TECHNICAL SPECIFICATION

INSTRUMENTED PROTECTIVE SYSTEMS

DEP 32.80.10.30-Gen.

July 1996

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.

When Contractors or Manufacturers/Suppliers use DEPs they shall be solely responsible for the quality of work and the attainment of the required design and engineering standards. In particular, for those requirements not specifically covered, the Principal will expect them to follow those design and engineering practices which will achieve the same level of integrity as reflected in the DEPs. If in doubt, the Contractor or Manufacturer/Supplier shall, without detracting from his own responsibility, consult the Principal or its technical advisor.

The right to use DEPs is granted by SIOP, SIEP or SIC, in most cases under Service Agreements primarily with companies of the Royal Dutch/Shell Group and other companies receiving technical advice and services from SIOP, SIEP or SIC. Consequently, three categories of users of DEPs can be distinguished:

1) Operating companies having a Service Agreement with SIOP, SIEP, SIC or other Service Company. The use of DEPs by these Operating companies is subject in all respects to the terms and conditions of the relevant Service Agreement.

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.

Without prejudice to any specific terms in respect of confidentiality under relevant contractual arrangements, DEPs shall not, without the prior written consent of SIOP and SIEP, be disclosed by users to any company or person whomsoever and the DEPs shall be used exclusively for the purpose for which they have been provided to the user. They shall be returned after use, including any copies which shall only be made by users with the express prior written consent of SIOP and SIEP. The copyright of DEPs vests in SIOP and SIEP. Users shall arrange for DEPs to be held in safe custody and SIOP or SIEP may at any time require information satisfactory to them in order to ascertain how users implement this requirement.

All administrative queries should be directed to the DEP Administrator in SIOP.

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.

TABLE OF CONTENTS

1. INTRODUCTION

1.1 SCOPE

This DEP, which is a revision of the DEP of the same number dated December 1993, specifies requirements and gives recommendations for project design engineers in defining the requirements for Instrumented Protective Systems (IPSs) (including Fire, Gas and Smoke detection and protection systems (FGSs)).

Use of this DEP is intended to lead to comparable Supplier quotations and to improve the efficiency of system evaluation and selection. Project specific amendments may be made in the requisition.

The document is written for projects on sites with no existing IPS. If it is used for additions to existing systems, adjustments may be required, e.g. SER data highway material may be copper instead of the specified fibre optic. In such cases, the user shall carefully screen this DEP and make the required amendments in the requisition.

Excluded from the scope of this DEP are pneumatic or hydraulic types of IPSs and the installation and maintenance of the IPS.

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 and Manufacturers/Suppliers nominated by them (i.e. the distribution code is "F" 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 the more stringent and which combination of requirements will be acceptable as regards 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 and/or local regulations. The Principal may then negotiate with the Authorities concerned with the object 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** 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

Fail Safe
A concept that defines the failure direction of a component or system as a result of specific malfunctions. That failure direction is towards a safer or less hazardous condition.

Failure
Actual performance falls short of specified performance.

Final Element
A device or combination of devices that manipulate a process variable or attract the attention of the operator to achieve risk reduction. The Final Element includes output cards or output relays, solenoid valves and cabling. Examples are valves, switchgear (rotating equipment stop circuits) and alarms.

Initiator
A device or combination of devices that indicates whether a process or equipment item is operating outside the operating envelope. The Initiator includes input cards and input relays. Examples are manual switches, position switches and measurement systems (including process connections, sensors, transmitters, cabling, trip amplifiers or input cards etc.).

Instrumented Protective Function
A function comprising the Initiator function, Logic Solver function and Final Element function for the purpose of preventing or mitigating Hazardous Situations.

Instrumented Protective Function Class
Unrevealed Failure class I, II, III, IV, V, VI and X, plus Revealed Failure class F or N detailing the requirements for an Instrumented Protective Function.

Instrumented Protective System
The electromechanical, electronic and/or programmable electronic Logic Solver component of the Instrumented Protective Function, complete with input and output equipment.

Requisition
The Data/Requisition sheets DEP 32.80.10.93-Gen. contained in the Requisitioning binder (DEP 30.10.01.10-Gen.).

Revealed Failure
A failure whose occurrence is inherently apparent.

Revealed Failure Robust
A configuration in which plant availability is not jeopardised by the Revealed Failure of a single IPF component.

Trip
An Instrumented Protective Function action to bring the Final Element(s) to a safe state.

Unrevealed Failure
A failure which is dormant in the Instrumented Protective Function and can only be revealed when the system has to perform a certain action or through testing.

Unrevealed Failure Robust
A configuration in which plant safety is not jeopardised by the Unrevealed Failure of a single IPF component.

1.4 ABBREVIATIONS

ac	Alternating Current
AK	Anforderungsklasse (requirement class)
CPU	Central processing unit
dc	Direct current
DCS	Digital control system
DIN	Deutsche Industrie Norm (German industrial standard)
EPROM	Erasable programmable read-only memory
FGS	Fire gas and smoke detection and protection system
FAT	Factory acceptance test
FLD	Functional logic diagrams
I/O	Input/output
IPF	Instrumented protective function
IPS	Instrumented protective system
MOS	Maintenance override switch
PC	Personal computer
PLC	Programmable logic controller
RAM	Random access memory
RLL	Relay ladder logics
RTU	Remote transmission unit
SER	Sequence of events recorder
SFC	Sequential function charts
SPIR	Spare parts and interchangeability record
TÜV	Technischer Überwachungsverein (German body, translates to Technical Inspection Agency).

NOTE Throughout this DEP, reference to TÜV means either TÜV Bayern or TÜV Rheinland.

UZ	Tag numbering system to indicate IPF group

1.5 ACTION ITEMS

A list of action items which need to be resolved when using this DEP is given in the requisition. The action items are cross-referenced to the appropriate section of this DEP.

1.6 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section number is shown in brackets. Other documents referenced in this DEP are listed in (18.).

2. GENERAL INFORMATION

2.1 GENERAL

2.1.1 This DEP covers the hardware definition, functional requirements and engineering support services necessary to design, manufacture, test and deliver IPSs, FGSs and the SER system. The relevant project name and number shall be indicated in the requisition.

2.1.2 The quotation shall be based on this DEP and the requisition.

2.1.3 The operator interface is entirely implemented through the DCS hence extensive communication with the DCS is specified.

2.1.4 The primary purpose of the IPS is to perform IPFs, the secondary purpose is to act as an SER.

2.1.5 The requirements stated in this DEP are closely related to the requirements in DEP 32.80.10.10-Gen.

2.2 PARTIES INVOLVED

2.2.1 Principal
The Principal shall be identified in the requisition.

2.2.2 Manufacturer/Supplier
The IPS Manufacturer/Supplier is referred to as the Supplier.

2.2.3 DCS Manufacturer/Supplier
The DCS Manufacturer/Supplier shall be identified in the requisition and is referred to as the DCS Supplier.

