seals and Purges

- 4.14.1 Installation shall be in accordance with [BS 6739](#) and [API RP 550](#) Part 1.
- 4.14.2 Meter seals and fluid purges shall be used only where process fluid or fluid conditions are not suitable for direct connection of an instrument.
- 4.14.3 Purge fluid shall be from a secure source and be compatible with the process fluid. The purge fluid shall be available for start-up, and shall assure adequate purging under all operating conditions. The purge supply header pressure shall be indicated and annunciated if it falls to an unacceptably low level.
- 4.14.4 Seal fluids in direct contact with the process shall be immiscible with the process fluid.
- 4.14.5 Where diaphragm and capillary seals are used, the capillaries shall be mechanically protected and supported. Errors shall not be introduced due to temperature gradients along the capillary, or temperature effects upon the diaphragm seal chamber.
- 4.14.6 Condensate pots should be provided on steam or vapour service only if displacement of the measuring fluid would introduce an unacceptable error.

4.15 Winterisation

- 4.15.1 Winterisation shall be in accordance with BP Group [RP 44-2](#), [BS 6739](#) and [API RP 550](#) Part 1.
- 4.15.2 The combination of heating and lagging shall not cause overheating of instrumentation.
- 4.15.3 Where impulse lines on differential pressure service are winterised, temperature gradients shall not occur between them.
- 4.15.4 All valves and external adjustments associated with an instrument shall be accessible without removal of lagging.
- 4.15.5 Winterising for pressure and differential pressure instruments (and other similar measurement devices) should be achieved by a secondary GRP enclosure; with heating if necessary. This enclosure shall not impede access to valve manifolds and instrument adjustments.
- 4.15.6 A secondary housing supplied as a factory built complete assembly with valve manifold, transmitter mounting and heating unit is preferred.



4.16 Tropicalisation

- 4.16.1 In hot climates, electronic instruments should be protected by a sun shade. Equipment designed for use in the field should be protected from direct sunlight and ambient temperatures higher than 40°C, or the manufacturer's maximum recommended temperature, whichever is the lower.
- 4.16.2 Air conditioning should be provided in equipment rooms to limit maximum temperatures to 30°C. Alarms should be provided to indicate failure of air conditioning. Automatic operation of ventilation louvres on a high differential temperature in case of air conditioning failure should be considered.
- 4.16.3 Air conditioning of equipment rooms containing battery systems shall ensure safe operation by efficient removal of hydrogen released during charging of lead acid batteries.
- Many so called sealed batteries can vent gas under certain circumstances (such as high charging rates). This may be diffused into the room or contained in the battery. Pressure relief valves are sometimes fitted to sealed batteries. It may be a requirement to vent the top of the battery to atmosphere.*
- 4.16.4 Instrument cases should be light coloured or silvered to reflect heat.
- 4.16.5 De-Humidifiers should be provided in equipment rooms where necessary to meet control equipment specification limits.
- 4.16.6 Electronic equipment shall be calibrated and sealed in a low humidity environment prior to installation in the field.

5. EARTHING AND BONDING SYSTEMS

This Section specifies BP general requirements for earthing and bonding systems.

5.1 General Requirements

- 5.1.1 In the UK, minimum earthing requirements for electrical systems shall comply with the [IEE Wiring Regulations](#) and [IEE Regulations for the Electrical and Electronic Equipment of Mobile and Fixed Offshore Installations](#). Requirements for earthing of equipment in hazardous areas shall comply with [BS 5345](#).

In Scotland, adherence to the IEE Wiring Regulations is mandatory.



- 5.1.2 Elsewhere in the BP Group, the appropriate national standards shall apply. Vendor recommendations shall also be taken into consideration.
- 5.1.3 Earthing and bonding shall be provided to:-
- (a) Protect personnel and plant.
 - (b) Maintain signal integrity.
 - (c) Provide a signal reference point where necessary.
- 5.1.4 Earthing and bonding for protection of personnel and plant shall be in accordance with BP Group [RP 12 Parts 5 and 16](#).
- * 5.1.5 At an early stage in the project, the contractor shall submit his earthing and bonding philosophy which shall be subject to approval by BP. The philosophy shall include an earthing and bonding diagram based upon the following Figures included at the end of this Recommended Practice:-
- Fig 5-1 Typical earthing diagram for instrumentation onshore.
- Fig 5-2 Typical earthing diagram for SCADA and computer type equipment.
- Fig 5-3 Typical installation detail for cable termination and earth bonding.
- Fig 5-4 Typical earthing diagram for instrumentation offshore.
- Fig 5-5 Typical earthing diagram for telecommunications equipment.
- 5.1.6 Continuity of earth on cable armouring shall be provided. Particular attention shall be paid when plastic cases or glands are used.
- 5.1.7 Earthing positions shall be selected to avoid earth loops which could result in common or series mode signal interference.
- 5.1.8 The arrangement of earthing of intrinsically safe equipment shall comply with equipment or system certification and local and national requirements ([BS 5345](#): Part 4 in the United Kingdom). In the selection of equipment, a check shall be made to ensure that there is no incompatibility between these requirements. The selected earthing arrangement will be specified in equipment enquiries/orders.
- 5.1.9 At the tender stage, suppliers shall confirm that equipment and system hazardous area certification is compatible with the project earthing arrangements.



- 5.1.10 Earthing conductors shall be stranded and insulated 600/1000 volt grade to [BS 6346](#) and be coloured green/yellow.
- * 5.1.11 Plug-in metal cased devices (e.g. electro mechanical relays) shall have the case earthed, and be arranged such that on removal continuity of the earth contact shall be maintained until all other circuits have been broken. This requirement may be relaxed for low voltage devices in safe areas, with the approval of BP.
- 5.2 Equipment Rooms**
- 5.2.1 Panel earth bars shall be hard copper to [BS 1433](#) or equivalent and a minimum of 75 mm² in cross sectional area. They shall be mounted on insulators with a minimum spacing of 25 mm from the panel frame. All earth bars shall be appropriately labelled according to their functions, e.g. earth/reference earth.
- 5.2.2 Interconnections between earth bars, control centre earth and power system earth shall be provided with insulated conductors of not less than 35 mm² in cross sectional area.
- 5.2.3 Where single conductors are used for interconnection between earth bars, they shall be double bolted for security.
- 5.2.4 Flexible earth straps shall be fitted between panel doors and frame.
- 5.2.5 Where an earth bond cannot be assured by the mounting arrangement, a separate earth conductor shall be run from the equipment case to the dirty earth bar.
- Screens shall be insulated from one another and earthed only at one point. That is:-
- (a) for IS circuits, at the IS earth bar,
 - (b) for non IS circuits, at the panel reference bar,
 - (c) for field earthed instruments, at the field junction box.
- 5.2.6 Where galvanically isolated barriers are to be provided, cable screens shall be taken to an IS earth bar if available.
- 5.2.7 Screen drain wires at the panel shall be provided with green/yellow heatshrink sleeves and appropriate identification.
- 5.2.8 Field instrument cables between a junction box and the control cabinet shall have the armour (and the lead sheath in onshore applications) earthed at both ends of the cable via the gland.

- 5.2.9 Earth leads between the control cabinet IS earth bar and the control outstation earth bar, shall be provided with identification labels at both ends indicating an intrinsically safe circuit.
- 5.2.10 The IS system earth shall be such that the impedance between any barrier bus-bar and the control centre main earth point shall not exceed 1 ohm.
- 5.2.11 On IS systems, if a power supply is earthed on the field side of a transformer, then twin channel shunt diode safety barriers or optically/galvanically isolated devices shall be provided.

5.3 Field

- 5.3.1 All metallic instrument enclosures in the field shall be bonded to the plant/platform steelwork at bolted connections. These shall be provided with serrated spring washers to give earth continuity. Where the earth bond cannot be assured, a 4 mm² single core, insulated conductor shall be provided between the enclosure and an effective local earth point.

5.4 Instrumentation on Cathodically Protected Pipelines

- 5.4.1 Installations shall comply with the requirements of BP Group [RP 12-16](#).
- 5.4.2 Above ground instrumentation shall be insulated from the cathodically protected structure and earthed.
- * 5.4.3 In the event of it not being practical to install a system as above the method of installation shall be subject to approval by BP.

Care should be taken when connecting instrumentation to cathodically protected pipelines to ensure that protection currents do not flow into the instrumentation earth system.

Special insulating kits for flanges exist, allowing impulse lines to be electrically isolated from the pipeline and earthed.

Some installations, such as limit switches on motorised valves etc., cannot be effectively insulated from the pipeline. In such cases, isolation can be achieved via galvanic isolators or isolation transformers. Use must be carefully controlled.

- 5.4.4 The use of earthed tip thermocouples is not permitted on cathodically protected systems.



5.5 SCADA and Computer Type Equipment

- 5.5.1 Where system earth and frame earth are bonded together, SCADA and computer type equipment shall be insulated from the structure.
- 5.5.2 Process data communication cables may be co-axial or twisted pairs as required by the system vendor. The system vendor's specific screening and earthing philosophy shall be complied with, provided it does not prejudice the conditions specified elsewhere in this Recommended Practice.
- 5.5.3 Incoming and outgoing signals shall not be connected to frame earth.
- 5.5.4 The signal carrying conductors shall be galvanically isolated from the transmitting and receiving equipment to ensure that earth loops are not created via signal paths.

5.6 Radio Frequency Cables

- 5.6.1 For co-axial cables carrying radio frequency signals, signal screens shall be earthed locally at each end of the cable and may be connected to frame earths as necessary when the cable passes through equipment panels.
- 5.6.2 In the case of antenna feeder cables, added protection against lightning strikes should be provided by earthing the screen to the antenna tower earth at the antenna, at the foot of the antenna structure and to the local earth at the transit into the equipment building.

5.7 Surge Diverters (Lightning Protection)

- 5.7.1 Where interconnections between remote equipment and control centres (or between control centres) may be subject to the effects of electrical storms, or high voltages induced from other sources, the interconnecting lines or cables shall be equipped with suitable surge diverters to prevent damage to instrumentation equipment.

Protection of every signal against the possibility of damage from static discharge or lightning is neither practical nor economic. However, signal pairs at high risk should be identified and added protection in the form of surge diverters included where safety, environmental or the economic consequences of failure dictate.

Examples of signal circuits at risk are flare stack or tank instrumentation and telecommunication lines.

- 5.7.2 The selection of surge diverter type shall depend on the level of protection required, the assessed risk level of lightning strikes or other

sources of induced high voltages, the criticality of the signal lines and characteristics particular to the location.

It is important that any surge diverting device is returned to the best possible earth via a substantial conductor. Currents in the order of hundreds of amps may be encountered during a strike and any resultant voltage developed across the earth lead will not be suppressed by the diverter.

5.7.3

Where large earth potential is known to exist at the ends of a cable requiring protection, consideration should be given to fitting a surge protection device at each end.

The Gas Discharge Tube is the simplest form of surge diverter. These are often specified by telecommunications authorities.

They consist of a gas filled glass envelope containing three electrodes. One electrode, usually the centre one, is connected to ground and the other two to the incoming lines.

In the event of a high voltage surge between the lines and earth, the tube 'strikes', conducting heavily and clamping both conductors to ground.

The tube takes approximately 0.2 microseconds to operate and limits the voltage presented to the equipment to approximately 30 volts.

This type of device does not give sufficient protection for general electronic instrumentation duties. A more complex device called a lightning protection unit (LPU) is required.

Lightning Protection Units (LPU's) generally consist of a gas discharge tube, to absorb the majority of the energy, followed by a network of silicon transient suppression diodes and Zener diodes.

Silicon transient suppression diodes have the ability to turn on very rapidly (e.g. 1 pico second) and absorb energy until the gas discharge tube conducts. The Zener diodes limit the output voltage excursions.

Some LPU's contain resistors in series with the signal path and others contain capacitors in parallel with the signal, therefore the effect of the LPU on the signal and/or the signal line's transmission characteristics must be considered.

Signals likely to be affected are those originating in thermocouples, resistance thermometers and other transducers producing low voltage signals, i.e. less than one volt.

Other categories of signals that can be affected by the LPU's transmission characteristics are radio frequency signals, audio frequency signals and digital data (e.g. process data highways).

In these cases the manufacturers of the signal source and destination equipment should be consulted.

(a) Disposable

These resemble a Zener barrier of the type used in intrinsically safe installations.

They absorb the majority of surges caused by static discharge/lightning strikes to adjacent structures, etc. In the event of a more serious occurrence they blow (short circuit to ground, open circuit to the equipment), while still protecting the equipment. The unit then has to be replaced, until which time there is a loss of service.

This type of device is suitable for the majority of applications at attended sites.

(b) Fuse Link

These units perform the same duty as the disposable LPU's, but are able to survive more serious lightning strikes, while protecting the equipment by blowing fuses to achieve isolation.

Unfortunately, they are expensive and prone to nuisance tripping.

(c) Self resetting

These are a development of the fuse link LPU's and have the advantage that they disconnect the protected equipment for the duration of the strike and then reconnect it.

The disconnection/connection is performed by a reed relay powered by the surge current. As the relay takes approximately 2 milliseconds to operate, the LPU must clamp the output voltage for this period to be effective.

These are expensive units and should only be considered for critical signal lines and/or unattended locations.

Protection of SCADA type equipment should comply with Fig 5-5 .

6. INSTRUMENT POWER SUPPLIES

This section describes BP general requirements for electrical power supplies for Instrumentation and control systems. This includes power supplies for field instrumentation, control panels, distributed control systems, telemetry systems, supervisory computer systems, emergency shutdown systems and fire and gas detection systems.

6.1 General Requirements

6.1.1 Instrument power supplies shall be designed such that the security of power supply is consistent with the integrity required by the connected loads, and does not exceed this requirement.

6.1.2 Power supplies shall be designed such that they meet the requirements of the connected loads in terms of:-



- (a) Voltage
- (b) Voltage stability
- (c) Frequency
- (d) Rate of change of frequency
- (e) R.F. content
- (f) Maximum interrupt time
- (g) Harmonic content
- (h) Power factor

6.1.3 Power supply capacities shall be rated to take account of switching surges and the effects of harmonics and transient loads.

6.1.4 Power supply capacities shall be rated to take account of any anticipated future expansion requirements.

* 6.1.5 The design philosophy for instrument power supplies shall be subject to approval by BP.

6.2 Security of Supply

6.2.1 Instrument power supplies shall be classified according to the required integrity of the connected loads as Class A, B or C according to the definitions of BP Group [RP 12-5](#).

The basis of this classification is that loss of supply will cause:-

(a) Class A

A shutdown of the whole or major part of a plant or process, a failure to shutdown under emergency conditions, loss of monitoring facilities on critical items of equipment, loss of fire and gas alarm annunciation, or loss of alarm annunciation on any other system specified by BP.

(b) Class B

An acceptable temporary loss of control, degradation of normal monitoring or control where alternative methods are available, or loss of other alarm annunciation facilities.

This classification can apply to a supervisory computer system where backup panel instrumentation exists or control room operation where local plant control panels exist. The operation of a plant from handwheels can not normally be considered as an acceptable form of backup control.



(c) Class C

No significant impairment of the ability of the operator to control and monitor the plant.

* 6.2.2 Classification of the power supplies shall be subject to approval by BP.

6.3 Design Requirements

6.3.1 Instrument power supplies shall fulfil the following requirements:-

(a) Class A

Supplies shall automatically maintain a continuously uninterrupted electricity supply within the required tolerances upon failure or deterioration of the primary source, or any other item of power conversion equipment, for a period of 30 minutes or as otherwise specified by BP. They shall be separate and independent from other supplies except the primary a.c. source.

(b) Class B

Supplies shall automatically maintain continuity of electricity supply within the required tolerances for a period of 30 minutes, or as specified by BP. The changeover time between normal and standby circuits shall not be greater than 10 m/sec or as otherwise specified by BP.

(c) Class C

Supplies have no requirement for a standby source of supply.

