PROCEDURAL SPECIFICATION

INSTRUMENTATION FOR EQUIPMENT PACKAGES

DEP 32.31.09.31-Gen.

November 1995
(DEP Circular 40/99 has been incorporated)

DESIGN AND ENGINEERING PRACTICE

PREFACE

DEP (Design and Engineering Practice) publications reflect the views, at the time of publication, of:

Shell International Oil Products B.V. (SIOP)
and
Shell International Exploration and Production B.V. (SIEP)
and
Shell International Chemicals B.V. (SIC)

The Hague, The Netherlands,

and other Service Companies.

They are based on the experience acquired during their involvement with the design, construction, operation and maintenance of processing units and facilities, and they are supplemented with the experience of Group Operating companies. Where appropriate they are based on, or reference is made to, national and international standards and codes of practice.

The objective is to set the recommended standard for good design and engineering practice applied by Group companies operating an oil refinery, gas handling installation, chemical plant, oil and gas production facility, or any other such facility, and thereby to achieve maximum technical and economic benefit from standardization.

The information set forth in these publications is provided to users for their consideration and decision to implement. This is of particular importance where DEPs may not cover every requirement or diversity of condition at each locality. The system of DEPs is expected to be sufficiently flexible to allow individual operating companies to adapt the information set forth in DEPs to their own environment and requirements.

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2) Other parties who are authorized to use DEPs subject to appropriate contractual arrangements.

3) Contractors/subcontractors and Manufacturers/Suppliers under a contract with users referred to under 1) or 2) which requires that tenders for projects, materials supplied or - generally - work performed on behalf of the said users comply with the relevant standards.

Subject to any particular terms and conditions as may be set forth in specific agreements with users, SIOP, SIEP and SIC disclaim any liability of whatsoever nature for any damage (including injury or death) suffered by any company or person whomsoever as a result of or in connection with the use, application or implementation of any DEP, combination of DEPs or any part thereof. The benefit of this disclaimer shall inure in all respects to SIOP, SIEP, SIC and/or any company affiliated to these companies that may issue DEPs or require the use of DEPs.

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NOTE: In addition to DEP publications there are Standard Specifications and Draft DEPs for Development (DDDs). DDDs generally introduce new procedures or techniques that will probably need updating as further experience develops during their use. The above requirements for distribution and use of DEPs are also applicable to Standard Specifications and DDDs. Standard Specifications and DDDs will gradually be replaced by DEPs.

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APPENDICES

1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the instrumentation of equipment packages. It is intended for use by the Principal and Contractor when preparing a specification for equipment packages.

This DEP is a revision of the previous publication of the same number dated March 1987.

It has been altered as follows:

- This DEP has changed from a Technical Specification to a Procedural Specification.
- This DEP explains how the instrument supply should be judged for a particular equipment package by introducing options for the scope of supply.
- This DEP includes improved administrative procedures and technical requirements, especially at the interface between different parties, with the aim that instrumentation from various sources will function as it should.
- This DEP includes a table indicating which topics shall be specified in the requisition for the different scope of supply options.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by SIOP and SIEP, the distribution of this DEP is confined to companies forming part of the Royal Dutch/Shell Group or managed by a Group company, and to Contractors nominated by them (i.e. the distribution code is "C" as defined in DEP 00.00.05.05-Gen.).

This DEP is intended for use in oil refineries, chemical plants, oil and gas production facilities and supply/marketing installations.

If national and or local regulations exist in which some of the requirements may be more stringent than in this DEP the Contractor shall determine by careful scrutiny which of the requirements are and which combination of requirements will be acceptable as regards to safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national codes and/or regulations. The Principal may then negotiate with the Authorities concerned with the objective of obtaining agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General Definitions

The **Contractor** is the party which carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier/Vendor** is the party which manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party which initiates the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

Distributed Control System (DCS)

A configurable microprocessor based control system.

Equipment Package

Single or combined units of equipment supplied by a Vendor which include instrumentation or to which instrument requirements may apply.

Functional tests

Tests carried out by simulating a process condition on the input side of the instrument to check the corresponding output 'function'. The conditions should be such that the required performance is demonstrated.

Instrument or instrument systems for equipment packages

Instruments or instrument systems necessary to operate the equipment package.

These may also include 'free issue items', which are those supplied free of charge to the equipment package Vendor.

Installation materials for equipment package instrumentation

Miscellaneous installation items required for the instruments in the equipment packages, such as tubing, fittings, cables etc.

Instrumented Protective Function (IPF)

A function composed of one or more initiators, an Instrumented Protective System and one or more actuators for the purpose of preventing hazards.

Instrumented Protective System (IPS)

The (electrical and/or electronic and/or programmable electronic) logic solver component of the Instrumented Protective Function complete with input and output equipment.

'Loops' in the equipment package

These are local control loops, i.e. all control components such as local control panels or receivers that are confined within the boundaries of the equipment package.

Remote control loops are control loops linked to the (F)AR through junction boxes installed within the boundaries of the equipment package. The primary element, final control element (control valve, etc.) and the transmitter are mounted inside the package and the indicator, controller and alarms are in the DCS.

Principal's standards

The standards specified in the contract or Purchase order (see 4.1).

Subsystem

A microprocessor based system configured for specific control and monitoring applications, which can operate in isolation or communicate with a DCS.

Total Cost of Ownership (TCoO)

The total costs of owning an asset over its entire life, from conception of the need through to ultimate disposal. It is made up of the following cost elements: specification, price, purchasing, introduction/ installation, execution/ operation and termination/ disposal.

Variety Control

The process of selecting an optimum number of different types of products, processes or services to meet prevailing needs. It rationalises the number of varieties of items used both within an operating company and among operating companies.

1.4 ABBREVIATIONS

CPU	Central Processing Unit
DCS	Distributed Control System
DEP	Design and Engineering Practice
ESD	Emergency Shutdown
(F)AR	(Field) Auxiliary Room
FAT	Factory Acceptance Test
FGS	Fire, Gas and Smoke detection system
IA	Instrument Air
IPF	Instrumented Protective Function
IPS	Instrumented Protective System
JB	Junction Box
MDF	Main Distribution Frame
MPT	Modbus Protocol Translator
PLC	Programmable Logic Controller
RTU	Remote Transmission Unit
SCADA	Supervisory Control and Data Acquisition
SER	Sequence of Events Recorder
SPIR	Spare Part Interchangeability Record
TCoO	Total Cost of Ownership

1.5 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section is shown in brackets. Other documents referenced in this DEP are listed in (5).

2. GENERAL

Equipment packages are being used increasingly in process plants.

As the content and complexity of these packages varies considerably from very simple fabricated skid mounted units to large, complicated proprietary units, a unique approach regarding the instrumentation scope of supply cannot be defined.

Previously the approach was procurement and installation of instrumentation by the Contractor or Principal. This was done to obtain the maximum level of standardisation and quality control but did not necessarily apply to all equipment package arrangements and did not result in reduced TCoO.

An instrument specification for an equipment package is dependent on:

- The type of equipment package.
- The extent to which specific instrument requirements have to be applied.
- The competence of the Vendor.

To reflect this, various instrument scope of supply options are introduced in this DEP.

Section (3) describes options for typical instrumentation extent of supply with a corresponding flowchart showing the selection process to arrive at a particular equipment package arrangement.

Section (4) gives the extent of instrument requirements particular to the options given in (3). It is primarily intended to guide the Contractor in what to specify in the requisition at the design stage of the project once a particular scope of supply option has been selected.