2.2.4 Contractor
The Contractor shall be identified in the requisition.

2.3 LAYOUT AND OVERVIEW

2.3.1 A simplified plant layout shall be given in the requisition.

2.3.2 The suggested system overview shall be given in the requisition.

2.3.3 The allocation of the various units and IPF groups to the IPS cabinets, racks and cards shall be specified in the requisition.

3. SCOPE OF SUPPLY

3.1 SCOPE

3.1.1 Manufacture and supply of TÜV-approved IPSs, including the IPS to IPS communication network. The type of IPS shall be indicated in the requisition.

3.1.2 Supply of TÜV-approved system software, if applicable.

3.1.3 Fulfilment of the following engineering tasks:

a. Configuration of I/O as per the I/O listings given in the requisition and/or provided on a medium indicated in the requisition.
b. Configuration of the IPS - DCS serial communications in accordance with communication listings given in the requisition.
c. Configuration of the IPS to perform the functions as detailed in the Principal's documents indicated in the requisition and provided on a medium as indicated in the requisition.
d. Configuration of trip settings, timers etc.
e. Factory Acceptance Testing (FAT) of the systems.

3.1.4 The requisition shall specify whether a (portable) PC based IPS engineering/diagnostic workstation is required.

3.1.5 Supply of an IPS SER (including printer) and an SER and maintenance and engineering network.

3.1.6 The IPS to IPS communication network and the SER and maintenance and engineering network fibre optic field cabling fall within the Principal's scope of supply. The Supplier shall provide the copper-to-fibre and fibre-to-copper converters. The Supplier shall specify the cable requirements and allowable attenuation.

3.1.7 The requisition shall specify whether re-programming equipment (EPROM programmer) is required.

3.1.8 Supply and engineering of all interface hardware and software to allow communication with the DCS, either direct or via gateways. The gateways in the DCS fall within the DCS Supplier's scope of supply.

3.1.9 Provide site assistance for specified installation and commissioning activities.

3.1.10 Packing, shipping and insurance up to and including point of delivery.

3.1.11 Supply of spare parts for the guarantee period.

3.1.12 Supply of documentation.

3.1.13 Training.

4. APPLICABLE DOCUMENTS

4.1 This DEP together with the requisition.

4.2 A number of documents as indicated in the requisition (e.g. FLDs) will only be available after order placement. The Supplier shall assume a typical complexity for petrochemical plants and oil/gas processing facilities and relate the engineering effort to the I/O list.

5. SYSTEM REQUIREMENTS

5.1 FUNCTIONALITY

5.1.1 The IPS shall be normally energised except for lamp outputs. A "1" logic signal is considered to be the normal state, and a "0" logic signal the abnormal (trip or failure) state. Output signals should go to a "0" (de-energised) state on power failure or on component failure.

NOTE Outputs which are energised to trip, such as in some cases emergency depressurising and FGS outputs, shall have line monitoring and earth fault detection for each output channel, see (5.9.4.3).

5.1.2 For commissioning purposes it shall be possible to force I/O signals to certain states via the engineering workstation. This forcing feature shall be under key-lock, and forcing shall be ineffective when the key is removed.

5.1.3 Loss of data communication with the DCS or in the SER and maintenance and engineering network shall not result in trips or status changes of the IPS communication points. Recovery of communication shall be automatic. The Supplier shall indicate the type of output (hardwired) that can be made available to permit (back-up) annunciation of communication failure at the DCS operator workstation.

5.1.4 The operator shall be continuously informed of the system status by means of IPS system and utility alarms transmitted to the DCS. As these are Supplier-specific, they are not included in the I/O listing provided by the Principal, but shall be included in the scope.

5.1.5 As a minimum a common cabinet utility alarm and a common system alarm shall be transmitted to the DCS for the attention of the operator.

5.1.6 For IPS system alarms and IPS utility alarms, extra (or all) diagnostic information may be transmitted from the IPS to the DCS in addition to the common alarms. This shall be indicated in the requisition.

5.1.7 A hard wired alarm shall be provided for total IPS failure.

5.1.8 The Supplier shall provide a list of those parameters that may cause a trip if not properly set.

5.2 CERTIFICATION

5.2.1 Where "TÜV-approved" or "TÜV-certified" is specified in this DEP, this shall be in accordance with DIN V VDE 0801 and DIN V 19250. The required AK class shall be indicated in the requisition.

5.2.2 The IPS hardware and system software (if applicable) shall be certified by TÜV.

5.2.3 All input and output cards shall be TÜV-approved.

5.2.4 All input and output cards shall be fail safe except for those outputs driving IPF class I or II outputs (not safety related) and those driving alarm lamps, as indicated in the requisition.

5.2.5 All conditions regarding application of the IPS listed in the TÜV approval report and in the IPS safety manual shall be met.

5.2.6 Disagreements between this DEP and the constraints of the TÜV approval report shall be indicated in the quotation.

5.2.7 TÜV certification shall include the serial communication with the DCS, SER and maintenance and engineering network, and IPS to IPS communication. The IPS shall be unresponsive to faults in the DCS, SER and maintenance and engineering workstation.

5.3 RESPONSE TIME

5.3.1 The cycle time of the IPS shall be maximum 300 ms. This results in a time from input change to output response of less than 600 ms with all spare capacity occupied. Based on the application, the cycle time requirements may be more stringent and shall be stated in the requisition. For FGSs, the maximum cycle time shall be 500 ms.

5.3.2 The Supplier shall indicate in the quotation the system base load (overhead) and the I/O load in terms of response time.

5.4 QUALITY

5.4.1 The hardware and software products quoted shall have a proven field record. The Supplier shall include a reference list in the quotation giving technical order size, year, hardware and software revision levels.

5.4.2 The Supplier shall specify which burn-in and heat cycle tests will be performed.

5.5 REVEALED FAILURE ROBUSTNESS

5.5.1 CPUs, if used in an IPS, shall be revealed failure robust.

5.5.2 Revealed failure robust internal communication busses and IPS to IPS communication links shall be used.

5.5.3 If the application logic is performed by solid-state, magnetic-core or relay cards, these cards are not required to be revealed failure robust.

5.5.4 The IPS-DCS communication and the SER and maintenance and engineering networks shall be revealed failure robust.

5.5.5 Unless otherwise indicated in the requisition, revealed failure robust analogue and digital input cards shall be used for those inputs performing executive actions.

5.5.6 Unless otherwise indicated in the requisition, digital output cards shall be revealed failure robust, except for those outputs driving alarm lamps.

5.5.7 If a revealed failure robust component fails the other(s) shall continue to operate in 'crippled mode'. In this crippled mode operation, a time limit of up to 72 hours (actual time limit depends on the application and shall be stated in the requisition) shall be defined to allow for sufficient repair time of the faulty component. Without corrective action and after this time period, the outputs concerned shall de-energise. The time outstanding shall be transmitted to the DCS for information to the operator.