6.3.2 Class A, B and C power supplies shall be designed according to requirements of BP Group [RP 12-5](#).

6.3.3 Alternating current power supplies shall comply with the requirements of BP Group [GS 112-10](#).

6.3.4 Direct current power supplies shall comply with the requirements of BP Group [GS 112-11](#).

6.3.5 Batteries shall be selected according to the guidelines in BP Group [RP 12-5](#).

6.3.6 Earthing systems shall be designed in accordance with BP Group [RP 12-16](#).



6.4 Distribution and Protection

- 6.4.1 Protective devices shall be time and current graded to maintain discrimination.
- 6.4.2 Cartridge type fuses should be used throughout the power supply system. Protective circuit breakers may be used only in final sub circuits provided it can be demonstrated that discrimination will be maintained with the other protective devices.
- 6.4.3 Separate feeders shall be provided where equipment is duplicated to increase availability.
- 6.4.4 A separate switched and fused sub circuit shall be provided for each functional loop. Redundant equipment shall be separately switched and fused.
- 6.4.5 Each sub circuit shall be clearly labelled with a unique identifier.
- 6.4.6 Power supplies to ancillary equipment such as heating and lighting shall be independent from the control system power supplies.
- 6.4.7 The distribution shall be designed such that failure of a single sub circuit does not cause an unacceptable loss of control or loss of data display to the plant operator.

6.5 Integral Power Supplies

- 6.5.1 Where power supply units are supplied integral to control systems equipment adequate provision shall be made for ventilation and heat dissipation.
- 6.5.2 Where dual power supplies are installed to increase availability indication shall be provided to show failure of a single supply.
- 6.5.3 Where dual power supplies are installed it shall be possible to replace a single failed supply without reducing the availability of the equipment.
- 6.5.4 Power supplies shall be clearly labelled with a unique identifier.

6.6 Monitoring and Alarm Systems

- 6.6.1 Sufficient information shall be provided either remotely or local to the power supply equipment to enable rapid identification of fault conditions or confirmation of healthy status.

6.6.2 Alarms shall be provided to indicate at a manned control point any fault condition on a major unit in a power supply system. This may take the form of a common alarm requiring examination of the local indication to diagnose a fault condition.

6.6.3 Remote signalling of alarm conditions shall be classified into the categories:-

Emergency Trip
Urgent Alarm
Information

7. INSTRUMENT AIR SYSTEMS

This Section specifies BP general requirements for instrument air systems.

Note: proposals for the use of fluids as an alternative to air are subject to approval by BP. (Refer to para 3.6 of this Recommended Practice).

7.1 General Requirements

* 7.1.1 Selection of equipment for the complete instrument air generation, purification, storage and distribution system should be in accordance with [BS 6739](#) and take into account:-

- (a) The criticality of supplied equipment (e.g. degradation of air supply quality could through subsequent instrument failure affect the integrity of automatic protection systems, or cause a loss of production).
- (b) The reliability of the system in terms of the availability of supply at the requisite quality.
- (c) System rating and reserve capacity, including any proposed use of instrument air for services other than instrumentation (e.g. for breathing air).
- (d) The means of ensuring a no-break supply during maintenance operations or routine inspections (e.g. receiver vessel inspection).
- (e) Environmental conditions (e.g. high humidity, extremes of ambient temperature).
- (f) Overall cost.

The contractor's basis for design shall be subject to approval by BP.



Instrumentation is sensitive to the quality of its air supply. Contaminants such as water, oil or particulate matter (e.g. corrosion products) can damage components, result in blockage of protective filters or orifices, and lead to equipment malfunction. Methods of avoiding contamination of the instrument air distributed to control equipment must be addressed at an early stage of project development.

The benefits and disadvantages of totally oil free versus oil lubricated air compressors should be addressed. The greater potential reliability of lubricated compressors may prove a negative benefit because a high level of maintenance or operator attention may be necessary on oil removal or drying equipment. Also, once oil has contaminated an air distribution system, it proves difficult to remove; particularly from any low points in the distribution pipework.

Note that oil lubricated compressors for instrument air supplies are specified for some offshore applications.

- 7.1.2 Dried, filtered compressed air shall be made available at the dryer outlet at a pressure which should not be less than 7 bar (ga) (100 psig) when under rated load. This may be reduced, provided that an economic benefit is shown and that other requirements of this Recommended Practice (in particular paragraphs 4.1 and 4.2) are complied with.

The design of the system including pipe diameter and length should ensure that the pressure drop between the air dryer outlet and the most remote consumer does not exceed 5% of the system pressure.

A pressure drop greater than 5% of system pressure at a remote consumer may be technically acceptable and economic; particularly where only a low supply pressure (e.g. below 2 bar) is necessary for connected equipment.

- 7.1.3 The oil content of instrument air at the normal temperature/pressure operating conditions shall not exceed 1 ppm by mass/mass. This permissible level of contamination in the instrument air supply system shall be further reduced to meet the specific requirements of measurement, control and protective instrumentation supplied from the distribution system. Instrument air quality shall also meet the requirements for any electrical apparatus protected by pressurisation or by continuous dilution (Ex p).

Instrument air quality stated in specifications for the supply of instrumentation and control equipment should include the design maximum oil content.

- 7.1.4 Drying plant, filters and coalescers shall be protected from the effect of surge in the air supply system (e.g. on start-up of a stand-by compressor following a sudden high demand).

- 7.1.5 The pressure in the main instrument supply line to a plant or complex shall be indicated and low pressure alarmed at the appropriate control centre(s).

Any abnormal deviation of other key parameters within the air supply generation, purification or distribution system shall be alarmed to the appropriate operators. This shall include extra low pressure downstream of the air dryers, and high differential pressure across filters and coalescers.

- 7.1.6 Water containing equipment, pipework and drains shall be winterised at locations where frost may be expected.

7.2 Capacity

- 7.2.1 The system shall be rated for all the connected loads plus a minimum of 20%, unless otherwise specified by BP.

Main equipment suppliers should be consulted for typical instrument consumption figures. However, in the absence of any better information, the following flow rates in units of cubic metres/hour (cubic feet/hour) at standard conditions, may be used for initial sizing:-

- (a) *For each pneumatic transmitter, controller and current/pneumatic transducer - 1.0 (35)*
- (b) *For each valve positioner - 1.5 (53)*
- (c) *For purge other than cat cracker catalyst duty - 1.0 (35)*
- (d) *For cat cracker catalyst duty - 2.0 (70)*

For cases (a) and (b) these figures when used for a number of instruments, some in steady state and some in dynamic motion, allow a reasonable assessment of capacity to be made. Allowance is made for a supply regulator of the bleed type. Cases (c) and (d) are continuous operations. 20% should normally be added to the calculated figure, to allow for a limited expansion of the instrumentation. No allowance should be made for leakages from poorly maintained instrument air systems.

Special care should be taken when assessing the demand for large intermittent users such as large piston operators on ESD duty.

Where an air purge (case(c)) is used to provide a safe environment for electrical instrumentation, the flowrate is in excess of the figure quoted for an initial short period (typically 2 to 5 minutes). It is not normally necessary to add a contingency for this. However, the purge pipework should be designed to take the larger flow rate without reducing the air supply pressure to other local users.

- * 7.2.2 The system shall contain such storage capacities located downstream of the air dryer that, for a period after system failure, all air-using apparatus under rated load can continue to operate normally. The reserve period will be specified by BP.



Reserve capacity of the system should be agreed with the end user or plant designer, as appropriate, at an early stage of design. Experience has shown 15 minutes reserve is usually adequate for general process plant. 5 minutes may be adequate for less complex facilities such as a simple oil/gas separator.

Storage capacity should be calculated using the following:-

- (a) *The air consumption given in 7.2.1. (above)*
- (b) *The decay of pressure in the system related to that required by an Instrument taking its supply directly from the header, i.e. without the aid of a local volume chamber.*
- (c) *Isothermal expansion and perfect gas law.*

* 7.2.3 The use of local volume chambers to enhance the performance of individual items of equipment should be avoided. When shown to be technically acceptable and economic, they may be used subject to BP approval for:-

- (a) equipment (e.g. high pressure actuators) which may fail before the majority of other users due to a reduction in the distribution system pressure.
- (b) intermittently operated high capacity equipment (e.g. large piston operators) which may otherwise cause an unacceptable disturbance in the supply to other users.

7.2.4 Local volume chambers shall be supplied via a non-return valve. They shall be protected by a pressure relief valve in accordance with BP Group [RP 44-1](#). The design should permit removal of the relief valve for testing without compromising the integrity of the supply.

7.3 Oil Removal Equipment

7.3.1 Oil removing equipment shall be provided immediately downstream of air compressors which use oil lubrication.

The potential failure situations within the compressors and oil removal equipment should be carefully assessed to ensure that oil breakthrough into the instrument air distribution system is very unlikely to occur.

7.3.2 The equipment shall maintain the oil content of the air supply below the maximum identified in 7.1.3. This shall apply to all expected environmental conditions, including high humidity when extensive water drop out may be expected. Equipment shall be protected from corrosion products and other contaminants.

7.3.3 Oil and water disposal shall be automatic. A manual bypass of the auto-dump facility shall be provided.



- 7.3.4 Duplex equipment which can be cleaned or replaced without interrupting the air supply or affecting its quality shall be provided. Requirements for change-over normally indicated by pressure drop shall be alarmed to the operator.

Sizing of equipment should be carefully considered, particularly with respect to items requiring regular manual attention (e.g. coalescer element replacement).

- 7.3.5 Oil removal equipment shall not be provided with a bypass.

- 7.3.6 A sampling point for oil content shall be provided at the air outlet of each oil removal train.

Methods to determine the oil content of instrument air at the ppm level are available (e.g. infra-red spectrometry). Advice may be obtained from Analytical Support, Group Research and Engineering Centre, Sunbury.

7.4 Air Drying

- 7.4.1 Dryers shall be of the absorption type unless otherwise approved by BP. They shall be arranged for continuous operation with automatic regeneration on a cyclic basis. Failure of the automatic regeneration system shall be alarmed in the appropriate control room.

Heat regenerated air dryers are usually more economical for larger capacity systems and consume less of the dried air during the regeneration cycle. Heatless dryers however, are simple in their operation and lower in initial cost of installation. Refrigeration type dryers may be more economic or more effective in hot/humid environments.

Selection should also take into account the oil content of the air supply which could ignite or otherwise damage the drier (e.g. during regeneration).

- 7.4.2 Where climatic conditions dictate, the air dryer should be installed under cover.

- 7.4.3 The dew point of the air anywhere in the system (measured at the distribution pressure and at the maximum air throughput) shall be at least 10°C (18°F) below the minimum ambient temperature quoted in the plant specification.

- 7.4.4 It shall be possible to maintain drying equipment without interruption of the dry air supply.

- 7.4.5 A duplex 3 micron filter, which can be cleaned without interrupting the air supply, shall be installed downstream of the dryer. A differential pressure gauge shall be fitted across the filter.



A separate filter/coalescer unit should be provided upstream of an air dryer to protect the absorbent material in the dryer from any contaminants in the air supply.

7.4.6 Branches should be provided to allow for bypass of the drying system.

* 7.4.7 A sampling point for dew point measurement shall be provided in the outlet pipe from each dryer. Any requirement for continuous dew point measurement shall be subject to approval by BP.

It is rarely necessary to provide permanent monitoring of instrument air dryness. Special circumstances would include stringent requirements for a process use of instrument air.

7.4.8 Valves on regenerative dryers shall be rated in excess of the temperatures achieved when flowing hot air.

7.4.9 Pilot operated valves shall be supplied with air from a cool location such as downstream of the air receiver.

7.5 **Distribution**

7.5.1 Dry oil-free air for purposes other than instrumentation may be taken from a point upstream of a non-return valve at the instrument air receiver inlet.

Any other interconnection between the instrument air distribution system and any other utility system, (e.g. plant air or nitrogen) shall be upstream of oil removal and drying equipment and subject to approval by BP.

Some older installations have a breathing air distribution system derived from the instrument air supply. System modifications should not compromise the breathing air capacity or quality.

7.5.1.1 Reference should be made to BP Group [RP 60-2](#) on the use of instrument air for breathing air supplies.

7.5.2 There shall be no interconnection between the instrument air system and the process unless there can be shown to be no other viable option. Where interconnection cannot be avoided, great care shall be taken in respect of the risk of contamination of the instrument air system with hydrocarbons and suitable protection methods shall be provided.

The use of instrument air for purposes other than instrumentation should be avoided because there is always the risk of contamination. There are however, sometimes strong economic reasons to relax this requirement (e.g. for catalyst activation) or for purging instrument impulse lines on air fluidised powder systems



(e.g. FCCU's). Precautions must be taken to minimise the risk of instrument air contamination due to reverse flow from the process (e.g. by the use of a suitable check valve).

It is normally preferable to provide an independent air distribution system for such services, even if this is an offtake from the instrument air main to or within a plant.

This is particularly important if such a non-instrument user has a high demand under normal, peak load or emergency conditions.

7.5.3 Air supply headers should be sized in accordance with the requirements of 7.1.2 and should be a minimum size of NPS 1/2 (DN 15). Each sub-header should have one spare distribution point.

7.5.4 The air supply to field mounted instruments and valve actuators shall be through individual isolating valves, filters and regulator sets with pressure gauges.

A protective device (e.g. pressure limiter/relief valve) shall be installed immediately downstream of the regulator set when:-

- (a) The device(s), including local reserve air receiver being supplied with air are not rated for the main air distribution pressure.
- (b) An actuator, coupling, valve or other operator could be overstressed on regulator failure.

Traditionally, protective devices have not been installed to protect instrumentation, valves or accessories should the air regulator fail to high output pressure. Air pressure regulators may fail to maximum output pressure (e.g. diaphragm rupture) and on a closed discharge application (e.g. ESD valve actuator system) could typically reach 90% of the primary supply pressure.*

The instrument, supply pressure gauge, accessories, positioner, actuator or air receiver could be overpressured; and protection must be addressed for any other pressure containing system.

* *Note that although instrument air supply regulators are normally of the 'bleed' type, the bleed port is not sized as a relief device should the supply port fail fully open.*

7.5.5 Refer to 7.7 for instrument air distribution within control panels.

7.5.6 Any Ex p equipment or other housing requiring purge air shall be supplied through an individual isolating valve and filter regulator.



7.6 Piping and Tubing

7.6.1 The Main Distribution air supply piping and fittings in the distribution system up to and including each instrument isolating valve shall be in accordance with BP Group [RP 42-1](#).

* 7.6.2 BP will specify the material required for low pressure air supplies and signal lines downstream of the instrument air supply isolating valve. Typical specifications for copper and stainless steel systems are as follows:-

(a) Typical Specification for Copper Systems

- (i) Tubing shall be solid drawn half-hard copper in accordance with [BS 2871](#) Part 2.
- (ii) Fittings shall be copper alloy compression type as shown as Type A in [BS 2051](#) Part 1 and Part 2.
- (iii) Tubing should normally be 6 mm nominal outside diameter x 1 mm wall thickness for transmitter/receiver connections, and 10 mm nominal outside diameter x 1 mm wall thickness for controller/control valve connections.
- (iv) Tubing in process areas should be sheathed in black PVC or polyethylene of nominal 1.5 mm thickness. The requirement for sheathing, and the material selected, shall be based on suitability for the plant environment.
- (v) Where sheathed tubing is used, any exposed sections of copper tube adjacent to a fitting should be sheathed by the use of a fitting with a secondary seal, or by using a separate shroud for the fitting and pipe.
- (vi) Valves and accessories shall be brass.

(b) Typical Specification for Stainless Steel Systems

- (i) Tubing shall be seamless Type 316 in accordance with [ASTM A 269](#).
- (ii) Tubing should normally be 6 mm nominal outside diameter x 0.5 mm wall thickness for transmitter/receiver connections and 10 mm nominal outside diameter x 0.6 mm wall thickness for controller/control valve connections.



- (iii) Fittings, valves and accessories shall be of Type 316 stainless steel.
- (iv) Tubing, fitting, valves and accessories shall be supplied in the solution annealed condition.
- (v) Compression fitting type and supplier shall be subject to approval by BP.

Reference should be made to BP Group [GS 142-13](#) and for further information on suitability of fittings to the custodian of this Recommended Practice.

- * 7.6.3 Multicore form tubing should be used when economic for long transmission distances (e.g. from a control room to the field). The multitube shall be sheathed overall in PVC or polyethylene (see 7.6.2).

Materials shall comply with 7.6.2. The use of plastic materials for the cores shall be subject to approval by BP.

Each tube shall be permanently identified throughout its length.
10% spare cores shall be provided.