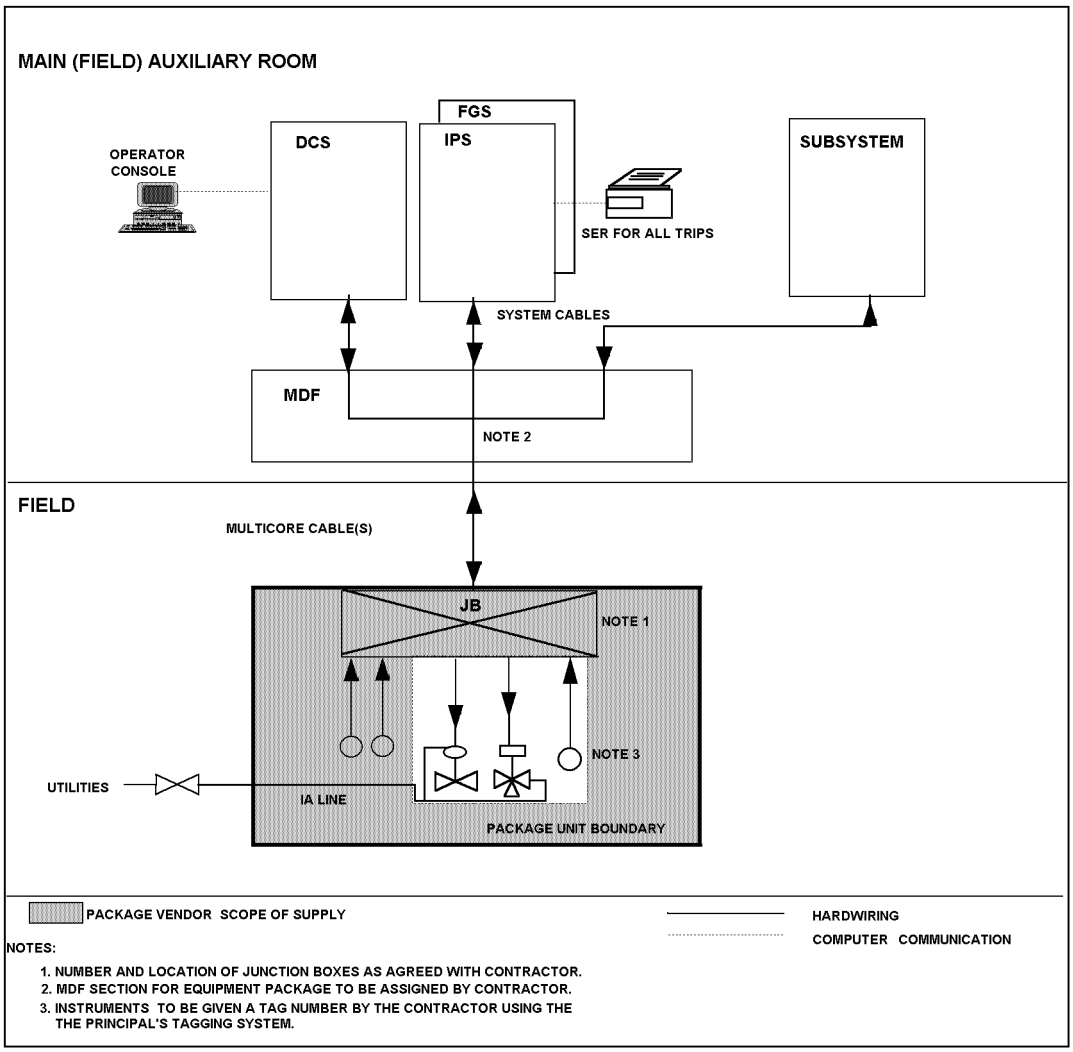
3. INSTRUMENT EXTENT OF SUPPLY

3.1 SCOPE OF SUPPLY OPTIONS

Table 1. Comparative overview of the different scope of supply options. Details of each of the options are given in (3.1.1) to (3.1.6).

Option	*Scope of Vendor*	*Vendor Competence*
A	Field instruments installed which are an integral part of the proprietary equipment. Functional specification, special tools, special test equipment, drawings and documents.	Limited to instrumentation which is considered an integral part of the proprietary equipment.
B	Field instruments installed which are an integral part of the proprietary equipment and any instrument installation materials required. Functional specification, special tools, special test equipment, drawings and documents.	Limited to instrumentation which is considered an integral part of the proprietary equipment and to the installation of installation materials.
C	Field instruments supplied and installed according to Principal's standards. Functional specification, special tools, special test equipment, drawings and documents.	Vendor is deemed competent by the Principal to meet the Principal's standards.
D	Field instruments supplied and installed according to Vendor's standards. Functional specification, special tools, special test equipment, drawings and documents.	Vendor's instrumentation standard used for the equipment package have been accepted by the Principal.
E	Field instrumentation, control room instrumentation and (F)AR instrumentation supplied and installed to the Principal's standards. The required control and IPF functionality, etc. are pre-configured in the (F)AR instrumentation. Functional specification, special tools, special test equipment, drawings and documents.	The Vendor is deemed competent by the Principal to meet the Principal's standards. Competent to manage complex interfaces between other equipment and Vendors.
F	Field instrumentation, control room instrumentation and (F)AR instrumentation supplied and installed to Vendor's standard, except each instrument to be given a tag number following the Principal's tagging system. The required control and IPF functionality, etc. are pre-configured in the (F)AR instrumentation. Functional specification, special tools, special test equipment, drawings and documents.	Vendor's instrumentation standards used for the equipment package have been accepted by the Principal.

3.1.1 Option A



3.1.1.1 Scope of Vendor

The Vendor shall supply the equipment package, complete with process tappings and the instruments which are an integral part of the proprietary equipment, e.g. speed governors, overspeed trip, proximitors, vibration pickups, etc.

The Vendor's scope of supply includes the functional specification, special tools, special test equipment, drawings and documents.