5.5.8 In the event of a failure of a revealed failure robust component, power supply or other function, the system shall change over to crippled mode operation without causing spurious trips, and shall give an indication of fault type and location.

5.5.9 The Supplier shall specify if there are cases where replacement of a component can lead to a complete IPS stop, de-energising of outputs or any loss of functionality (e.g. detection of trip conditions).

5.6 RESPONSIBILITIES

5.6.1 The Supplier is responsible for the selection of components to perform the functions as described in the functional logic diagrams, narratives or other documents.

5.6.2 The Supplier is responsible for the layout of the cards in the racks in accordance with the requirements given in this DEP.

5.7 STRUCTURE

5.7.1 The requisition shall indicate a suggested number of independent IPSs. This number shall be based on the relation, operation and maintenance of the various process units. The Supplier shall verify the resulting IPS loading and cycle time and propose a different arrangement of IPSs where required in order to comply with loading criteria.

NOTE Major process equipment such as boilers, turbines and compressors that are redundant shall be engineered into separate IPSs. Process units that are independent from each other, i.e. can be operated whilst other process units are shut down, shall be implemented in separate IPSs.

5.7.2 Each process unit may contain more than one separate IPF group (UZ). In general one I/O card shall not contain the I/O of more than one process unit. Non FGS related lamp outputs may be combined, i.e. no process unit split is necessary. Cards belonging to one UZ group shall be grouped together. Any exceptions to these rules shall be stated in the requisition.

5.7.3 Each IPS shall operate independently of other IPSs, except for the communication links.

5.7.4 Signals for IPFs of IPF class III and higher (and IPF class II if implemented in the IPS) shall be communicated through the IPS to IPS communication link. The communication route via the DCS, or via the SER and maintenance and engineering network, shall not be used for this purpose.

5.7.5 The suggested system overview shall be indicated by the Principal in the requisition.

5.8 SPARE CAPACITY

5.8.1 The minimum hardware spare capacity per process unit, in terms of unused I/O channels and power supply, shall be indicated in the requisition. These spare I/O channels shall be fully wired to Elco sockets/interconnection boards.

5.8.2 The hardware spare capacity, in terms of spare I/O card positions over and above the installed spare capacity, shall be indicated in the requisition. The requisition shall also indicate whether or not these spare card positions shall be wired to Elco sockets.

5.8.3 The application software spare capacity for the IPS-PLC (if applicable), for the SER PC and for communication links shall be 15% at plant start-up. The cycle time calculations shall be based on the assumption that all spare capacity is used.

5.8.4 The Supplier shall propose the minimum required number of different card types.

EXAMPLE: If 20 digital outputs are required within one process unit (excluding spares) and the Supplier has standard 8 and 16 channels cards, the Supplier shall propose three 8 channel cards or two 16 channel cards, not one 16 channel card plus one 8 channel card.

5.8.5 If major cost reductions are possible by introducing more card types, the Supplier shall provide options to achieve a balance between minimum number of card types and system cost.

5.9 SYSTEM HARDWARE

5.9.1 General

5.9.1.1 Input and output cards shall have electrical isolation between field equipment and the IPS.

5.9.1.2 Unrevealed or revealed failure robust inputs shall be wired to separate revealed failure robust sets of input cards.

5.9.1.3 It shall be possible to replace cards without switching off the power and without disturbing the process.

5.9.1.4 Short circuiting of individual inputs and outputs shall not affect other inputs and outputs respectively. The use of fuses for the protection of individual inputs and outputs shall be avoided.

5.9.1.5 To assess the Supplier's recommendation for spare parts, theoretical failure rate figures according to MIL-HDBK-217 of all boards, power supply units and other functional sub-assemblies in the system shall be given in the quotation. Calculations shall be based on the worst case and the normal environmental conditions specified in (8.).

5.9.1.6 The Supplier shall indicate whether anti-static precautions are necessary when handling cards. If such precautions are required, grounding wrist straps shall be supplied as permanently installed items.

5.9.2 Analogue Inputs

5.9.2.1 The IPS shall be able to receive the following types of input signals:
- 4-20 mA, non-earthed, passive, 24 V(dc), 2-wire;
- 4-20 mA, non-earthed, active, 24 V(dc), 2-wire;
- 3 or 4 wire platinum resistance temperature detector (RTD);
- pulse/frequency;
- type K, J, or B thermocouples.

5.9.2.2 The requisition shall indicate to which signals square root extraction is applicable.

5.9.2.3 Analogue inputs shall have open and short circuit and out-of-range detection. The range shall be configurable per input channel. The detected results shall be available for use in the application logic. Therefore transmitters, including those used for high trip functions, shall be direct acting.

5.9.2.4 The power for field mounted passive 4-20 mA transmitters connected to the IPS shall be supplied by the IPS.

5.9.3 Digital Inputs

5.9.3.1 The IPS shall provide the wetting voltage for digital inputs which are connected to switches which have voltage free contacts (e.g. reset and Emergency Shutdown switches).

5.9.3.2 For solid state sensors (e.g. proximity sensors) voltage carrying inputs shall be provided.

5.9.3.3 Normally Open digital inputs shall be provided with open and short circuit detection per input channel. The detection results shall be available for use in the application logic. Normally open digital inputs for field mounted reset switches, MOS enable switches, lamp test, acknowledge and reset switches in local panels do not require open and short circuit detection.

5.9.3.4 IPS PLCs, in addition to their normal connection to fail safe input cards, shall allow IPF class VI trip functions to be connected (hard wired) to either the watchdog or a secondary power disconnection device of the output card(s) on which the action has to take place. This function shall not be provided by application software. Applicable tag numbers shall be indicated in the requisition.

5.9.4 Digital Outputs

5.9.4.1 The IPS shall provide the power for the output circuit loads.

5.9.4.2 The following output types shall be supported:

- Solenoid valves with coil voltage of 24 V(dc). The power consumption shall be indicated in the requisition.
- Interfacing relays (to motor control units) with coil voltage of 24 V(dc) and power consumption of 3 W.
- Control room and/or local panel alarm lights with lamp rating of 24 V(dc) and power consumption of 3 W.

5.9.4.3 Normally De-Energised outputs, except for lamp outputs, shall be provided with open and short circuit and earth fault detection per output channel. The detection results shall be available for use in the application logic. The detection shall be independent of cable length between output card and final element.

NOTE The IPS-PLCs are designed, especially with respect to the internal diagnostics, for the de-energised signal being the safe state of inputs and outputs. For normally de-energised (NDE) applications which do not employ an external inverter such as a relay, the IPS-PLC shall also be designed for the energised signal being the safety related input or output state. If this is not the case, inverter relays with the appropriate classification shall be used. The Supplier shall indicate in the quotation whether the IPS is also TÜV certified for the de-energised signal being the safe state of inputs and outputs.

5.9.4.4 IPS-PLC outputs shall not be switched via relay contacts; only solid-state switching shall be used. See also (5.9.4.3).