Copper is not suitable for offshore applications, either bare due to direct corrosion or with a plastic jacket which is adversely affected by moisture and light. Type 316 stainless steel and 'Alloy 825' are available alternatives. At temperatures above about 50°C, type 316 stainless steel may suffer stress corrosion cracking if exposed to a marine environment; it may also suffer crevice corrosion. Monel 400 is a suitable material in H₂S environments providing temperatures are below about 150°C. However, if Monel is exposed to a mixture of H₂S and air in damp conditions, fairly rapid corrosion can occur. In such cases plastic coatings have been used successfully to protect the Monel.

- 7.6.4 Tubing should be 6 mm O.D. x 1 mm wall thickness for transmitter and receiver connections, and 10 mm O.D. x 1 mm wall thickness for higher capacity services.

The use of nylon or plastic, both of which provide flexibility should be considered when economic or where metals could become work hardened by continuous movement. Care should be taken in the selection of tubing connections, both from materials and joint integrity viewpoints. Advice on the correct selection of materials can be obtained from Group Research and Engineering, Sunbury

Plastics generally should not be used in direct sunlight since they may become brittle.

- 7.6.5 Armoured flexible tubes may be used for signal connections to equipment prone to vibration or movement.



- * 7.6.6 Special materials for unusual applications shall be subject to approval by BP.

7.7 Arrangement within Instrument Panels

- 7.7.1 Panels requiring instrument air shall obtain their supply from a header or distribution block within or at the back of the panel. Normally, the supply pressure is 1.5 bar (ga) (22 psig) and this shall be indicated on a suitable gauge on the panel.
- 7.7.2 The header shall be fed from two sets of isolating valves, filters, pressure reducing valves and pressure gauges installed in parallel and arranged to permit on-stream maintenance. Each set shall be capable of handling the rated load.
- 7.7.3 All supply points shall be taken from the top of the low pressure header via isolating valves. A minimum of 20% spare supply points shall be provided. The header, adequately sized to suit the duty, shall be sloped at a minimum gradient of 1:12 and fitted with a drain valve at the lower end.
- * 7.7.4 The header should be of brass or stainless steel with air connections downstream of the low pressure header as specified in 7.6.2. Materials such as nylon or plastic may be used, subject to approval by BP.

The criteria of 7.6.4 generally apply with regard to the use of plastic or nylon tubing and fittings within panels.

- 7.7.5 Low pressure in the header shall be alarmed to the appropriate operator.

7.8 Installation

For instrument installation requirements, refer to Section 4 of this Recommended Practice.

8. HYDRAULIC POWER SYSTEMS

This Section specifies BP general requirements for hydraulic power systems to be used for control systems, valve actuation, and similar equipment for wellheads and pipeline valves. It should be read in conjunction with BP Group [GS 134-1](#) Hydraulic Power Supplies.

BP Group [GS 134-1](#) specifies BP general requirements for the design, fabrication, testing and installation of hydraulic power units and the associated piping systems.



8.1 General Requirements

- 8.1.1 Each system shall be skid mounted and except for utilities and signal sources the system shall be complete. It shall be suitable for the atmosphere in which it is installed. For hazardous area installations, all electrical devices shall comply with [BS 5345](#) and BP Group [RP 12-2](#).

For equipment installed outside the UK, international or relevant national standards may apply. The engineer should make himself fully aware of any standards which may be applicable and any of the local statutory requirements for the equipment concerned.

- 8.1.2 Instrumentation within the hydraulic power system shall relate to the monitoring and control of operating conditions, which shall be as simple as possible and be the minimum consistent with the requirements for reliability and safety.
- 8.1.3 When specified by BP, a Failure Modes and Effects Analysis of the hydraulic system shall be carried out.
- * 8.1.4 The type of system, whether once-through or closed, will be specified by BP. Once-through systems should use water based hydraulic fluid.
- 8.1.5 Requirements for interfaces with other hydraulically operated surface or subsea control equipment, and with general plant or platform shutdown system, and central monitoring system shall be clearly defined, and responsibilities communicated to vendors.
- 8.1.6 The system shall be capable of operating unattended. All equipment and components shall be easily accessible for maintenance and shall have facilities to permit replacement and in situ testing without causing shutdown of hydraulic supply to the system users.
- 8.1.7 Proven equipment should be used, all of which shall be fully compatible with the hydraulic fluid.
- 8.1.8 Provision shall be made for the safe lifting and handling of a hydraulic skid module. Appropriate lifting lugs shall be provided on the skid and equipment by the vendor.

8.2 Design Objectives

- 8.2.1 The design of the hydraulic power system shall meet the requirements of equipment to be controlled; it may have to be custom designed for a specific application. A typical design should include a reservoir, filters, pumps with drivers, accumulators, regulators, relief valves and a distribution system. Liquid should be pumped from the reservoir into the accumulators which feed a hydraulic distribution system or control



equipment via pressure regulators. The pumps may be designed to cut-in and cut-out within a defined operating pressure band.

- 8.2.2 The system shall be designed to maintain a supply pressure not greater than 200 bar(ga) (2900 psig) unless otherwise approved by BP. If the control equipment requires different pressure levels, duplicated regulators in parallel configuration shall be considered, in preference to separate sets of pumps to generate the required pressure.

It is usual for hydraulic systems pressures not to exceed 200 bar(ga) (2900 psig), as in the past, problems have been experienced with umbilicals and connectors. However, higher hydraulic pressures may be necessary to increase the speed of system response, provide increased actuator torque, or to reduce actuator size where space is limited. Wellhead down-hole safety valve actuators normally require an operating pressure of at least 50 bar (725 psi) above the wellhead shut in pressure. The hydraulic power system working pressure must take this into account. Down-hole safety valve hydraulic operating pressure should be adjustable to match the fall in wellhead shut-in-pressure as the reservoir declines in order to minimise possible seal leakage. Special attention should be given to component selection at higher hydraulic pressures.

- * 8.2.3 Capacity requirements shall comply with BP Group [GS 134-1](#) and shall be subject to approval by BP.

The system capacity required is dependent on the frequency of operation, volumetric flow, minimum working pressure of individual components and the number of components in use at any one time. For continuous usage systems, constant running, self modulating full capacity pumps and sufficient accumulator storage to accommodate surge should be considered. For intermittent systems, consideration should be given to the provision of sufficient accumulator capacity to meet a specific short term demand, with auto start pumps sized to recharge the system in a given time.

- 8.2.4 A dynamic hydraulic analysis shall be carried out in all cases where speed of valve operation to open or to close is critical. Typical examples are: Wellhead valves, BOP valves, Diverter Valves or Shear Rams.

The Analysis should include details of hydraulic fluid flow and control line and component pressure drops.

- 8.2.5 Hydraulic circuits shall be kept free from air, water and dirt, to provide reliable safe performance. Provisions shall be made to permit air bleeding of the system. System filters shall be located to protect components. Adequate drainage and sampling provision shall be made.

Hydraulic cleanliness is of prime importance. Specific measures should be taken during construction to prevent dirt ingress by capping pipework and ensuring that assembly is carried out in a clean environment.



Full system flushing, to a cleanliness level dependent on the dirt tolerance of the system's components, should be carried out at the vendor's works for panels and modules, and again on site when the system is installed. Off-line filtration facilities should be considered in order to allow cleanliness levels to be maintained in service. The cleanliness levels required should normally be specified, e.g. [NAS 1638](#), Class 6 or [BS 5540](#) : Part 4, Code 15/12.

The prevention of water ingress is relevant on systems located out of doors, particularly in marine environments. Provisions should be made to prevent water ingress into system components and into the reservoir by breathing. The prevention of water ingress by breathing can be minimised by the use of a desiccant breather in the vent. Also, the reservoir tank should be designed to allow the draining of water which permeates into the system.

- * 8.2.6 Parameters to be monitored shall comply with BP Group [GS 134-1](#).

In some cases, flow metering is required for fluid supply to subsea umbilicals. For water based fluids, additional measurements are required. The measurements and remote indications required for each application will be specified by BP.

For low and extra low level in a reservoir (alarm and subsequent pump cut-out), the reservoir should be sized to allow time for operator intervention between the reservoir low level alarm and trip points.

There should be sufficient accumulator capacity to allow shutdown of the plant in a controlled manner following a hydraulic pump trip on reservoir extra low level.

For low and extra low supply pressure (alarms), the extra low system supply pressure sensor may be required to initiate plant shutdown before unprogrammed shutdown occurs.

- * 8.2.7 In general, the hydraulic system shall utilise an open vented type stainless steel reservoir from which liquid is drawn. The vent shall include a filter and a breather desiccator. The pumps shall be fed by adequate gravity head. Closed type systems using inert gas for purging and pressurisation or other air exclusion systems shall be subject to approval by BP.

- 8.2.8 Redundant components such as dual regulators and stand-by pumps should be provided to enhance overall system reliability.

No single fault shall prevent operation of the system or cause shutdown of the control equipment fed by the hydraulic power supply.

8.3 Design Considerations for System Components

- * 8.3.1 Hydraulic Fluid and Material Compatibility



The type of hydraulic fluid and any additives used (e.g. biocidal additives, viscosity index improvers, oxidation inhibitors, corrosion and rust inhibitors, metal deactivators, anti-wear and load carrying agents and foam inhibitors) shall be subject to approval by BP.

The use of additives in the hydraulic fluid is a very specialised subject; professional advice on this should be taken from the appropriate Department within BP.

Materials shall be suitable for use with the selected hydraulic fluid, associated additives and where necessary, with sea water contamination. The fluid may be mineral oil or water and glycol based according to the application. O-rings, gaskets and seals in particular shall be compatible with the hydraulic fluid employed.

To minimise the effect of temperature change on viscosity, fluid should have a high viscosity index.

Stability of the hydraulic fluid with respect to its resistance to oxidation shall be considered when selecting a fluid. The basis for selection shall include such considerations as component clearance, leakage, operating temperature, pressure range and its fire resistant characteristics.

* 8.3.2 Reservoir and Mixing Tanks

The reservoir tank shall have adequate capacity for supply and operation of the control equipment without frequent replenishment. The precise requirement for each application will be specified by BP.

The reservoir should be cylindrical and shall be made from stainless steel to avoid scaling. The following facilities should be provided in addition to the requirements of BP Group [GS 134-1](#):-

- (a) Block valves on the armoured type gauge glass.
- (b) Vent valves.
- (c) Sampling facility on the drain connection.
- (d) Sloped or coned base to facilitate drainage.

The capacity of the reservoir shall be sized such that the operating volume between the normal maximum and normal minimum levels shall hold the complete control system capacity plus 20%, or such additional spare capacity as specified by BP.

The capacity required for subsea umbilical filling shall be excluded. However, allowance shall be made for the vent volume on depressurisation of the umbilical.



Return and suction connections on the reservoir shall be adequately separated to maximise settling and cooling. The return line shall terminate so that it is submerged at all times. No drains shall be returned to the reservoir.

If the hydraulic fluid selected is a water based fluid, a stainless steel mixing tank shall be provided. A mixing system shall be included to ensure correct mixing of the various proportions of the constituents. Steps shall be taken to ensure the cleanliness of fluids during mixing.

Where mineral oil is used, it shall be contained and circulated within a closed system. On-line filtering facilities shall be provided. Where fluid contamination is possible (e.g. subsea or wellhead applications) a separate return tank upstream of the reservoir should be provided. Returned fluid should be transferred from the tank to the reservoir via filters, coalescers and degassers as necessary, to ensure fluid quality in the reservoir meets the control equipment manufacturer's specifications.

Foreign bodies (metals, plastics and rubber) due to mechanical wear and tear in control equipment, actuators, hoses, piping and fittings may be expected in returned fluid; particularly as a system ages. Sea water contamination can occur following degradation of subsea umbilical hoses, connectors and seals. Crude oil or gas contamination can occur due to failures at high pressure downhole valves. Such contamination can seriously damage hydraulic systems.

For these reasons the relative merits of once through sea-water systems versus closed oil based systems must be addressed. The practical difficulties in maintaining the necessary fluid purity in closed systems should not be underestimated.

* 8.3.3 Pumps and Drivers

Electrically driven pumps should be used for the generation of hydraulic pressure. Unless otherwise specified by BP, the minimum requirement is for one duty pump and one stand-by (selectable). Other additional pumps may be required (e.g. diesel, hand or air driven).

For non-critical applications only, BP may specify a single pump to save space, weight and installed cost.

Each pump shall be sized to recharge the system at a rate to be specified by BP.

Basic controls on the pump drives shall be as follows:-

- (a) Selector switch for duty and stand-by.
- (b) Stop and start controls for each pump.



- (c) Automatic cut-in and cut-out to maintain pressure within a band, to be subject to approval by BP.

Automatic cut-in and cut-out of the pressurising pump should only be considered where the system is used for intermittent service.

- (d) Reservoir extra low level cut-out; restart shall require manual reset.

Pumps shall be capable of individual isolation. The drive couplings and mountings of pumps and drivers shall be designed to allow easy removal.

8.3.4 Accumulators

In addition to the requirements of BP Group [GS 134-1](#), the following shall apply.

- (a) The accumulator(s) should be of the hydro-pneumatic bladder type, manufactured from seamless chromium-molybdenum steel free from welds and joints. The charging medium shall be nitrogen. Hydro-pneumatic bladder type accumulators are not recommended where high frequency operation would result in high wear rates. Manufacturing specification shall be in accordance with [BS 5045](#). The bladder shall have low permeability in accordance with [BS 903](#) : Part A30.

Inspection and testing of the accumulator shell shall be carried out to the satisfaction of an independent inspection authority appointed by BP, any statutory authority, or both, as may be required. The inspecting authority shall certify that the shell complies with the requirements of the design code.

- (b) The accumulator(s) shall be fitted to the common pump discharge manifold with individual isolation and drain. The capacity within a defined pressure band (see 8.2.3) shall be sized in accordance with the requirements of BP Group RP 30-3 Section 2 (which refers to the number of operations of actuated valves).
- (c) Based upon the maximum hydraulic demand as determined in 8.3.4(b), the accumulator pressure shall not be permitted to drop below a minimum pressure required to operate the control equipment.

- (d) Facilities shall be provided to safely check and re-charge the accumulator(s) nitrogen precharge.
- (e) All accumulators shall be provided with a pressure relief valve.



8.3.5 Filtration Equipment

In addition to the requirements of BP Group [GS 134-1](#), the following requirements shall be met:-

- (a) Screen filters shall be used at each pump suction.
- (b) Duplex filters should be provided before the distribution system; the size of filter element being dictated by the cleanliness requirements of system concerned.
- (c) Screen filters shall be used on the reservoir filler caps; mesh size shall be a minimum of 200 microns.
- (d) Factors to be considered for the installation of filters shall include the following:-
 - (i) Service and condition of operation.
 - (ii) Hydraulic fluid flow-rate.
 - (iii) Type of hydraulic fluid and its viscosity.
 - (iv) Type and probable amount of contamination.
 - (v) Type of hydraulic components.
 - (vi) Location for easy filter element removal.
- (e) Types of filters shall be chosen to permit ease of element replacement and cleaning.
- (f) Isolation and depressuring valves shall be fitted to allow safe removal of an element without draining down pipework. Drip trays shall be provided where necessary.

Isolation for duplex installations shall permit element removal without causing main distribution system pressure loss or shutdown.

8.3.6 Regulators

Regulators should be the self-acting type.

8.3.7 Relief Valves

A relief valve shall be installed on the discharge of each pump. Additional relief valves may be required in other parts of the system. Relief shall return directly to the reservoir without isolation or restriction. Thermal relief valves are required for sub-systems in which the liquid can be blocked-in.



8.3.8 Coolers

Where coolers are supplied as part of a packaged unit they may be to the vendor's standards, providing the vendor can demonstrate the type of cooler has been proven under a similar application.

8.3.9 Tube and Fittings

Stainless steel tube and fittings conforming to the requirements of BP Group [GS 134-1](#) should be provided for all system pipework. Compression fittings shall be applied and installed strictly in accordance with the fitting manufacturers instructions. Flexible hoses should only be used where it is necessary to allow for relative movement between components.

8.3.10 Local Control Panel

A local control panel shall be provided as an integral part of the hydraulic power supply unit.

The panel shall provide local control and monitoring of the hydraulic power supply operation. The functions controlled and monitored shall include the following:-

- (a) Pump start and stop controls.
- (b) Parameters defined in 8.2.5.

All alarms shall be in accordance with Section 2 of BP Group [RP 30-5](#) this and shall be capable of being repeated to a remote control centre.