3.1.1.2 Vendor Competence

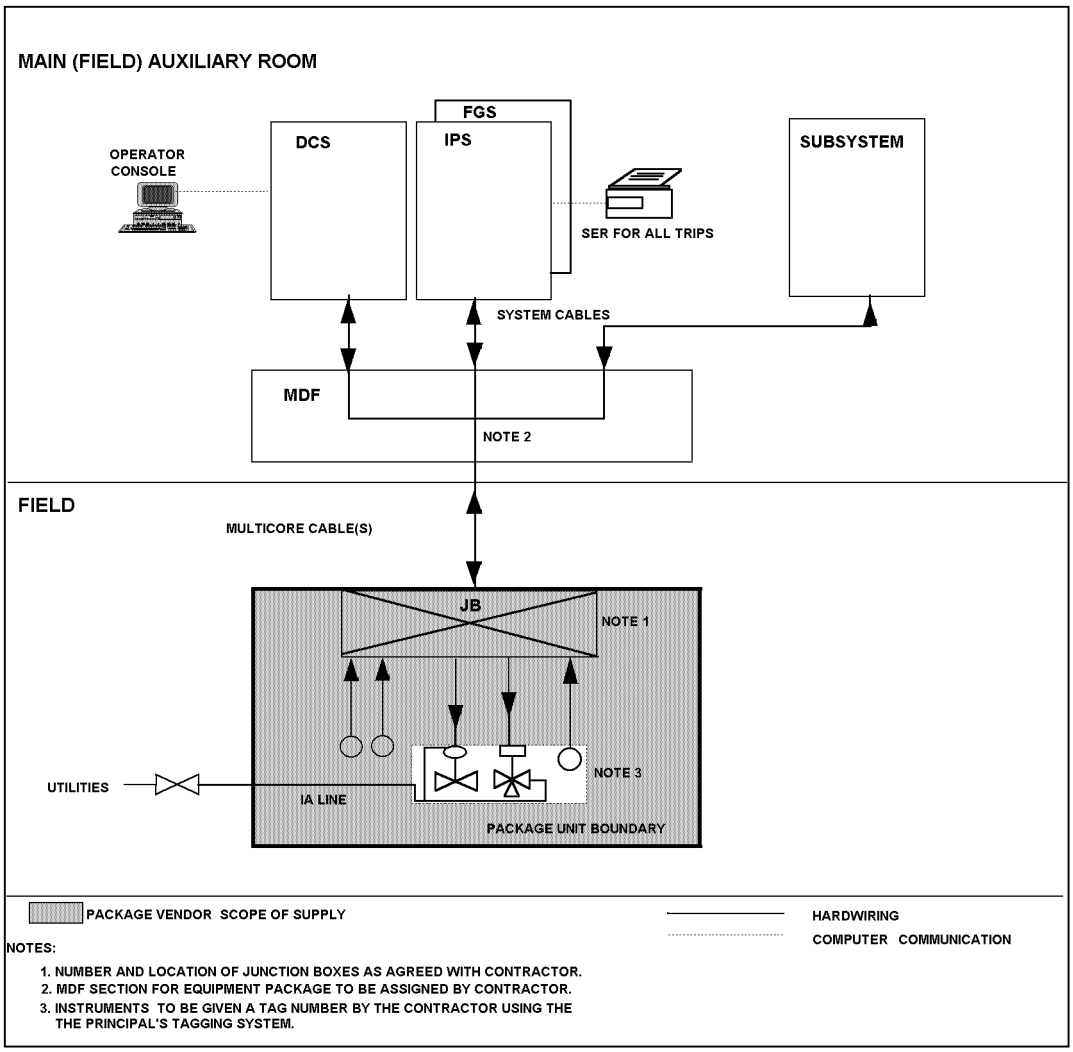
The Vendor's competence is limited to instrumentation which is considered an integral part of the proprietary equipment.

3.1.1.3 Scope of Contractor

The Contractor shall design, engineer, supply and install all remaining field instrumentation and installation materials and all cabling between the field junction box(es) and the (F)AR.

The Contractor shall be responsible for the configuration of the DCS, IPS or subsystem to perform the required control and IPF functionality, etc. as specified by the Vendor's functional specification.

3.1.2 Option B



3.1.2.1 Scope of Vendor

The Vendor shall supply the equipment package, complete with process tappings and the instruments which are an integral part of the proprietary equipment, e.g. speed governors, overspeed trip, proximitors, vibration pick-ups, etc.

In addition, the Vendor shall supply any instrument installation materials required. The installation materials shall be as specified on the engineering documentation prepared by the Contractor and issued to the Vendor. The detailed design of the installation shall be the responsibility of the Vendor.

The Vendor's scope of supply shall include the functional specification, special tools, special test equipment, drawings and documents.

3.1.2.2 Vendor Competence

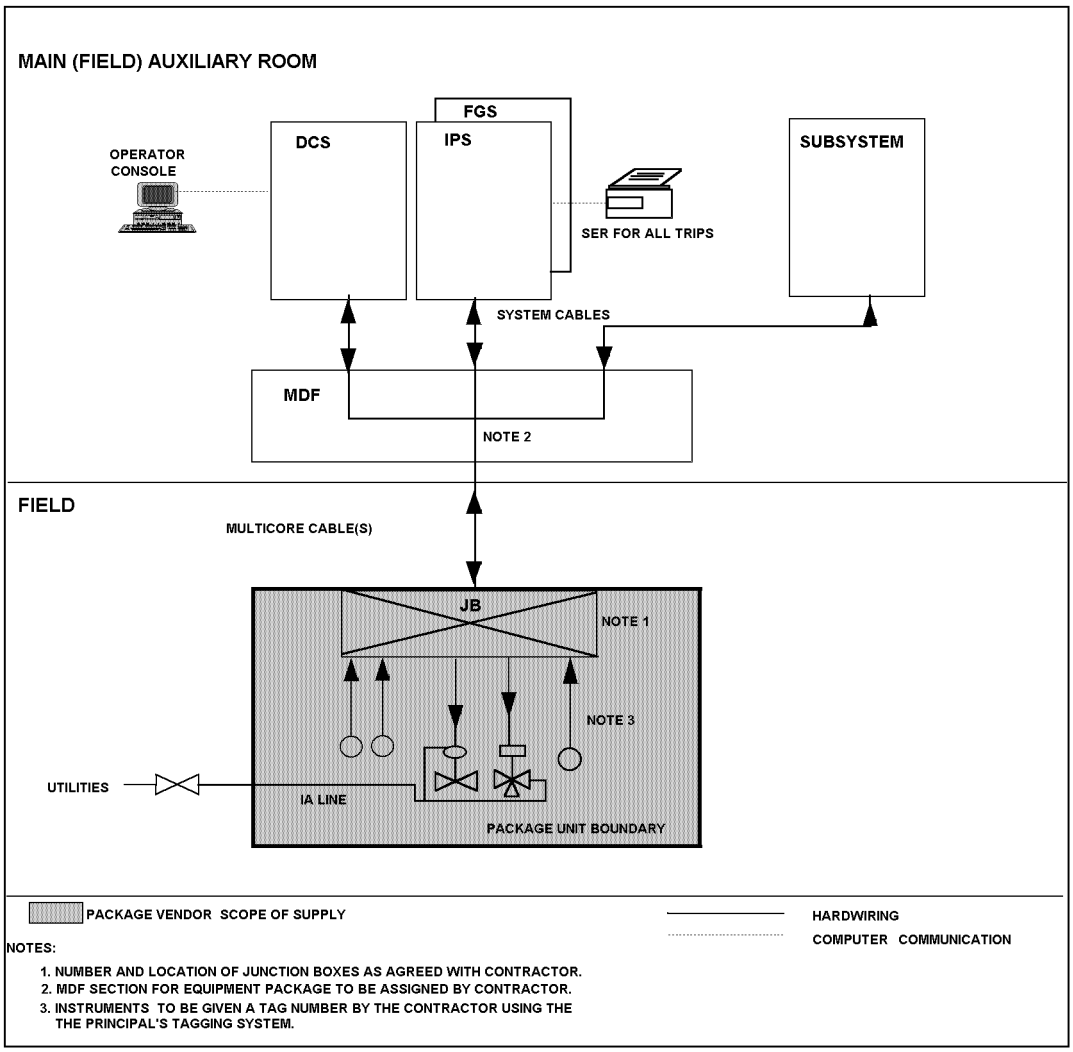
The Vendor's competence is limited to instrumentation which is considered an integral part of the proprietary equipment, and to the installation of installation materials.

3.1.2.3 Scope of Contractor

The Contractor shall design, engineer, supply and install all remaining field instrumentation and all cabling between the field junction box(es) and the (F)AR.

The Contractor shall be responsible for the configuration of the DCS, IPS or subsystem to perform the required control and IPF functionality, etc., in accordance with the Vendor's functional specification.

3.1.3 Option C



3.1.3.1 Scope of Vendor

The Vendor shall supply the equipment package complete with field mounted instruments installed.

All instrumentation in the scope of supply of the Vendor shall be supplied and installed according to the Principal's standards.

The Vendor's scope of supply includes functional specification, special tools, special test equipment, drawings and documents.