5.10 SYSTEM AND APPLICATION SOFTWARE

5.10.1 Only the Supplier's standard configuration method (e.g. FLD, RLL or SFC) shall be used. Neither mnemonic nor high level language type programming, such as PASCAL or BASIC, shall be used.

5.10.2 For PLC type IPSs, the setting of trip alarm levels for analogue inputs, setting of timers and selection of normally open or normally closed configuration for digital I/O shall be done by software configuration. For other types of IPSs, this shall be explained by the Supplier in the quotation.

5.10.3 The Supplier shall indicate the facilities and limitations of the system (if any) in performing simple calculations such as compressor surge trip parameters, furnace air-fuel ratio etc.

5.10.4 The Supplier shall indicate whether the combination of inputs into a calculation may be such that a calculation error can occur (e.g. division by zero). In that case the Supplier shall propose the logic changes required to avoid the possible error and request the required actions to be incorporated in the logic in case the input combination is such that a calculation error would occur (e.g. trip the unit or hold the last inputs and alarm the operator).

5.10.5 DCS interface points shall be configurable. Neither mnemonic nor high level language type programming shall be used.

5.10.6 Application programs, if applicable, shall be split into well defined functional modules.

5.10.7 The application programs (software), if applicable, may initially be stored in RAM for system testing, commissioning and plant start-up and shall thereafter be stored either in non-volatile EPROM or in volatile RAM or flash EPROM as indicated in the requisition.

5.10.8 For IPS PLCs, the Supplier shall indicate in the quotation whether de-compile software is supplied with the system. Both the operating system compile software and (if applicable) the de-compile software shall be TÜV approved.

5.10.9 For IPS PLCs, a software package should be supplied which is capable of comparing two application software versions and indicating where the variations have taken place. This package shall be TÜV approved.

5.10.10 Two sets of operating system diskettes shall be supplied. The operating system diskettes shall allow at least 5 installations of the operating system on different PCs for each set of diskettes. If there are limitations with regard to the number of installations, un-install utilities shall be provided.

5.11 COMMUNICATION IPS - DCS

5.11.1 Each IPS shall communicate via individual, galvanically isolated serial links with the DCS using Modbus Remote Transmission Unit (RTU) protocol.

5.11.2 Changing the memory allocation to suit the particular application shall be user-friendly.

5.11.3 The serial link communications as indicated in the I/O list shall be based on the following principles:

For each hard wired analogue input:
- Analogue measurement to DCS (the Supplier shall indicate units and resolution);
- Trip setting to DCS;
- Trip alarm to DCS;
- Measurement diagnostic status to DCS;
- Maintenance override from DCS;
- Feedback on maintenance override to DCS;
- First-up indication to DCS. If this is not required, it shall be indicated in the requisition;
- Input force status to DCS.

For each hard wired digital trip input:
- Trip alarm to DCS;
- Input diagnostic status for inputs with short circuit or line monitoring to DCS;
- Maintenance override from DCS;
- Feedback on maintenance override to DCS;
- First-up indication to DCS;
- Input force status to DCS.

For fire and gas inputs:
- Details depend on the detectors used and shall be indicated in the requisition.

For each hard wired acknowledge and first-up reset and lamp test input:
- No signal to DCS required.

For each first-up reset generated by the DCS:
- The first-up reset signal from DCS.

For each hard wired operational override input:
- The operational override to DCS.

For each reset and permission input generated by the DCS:
- The relevant signal from DCS.

For each hard wired reset and enable input:
- The reset/enable signal to DCS.

For each IPS output:
- The output state to DCS;
- The output diagnostic status for outputs with line monitoring to DCS;
- The output force status to DCS.

IPS system and utility alarms:
- See (5.1).

5.11.4 IPS and DCS Suppliers shall work out the message contents and other details such as hardware and software requirements. The DCS system is communication master. The DCS Supplier has the final responsibility.

5.11.5 The Supplier shall indicate in the quotation whether full floating point communication between the IPS and DCS is possible.

5.11.6 If generated in an IPS, all signals shall be available for transmission to the DCS within one second.

5.11.7 The Supplier shall indicate the refresh rate of the analogue signals available for transmission to the DCS.

5.11.8 The supply and testing of all interconnecting cabling shall be the responsibility of the IPS Supplier or the DCS Supplier, as indicated in the requisition.

5.12 ALARM SIGNAL HANDLING

5.12.1 The IPS shall have facilities to generate alarm output signals (serial and hard wired).

5.12.2 Each alarm is included in a UZ group, except for the system and utility alarms.

5.12.3 Each UZ group shall form a first failure alarm group in which the first trip alarm that comes up is recognisable. For local panels, all alarms shall be assigned to two first-up groups, one for the local panel itself and the other for the signals to the DCS. The first failure resets for these two groups shall be by means of a button on the local panel and a signal from the DCS, respectively.

5.12.4 The first failure alarm coming up in a UZ group shall be transmitted as such to the DCS or, in the case of local panels, shall cause the lamp to flash at twice the frequency of subsequent alarms. UZs tagged 'misc' (miscellaneous) do not require the first failure feature.

5.12.5 For alarms presented to the DCS, the DCS shall take care of the sequence upon receipt of the alarm and the first failure indication. First failure reset signals shall be provided by the DCS.

5.12.6 For local panels and FGS mimic panels, the alarm sequence shall be in accordance with ISA S18.1 M (alarm only with lock-in facilities) and ISA S18.1 F (first failure or first-up alarm groups). The acknowledge, first up reset and lamp test shall be hard wired potential free contact inputs from the local panel or FGS mimic panel. The supply voltage and power consumption of the audible alarms on the local panels and on the FGS mimic panel shall be indicated in the requisition.

5.12.7 The acknowledge, first-up reset, lamp test and audible alarms (per UZ group) need not be reflected on the functional logic diagrams provided.

5.12.8 DCS generated pre-alarms indicated on local panels shall be wired direct from the DCS to the lamps on the local panels. These alarms shall not be incorporated in a test and acknowledge group and therefore the lamp test shall be functionally built into the DCS (i.e. power all lamp outputs when the lamp test on the DCS is activated) and the lamps need not flash when an alarm is activated.

5.12.9 IPS common utility and common system alarms shall cover such conditions as (partial) power supply failures, abnormal temperature conditions within cabinets, CPU failure, module failures and earth faults. These alarms shall be logged by the SER. For each IPS cabinet, at least one common utility alarm and one common system alarm shall be transmitted to the DCS. See also (5.1).

5.13 SEQUENCE OF EVENTS RECORDER

5.13.1 Preferably, all SER related information as mentioned in (5.13.4) is transmitted with a time stamp to the DCS through a standard protocol and all functionality described in (5.13) is included in the DCS. The DCS should also have the possibility to combine SER information from various sub-systems with the DCS alarm list and audit trail so that a complete sequence of events can be presented to the operator. As this functionality is not available from the supported DCS Suppliers as standard at the time of publishing this DEP, detailed SER requirements are given.