All cables shall be logically grouped, segregated and terminated in skid mounted junction box(es).

Tube shall be terminated in bulkhead fittings at a common location. All terminations shall be capped for shipment to prevent ingress of dirt or moisture.

A removable gland plate may be required for cable entries into the panel, to enable cables to be directly connected to the junction box(es).

8.4 Safety

8.4.1 Safety design shall comply with all applicable national regulations and BP Group Recommended Practices and Specifications for Engineering.

8.4.2 The design and installation shall ensure safe operation during normal and abnormal circumstances and permit safe maintenance.



- 8.4.3 Particular note shall be taken of the high pressures involved.
- 8.4.4 Appropriate warning notices shall be displayed prominently adjacent to the storage accumulators.
- 8.4.5 High pressure discharges and relief points shall be protected and piped to a safe point.
- 8.4.6 The hydraulic fluids used may be potentially toxic or irritant. Provision shall be made for safe storage, handling, mixing and drainage. Drip trays and open grating flooring shall be provided where appropriate.
- 8.4.7 Measures necessary for safe operation and maintenance shall be included in the relevant manuals. This shall include any precautions necessary due to fluid toxicity.
- 8.4.8 Pressure gauges shall be in accordance with BP Group RP 30-2 Section 3.
- 8.4.9 To avoid insulation degradation, electrical cabling should not be run in close proximity to components containing oil based hydraulic fluids. Drip covers shall be provided where applicable.

8.5 Performance Tests

- 8.5.1 To demonstrate that all equipment functions are according to specification, complete performance tests shall be carried out at the vendor's works and witnessed by BP. The tests shall include a full system pressure test. A detailed test procedure and programme shall be submitted to BP at least 3 weeks before testing commences. System documentation and certification shall be available for inspection during the acceptance test.

Hydraulic systems are usually custom built. The inspection engineer should ensure that all components and functions are tested under normal operating conditions.

For pressure testing, the test pressure is normally 1.5 times the maximum working pressure; this pressure should be held for at least one hour without loss. Some equipment may need to be isolated during this test to prevent overpressurisation damage.

The system should be thoroughly flushed and filtered to the required cleanliness level before function tests are carried out. Fluid samples should be checked by particle contamination measurement.



8.6 Documentation Requirements

- * 8.6.1 BP will specify documentation to be submitted by the vendor. The documentation, which shall include the following items, will be subject to approval by BP:-
- (a) Schematic Piping and Instrument Diagram for the complete hydraulic power system.
 - (b) General Arrangement of the complete hydraulic power system, including the control panel.
 - (c) Detailed drawings showing sizes of pumps, tanks, accumulators, and all the mechanical items of 8.3.
 - (d) Material specifications and certificates.
 - (e) Calculations and relevant sizing details.
 - (f) Hook-up, wiring and termination diagrams.
 - (g) Detail layout of the local panel.
 - (h) Test programme.
 - (i) Commissioning procedures.
 - (j) Operating and maintenance instruction manual.
 - (k) Certification documentation.

9. CONTROL PANELS

This Section specifies BP general requirements for control panels.

9.1 General Requirements

- 9.1.1 This Section applies to control panels containing instrumentation and associated equipment. Totally enclosed, ventilated and open forms of panel are covered. The requirements also apply to cubicles and non-proprietary equipment cabinets.
- 9.1.2 Control panels shall conform to [EIC Specification CCI P/3](#), with the additions and exceptions identified in this Section of the Recommended Practice.



The EIC (Energy Industries Council) [Specification CCI P/3](#) is very specific in many aspects of design, construction and inspection. It also contains statements of significance to procurement, packing and shipping.

- * 9.1.3 The type of control panel for each application and its size and layout shall be subject to approval by BP.

It is desirable that BP specifies the operating policy, basis of design and provisional layout and size in contract documents. This is particularly important for an extension to an existing facility to ensure conformity in operator and maintenance facilities. Space for project development and future expansion should be considered.

Account should be taken of the average height of operating and maintenance personnel as this varies significantly world-wide.

- 9.1.4 The requirements for alarm systems are detailed in BP Group [RP 30-5](#).

- 9.1.5 The requirements for digital systems are detailed in Section 2 of BP Group [RP 30-4](#).

Equipment covered by this Recommended Practice may interface with distributed control systems, telemetry equipment, or computer systems. BP should properly identify suppliers responsibility at each interface, including compatibility of equipment.

9.2 Selection of Control Panels

9.2.1 Basis of Design

Control panels may be self contained or supported by auxiliary equipment cabinets. Equipment cabinets may be remote from the operational area, provided that an overall economic benefit (e.g. space saving, environmental factors) is shown and maintenance operations are not impeded.

The design and location of control panels shall permit maintenance while the associated plant is in operation.

Control panels and auxiliary equipment shall be isolated from plant structural vibration.

Control panels located outside control buildings shall be protected from the environment. This protection shall extend to cover maintenance operations (e.g. open doors).

The level of necessary protection from the heating effects of direct sun should be assessed.



On-plant control panels shall be supplied as a free standing assembly supporting the instrumentation and related equipment.

Panel design should take account of transportation and site handling, such as structural strength, lifting arrangements, size and weight.

Panels containing instruments directly connected to process fluid shall be arranged to ensure that other equipment in the panel is not damaged by leakage or spillage. Instruments and associated piping containing process fluid, shall be mounted only in freely ventilated cubicles or open panels.

Control panels and equipment shall satisfy the electrical area classification of the location. The 'Exp' form of protection should not be used.

In some locations, notably on offshore platforms, equipment is specified for the expected area classification. However, under some emergency conditions (such as failure of a purge system or a red shutdown) the area may be more hazardous than that for which the equipment was originally designed.

In these circumstances, it is normal to power-down electrical equipment which is unsuitable for operation in the increased hazardous environment. However, some equipment may be required to operate in this environment. The designer should ensure that in this case, the installed equipment is suitable for operation under the more stringent conditions.

Large air purged or pressurised enclosures are difficult to seal effectively, particularly in the longer term, due to gasket wear, distortion or mechanical damage. They also create difficulty for maintenance access and may require a purging period before equipment may be re-energised.

The affect to operations of purge failure should be taken into account. This is true for automatic purge protection systems as well as advisory systems.

9.2.2

Layout

Individual plant areas should occupy separate areas or sections of the panel. Each area should be identified by a bold nameplate mounted in the top section of the panel.

Instruments shall be grouped in relation to their application in the plant.

Controls initiating shutdown action shall be located in an easily identified and accessible position. They shall be arranged to minimise the risk of accidental operation.



9.3 Panel Assembly

* 9.3.1 Construction

Control panels shall be adequately ventilated. Calculations shall be carried out by the vendor/contractor to establish whether fan assisted ventilation or HVAC is required. Ventilation provisions shall be subject to approval by BP.

If forced ventilation is considered, the designer should carefully assess the implications of fan failure or fan power supply failure. If a fan is necessary to remove heat, can the instrumentation reliability monitor and control the plant when the fan or fans stop? Redundancy in both fans and fan power supply should be addressed.

Overheating is one of the main causes of failure of electronic equipment. The importance of adequate ventilation cannot be under estimated.

The level of environmental and personnel protection will be specified by BP in accordance with Appendix A of [BS 5345](#): Part 1.

The designer should consider the cost and technical merit of some form of shelter to protect a field panel, as an alternative to a high category of protection for individual instrument enclosures.

Panels shall be constructed with lifting points capable of supporting the panel, including installed instruments, cables, piping, etc. Lifting bars should be provided, where necessary, to protect panel or equipment.

* 9.3.2 Painting of Panels

The exterior colour, the surface finish and the painting specification shall be subject to approval by BP.

Economic factors should be considered when specifying the colour of a panel. It may be more economical to select a colour to match or complement other equipment within a control room (e.g. equipment racks) rather than have each item painted to a specific colour.

Paint batch and surface texture variations sometimes result in a significant mismatch between equipment from different suppliers.

The exterior colour of panels for installation in a control room should be co-ordinated with the control room colour scheme.

9.3.3 Piping and Tubing

The selection of materials for impulse piping shall be in accordance with BP Group [RP 42-1](#).

Instrument air systems shall be in accordance with Section 7 of this Recommended Practice.

EIC Specification CCI P/3 calls for polyethylene tubing as standard. The designer needs to specify copper, sheathed copper or stainless steel, if required.

* 9.3.4 Electrical Wiring

Electrical isolation requirements for maintenance will be specified by BP.

Earthing shall be in accordance with Section 5 of this Recommended Practice and subject to approval by BP.

Power supplies and distribution to instrumentation and ancillaries shall be in accordance with of BP Group [RP 12 Part 5](#), and Section 6 of this Recommended Practice.

There shall be a separately switched and fused power sub-circuit for each functional loop. Redundant equipment shall be independently switched and fused.

Terminal blocks shall be of the slot headed screw clamp type. They should incorporate a built-in disconnect facility. Stranded conductors shall be terminated using an approved crimped connector.

Power supplies and distribution to panel heating and lighting shall be independent of the instrumentation system. They shall be installed in accordance with BP Group [RP 12](#). Lighting and heating shall operate safely during instrument maintenance operations. BP will specify where panel heating is required.

* 9.3.5 Nameplates

Each item of equipment shall be identified by a nameplate attached to the panel or to the panel frame by screws. Other permanent methods of attachment may be used subject to approval by BP. Nameplates shall be consistent with information in the plant operation and maintenance manuals.

Size and colours of both text and background should be requested on the schedule of labels submitted to BP for approval. Distance of



reading, colour contrast, lighting and ease of cleaning should be addressed during the selection process.

Indicators and recorders not scaled in engineering units shall be fitted with nameplates stating the scale range in engineering units.

For identification when removed from the panel, all equipment shall have a removable nameplate attached giving the tag number.

9.4 Drawings and Documentation

Drawings and documentation shall be in accordance with BP Group [GS 130-3](#).

9.5 Inspection and Testing

Inspection and testing shall be in accordance with BP Group [GS 130-3](#).

9.6 Installation

Reference shall be made to Section 4 of this Recommended Practice for details of panel installation and local lighting.

10. CONTROL BUILDINGS

This Section specifies BP general requirements for control buildings.

10.1 General Requirements

10.1.1 A control building shall be provided wherever remote instrumentation is required to be grouped. Such a building shall provide appropriate environmental protection for the instrumentation and operators. The instrumentation shall be suitable for the area classification of the building, determined in accordance with BP Group [RP 44-6](#).

For offshore applications, areas within modules or rooms shall be provided conforming to the above.

This Section of the Recommended Practice covers the requirements of control buildings in relation to Instrumentation. Other factors such as office accommodation, facilities for personnel and safety equipment need to be addressed in relation to the building as a whole (see BP Group [RP 4-4](#) - Buildings).

10.1.2 The control building may accommodate one or more of the following functional areas:-



- (a) Remotely located, continuously manned control centre (remote control centre or process control centre).
 - (b) Locally located, continuously manned control room.
 - (c) Local, unmanned control room.
 - (d) Equipment room.
 - (e) Computer room.
- * 10.1.3 The choice of control building type shall depend on the type and complexity of the plant and its instrumentation. This shall be subject to approval by BP.
- External factors, such as proximity to plant, may dictate the method of construction. The control system designer should consult with process plant and civil/buildings designers and the operator (or his representative) to establish an overall economic policy for the size, location and method of construction of control buildings on a project. The basis of design should then be stated in the Statement of Requirement for the project.*
- * 10.1.4 Land based control buildings shall be located according to BP Group [RP 44-7](#) and constructed to BP Group [RP 4-4](#).
- For offshore applications, location and construction will be specified by BP. The functional requirements shall conform to BP Group [RP 4-4](#).
- 10.1.5 The design of control buildings and rooms shall make provision for any future requirements specified by BP.
- * 10.1.6 Prefabricated control buildings and houses may be used, subject to approval by BP.
- The use of prefabricated control buildings is acceptable to BP providing they give adequate protection to equipment and personnel and can be demonstrated to be cost effective.*
- 10.1.7 Reference shall also be made to [BS 6739](#) and [API RP 550](#) Part I Section 12.
- 10.2 Layout**
- 10.2.1 Layout shall conform to the requirements of BP Group [RP 4-4](#). Equipment shall be located so as not to impede escape routes for personnel.



Early consideration should be given to the location of equipment not forming an integral part of the main system, but closely associated with it. Examples are fiscal measurement equipment, VDU's (Visual Display Units) for tank gauging, maintenance systems (Teroman) and fire and gas monitoring equipment.

- * 10.2.2 A minimum unobstructed passage way of 2000 mm (6 ft 6 in) shall be provided in front of operator controls. This spacing may be relaxed in local control rooms, subject to approval by BP.

This spacing is based on normally manned control centres, where more than one operator plus maintenance technicians may be present. It may be reduced in unmanned, or infrequently manned control centres, or in relation to the manning expected.

Most manufacturers' documentation gives advice on layout and space requirements. Particular attention should be given to handling existing or new equipment modules during removal and installation operations. This should include the size and layout of passages and doorways.

Facilities for instrument maintenance should be considered (e.g. space for hot standby spares racks, test equipment storage, manuals/operating instructions, magnetic program disk/tape storage)

- 10.2.3 Access for maintenance operations and removal of equipment shall be provided. Where panels or racks have doors, there shall be access past them when they are open.

- 10.2.4 Provision shall be made in control rooms for a supervisor's desk or console, as specified by BP.

- 10.2.5 Provision shall be made for communications equipment (e.g. telephone, radio, loud hailer) on operators and supervisors desks and consoles, offices and equipment areas as appropriate to the application.

Requirements for communications equipment should be specified early in the design to ensure adequate space is provided on consoles/panels and in equipment areas.

10.3 Heating, Ventilation and Air Conditioning (HVAC)

- * 10.3.1 Where an HVAC system is required, then the installation shall be in accordance with BP Group [RP 4-4](#) and BP Group [RP 14-2](#). BP will specify general requirements which shall include the following design factors appropriate to the operation and maintenance of control equipment:-

- (a) Heat removal from equipment.
- (b) Dust removal.
- (c) Humidity control.
- (d) Personnel comfort.



- (e) Any chemical filtering that is necessary.
- (f) Fire and gas monitoring and protective control actions. (See 10.9).

It should be noted that different parts of the building may have different requirements in terms of acceptable variations in the environment, based on the tolerance of individual installed equipment. To provide a high quality environment for the whole building may not be cost effective.

It may be necessary to include automatic protective action (e.g. remove power for uncertified equipment) should flammable or toxic gas be detected at the air inlet.

- 10.3.2 Special attention shall be given to the reliability and quality of the environmental control to ensure that it is entirely suitable for the installed equipment.

Particular measures should be taken to ensure that on HVAC failure, the heating effect of installed equipment does not raise the ambient temperature above manufacturers' specified limits, which may result in control system failure and plant shutdown.

10.4 Pressurisation

Where pressurisation of a control room and building is required for reasons of hazardous area certification, requirements shall be in accordance with [BS 5345](#): Part 5 and any national or local authority regulations.

10.5 Analyser Houses

- 10.5.1 These shall be in accordance with BP Group [RP 30-2](#) Section 7.

10.6 Lighting Levels

- 10.6.1 Operational areas of control rooms should have lighting intensity of 500 lux, uniformly distributed, unless subdued lighting is required for front of panel. If subdued lighting is provided, it shall be possible to continuously vary the lighting intensity up to 500 lux from a single control.

- 10.6.2 Other areas shall have a lighting intensity and distribution consistent with access and maintenance operations. (Minimum 300 lux (average)).

It is not practical to define lighting levels universally. The designer should review the requirements on an individual basis.

- 10.6.3 Where VDUs are installed, glare shields shall be fitted to reduce the amount of light which can fall on the VDU screen.



- 10.6.4 Emergency lighting supplied from its own batteries shall be provided.

10.7 Power Supplies for Test Equipment

- 10.7.1 Power outlet sockets, at a voltage of not more than 125 V, shall be provided within 3000 mm (10 ft) of all installed instrumentation. This shall apply to equipment racks, control panels and consoles.

- 10.7.2 Sockets shall be supplied from the non-essential distribution system. They should not be derived from the instrument Class A or Class B supply.

- 10.7.3 Installation shall conform to BP Group RP 12 with precautions taken (e.g. plug format) to ensure that only the correct voltage equipment may be connected to the power supply.