3.1.3.2. Vendor Competence

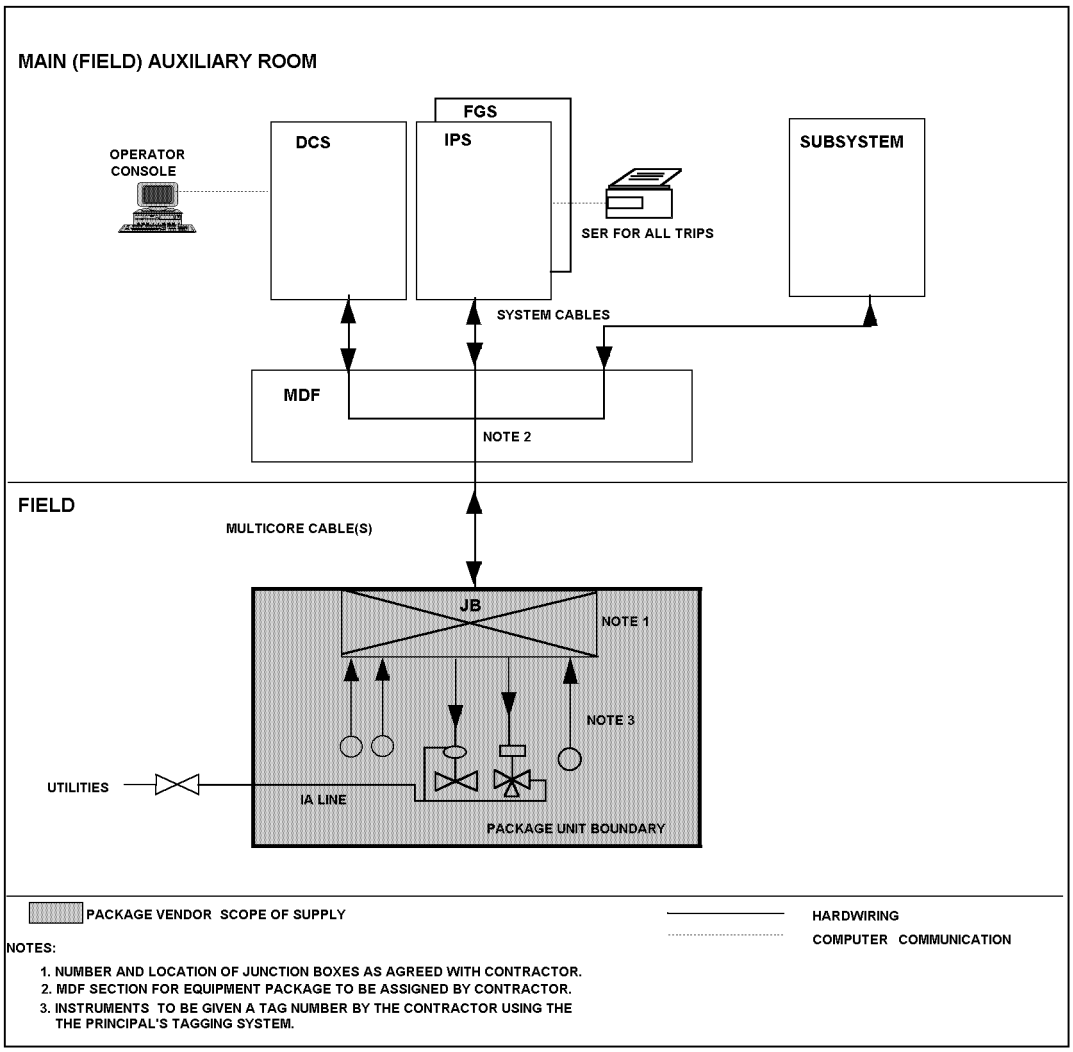
The Vendor shall have been deemed competent by the Principal to meet the Principal's standards.

3.1.3.3. Scope of Contractor

The Contractor shall design, engineer, supply and install all cabling between the field junction box(es) and the (F)AR.

The Contractor shall be responsible for the configuration of the DCS, IPS or sub-system to perform the required control and IPF functionality, etc., in accordance with the Vendor's functional specification.

3.1.4 Option D



3.1.4.1 Scope of Vendor

The Vendor shall supply the equipment package complete with field mounted instruments installed.

All instrumentation in the scope of supply of the Vendor shall be supplied and installed according to the Vendor's standards.

The Vendor's scope of supply shall include the functional specification, special tools, special test equipment, drawings and documents.

3.1.4.2. Vendor Competence

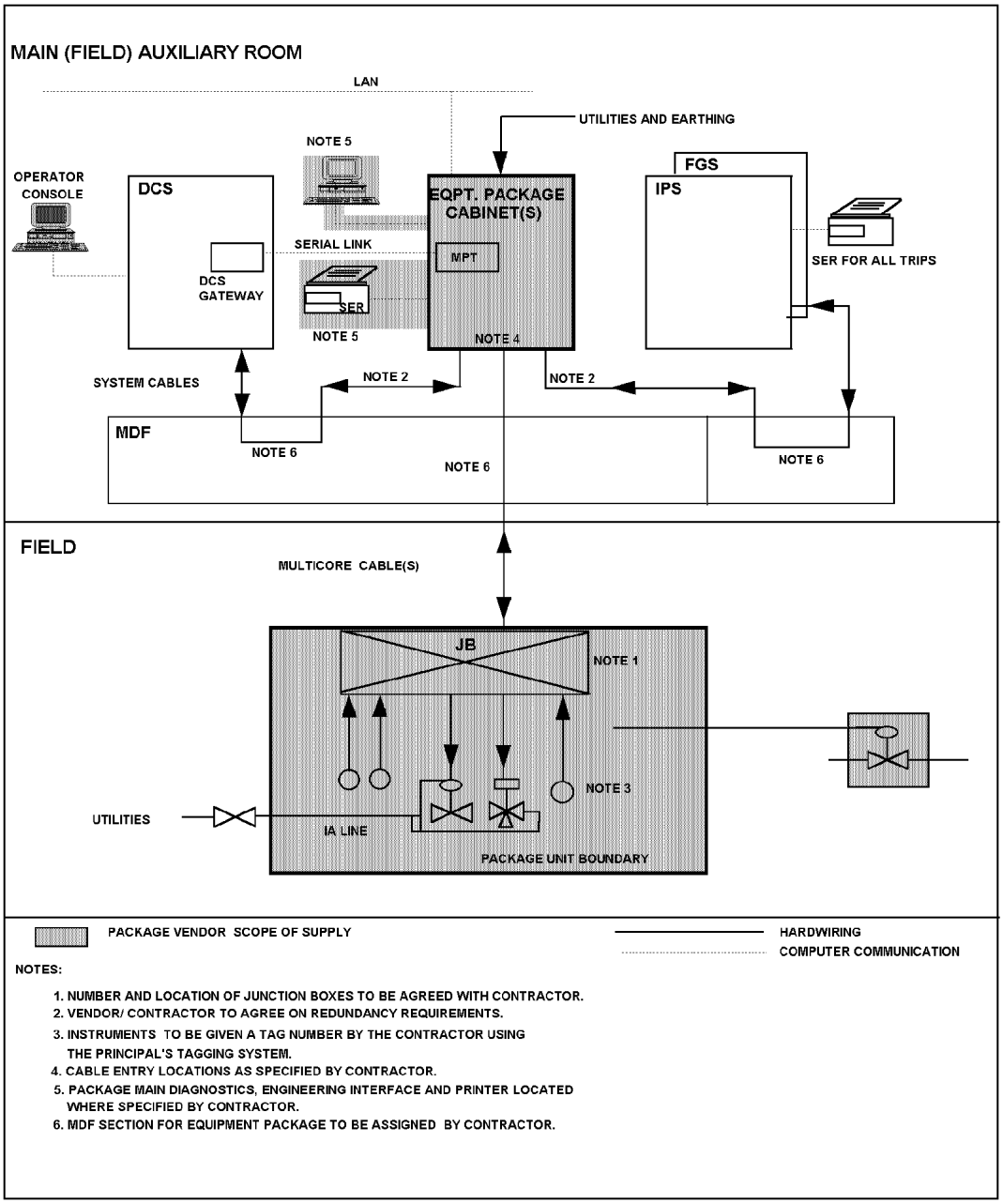
The Vendor's instrumentation standards used for the equipment package shall have been accepted by the Principal.