5.13.2 An SER system shall primarily function as back-up for the DCS logging equipment and provide a high resolution audit trail. For post mortem analysis, the SER shall be capable of storing 100 000 time-stamped events in a circular file. The time stamp shall equal the IPS clock time at the time the trip alarm is generated, with a resolution equal to or better than the smallest scan time of any of the IPSs.

5.13.3 To allow for SER or communications failure, at least the last 100 events shall be stored in a buffer in the IPS.

5.13.4 The following signals or changes of state shall be logged by the SER:

For each hard wired analogue trip input:
- Trip alarm;
- Measurement diagnostic status (e.g., out of range);
- Maintenance override;
- Feedback on maintenance override;
- Input force status.

For each hard wired digital trip input:
- Trip alarm;
- Input status (e.g., line break);
- Maintenance override;
- Feedback on maintenance override;
- Input force status.

For fire and gas inputs:
- Details depend on the detectors used; refer to requisition.

For each hard wired acknowledge and first-up reset and lamp test input:
- The acknowledge/first-up reset/lamp test.

For each first-up reset input generated by the DCS:
- The first-up reset signal.

For each hard wired operational override input:
- The operational override.

For each reset and permission input generated by the DCS:
- The relevant signal.

For each hard wired reset and enable input:
- The relevant signal.

IPS system and utility alarms:
- Each individual system and utility alarm.

5.13.5 Time synchronisation of all IPSs, SER and DCS shall be effected from an external clock. The Supplier shall state how this will be achieved.

5.13.6 For each SER input a unique tag number and service description shall be assigned. A tag number shall consist of at least 12 alphanumeric characters, starting with either an alpha or a numeric character. The minimum number of characters for the service description shall be 30. The Supplier shall clearly confirm the maximum system capacity for accepting tag numbers and shall identify any constraints.

5.13.7 It shall be possible to copy the SER file onto a back-up medium.

5.13.8 The location of the SER shall be indicated in the requisition.

5.13.9 The Supplier shall provide all software for the SER and its configuration.

5.13.10 It shall be possible, with the correct authorisation by means of a password or key, to disable and enable inputs from being recorded on an individual, selected UZ group or process unit basis.

5.13.11 The following reporting functions shall be provided (and their display activated on request only):
- Daily reports (24 hours);
- Shift reports (8/12 hours);
- Maintenance and operational overrides usage (MOS/OOS);
- Process alarms per process unit;
- System/utility alarms;
- "Forced" I/O.

5.13.12 Event "play-back" and print-out for selected time frames, process units and tag numbers shall be possible. The Supplier shall state the details in the quotation.

5.13.13 Common database facilities such as sorting, querying etc. shall be available, as well as the possibility to export the SER file to Microsoft Windows based applications. The Supplier shall state the possibilities in the quotation.

5.13.14 Historical data shall be retained on loss of power supply to the system.

5.14 ENGINEERING INTERFACE

5.14.1 The engineering interface shall be such that UZ group modules can easily be displayed.

5.14.2 It shall be possible to view the status of input and output signals and the actual values of inputs in engineering units.

5.14.3 It shall be possible to view the status of intermediate points in the logic.

5.14.4 Access shall be password protected or under key lock.

5.15 PROJECT TIMING

5.15.1 The Supplier shall specify the system hardware freeze date and the software freeze date to meet the required site delivery date indicated in the requisition.

6. HARDWARE CONSTRUCTION REQUIREMENTS

6.1 CABINETS

6.1.1 The type of cabinets shall be the Supplier's standard unless Rittal is specified in the requisition. The cabinets shall be painted and finished to the Supplier's standards and suitable for indoor use.

6.1.2 All cabinets supplied shall be identical and have the same physical dimensions. If Rittal cabinets are specified, the physical dimensions of the cabinets shall be specified in the requisition.

6.1.3 The cabinets shall be of the free standing type, with two doors or four doors as indicated in the requisition.

6.1.4 If dictated by the environmental conditions, cabinets shall be provided with a heat extraction fan, louvers and dust filters. Each cabinet shall have a temperature switch to generate an alarm in the event of high inside temperature. This alarm shall be included in the cabinet common utility alarm.

6.1.5 Failure of a single heat extraction fan, if installed, shall not lead to such a high temperature that the power has to be cut off. In such cases the Supplier shall supply revealed failure robust fans. Fan failure shall be included in the cabinet common utility alarm.

6.1.6 The cabinets shall be designed so that they can be connected together. The Supplier shall advise on the use of side/back plates with regard to ventilation, heat dissipation and interconnection of cabinets.

6.1.7 Cabinet layouts shall be of a standard design for the type of cabinet.

6.1.8 All doors shall be hinged opening, preferably 180 degrees, and detachable. If the cabinets are required to be lockable (as indicated in the requisition), the keys shall be identical for all cabinets under the Supplier's scope of supply.

6.1.9 Eye bolts shall be fitted on top of the cabinets for lifting purposes.

6.1.10 If cabinets are permanently bolted together to form sections, the length of these sections shall not exceed 1 800 mm.

6.1.11 Anchor bolt holes shall be provided.

6.1.12 Unused card locations shall be fitted with cover plates.

6.2 CABLING

6.2.1 The Principal-supplied input and output cabling shall terminate in the cabinets via system cables with Elco connectors. These cables will connect to Elco receptacles mounted on Radikor or equivalent boards.

6.2.2 Elco connectors and sockets shall conform to DEP 32.37.20.31-Gen. Special attention shall be paid to the accessibility and withdrawal of the system cables.

6.2.3 Sockets for system cables shall be Elco connection boards Radikor type EM56 (connector type 8016) or E38 (connector type 8016) or equivalent. For solenoid valve outputs, Elco boards E30 (connector type 8027) or equivalent shall be used.

6.2.4 The allocation of I/O cards to connectors shall be such that:
- Cards are always fully wired to connectors.
- Cards shall not be shared by more than one Elco connector.
- One connector shall not contain I/O of more than one process unit.

6.2.5 The universal wiring shall permit the Principal to use all the available terminals of I/O components, i.e. all spare input/output channels shall be completely wired out. In the case of digital outputs providing a change-over contact, only one half (open if de-energised) of the contacts shall be wired to the Elco connectors.

6.2.6 Location of cable entry (top or bottom) shall be indicated in the requisition. Bottom or top plates shall have removable sealing clamp plates for cable entries. Sufficient free space shall be made available for proper accommodation and termination of the cables.

6.2.7 Cable clamps and supports shall be provided for all incoming cables. Adequate cable connection stress relief shall be provided.

6.2.8 Wiring shall have PVC or Teflon insulation, suitable for the loads applicable. Connected wiring shall have an adequate cross section (not less than 0.2 mm^2). If stranded copper wire is used, wire ends at terminal points shall be provided with suitable wire crimp pins/lugs and markers. If 'termipoint' or wire wrap is used, suitable terminating pins at the Elco boards shall be provided. The Supplier shall specify how this is included in the proposed design.