10.8 Cabling

- * 10.8.1 Routing of instrument power supply, signal and communications cables into and within control buildings and equipment rooms shall be shown on a layout drawing which shall be subject to approval by BP. This shall include details as to the size and quantity of cables in relation to entry points, cable tray and termination points, segregation of cable types, the order in which they will be laid and facilities provided for future expansion of the system.

Generally, signal cabling is run below a computer floor. The height of this floor and its support beams should be reviewed in relation to the quantity of cabling below and the ease of cable pulling and stripping. The size and number of cable entry points should be carefully addressed, particularly in relation to any requirement for future plant expansion.

- 10.8.2 Cable installation should be consistent with the design and support arrangement of the computer floor.

10.9 Fire and Gas Monitoring

- 10.9.1 Fire and gas monitoring, protective control actions and locations of control panels shall as a minimum requirement meet local and national authority codes, standards and regulations. Any additional requirements will be specified by BP.

Requirements for fire and gas monitoring and associated protective actions are often included in local and national regulations applicable at the particular location. Specialist advice should be obtained from a BP or external consultant when specifying equipment.



Consideration should be given to additional fire monitoring and protection at unmanned buildings or rooms, particularly where expensive equipment is located or where loss or damage could result in extended downtime. Fire detection in cable voids may be desirable.

- 10.9.2 Equipment and installation shall comply with BP Group [RP 30-5](#) Section 4.

11. INSTRUMENT DATABASE SYSTEMS

11.1 Objectives

- 11.1.1 The design and configuration of instrumentation and control systems requires that large amounts of data are generated and manipulated. A computerised instrument database system shall be used, either as a stand-alone package or integrated into other design systems to handle this data in an efficient manner.

- 11.1.2 The functional requirements of an instrument database shall be fully specified prior to setting up the database and entering data into it. The functional specification shall cover every stage of the project, from design through to operation and maintenance, in which the system is to be applied.

Refer also to BP Group [RP 30-9](#) for minimum specification requirements.

- 11.1.3 The database system shall minimise the man-hours required for basic design work by automatic data transfer and generation of instrumentation documentation.

- 11.1.4 The database system shall interface effectively with other systems used on a project in order to minimise any requirement for manually entering duplicate data into different systems.

There may also be a requirement to interface to the operators maintenance management system

- 11.1.5 The database system shall improve the quality and consistency of documentation by reducing the errors due to manual data transfer, and automatically checking for discrepancies.

- 11.1.6 The database system shall maintain the data in a secure condition, and provide a reliable record of updates and revision changes.

- 11.1.7 The database system shall function as a flexible design tool. The actual design produced shall not be dictated by limitations of the database system and associated design packages.



In some cases the application of an integrated instrument database package, CAD package and DCS configuration system has been found to hinder the design process and restrict the final design produced. This has particular relevance to re-instrumentation projects where the design packages may for example make assumptions about field cabling and marshalling arrangements which are not compatible with the existing plant installation.

11.2 Selection of System

11.2.1 Selection of the type of system required shall consider both the type of project on which it is to be applied and the manner in which the project is to be executed.

Projects in which an instrument database is required can range from a small re-instrumentation project on a single plant executed by a BP on-site team, to a new offshore development implemented by a major contractor. The data required, the users of this data and the data flow within the project will differ significantly between these two extremes. A significant consideration is the requirement for transfer of data to the operator at the end of the project.

Most sites will have a maintenance system already in place (frequently 'TEROMAN' or similar purpose built system), and it is important that information stored in the instrument database can be easily transferred into this site facility rather than the database itself offering a parallel maintenance utility.

11.2.2 The main options to be considered are:-

- (1) The use of a fully developed proprietary instrumentation database package.**
- (2) Use of a contractors 'in-house' system specifying particular BP requirements.**
- (3) The use of a general purpose database package such as 'dBase' to create a database tailored to meet specific project requirements.**

Option 1 may prove to be expensive depending on the system selected and the size of the project. A contractor may be reticent to have a proprietary system imposed on him depending on the in-house system which is usually used in his offices.

Where Option 2, a contractor's system is used, the BP requirements must initially be fully specified to the contractor. Some of the advantages of using a computerised database system will be lost if incompatible or paper systems are used when the design is completed and the project moves from the contractors office into the construction, commissioning and maintenance phases.

Option 3, a general purpose database package, may provide a suitable solution, especially for smaller projects. The ability of such a system to interface with other packages, the possible need to write interface routines, and the possible need for

some in depth knowledge of the database language should however be carefully considered.

- 11.2.3 Consideration shall be given to the hardware platform on which the system will run, and in particular the compatibility of the hardware with existing site systems if the database is to be handed over to the operator on completion of the project.

Preference within BP is for the use of DEC VAX equipment or IBM compatible personal computers. The use of IBM PC based systems provides maximum system flexibility. For medium sized multi-user systems the use of networked PCs should be considered. A typical system could consist of a number of PCs on a 'Novell' network with one or two PCs acting as file servers with hard disk and possibly optical disk drive file storage.

- 11.2.4 Hardware requirements for production of documentation shall be fully established.

Consideration should be given both to the style and quantity of documentation required. Laser printers produce better print quality at a higher speed than dot matrix printers. Reports may be required in both landscape and portrait format. Reports may require paper sizes great than A4 size. Plotters may be required for the production of drawings.

11.3 Functional Requirements

- 11.3.1 The database system functional requirements shall be fully defined at the start of the project. A statement of requirements shall be prepared to ensure that any system offered by a contractor will meet these functional requirements. The following points must be addressed when defining the functional requirements:-

- 11.3.2 The amount of data to be entered into the database. Where a large number of tag numbers are to be entered into the system it may be more efficient to divide the database into a number of sub-directories. Where sub-directories are required, a coherent database structure shall be maintained. The need to change the same fields in several sub-directories shall be avoided.

Sub-division may be necessary if the amount of data produces too slow a response on the hardware to be used or if the database is to be used in different physical locations. Division may be by process module, physical location, or possibly into divisions such as field, control room, DCS and supervisory system data.

- 11.3.3 The format of data to be entered into the system. The tag numbering system to be used requires careful consideration. The use of separate data fields for each part of the tag number i.e. plant number, instrument identifier, loop number, suffix etc. will facilitate the manipulation and sorting of data records.

In some cases the standard ISA format may prove to be adequate. Alternatively the tag numbering system may have to conform to existing plant or site standards. Particular care must be taken when the project consists of a number of modular or packaged units. The option in this case is for the package vendor to supply the tag numbers and a package prefix to be added, or the design contractor to supply the tag numbers to the vendor. Care should be taken where the instrument database is merged with an overall equipment database that non instrumentation items such as HVAC equipment are not given a numbering system that conflicts with the instrument tag numbering system.

- 11.3.4 Data fields that will be required. This should include field name, length, alphabet or numeric input, syntax or arithmetic checking and source of the data.
- 11.3.5 Data output requirements. This should include the requirements for standard or free format reports and the requirement for the generation of documents such as instrument specification sheets, loop drawings, hook-up drawings, and termination schedules.
- 11.3.6 Data transfer requirements. This should especially consider the requirements for transfer of data for purposes such as DCS configuration and any interface with CAD systems.
- 11.3.7 Access and security requirements. This should consider the users of the system, their physical location, and overall management of the system to maintain the integrity of the data entered on the system.

11.4 Data Entry & Manipulation

- 11.4.1 The facilities available for manual data entry on a database system will have a significant effect on the accuracy and speed of data input. Typical features which should be available are:-

Default from reference data, which can be overwritten in individual records when required.

Selection of data from look-up tables.

Duplication of previous entry, including repeat of whole previous record or dummy record.

Ability to globally change given fields in selected records.

Ability to copy blocks of database records.

Help screens to define input requirements.

The ability to copy blocks of database records is particularly applicable where a plant consists of a number of identical process trains.

- 11.4.2 The database system shall provide error checking when data is entered. Typically checks should include:-

Field length over run.

Repetition of a unique identifier e.g. tag number, DCS slot etc.

Syntax check (Alphabet fields).

Arithmetic check, value within range (Numeric Fields).

- 11.4.3 The database system shall provide facilities for sorting data records into sub-sets of the database by sorting on specified fields. The sorting facility should allow the use of conditional functions such as AND, OR and NOT. The system shall provide a count of the number of records which have fulfilled the sort requirements. Typical fields on which the database may be sorted could include:-

Tag Number

Part of Tag Number e.g. area code

Loop number or part of loop number

Instrument type

DCS equipment location

Requirements for database sorting may include several conditional sorts. e.g. sort for a specified instrument type within a specified plant area.

- 11.4.4 To enable full use to be made of sorting facilities, data shall be entered in a consistent manner. This requirement shall be particularly observed when data is entered by a number of users, who may be in different physical locations.

An example of this would be in entering instrument type. If the description for a differential pressure transmitter is entered in different forms such as 'DP cell', 'DP transmitter', 'Diff Press TX' or 'DP TX' then the sorting process will have to search for all variants of this description.

- 11.4.5 The database system shall provide the facility to order tag numbers both numerically and alphabetically on the part of the tag number specified by the user.



For example the database may be ordered numerically on the plant prefix part of the tag number, then alphabetically on the instrument identifier part of the tag, then numerically on the loop number.

- 11.4.6 When the system takes a significant time period to manipulate data, the user should be provided with indication that processing is in progress and an indication of the progress in completing the task.

11.5 Data Transfer

- 11.5.1 Requirements for data transfer shall be fully defined at the start of the project. This should include requirements for data transfer between DCS configuration systems, CAD systems, other design database systems, systems used by vendors, contractors, and plant operators.
- 11.5.2 The method of implementing these transfers shall be defined, considering whether they will be carried out via a modem link, local area network, or using storage media such as magnetic tapes or disks.
- 11.5.3 Where possible data transfers shall be carried out automatically when required. This will ensure that systems do not become out of step due to data transfers not being manually initiated at the correct time.
- 11.5.4 All data transfers shall be tested with dummy data at the time the system is initially set up. This will prevent the possible need to re-enter data in a different format should data transfer be found not to be successful.
- 11.5.5 Any requirement for holding transferred data in a separate file for checking prior to merging with the main database shall be considered.

11.6 Security

- 11.6.1 Security and control features shall be provided to protect the data within the database. The extent of these features will depend on the size and nature of the project.
- 11.6.2 A number of different access levels may be provided to control access to different facilities and different areas of the database.
- 11.6.3 Each user may have a unique identity and password which is recorded against any changes that he makes.
- 11.6.4 A user should be granted access only to those facilities which he needs to use, and only to those areas of the database which he is involved in. 'Write protection' may be required for specific database fields.



- 11.6.5 A revision logging system for all data changes is essential. This may include logging the identity of the user making the change and the reason for the change.
- 11.6.6 The system shall provide reports detailing all changes made in a specific period, all changes made by a specific user, and all changes relating to a specified drawing or item of plant.
- 11.6.7 The database should be backed up on a regular basis. These backups should preferably be initiated automatically by the system. In the event of total system failure it should be possible to fully recover the system from these backups.
- On smaller applications this may involve backing up on to magnetic floppy disks or tapes. For larger networked applications it may be more efficient to use a number of file servers with hard disks or optical disk drives.*
- 11.6.8 Security procedures shall address the possibility of transfer of computer 'viruses'. Consideration shall be given to the use of 'sweep' programmes when data is transferred between systems.

11.7 System Maintenance

- 11.7.1 Overall control of all database activities shall be exercised by a single person such as a 'system manager' or 'data co-ordinator'. This should not be a primarily technical system function but should be carried out by an individual with an understanding of the application of the system within the project. This person shall be responsible for the integration of data from different sources and the transfer of data between the database system and other systems.
- 11.7.2 Consideration shall be given to the support and maintenance requirements of the database system throughout the lifetime of project. This will require particular consideration if it is intended to hand the system over to the operator at the operation and maintenance stage of the project.
- 11.7.3 An engineer with in depth knowledge of the database system language shall not be constantly required to maintain and support the system. The availability of the specialist technical support which may be required on an occasional basis should however be reviewed.

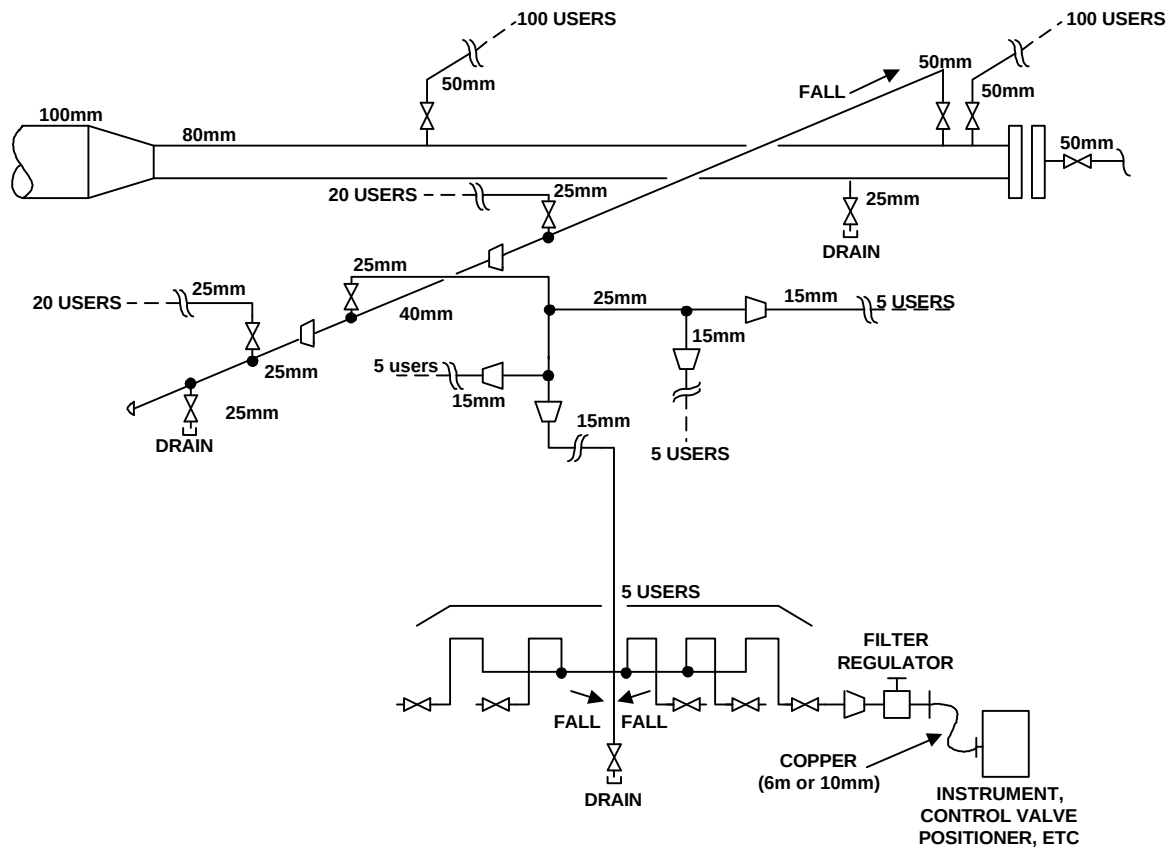
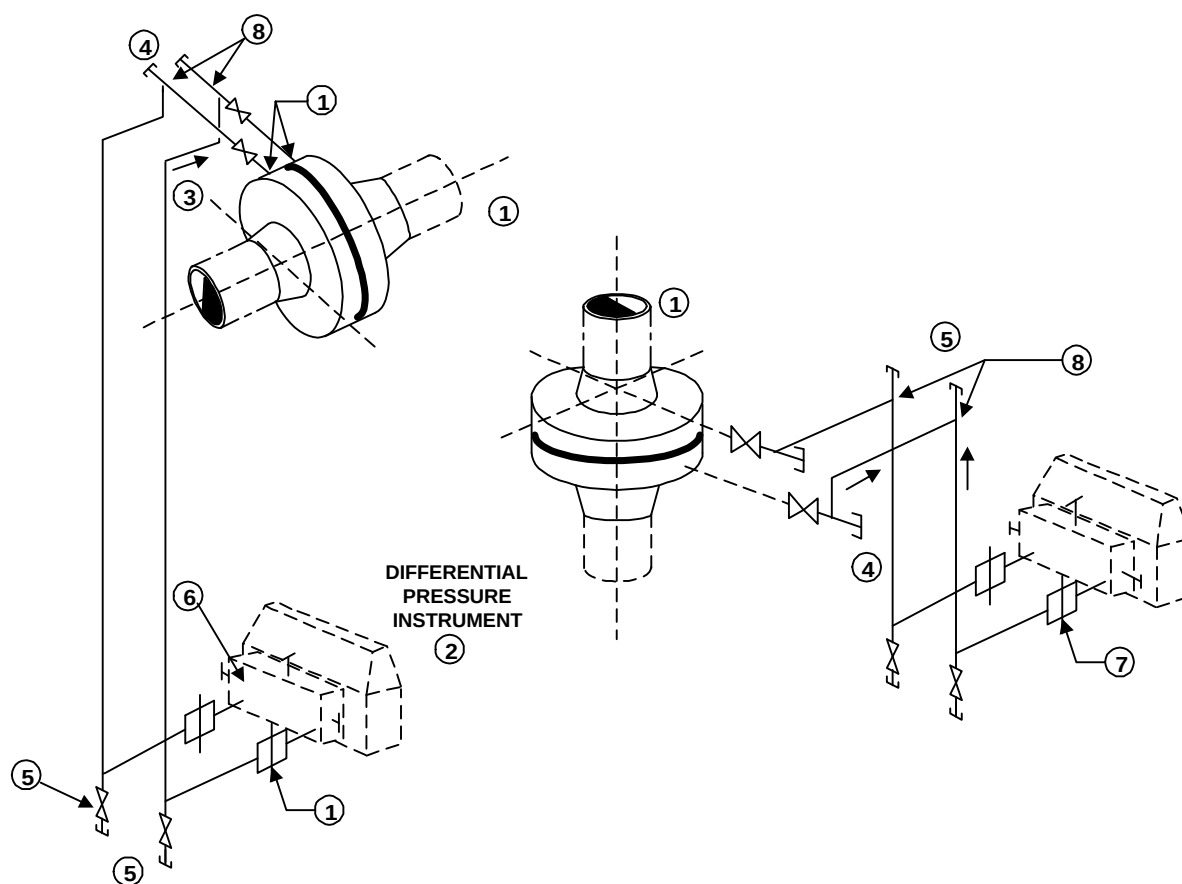