3.1.4.3. Scope of Contractor

The Contractor shall design, engineer, supply and install all cabling between the field junction box(es) and the (F)AR.

The Contractor shall be responsible for the configuration of the DCS, IPS or sub-system to perform the required control and IPF functionality, etc., in accordance with the Vendor's functional specification.

3.1.5 Option E



3.1.5.1 Scope of Vendor

The Vendor shall supply the equipment package complete with field instrumentation, control room instrumentation and (F)AR instrumentation. The required control and IPF functionality, etc. are pre-configured in the (F)AR instrumentation. Field instrumentation within the equipment package boundary shall be installed by the Vendor.

All instrumentation shall be supplied to the Principal's standards.

The Vendor's scope of supply shall include the functional specification, special tools, special test equipment, drawings and documents.

3.1.5.2 Vendor's Competence

The Vendor shall have been deemed competent by the Principal to meet the Principal's standards.

The Vendor shall be competent to manage complex interfaces between other equipment and other Vendors.

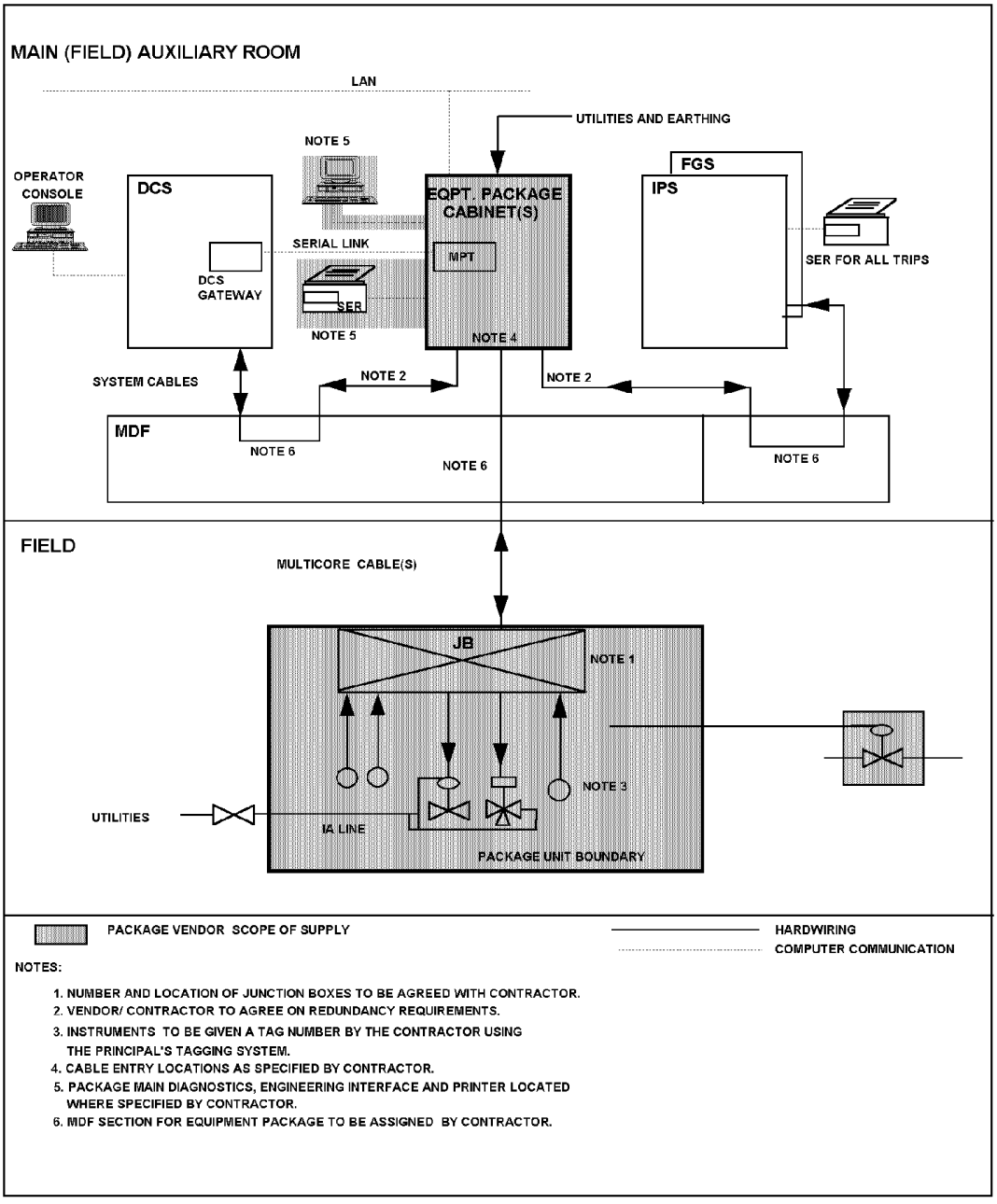
3.1.5.3 Scope of Contractor

The Contractor shall specify, route, supply and install all cabling between the field junction box(es) and the equipment package cabinet(s).

The Contractor shall install all control room and (F)AR equipment and any instrument supplied as part of the package but not installed by the equipment package Vendor.

The Contractor shall be responsible for the interfacing requirements of the equipment package with the DCS and IPS.

3.1.6 Option F



3.1.6.1 Scope of Vendor

The Vendor shall supply the equipment package complete with field instrumentation, control room instrumentation and (F)AR instrumentation. The required control and IPF functionality, etc. shall be pre-configured in the (F)AR instrumentation. Field instrumentation within the equipment package boundary shall be installed by the Vendor.

Instrumentation shall be supplied to the Vendor's standards, except that each instrument shall be given a tag number following the Principal's tagging system.

The Vendor's scope of supply shall include the functional specification, special tools, special test equipment, drawings and documents.

3.1.6.2 Vendor's Competence

The Vendor's instrumentation standards used for the equipment package shall have been

accepted by the Principal.