6.2.9 All internal wiring shall be laid in PVC close-slotted ducting with a covering lid. Ducting shall have 40% spare capacity.

6.2.10 Wiring carrying signals susceptible to electrical interference shall be adequately screened.

6.2.11 All inter-section wiring shall pass through the normal cabinet entries.

6.2.12 Colour code and marking of wires shall be in accordance with the standards indicated in the requisition. All power wiring shall be clearly marked with reference codes and/or tag numbers.

6.2.13 Terminals shall be Weidmuller or an equivalent recommended by the Supplier. If fused terminals are required, they shall be equipped with 'blown' indicators.

6.2.14 Terminal arrangements shall be such that all single cores, including spares, of multi-core cables can be connected in the same sequential order as the pattern and layout of the cores in the cable.

6.3 EARTHING

6.3.1 Two earths, instrument screen earth and plant safety earth, shall be made available by the Principal. The Principal shall connect the instrument screen earth system to the plant safety earth system at strategic points.

6.3.2 All metallic equipment of and within the cabinets shall be connected to a single "common cabinet" plant safety earth point. Each cabinet shall be provided with an M10 earth bolt for connection to the plant safety earthing system.

6.3.3 Screens for cables interconnecting cabinets shall be earthed at one end only to the instrument screen earth. For this purpose the Supplier shall provide an insulated instrument screen earth bar.

6.3.4 Screen earth for incoming and outgoing cables shall not be connected at the IPS end; hence the screen earth terminal on the sockets shall remain unconnected.

6.3.5 Screen earth for serial communication lines between the IPS and the DCS shall be connected at the DCS side only.

6.3.6 The Supplier shall state the earthing requirements for the system in the quotation.

6.3.7 The Supplier shall provide one earth leakage monitor per cabinet unless otherwise stated in the requisition. The associated alarm shall be incorporated in the common cabinet utility alarm.

6.3.8 See (5.9.4.3) for earth monitoring on outputs.

6.4 LABELLING

6.4.1 Terminals carrying voltages higher than 48 volts shall be protected against accidental contact by having removable cover plates, and shall be labelled to indicate high voltage.

6.4.2 Sockets, terminals and main wiring shall be clearly identified in accordance with the system documentation. Earthing for screens, ac and dc systems shall be segregated and identified.

6.4.3 Each cabinet and all major system components, card files and individual card locations shall be clearly labelled and identified with a tag number. Nameplates shall be in the English language. In addition, all equipment shall be durably identified with the Supplier type and serial number and with the Principal's order number to facilitate future reference. Cabinets shall be identified with tag numbers.

6.4.4 Separate cabinets, or segregated sections within a cabinet, that are provided for intrinsically safe signals (Ex(i)a or Ex(i)b) shall be labelled as such. Cables and ducting for intrinsically safe signals shall have a blue colour.

7. POWER SUPPLY

7.1 POWER SUPPLY FACILITIES

7.1.1 Each IPS shall receive ac power, provided by the Principal, from two different sources.

7.1.2 Power supply shall be to the following specifications:
- Voltage as indicated in the requisition (220 or 230 or 240) V(ac) ± 10%
- Frequency as indicated in the requisition (50 or 60) Hz ± 2%
- Total harmonic distortion: 5% max., linear load
  15% max., non-linear load

7.1.3 The Supplier shall supply mains-to-24 V(dc) power supply units which are fully revealed failure robust. Internal power supplies for CPU and I/O shall be separated and galvanically isolated.

7.1.4 Each power supply in a revealed failure robust set of power supplies shall be rated such that all loads, including spares, can be simultaneously powered.

7.1.5 Diagnostics, signalling and isolation facilities shall be provided to service or replace a faulty power supply unit.

7.1.6 The power supply to the input and output circuits shall be floating (non-earthed). Hardware shall be provided which automatically checks and alarms if the supply is not floating due to a fault in the system. These alarms shall be included in the common cabinet utility alarm.

7.1.7 It shall be possible to isolate, disconnect, remove and replace faulty power supplies without loss of operation.

7.2 POWER CONSUMPTION AND TOLERANCE

7.2.1 The Supplier shall present to the Principal a listing and detailed schematics of the number of electrical feeders, their termination points and respective loads.

7.2.2 The Supplier shall include in the quotation a calculation of the estimated power consumption of the system (volts, amps, watts and heat dissipation). These data shall be resubmitted two weeks after the hardware freeze date.

7.2.3 Mains power interruptions of up to 100 ms shall not affect operation.

7.2.4 The Supplier shall state in the quotation the maximum mains power surge that may occur when the system is switched on.

7.2.5 The Supplier shall indicate in the quotation the maximum allowable mains voltage spikes (amplitude and duration) that the system can withstand without affecting operation.

7.2.6 The Supplier shall indicate in the quotation the procedures to be followed and the features of the system which allow system recovery after power failure.

7.3 POWER DISTRIBUTION

7.3.1 The Supplier shall specify in the quotation all the necessary power data (voltages, frequency, etc.) that individual components and modules require.

7.3.2 The power distribution shall be revealed failure robust.

7.3.3 Separate isolation of power for each process unit shall be provided in the IPS cabinets by means of miniature circuit breakers (including fuse functionality) or switch and fuse. Exceptions to this, if any, shall be given in the requisition.

7.3.4 It shall be possible to replace fuses easily. The Supplier shall provide sketches in the quotation to show the proposed fusing method.

7.4 BATTERIES

7.4.1 The Supplier shall provide a list detailing all the batteries within the system. The list shall contain information on battery type, rating, shelf life, location, duty and renewal frequencies.

7.4.2 The state of charge of batteries shall be indicated. The Supplier shall advise how this is achieved.

8. ENVIRONMENTAL CONDITIONS

8.1 The equipment shall be suitable to operate in a room with the following ambient conditions:

- Temperature: 18-27 °C normal (5-40 °C abnormal, maximum duration of one abnormal period 72 hours)
- Relative humidity: 35-75% normal (20-95% abnormal, maximum duration of one abnormal period 72 hours)
- Temperature variation: less than 1 °C per minute

Normal dust filters will be used for heating, ventilation and air-conditioning (HVAC) equipment.

8.2 The Supplier shall specify the required storage conditions for the equipment.

9. FACTORY ACCEPTANCE TEST

9.1 GENERAL

9.1.1 The Factory Acceptance Test (FAT) shall be divided into two phases. Phase 1 tests shall be carried out at the Supplier's works. Phase 2 tests shall be carried out at the DCS Supplier's works.

NOTE The FAT is performed to demonstrate that all required testing has already been successfully performed by the Supplier. It shall not be used as a substitute for the Supplier's own tests.

9.1.2 Before FAT Phase 1 the IPSs shall be continuously energised for a period of at least 7 days.

9.1.3 During the manufacturing period the Supplier shall perform hardware checks to detect component failures. If any failures are discovered and replacements made, these shall be noted and logged.