FIGURE 4-1
TYPICAL AIR HEADER ARRANGEMENT





TYPICAL INSTRUMENT PNEUMATIC MULTITUBE TERMINATION



NOTES:

1. HORIZONTAL OR VERTICAL LINE
2. INSTRUMENT MOUNTED BELOW ELEMENT
3. PIPWORK CONFIGURED WITH UPWARD SLOPE TO REFERENCE DATUM POINT 1:10
4. RODDING OUT POINTS TO BE CAPPED OR BLANKED
5. DRAINS AND VENTS TO BE CAPPED OR BLANKED, OR PIPED TO SAFE DISPOSAL (SEE TEXT)
6. INTEGRAL 3 OR 5 VALVE MANIFOLD PREFERRED (SEE TEXT)
7. COUPLING FOR INSTRUMENT REMOVAL
8. REFERENCE DATUM POINTS TO BE AT SAME LEVEL TO ENSURE EQUAL CONDENSATE HEADS ON EACH SIDE OF INSTRUMENT. CONDENSATE POTS TO BE USED FOR HIGH DISPLACEMENT INSTRUMENTS.

FIGURE 4-3

FLOW INSTRUMENT HOOK-UP CONDENSABLE SERVICE PREFERRED ARRANGEMENT

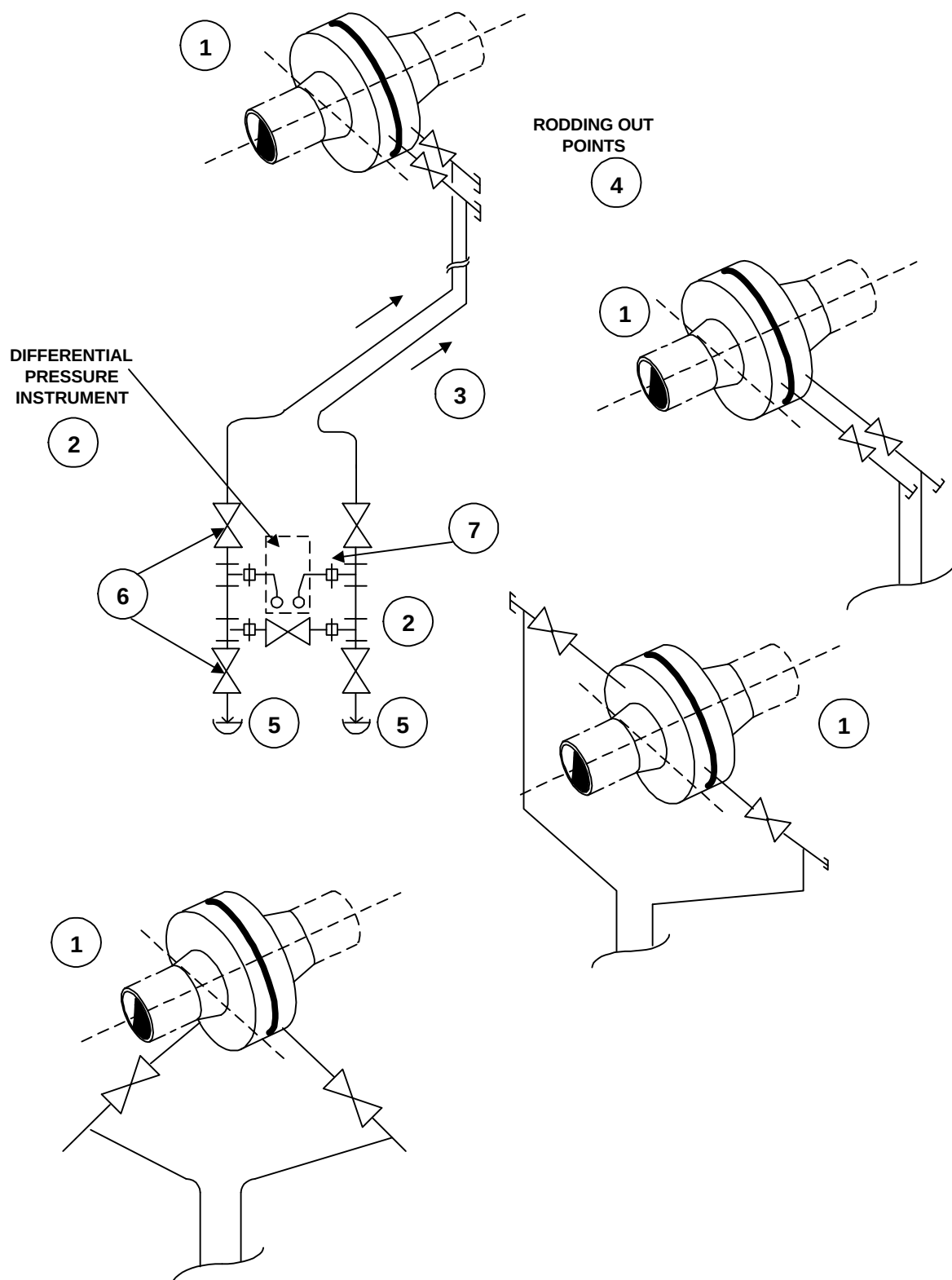


FIGURE 4-4(PAGE 1 OF 2)

FLOW INSTRUMENT HOOK-UP LIQUID SERVICE PREFERRED
ARRANGEMENT

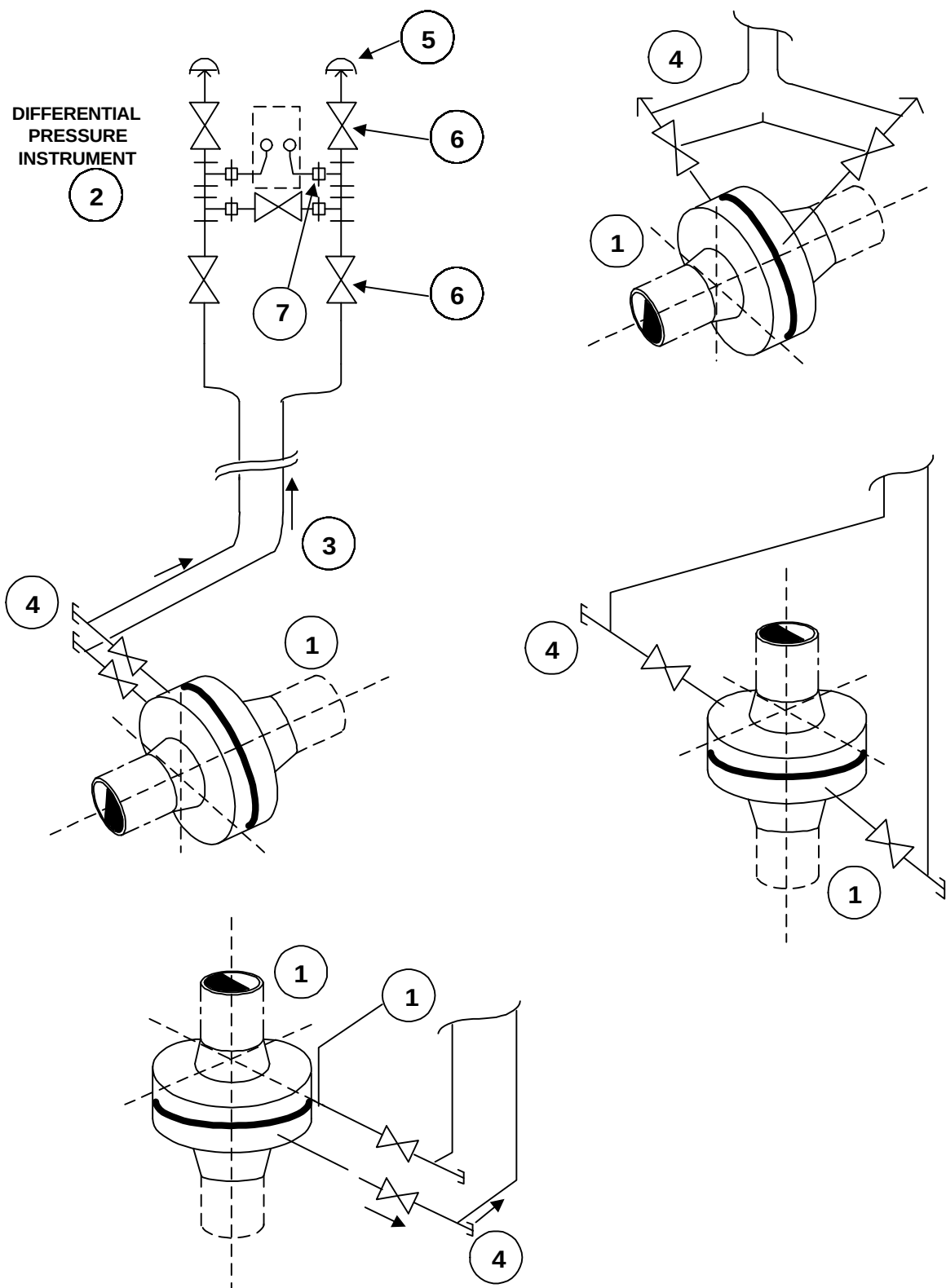
NOTES:

1. HORIZONTAL LINE
2. INSTRUMENT MOUNTED BELOW ELEMENT
3. PIPWORK CONFIGURED IN SELF - VENTING MODE WITH UPWARD SLOPE THROUGHOUT OF 1:10 MINIMUM.
4. RODDING OUT POINTS TO BE CAPPED OR BLANKED
5. DRAINS AND VENTS TO BE CAPPED OR BLANKED, OR PIPED TO SAFE DISPOSAL (SEE TEXT)
6. INTEGRAL 3 OR 5 VALVE MANIFOLD PREFERRED (SEE TEXT)
7. COUPLING FOR INSTRUMENT REMOVAL

FIGURE 4-4(PAGE 2 OF 2)

**FLOW INSTRUMENT HOOK-UP LIQUID SERVICE PREFERRED
ARRANGEMENT**





**FIGURE 4-5(PAGE 10F 2)
FLOW INSTRUMENT HOOK-UP GAS SERVICE PREFERRED ARRANGEMENT**

NOTES:

1. HORIZONTAL LINE
2. INSTRUMENT MOUNTED BELOW ELEMENT
3. PIPWORK CONFIGURED IN SELF-VENTING MODE WITH UPWARD SLOPE THROUGHOUT OF 1:10 MINIMUM.
4. RODDING OUT POINTS TO BE CAPPED OR BLANKED
5. DRAINS AND VENTS TO BE CAPPED OR BLANKED, OR PIPED TO SAFE DISPOSAL (SEE TEXT)
6. INTEGRAL 3 OR 5 VALVE MANIFOLD PREFERRED (SEE TEXT)
7. COUPLING FOR INSTRUMENT REMOVAL

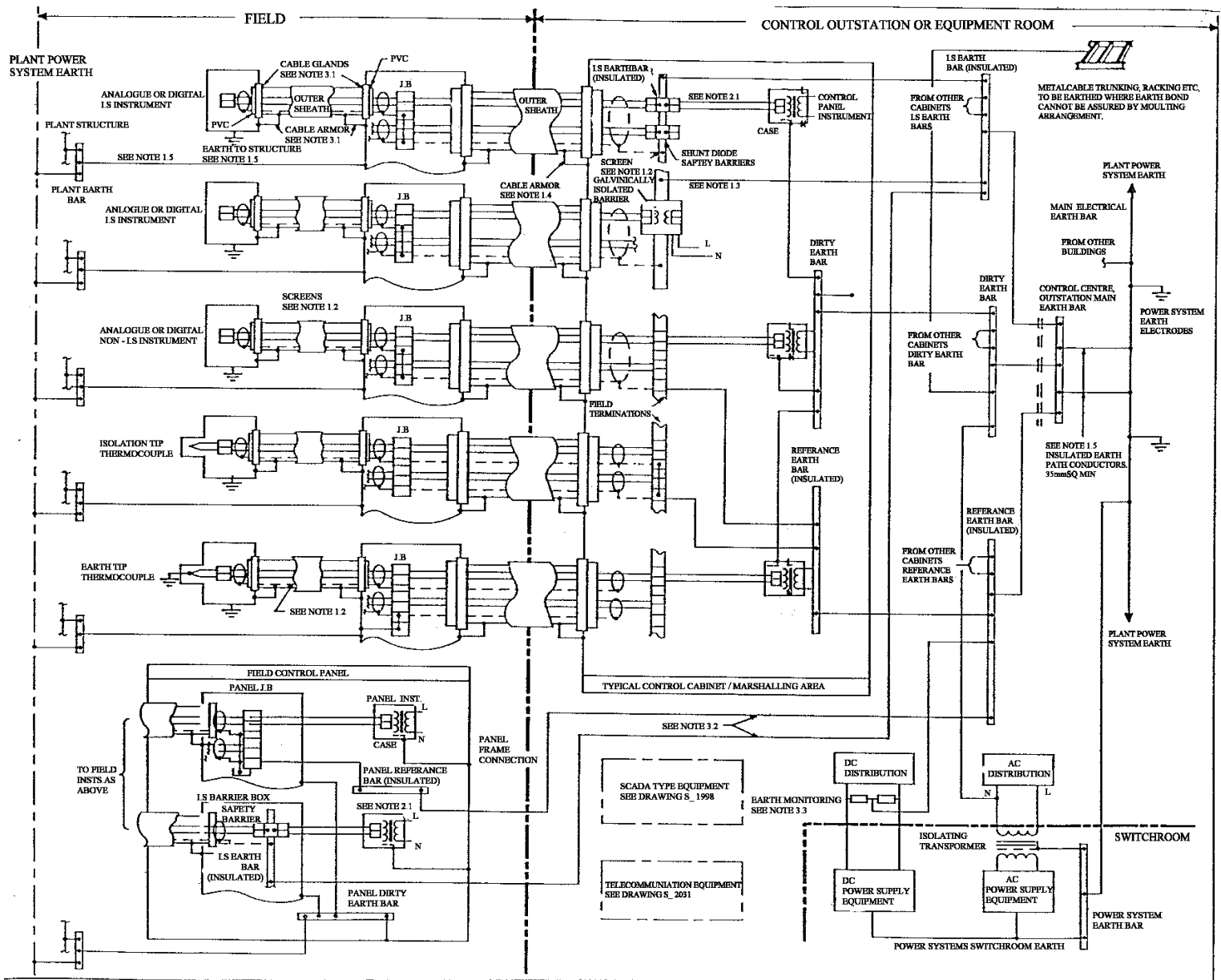
FIGURE 4-5(PAGE 2OF 2)

FLOW INSTRUMENT HOOK-UP GAS SERVICE PREFERRED ARRANGEMENT





FIGURE 5-1(PAGE 1 OF 2)



NOTES:

2.0 EQUIPMENT ROOM

2.1 IF THE POWER SUPPLY IS EARTHED ON THE FIELD SIDE THEN TWIN CHANNEL SHUNT DIODE SAFETY BARRIERS OR OPTICALLY, GALVANICALLY ISOLATED DEVICES MUST BE USED.