3.1.6.3 Scope of Contractor

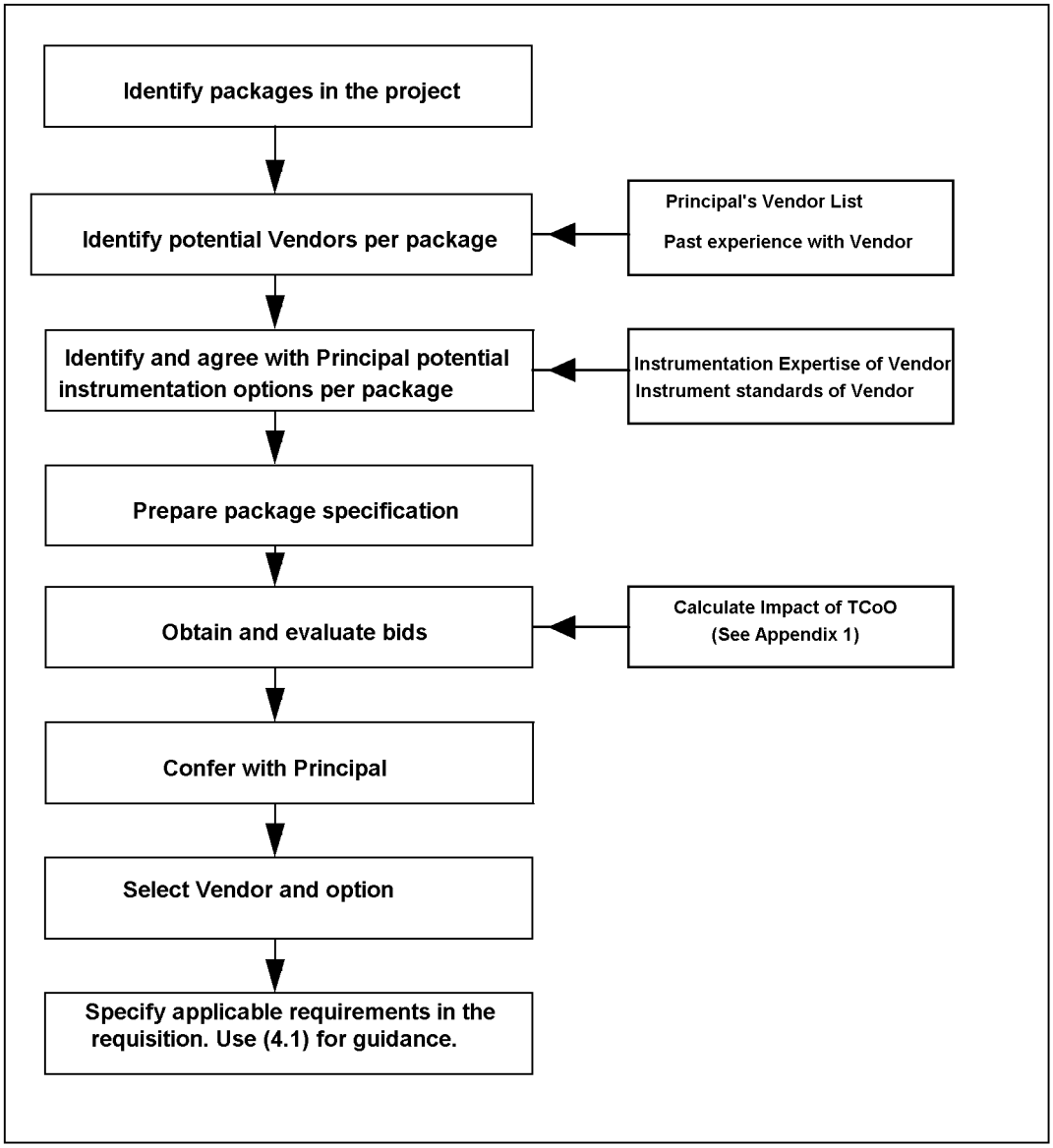
The Contractor shall specify, route, supply and install all cabling between the field junction box(es) and the equipment package cabinet(s).

The Contractor shall install all control room and (F)AR equipment and any instrument supplied as part of the package but not installed by the equipment package Vendor.

The Contractor shall be responsible for the interfacing requirements of the equipment with the DCS and IPS.

3.2 GUIDANCE ON OPTION SELECTION

The flowchart below should be used to select one of the options in (3.1). It describes how the option selection process shall be approached by the Contractor. The Contractor shall demonstrate to the Principal that all steps in the selection process have been followed in selecting the most suitable option for the particular equipment package.



4. SPECIFICATION TABLE AND SPECIFIC CONDITIONS

4.1 SPECIFICATION TABLE

The table below lists the topics which shall be specified relative to the instrumentation scope of supply option selected.

"S" (Specify) means that the topic is applicable for the particular scope of supply option and requirements shall be specified in the requisition based on the referenced standard or section of this DEP.

"V" (Vendor) means that the Vendor's standard is applicable.

"-" (dash) means that the topic/section is not usually applicable for the particular option and does not need to be specified.

Table 2 Specification Table

Amended per Circular 40/99

TOPICS *options →*	*A*	*B*	*C*	*D*	*E*	*F*	*Referenced standard/ section of this DEP*
GENERAL							
Limits of supply	**S**	**S**	**S**	**S**	**S**	**S**	**(4.2)**
Instrumentation Variety Control	**S**	**S**	**S**	**V**	**S**	**V**	**(4.3)**
DESIGN CRITERIA							
Hazardous area classification	**S**	**S**	**S**	**S**	**S**	**S**	**DEP 32.31.00.32-Gen.**
Electrical Safety for instrumentation	**S**	**S**	**S**	**V**	**S**	**V**	**DEP 32.31.00.32-Gen.**
Instrument process connections	**S**	**S**	**S**	**V**	**S**	**V**	**DEP 32.31.00.32-Gen. DEP 32.31.50.10-Gen. DEP 32.31.50.11-Gen.**
Instrument impulse lines	**-**	**S**	**S**	**V**	**S**	**V**	**DEP 32.37.10.11-Gen.**
Instrument air lines	**-**	**S**	**S**	**V**	**S**	**V**	**DEP 32.37.51.11-Gen.**
Instrument signal lines	**-**	**S**	**S**	**V**	**S**	**V**	**DEP 32.37.20.10-Gen.**
Signal transmission type	**-**	**-**	**S**	**S**	**S**	**V**	**DEP 32.31.00.32-Gen.**
Environmental conditions	**S**	**S**	**S**	**S**	**S**	**S**	**DEP 32.31.00.32-Gen.**
Electricity supply	**S**	**S**	**S**	**S**	**S**	**S**	**DEP 33.64.10.10-Gen.**
Earthing	**S**	**S**	**S**	**S**	**S**	**S**	**DEP 32.37.20.10-Gen. DEP 33.64.10.10-Gen.**
Radio frequency interference immunity	**-**	**-**	**S**	**V**	**S**	**V**	**DEP 32.31.00.32-Gen.**
Units of measurement	**S**	**S**	**S**	**V**	**S**	**V**	**DEP 32.31.00.32-Gen.**
INSTRUMENTATION DESIGN							
Field instruments	**-**	**-**	**S**	**V**	**S**	**V**	**DEP 32.31.00.32-Gen.**
Control valves and accessories	**-**	**-**	**S**	**V**	**S**	**V**	**DEP 32.36.01.17-Gen.**
Control system	**-**	**-**	**-**		**S**	**V**	**(4.1)**
IPF/IPS	**-**	**-**	**-**		**S**	**V**	**(4.2) DEP 32.80.10.30-Gen.**
Communication to the plant DCS	**-**	**-**	**-**		**S**	**S**	**(4.5)**
Machine Monitoring system	**-**	**-**	**-**		**S**	**V**	**DEP 32.31.00.32-Gen.**
Instrument nameplates	**V**	**V**	**S**	**V**	**S**	**V**	**DEP 32.31.00.32-Gen.**
Instrument tag numbering	**S**	**S**	**S**	**S**	**S**	**S**	**DEP 32.10.03.10-Gen.**
QUALITY CONTROL							
Functional, performance and interface test	**-**	**-**	**S**	**S**	**S**	**S**	**(4.6)**
DRAWINGS AND DOCUMENTS							
Documentation with the quotation	**S**	**S**	**S**	**S**	**S**	**S**	**(4.7.1)**
Documentation deliverable	**S**	**S**	**S**	**S**	**S**	**S**	**(4.7.2) DEP 32.10.03.10-Gen. DEP 32.31.00.34-Gen.**
AFTER SALES SERVICE							
Maintenance and support services	**-**	**-**	**S**	**S**	**S**	**S**	**(4.8.1)**
Site support during construction and commissioning	**-**	**-**	**S**	**S**	**S**	**S**	**(4.8.2)**
TRAINING	**-**	**-**	**S**	**S**	**S**	**S**	**(4.9)**

4.2 LIMITS OF SUPPLY

The Vendor shall provide junction boxes, electrical connections and air supply connections at the battery limit of the skid to provide an interface for the Principal's cabling and instrument air supply.