9.1.4 The Supplier shall provide adequate personnel, test facilities and test equipment for the FAT.

9.1.5 The Supplier shall provide FAT procedures. These shall include:
- Timing of activities;
- Supplier's personnel attending the FAT (with responsibilities);
- Methods by which deficiencies shall be identified, recorded and rectified.

The test procedures shall be made available 6 weeks prior to the FAT.

9.1.6 The Supplier shall notify the Principal 4 weeks in advance of when the system will be ready for FAT.

9.2 FAT PHASE 1

9.2.1 FAT Phase 1 consists of a full functional test performed at the Supplier's works. This phase is to test whether the FLDs have been properly implemented, not to test the correctness of the FLDs.

9.2.2 This phase shall also include visual checks on workmanship, insulation tests and functional tests, including full simulation of all inputs, outputs and logic. Inputs and outputs shall be simulated from the cabinet Elco boards.

9.2.3 The Supplier shall provide the relevant TÜV certificates (covering hardware and system software if applicable) before this phase.

9.2.4 Final documentation shall be available during this test.

9.2.5 The IPS and all its applied features shall be checked against the TÜV approval report and the IPS safety manual.

9.3 FAT PHASE 2

9.3.1 This phase will take place at the DCS Supplier's works. The location shall be advised by the Principal when the DCS Supplier has been selected. The Supplier is responsible for loading the equipment at the Supplier's works, transporting it to and unloading/loading it at the DCS Supplier's works, and for insurance covering the time the system is installed at the DCS Supplier's works.

9.3.2 FAT Phase 2 includes connection of the IPSs to the DCS system and testing of the serial communication with the DCS. This will involve:
- 100% test of MOS functionality;
- 25% random test of analogue signals transmitted to the DCS. If no failures are found, the test is considered acceptable. If any failures are found, a further 25% shall be tested, and so on;
- 25% random test of digital signals transmitted to DCS. If no failures are found, the test is considered acceptable. If any failures are found, a further 25% shall be tested, and so on;
- First-up alarms, testing at least two points per UZ group. All first-up groups.

9.3.3 Punchlist items from FAT Phase 1 shall be tested during FAT Phase 2.

9.3.4 After successful FAT, the IPS shall be released for shipment.

10. PACKING AND TRANSPORT

10.1 PACKING

10.1.1 After the FAT, the equipment shall be securely packed under the responsibility of the Supplier for the type of freight indicated in the requisition, and properly marked and tagged.

10.1.2 The system shall be dismantled into individual shipping sections. Items which are separated shall have their interconnecting parts clearly tagged to facilitate trouble free re-assembly at site.

10.1.3 If indicated in the requisition, cabinets and/or panels shall be enveloped in plastic sheeting and hermetically sealed. In any case, moisture absorbing desiccant crystals shall be placed in the cabinets. A completely itemised packing list shall be enclosed in stout linen envelopes securely fixed both inside and outside the box. The system shall be packed in individual shipping sections.

10.1.4 The Supplier shall state any special requirements for storage at the destination.

10.2 TRANSPORT

10.2.1 The system shall be delivered according to the Principal's order instructions to the location indicated in the requisition.

10.2.2 The Supplier shall be fully responsible for supplying all necessary documentation to enable customs clearance of the equipment.

11. DRAWINGS AND DOCUMENTATION

11.1 GENERAL

11.1.1 All documentation shall be in the English language.

11.1.2 Only the following standard paper sizes, in order of preference, may be used:

A4	210 * 297 mm
A3	297 * 420 mm
A2	420 * 594 mm
A1	594 * 841 mm

11.1.3 Prints shall be folded to A4 size with the title block visible at the front.

11.1.4 Where possible the self documenting features of the IPS shall be used.

11.2 DRAWINGS WITH QUOTATION

11.2.1 Planning

11.2.1.1 A project planning schedule broken down into weeks shall be provided with the quotation. The schedule shall include at least the following activities:

- Design definition of the system and cabinets;
- System/cabinets/panels layout, cabling and wiring;
- Configuration (programming);
- Hardware/software freeze dates from the Principal;
- Fabrication, testing, packing and shipment schedule;
- Factory acceptance tests;
- Site installation (if applicable);
- Documentation deliveries;
- Spare parts deliveries;
- Design check stages to be performed by the Principal.

The planning schedule shall show all critical path items.

11.2.2 Standard Documentation

11.2.2.1 Full technical specifications of all Supplier hardware and software quoted.

11.2.2.2 Full details of guarantee offered both on the overall system and on (commissioning) spares.

11.2.3 Project Specific Documentation

11.2.3.1 System block diagrams, e.g. a detailed system overview.

11.2.3.2 Functional system descriptions.

11.2.3.3 Cabinet descriptions in terms of signals and units, power distribution single line diagram, revealed failure robustness concepts, etc., to demonstrate that the system quoted will meet the specified functional requirements.

11.2.3.4 Tabular information should be presented comparing the proposed system capability and the Principal's requirements. It shall be clearly indicated where the system has spare capacity in terms of I/O, logic, memory, communication interface capabilities, electrical loads and other expansion capabilities associated with the system.

11.2.3.5 Power requirements.

11.2.3.6 Cabinet details (physical layout).

11.2.3.7 Heat dissipation data.

11.2.3.8 Earthing requirements.

11.2.3.9 A completed "Table of compliance".

11.3 DRAWINGS AND DOCUMENTATION AFTER ORDER PLACEMENT

11.3.1 General

11.3.1.1 Essential design drawings and manuals shall be submitted within 4 weeks after the supply of 'released for construction' information to the Supplier.

11.3.1.2 All non-essential drawings such as wiring diagrams shall be submitted in accordance with the planning schedule.

11.3.1.3 Two copies shall be supplied of intermediate and final issues of documents and drawings.

11.3.1.4 In addition to the requirement above, the final issues of all documents and drawings that are prepared electronically shall be supplied on diskette, all others on transparencies.

11.3.2 List Of Drawings

11.3.2.1 Summary of Supplier documents.

11.3.2.2 System block diagrams, e.g. a detailed system overview.

11.3.2.3 Functional descriptions.

11.3.2.4 Power requirements.

11.3.2.5 Cabinet details with physical layouts and card arrangements.

11.3.2.6 System cable connection details.

11.3.2.7 Heat dissipation data.

11.3.2.8 Earthing requirements.

11.3.2.9 System cable drawings showing connections between all Supplier-supplied equipment.

11.3.2.10 Dimensional drawings for each piece of equipment.

11.3.2.11 Cabinet cable drawings showing the internal cabling between all items in the cabinets.

11.3.2.12 Terminal allocation diagrams.

11.3.2.13 Power supply distribution diagrams.

11.3.2.14 One-line diagram of electrical supply for all devices in the system.

11.3.2.15 Block diagrams showing the function blocks and modules and the linkages between them.

11.3.2.16 Software configuration listing.

11.3.2.17 Program listings for all project specific programs.

11.3.2.18 SER listing.

11.3.2.19 FAT test procedure.

11.3.2.20 List of all batteries and fuses within the IPS.

11.3.2.21 Completed SPIR forms or E-SPIR in accordance with DEP 70.10.90.11-Gen.

11.3.2.2 Manuals:

- Hardware maintenance manuals;
- Software reference manuals;
- Hardware reference manuals;
- System operating manuals;
- Engineering manuals;
- System installation manuals.