3.0 FIELD

3.1 THE LEAD SHEATH (WHERE PROVIDED) AND ARMOUR TO BE BONDED TOGETHER AND TO THE ENCLOSURE AT THIS POINT BY A BRASS CABLE GLAND. IF A NON-METALLIC ENCLOSURE IS USED, MEASURES SHALL BE TAKEN TO ENSURE ARMOURS AND LEAD SHEATHS (WHERE PROVIDED) OF ALL CABLES ENTERING THE ENCLOSURE ARE BONDED TO ONE ANOTHER AND TO THE PLANT POWER SYSTEM EARTH. EACH SCREEN SHALL BE INSULATED WITH A SLEEVE.

3.2 DEPENDING ON SYSTEM REQUIREMENTS AND POWER SUPPLY DISTRIBUTION THESE EARTHS MAY BE TAKEN TO A LOCAL EARTH POINT.

3.3 THIS SHOWS THE PREFERRED EARTHING SYSTEM. IT MAY BE NECESSARY IN SOME CASES TO EARTH ON SIDE OF THE D.C SUPPLY (SEE ALSO NOTE 2.1)

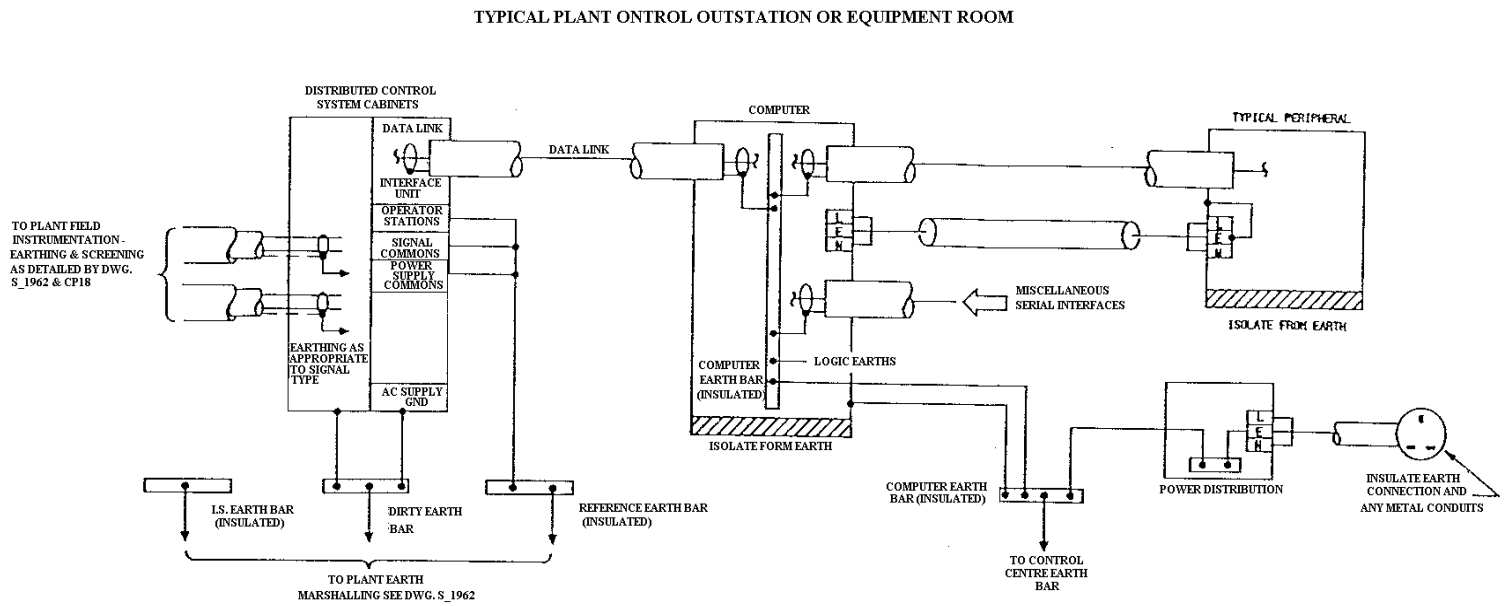
FIGURE 5-1(PAGE 2 OF 2)

TYPICAL EARTHING DIAGRAM FOR INSTRUMENTATION ONSHORE



TYPICAL EARTHING DIAGRAM FOR SCADA AND COMPUTER TYPE EQUIPMENT

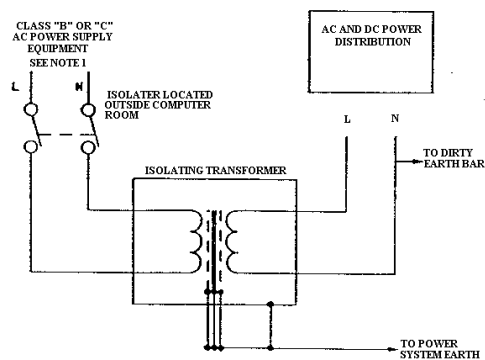
FIGURE 5-2(PAGE 1 OF 2)



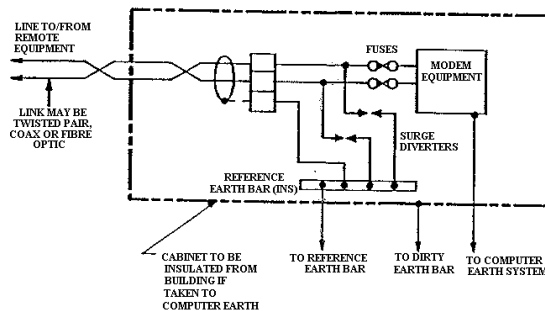
NOTES

1. MORE THAN ONE CLASS "B" AC POWER SUPPLY AND ISOLATING TRANSFORMER MAY BE REQUIRED
2. REPRESENTATION IS TYPICAL ONLY - ALL EARTHING AND BONDING OF SCADA AND COMPUTER TYPE EQUIPMENT TO BE IN ACCORDANCE WITH MANUFACTURERS REQUIREMENTS SUBJECT TO SAFETY REGULATIONS.

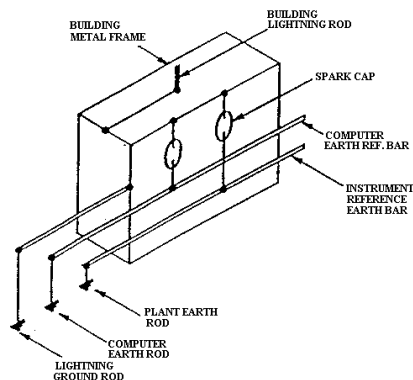
POWER DISTRIBUTION EQUIPMENT



EARTHING OF TELEMETRY EQUIPMENT



LIGHTNING PROTECTION



NOTES:

1. MORE THAN ONE CLASS 'B' AC POWER SUPPLY AND ISOLATING TRANSFORMER MAY BE REQUIRED.
2. REPRESENTATION IS TYPICAL ONLY - ALL EARTHING AND BONDING OF SCADA AND COMPUTER TYPE EQUIPMENT TO BE IN ACCORDANCE WITH MANUFACTURERS REQUIREMENTS SUBJECT TO SAFETY REGULATIONS.

FIGURE 5-2(PAGE 2 OF 2)

TYPICAL EARTHING DIAGRAM FOR SCADA AND COMPUTER TYPE EQUIPMENT



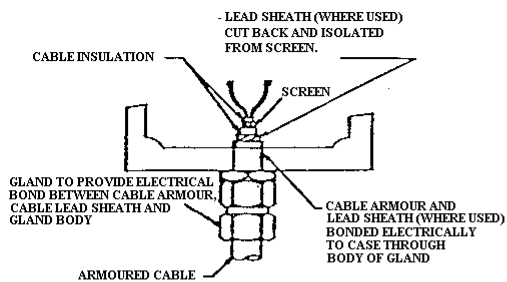


FIG. 1 FIELD FLAMEPROOF GLANDING

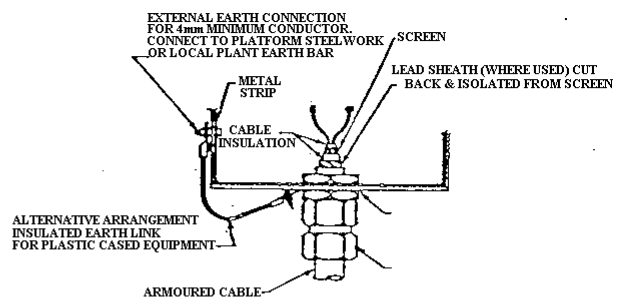


FIG. 2 FIELD NON-FLAMEPROOF GLANDING PLASTIC CASE (NOTE 1)

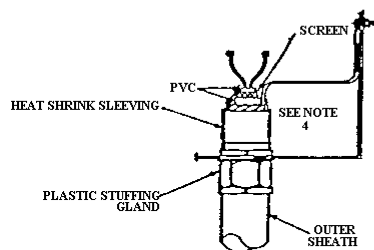


FIG. 3 TYPICAL EARTHING DETAIL - PLASTIC STUFFING GLAND

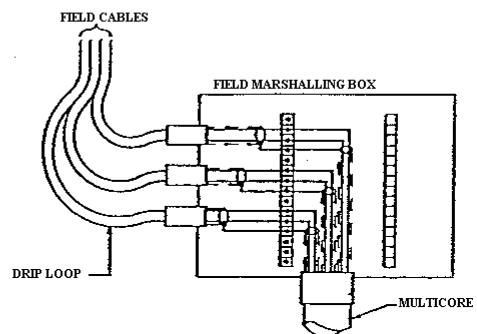


FIG. 4 FIELD M.B. TERMINATION (INDIVIDUAL SCREENS)

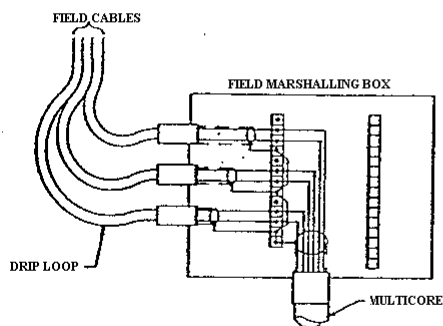


FIG. 5 FIELD M.B. TERMINATION (OVERALL SCREEN)

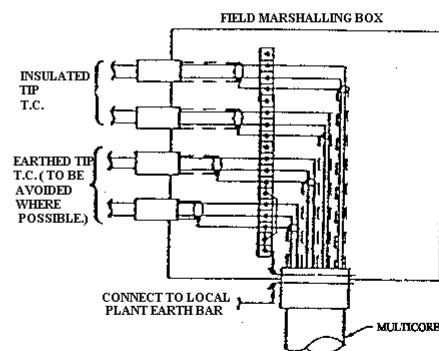


FIG. 6 FIELD M.B. TERMINATION (THERMOCOUPLES).

FIGURE 5-3 (PAGE 1 OF 2)

TYPICAL INSTALLATION DETAIL FOR CABLE TERMINATION AND EARTH BONDING



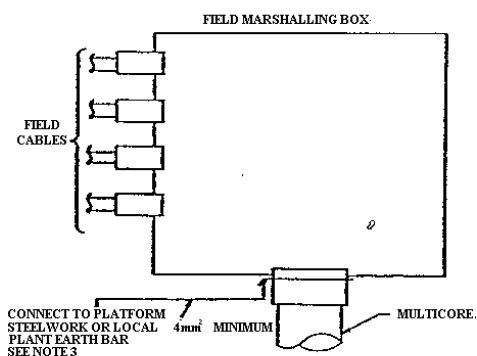


FIG. 7 GLAND AND MARSHALLING BOX EARTHING METAL CASE - FOR PLASTIC REFER TO FIG. 2

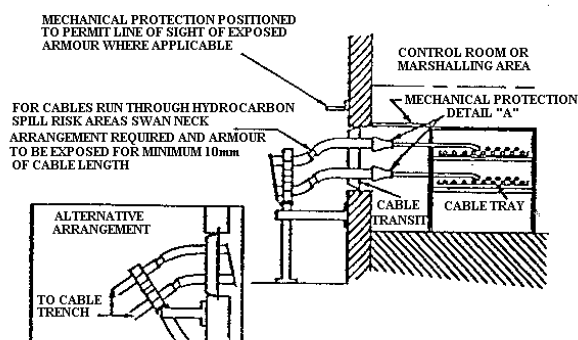


FIG. 8 CONTROL ROOM OR MODULE CABLE ENTRY NOTE 2

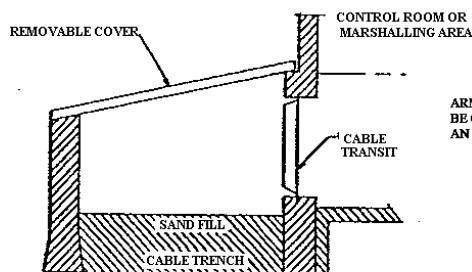
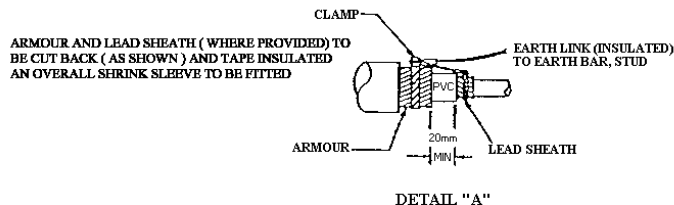


FIG. 9 TYPICAL ONSHORE CONTROL ROOM CABLE TRENCH ARRANGEMENT



NOTES:

1. FOR METAL CASE PROVIDE STAR WASHER BETWEEN BACKING NUT AND CASE. EARTH TAG AND EXTERNAL WIRING ARE NOT REQUIRED.
2. THIS METHOD SHOULD BE RESTRICTED TO THE SITUATION WHERE MULTICORE CABLES ARE RUN UNDERGROUND. WHERE MULTICORE CABLES TO BE RUN UNSTRIPPED TO A GLANDPLATE.
3. PROVIDED THE ENCLOSURE IS METAL AND IS ADEQUATELY BONDED TO EARTH VIA THE MOUNTING ARRANGEMENT. THE EARTH BOND MAY BE OMITTED.
4. WHERE BRAIDED ARMOUR ENTERS FIELD EQUIPMENT IT IS TO BE TEASED OUT, TWISTED SLEEVED WITH GRN/YEL HAET SHRINK AND CONNECTED TO LOCAL EARTH BAR/STUD. (FIG 3) WHERE STEEL WIRE ARMOUR ENTERS EQUIPMENT IT IS TO BE CLAMPED AND THE INSULATED EARTH LINK TO BE TAKEN TO LOCAL EARTH BAR/STUD. (DETAIL A).

FIGURE 5-3 (PAGE 2 OF 2)

TYPICAL INSTALLATION DETAIL FOR CABLE TERMINATION AND EARTH BONDING

Figure 1 is a detailed schematic diagram titled "Typical earthing arrangement for a control outstation or equipment room". It illustrates the electrical grounding and shielding requirements for various types of instruments connected from a "FIELD" to a "CONTROL OUTSTATION OR EQUIPMENT ROOM".

Instrument Types and Connections:

- Analogue or Digital LS Instrument:** Connected via cable glands (see Note 3.1), PVC, J.B. (Joint Box), outer sheath, cable armour (see Note 3.1), and screens (see Note 1.2). It includes an "EARTH TO STRUCTURE" connection (see Note 1.4).
- Analogue or Digital LS Instrument:** Similar connection to the first type, but with a different internal configuration.
- Analogue or Digital NON-LS Instrument:** Connected via screens (see Note 1.2) and J.B.
- Insulated Tip Thermocouple:** Connected via J.B. and includes "FIELD TERMINATIONS".
- Earth Tip Thermocouple:** Connected via J.B. and includes "SEE NOTE 1.2".