The Contractor shall be responsible for the interface between the equipment package and the rest of the plant.

4.3 INSTRUMENTATION VARIETY CONTROL

Except for Options D and E, field instruments, control and logic sequence system, IPS, accessories and installation materials of the equipment package, and instrumentation shall be supplied in accordance with the Principal's Project List of Selected Instrument Vendors and Equipment which shall be supplied together with the requisition.

4.4 CONTROL AND IPF

Control and IPF for the equipment package shall be implemented in separate systems. The

Principal's approval shall be obtained where control and IPF functions are to be implemented together in one system.

4.4.1 Control

Control equipment CPU, power supply units and internal communication buses shall be redundant.

Control input cards and control output cards shall be redundant unless single loop integrity is implemented.

The equipment package control system shall communicate with the plant DCS or SCADA for indications and alarms as described in (4.5).

4.4.2 IPF

DEP 32.80.10.30-Gen. shall be applied for PLC-based IPS and may also be used for solid state or magnetic core IPSs.

4.5 COMMUNICATION TO THE PLANT'S DCS

Communication between the packaged unit control system and IPS and the plant DCS shall be implemented via galvanically isolated serial communication links using the Modbus RTU protocol. Redundancy requirements shall be indicated in the requisition. The Contractor shall ensure that the equipment package Vendor details the hardware and software requirements with the DCS Vendor to enable inter-system communication.

All signals generated from the equipment package control system and IPS shall be available for transmission to the plant DCS within one second. The Vendor shall indicate the refresh rate of analog signals in his system.

The Contractor shall specify the amount and type of data that will be transmitted to the DCS, together with the required faceplates, graphics, trends, etc. which shall be made available on the DCS operator interface. The equipment package Vendor shall configure his system for transmitting the specified amount and type of data and work out with the DCS Vendor how the data will be received together with the required presentation format at the operator interface.

Where the equipment package unit control system or IPS makes use of another transmission protocol as a standard, the equipment package Vendor shall confirm with the DCS Vendor that this particular protocol can be implemented in the plant DCS. The Vendor shall further demonstrate that the protocol is industry-tested and proven. The Principal's approval shall be obtained for the use of such transmission protocols.

The Contractor shall have the final responsibility of ensuring satisfactory communications with the plant DCS.

4.6 FUNCTIONAL, PERFORMANCE AND INTERFACE TEST

The Vendor shall prepare a FAT procedure and schedule for the Contractor and Principal's approval. The purpose of this FAT is to demonstrate with a total system functional test, that the operation of the control, monitoring, IPF and logic systems included in the equipment package perform as specified in the requisition.

The functional test shall include the communication link to the plant DCS. The Vendor shall provide the necessary equipment to demonstrate the full functionality of the communication links.

The functional test record shall include all the pre-set values.

The Contractor shall prepare a punch list of non-conforming items and correct them before the functional test is agreed as complete.

4.7 DRAWINGS AND DOCUMENTS

4.7.1 Documentation to be provided with the quotation

The Contractor shall obtain from the Vendor the necessary documents and drawings which will assist him in the option selection process in (3). This includes documents describing Vendor competence, instrument scope of supply approach relative to options in (3) and the standards to be used for instrumentation.

4.7.2 Documentation to be provided with the equipment

Documentation shall be provided as detailed in the general specifications for equipment packages. Unless specified differently in project or local site requirements at least the following instrumentation documentation shall be provided:

1) Instrumentation loop and block diagrams for the control and operation of the equipment, showing all instrumentation together with connections required, using the Principal's instrument symbols and tag numbering system.

   NOTE: Blocks of tag numbers should be provided by the Contractor to the Vendor as early as possible.

2) Functional logic diagrams and function descriptions for start-up, sequence control, IPF and (emergency) shutdown procedures.
3) A list of all instruments, giving the make and type, operating data, length of thermowells.
4) Typical process hook-up drawings.
5) Equipment lay-out drawings, showing the location of the instruments, junction boxes, (local) instrument panels, the cable routing between the individual instruments, junction boxes and panels, etc.
6) If cable junction boxes are included in the supply of the equipment, the documentation shall include terminal arrangement, signal wire allocation and make, type and size of the cable glands.
7) All equipment calculation sheets, e.g. for control valves and flow measuring devices.
8) A list of the trip and alarm settings.
9) Full documentation of all application software for the equipment package, and copies of the program listing. The Principal shall specify if the source codes for the software are also required.
10) All operations and maintenance manuals for the equipment package.
11) SPIR (Spare Parts Interchangeability Record). Where possible, the electronic version (E-SPIR) should be used. See DEP 70.10.90.11-Gen.
12) FAT procedure and schedule.
13) Any other documents which may be requested by the Principal.

4.8 AFTER SALES SERVICE

4.8.1 General

If there is a local representation, the Vendor shall indicate how and in what time and what kind of services can be made available at site.

The Vendor shall quote for the various forms of maintenance and support services agreements he can offer plus details of his spare parts holding.

4.8.2 Site Support during construction and commissioning

The Vendor shall quote for support to check whether or not the system installation conforms to the Vendor's specification as well as for start-up commissioning assistance.

4.9 TRAINING

The Vendor shall quote what training can be provided both at his works and on site for instrument, maintenance and design engineers, maintenance technicians and operators.

For each training programme the following shall be provided:

- Types of courses
- Duration periods of courses
- Cost per course per person and maximum number of participants (at Vendor's works and at site)
- Training documentation provided
- Prerequisite knowledge of the participants.
- Scope of the course and who should attend it.

5. REFERENCES

In this DEP reference is made to the following publications:

NOTE: Unless specifically designated by date, the latest edition of each publication shall be used, together with any amendments/supplements/revisions thereto.

Amended per Circular 40/99

SHELL STANDARDS

Index to DEP publications and standard specifications	DEP 00.00.05.05-Gen.
Instrumentation symbols and identification on Process Engineering flow schemes	DEP 32.10.03.10-Gen.
Instruments for measurement and control	DEP 32.31.00.32-Gen.
Instrumentation documents and drawings	DEP 32.31.00.34-Gen.
On-line process stream analysis- Sample take-off and transportation	DEP 32.31.50.10-Gen.
On-line process stream analysis- Sample conditioning	DEP 32.31.50.11-Gen.
Control valves: Selection and specification	DEP 32.36.01.17-Gen.
Instrument impulse lines	DEP 32.37.10.11-Gen.
Instrument signal lines	DEP 32.37.20.10-Gen.
Instrument air lines	DEP 32.37.51.11-Gen.
PLC base instrumented protective systems	DEP 32.80.10.30-Gen.
Electrical engineering guidelines	DEP 33.64.10.10-Gen.
Spare parts	DEP 70.10.90.11-Gen.

6. BIBLIOGRAPHY

In preparing this DEP, information has been used from the documents listed below:

NOTE: The following documents are for information only and do not form an integral part of this DEP.

The Total Cost of Ownership Series
SIPM EP/PT TCoO - Implementation Project Team

Implementing Total Cost of Ownership Route Map

TCoO Introduction and Generic Process Model EP 94-0351 / PT 94-4018

"Dos" and "Don'ts" TCoO - Key Cost Drivers EP 95-0535 / PT 95-003

Performance Indexing, A Tool for Managing TCoO EP 94-0354 / PT 94-4021

Modern Cost Engineering: Methods and Data Volume II.
Chemical Engineering Magazine 1984, Mc Graw Hill Pub. Co.

APPENDIX 1 HOW TO CALCULATE TOTAL COST OF OWNERSHIP (TCoO)

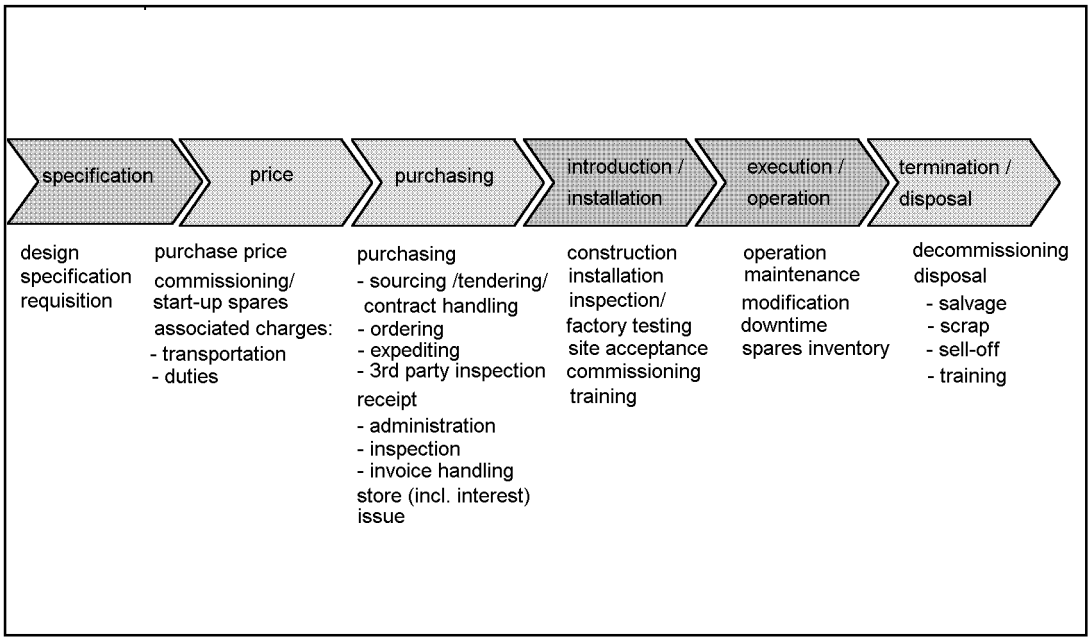
1. From Figure 1, select TCoO cost drivers for the equipment package. See TCoO main cost driver matrix in Figure 2.
2. Prepare a spreadsheet detailing cost cash flow profile as shown in Figure 3.
3. If appropriate, correct the cost values for inflation, depreciation, taxation, etc.
4. Calculate present values (PV) using discounted cash flow (DCF) formula.

NOTE: 1. Spreadsheet softwares usually have a built in DCF calculation function.

2. DCF formulas for PV covering fixed amount and annuities are shown in Figure 4.

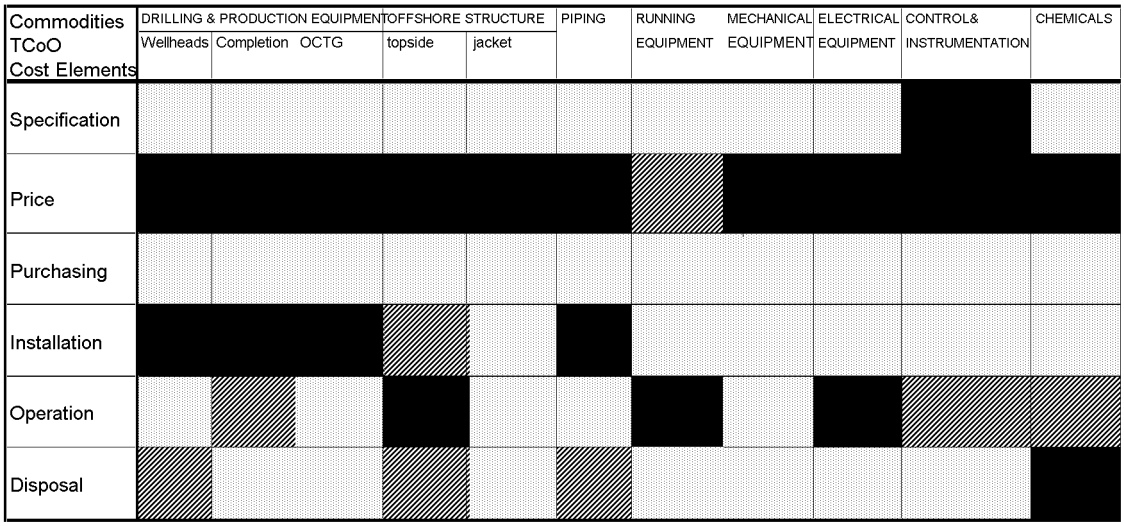
5. Sum of PVs is the present value of the TCoO.

Figure 1 TCoO Cost Element Chain



NOTE: Items listed above are commonly encountered cost elements in the TCoO cost chain. Other specific cost items can be added in the above cost chain.

Figure 2 TCoO Main Cost Driver Matrix



=dominant cost driver = major cost driver = minor cost driver

HOW TO USE THE ABOVE MATRIX

1. Derive the TCOO profile of concerned good or service. (Take the above profile as check)
2. Quantify (calculated or estimated) at least the dominant and main cost drivers prior to deciding on what to buy.
3. Focus efforts on dominant and main cost drivers.

NOTE: Main cost drivers in specific cases may differ significantly from the generalized case presented here!

Figure 3 Cost Cashflow Profile Spreadsheet

						year 0 constant monev in GBP.						
COMPRESSOR TCoO cost cashflow profile .												
		year										
COST ELEMENT		-1	0	1	2	3	4	5		23	24	25
specification	design	10189										
	specification	5599										
	requisition	3232										
	ass. cost	600										
price	purchase price		334285									
	commissioning /start up spares		800									
	transportation		4488									
	ass. cost											
purchasing	sourcing		42503									
	ordering		6191									
	expediting		19175									
	3rd party inspection											
	receipt admin.											
	inspection		11586									
	invoice handling		400									
	storage											
	issue											
	doc.review		15049									
	spec. updating		15086									
	spares man.		4920									
	ass. cost											
installation	construction											
	installation		15100									
	inspection											
	site acceptance											
	commissioning		14650									
	training											
	planning											
	ass. cost											
operation	operations /utilities			77750	77750	77750	77750	77		77750	77750	77750
	maintenance av.			3222	3222	3222	3222	3		3222	3222	3222
	downtime											
	spares		80568									
	ass. cost											
disposal	decommissioning											1000
	disposal											
	salvage											
	scrap											
	sell-off											
	training											
	ass. cost											

Figure 4 DCF formulas for PV covering fixed amount and annuities.

The Present Value of an amount C in year n is given by the following formula:

$$PV_{C_n} = C_n \, (\, 1/(1+i)^n \,)$$

where i = interest rate (given for a particular project)
and n = the year in which the interest is compounded.

The Present Value of an annuity C up to year n is given by the following formula:

$$PV_C = C\left(\frac{((1+i)^n - 1)}{(i(1+i)^n)}\right)$$

where i = interest rate (given for a particular project)
and n = the year in which the interest is compounded.