Control Outstation Components:

- Typical Control/Marshall Area:** Contains a "CONTROL PANEL INSTRUMENT" with L, N, and CASE connections. It features "LS EARTH BAR (INSULATED)", "FROM OTHER CABINETS REFERENCE EARTH BARS", "REFERENCE EARTH BAR (INSULATED)", and a "DIRTY EARTH BAR".
- Earthing Connections:** Includes "EARTH TO STRUCTURE", "EARTH TO STRUCTURE", "INSULATED EARTH PATH CONDUCTORS", and "EARTH TO STRUCTURE".
- Field Control Panel:** Located at the bottom left, it includes "PANEL J.B.", "PANEL INST.", "PANEL FRAME CONNECTION", "PANEL REFERENCE BAR (INSULATED)", "PANEL DIRTY EARTH BAR", and "L.S. BARRIER BOX". It references "SEE NOTE 3.4" and "SEE NOTE 3.3".

Power System and Switchroom:

- DC Distribution:** Includes "DC POWER SUPPLY EQUIPMENT" and "EARTH MONITORING" (see Note 3.3).
- AC Distribution:** Includes "AC POWER SUPPLY EQUIPMENT" and an "ISOLATING TRANSFORMER".
- Switchroom:** The entire system is grounded to the "POWER SYSTEM SWITCHROOM EARTH", which is connected to "TO LOCAL EARTH".

Notes and References:

- SEE NOTE 3.1: Cable glands, PVC, J.B., outer sheath, cable armour, screens.
- SEE NOTE 1.2: Screens, field terminations.
- SEE NOTE 1.4: Earth to structure.
- SEE NOTE 3.2: Connection to the main earthing system.
- SEE NOTE 3.3: Earth monitoring.
- SEE NOTE 3.4: Field control panel details.
- SCADA TYPE EQUIPMENT: SEE DRAWINGS-1998.
- TELECOMMUNICATION EQUIPMENT: SEE DRAWINGS-2031.

NOTES:

2.0 EQUIPMENT ROOM

2.1 IF THE POWER SUPPLY IS EARTHED ON THE FIELD SIDE THEN TWIN CHANNEL SHUNT DIODE SAFETY BARRIERS OR OPTICALLY, GALVANICALLY ISOLATED DEVICES MUST BE USED.

3.0 FIELD

3.1 THE LEAD SHEATH (WHERE PROVIDED) AND ARMOUR TO BE BONDED TOGETHER AND TO THE ENCLOSURE AT THIS POINT BY A BRASS CABLE GLAND. IF A NON-METALLIC ENCLOSURE IS USED, MEASURES SHALL BE TAKEN TO ENSURE ARMOURS AND LEAD SHEATHS (WHERE PROVIDED) OF ALL CABLES ENTERING THE ENCLOSURE ARE BONDED TO ONE ANOTHER AND TO THE PLANT POWER SYSTEM EARTH. EACH SCREEN SHALL BE INSULATED WITH A SLEEVE.

3.2 DEPENDING ON SYSTEM REQUIREMENTS AND POWER SUPPLY DISTRIBUTION THESE EARTHS MAY BE TAKEN TO A LOCAL EARTH POINT.

3.3 THIS SHOWS THE PREFERRED EARTHING SYSTEM. IT MAY BE NECESSARY IN SOME CASES TO EARTH ON SIDE OF THE D.C SUPPLY (SEE ALSO NOTE 2.1)

3.4 THIS DETAIL ALSO GIVES THE PREFERRED EARTHING ARRANGEMENT FOR SAFETY BARRIERS FIELD MOUNTED IN EXPLOSION PROTECTED ENCLOSURES.

FIGURE 5-4(PAGE 2 OF 2)

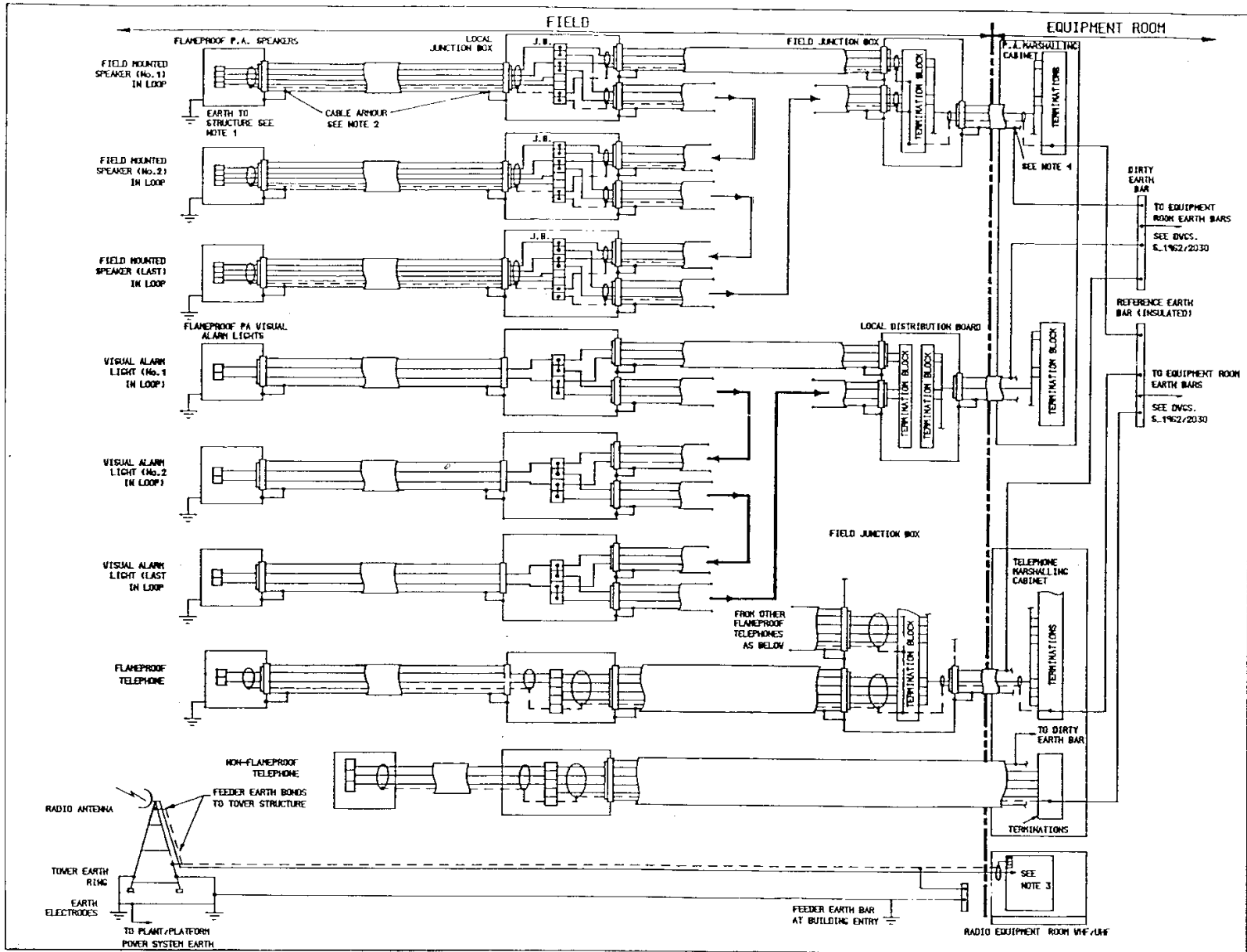
TYPICAL EARTHING DIAGRAM FOR INSTRUMENTATION OFFSHORE





TYPICAL EARTHING DIAGRAM FOR TELECOMMUNICATIONS EQUIPMENT

FIGURE 5-5(PAGE 1 OF 2)



NOTES:

1. METTALIC TELECOMMUNICATION FIELD EQUIPMENT SHALL NORMALLY BE ASSUMED TO BE BONDED TO EARTHED METALWORK.
2. FIELD CABLES TO HAVE THE ARMOUR EARTHED AT BOTH ENDS VIA CABLE GLANDS
3. CABLE SCREEN EARTHED AT CABINET FRAME VIA CONNECTION.
4. WHERE CABLE ENTERS MARSHALLING CABINET, ARMOUR IS TO BE SLEEVED WITH GRN/YEL HEATSHRINK AND CONNECTED TO DIRTY EARTH BAR.

FIGURE 5-5(PAGE 2 OF 2)

TYPICAL EARTHING DIAGRAM FOR TELECOMMUNICATIONS EQUIPMENT



DEFINITIONS AND ABBREVIATIONS

Definitions

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

contract:	the agreement or order between the purchaser and the vendor (however made) for the execution of the works including the conditions, specification and drawings (if any) annexed thereto and such schedules as are referred to therein.
Ex:	electrical apparatus protected to meet hazard classification in accordance with EN 50 000 series.
cost of ownership:	the life cost of a system including initial supply contract value, installation cost, ongoing support costs (e.g. spares, maintenance and service charges).
works:	all equipment to be provided and work to be carried out by the vendor under the contract.

Abbreviations

abs	Short for 'absolute'
a.c.	Alternating Current
ADC	Analogue Digital Conversion
ANSI	American National Standards Institute
API	American Petroleum Institute
ASTM	American Society for Testing and Materials
BASEEFA	British Approvals Service for Electrical Equipment in Flammable Atmospheres
BOP	Blow Out Preventer
BS	British Standard
CAD	Computer Aided Design
CCI	Construction Contracting Industries
DAC	Digital to Analogue Converter
d.c.	Direct Current
DCS	Distributed Control System
dia.	Diameter
DN	Nominal Diameter
DP	Differential Pressure
EC	European Community
EEMUA	Engineering Equipment and materials Users Association
EIC	Energy Industries Council



EMI	Electro-Magnetic Interference
EMUG	European Manufacturing and User Group
EN	European Standards issued by CEN (European Committee for Standardisation) and CENELEC (European Committee for Electrotechnical Standardisation)
ERA	Electrical Research Association
ESD	Emergency Shutdown
FCCU	Fluid Catalytic Cracking Unit
FEED	Front End Engineering Design
GRP	Glass Reinforced Plastic
HVAC	Heating, Ventilation and Air Conditioning
IEC	International Electrotechnical Commission
IEE	Institution, , , , , of Electrical Engineers
IEEE	Institute of Electrical and Electronic Engineers (USA)
IP	Institute of Petroleum
IS	Intrinsically Safe
ISA	Instrument Society of America
ISO	International Organisation for Standardisation
LCD	Liquid Crystal Display
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
LPU	Lighting Protection Unit
L/R	Ratio of Inductance to Resistance
Lux	Unit of light level measurement
MAP	Manufacturing Automatic Protocol
MCC	Motor Control Circuit
NAS	National Aerospace Standard
NPS	Nominal Pipe Size
PC	Personal computer
P&I	Process and Instrumentation Drawing
PLC	Programmable Logic Controller
psig	Pounds per square inch gauge
PTFE	Polytetrafluorethylene
PVC	Polyvinyl Chloride
RF	Radio Frequency
RTD	Resistance Temperature Detector
SCADA	Supervisory Control and Data Acquisition
SI	Système International d'Unités
SIRA	Scientific Industries Research Association
UK	United Kingdom
UL	Underwriters Laboratory
UPS	Uninterruptable Power Supply
VDU	Visual Display Unit



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.

ISO 1000 (Identical to BS 5555)	SI units and recommendations for the use of their multiples and of certain other units.
IEE	Recommendations for the electric and electronic equipment of mobile and fixed offshore installations.
IEE	Regulations for electrical installations (wiring regulations).
IEE Publication ISBN 086341-0464	Guidelines for the documentation of software in industrial computer systems.
IEC 92	Elastomer cables for ship wiring.
IEC 304	Standard colours for insulation for low-frequency cables and wires.
IEC 381	Analogue signals for process control systems. Part 1: Direct current signals (IEC 381-1). Part 2: Direct voltage signals (IEC 381-2).
IEC 382	Analogue pneumatic signal for process control systems.
IEC 529	Classification of degrees of protection provided by enclosures.
EIC Spec CCI P/3	Specification for instrument panels.
EIC Spec CCI P/4	Specification for colour coding of instrument signals cables.
EIC Spec CCI P/7	Specification for instrument cable numbering and junction box identification.
ANSI B16.5	Pipe flanges and flanged fittings.
ANSI/IEEE 802.4	Token passing bus access method and physical layer specifications.
API RP 550	Instrumentation.



ANSI/ISA S5.1	Graphic Symbols for process Displays
BT 1308A	2000 Series telephone cables.
ASTM A269	316 Stainless steel tubing.
BS 1042	Measurement of fluid flow in closed conduits.
BS 5308 Pt. 1	Instrumentation cables. : Specification for polyethylene insulated cables.
BS 5308 Pt. 2	Instrumentation cables. : Specification for PVC insulated cables.
BS 6346	PVC insulated cables for electricity supply.
BS 5540	Evaluating particulate contamination of hydraulic fluids. Part 4. method of defining levels of contamination (solid contaminant code).
BS 5045	Transportable gas containers.
BS 903 Pt A30	Permeability of rubber to gasses.
ISO 3511	Representation for control functions and instrumentation.
BS 5345	Recommended practice for the selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres (other than mining applications or explosive processing and manufacture).
BS 1553	Graphical symbols for general engineering.
BS 6739	Recommended practice for instrumentation in process control systems: installation design and practice.
BS 6883	Elastomer insulated cables for ships
BS 6746C	Colour chart for PCV insulation and sheath of electric cables.
BS 1433	Copper for electrical purposes.
BS 2051	Tube and Pipe fittings.
BS 2871	Copper and Copper alloy tubes.
NAS 1638	Cleanliness requirements of parts used in hydraulic systems.



EEMUA Publ. No. 138	Design and installation of on-line analyser systems.
ERA report 4120/06	Guidelines on Exp
BPE.91.ER.103	Categorisation of ESD systems
BP Group RP 44-7	Plant Layout (replaces BP CP 3)
BP Group RP 22-1	Fired Heaters (replaces BP CP 7)
BP Group RP 34-1	Rotating Machinery (replaces BP CP 10)
BP Group RP 42-1	Piping Systems (replaces BP CP 12)
BP Group RP 44-1	Overpressure Protection Systems (replaces BP CP 14)
BP Group RP 32-2	Site Inspection, Testing and Pre-Commissioning of New Plant (replaces BP CP 20)
BP Group RP 32-3 BP Group RP 32-4 BP Group RP 32-5	Inspection and Testing of Plant in Service (replaces BP CP 52)
BP Group RP 12	Electrical Systems and Installation Part 2 : Electrical Equipment in Flammable Atmospheres and Combustible Dusts. Part 5 :- Power Supplies for Control Systems Part 16 :- Earthing and Bonding. (replaces BP CP 17)
BP Group RP 4-4	Buildings (replaces BP CP 19)
BP Group RP 44-2	Winterisation (replaces BP CP 24)
BP Group RP 14-2	Heating, Ventilating and Air Conditioning (replaces BP CP 29)
BP Group RP 60-2	Breathing Air Line Installations (replaces BP CP 31)



BP Group RP 44-6	Area Classification (replaces BP CP 39)
BP Group RP 30-6 BP Group RP 30-7	Protective Instrumentation/Fire and Gas (replaces BP CP 48)
BP Group RP 30-9	Guide to Instrument Databases
BP Group RP 50-2	Guide to Reliability and Risk Analysis (replaces BP CP 62)
BP Group RP 52-1	Thermal Insulation (replaces BP CP 13)
BP Group GS 112-1	Electrical Engineering Specification for Materials and Workmanship (replaces BP Std 121)
BP Group GS 130-2	Instrumentation for Rotating Machinery (replaces BP Std 128)
BP Group GS 134-1	Hydraulic Power Supplies
BP Group GS 130-3	Testing and Inspection of Instrument Panels (replaces BP Std 130)
BP Group GS 142-6	Piping Specifications (replaces BP Std 170)
BP Group GS 112-12	Fire Resistant Instrument Cables (replaces BP Std 236 + 242)
BP Group GS 142-13	Compression Fittings (replaces BP Std 261)
BP Group GS 112-11	DC Power Supplies (replaces BP Std 228)
BP Group GS 112-10	AC Power Supplies (replaces BP Std 231)