11.4 SUPPLIER'S DATA BOOKS

11.4.1 Two copies of the Supplier's data books shall be supplied.

11.4.2 The Supplier's data books shall contain as a minimum the following information:
- TÜV approval documents;
- Test reports signed by all parties involved;
- Dimensional drawings;
- Records of authorised deviations.

11.5 APPROVAL OF DRAWINGS

11.5.1 All drawings and engineering documents shall be subject to comments and approval by the Principal.

11.5.2 Approval is for the purpose of ascertaining conformance to the specifications and standards and does not relieve the Supplier of the responsibility to provide a fully operational system.

11.5.3 A period of two weeks shall be allowed for the Principal to give comments. The Supplier shall not commence fabrication before approval of the relevant drawings has been received.

11.6 AS-BUILT DRAWINGS

11.6.1 Within four weeks of the acceptance of the system by the Principal, the Supplier documents shall be updated by the Supplier and issued 'as-built'.

11.6.2 Two hard copies and (for documentation prepared electronically) a diskette of all documents and drawings shall be provided.

12. PROJECT MANAGEMENT

12.1 ORGANISATION

12.1.1 The Supplier shall assign a suitably qualified project co-ordinator for the entire duration of the project.

12.1.2 After the job has been awarded, the Supplier shall assign a project team. The team shall be entirely responsible for handling the project from order date up to and including the successful completion of the FAT of the system.

12.1.3 The project co-ordinator will be the sole source of contact for the Principal up to and including the successful completion of the FAT.

12.1.4 All correspondence and documentation shall be in the English language.

12.1.5 The Supplier shall indicate details in terms of technical expertise, technical infrastructure (facilities), maintenance service support (policies, capabilities) and spare parts (start-up, normal operation).

12.2 PLANNING

12.2.1 The Supplier shall provide a planning schedule, indicating time schedules (broken down into weeks) and proposed resources, and showing all activities until completion of the FAT.

12.2.2 The following data shall be shown for each activity:
- Duration;
- Planned start date;
- Percentage complete;
- Resources.

12.2.3 The planning schedule shall show the critical path.

12.2.4 The planning schedule shall be updated monthly and submitted to the Principal, either on paper or diskette in the Principal-approved PC program format.

12.3 PROGRESS MEETINGS

12.3.1 Progress meetings shall be held on a regular basis; frequency and venue as indicated in the requisition.

12.3.2 The following items should as a minimum be discussed during these meetings:
- Progress of work;
- Activities performed since last meeting, detailing milestones reached;
- Explanation of delays, if any;
- Problem areas;
- Critical path activities;
- Proposed variations;
- Personnel changes;
- Details of work planned before the next meeting.

12.3.3 Within 2 working days after the meeting, the following documents shall be updated and issued by the Supplier:
- Project planning;
- Summary of Supplier documents;
- Minutes of meeting.

13. TRAINING

13.1 The Supplier shall supply detailed information on the various training facilities that can be provided both at his works and on site for instrument maintenance/design engineers, maintenance technicians and operators.

13.2 For each training programme the following shall be provided:
- types of courses;
- duration and periods of courses;
- costs per course (at the Supplier's works or at site);
- training documentation provided;
- prerequisite knowledge of participants.

14. AFTER SALES SERVICE

14.1 GENERAL

14.1.1 The Supplier shall indicate the types of services that can be made available at site.

14.1.2 The Supplier shall indicate in the quotation detailed information on the various forms of maintenance and support service agreements that can be offered.

14.1.3 The Supplier shall indicate in the quotation the possibilities regarding remote maintenance and the cost of such maintenance.

14.1.4 The Supplier shall provide details on his spare parts holding, such as which spares are available and at what notice.

14.2 SITE SUPPORT

14.2.1 The Supplier shall quote for support to check whether or not the system installation conforms to the Supplier's specification.

14.2.2 The Supplier shall quote for assistance to power-up the system and to run diagnostic programs to ensure hardware integrity.

14.2.3 The Supplier shall quote for support to install the system configuration.

14.2.4 The Supplier shall quote for start-up/commissioning assistance.

15. SPARE PARTS

15.1 GENERAL

15.1.1 The Supplier shall give an undertaking that either repair capabilities or equivalent replacements will be available for its standard parts for a minimum of ten years after production line manufacturing of the system or items has been discontinued.

15.1.2 The Supplier shall complete the SPIR or E-SPIR after order placement (see DEP 70.10.90.11-Gen.). Deviations from quoted quantities shall be explained.

15.2 COMMISSIONING SPARES

15.2.1 The Supplier shall include spares for commissioning in the quotation. Quantities recommended shall take into consideration the Supplier's experience regarding the failure rate of the components.

15.3 GUARANTEE PERIOD SPARES

15.3.1 Any spares used during the guarantee period shall be replenished at the Supplier's expense. The time and procedure for repair and/or replacement shall be clearly stated in the quotation.

15.4 MAINTENANCE SPARES

15.4.1 The Supplier shall quote for maintenance spares required for two years of continuous operation.

16. TABLE OF COMPLIANCE

16.1 The Supplier shall complete a table of compliance covering every paragraph of this DEP.

16.2 An example of the table of compliance is given below:

TABLE OF COMPLIANCE

Date:

Project:

Indent Number:

Supplier:

PARAGRAPH NUMBER	ENHANCEMENT	CONFORMS	VARIATION	ALTERNATIVE	EXCEPTION	NOTED

16.3 Definition of the column headings is as follows:

Enhancement
Feature fully complies with the specification and offers more functionality. The Supplier shall give full description.

Conforms
Feature fully complies with the specification.

Variation
Feature offers the same functionality in a different execution. The Supplier shall give a full description.

Alternative
Feature does not meet the specification but the functional requirements can be met in a different way. The Supplier shall give a full description.

Exception
The Supplier cannot meet the specification.

Noted
The relevant paragraph in the specification does not contain any requirements.

17. SYSTEM QUOTATION

17.1 GENERAL

17.1.1 The Supplier shall supply three copies of the quotation.

17.1.2 The Supplier shall quote on the basis of the following three options:

17.1.2.1 The Supplier receives Process Engineering Flow Schemes, Process Safeguarding Flow Schemes, Safeguarding Narratives and Cause And Effect Matrices. From this information the Supplier prepares the engineering level definition, i.e. Functional Logic Diagrams (FLDs), Relay Ladder Logics (RLLs) or Sequential Function Charts (SFCs) on his system.

17.1.2.2 The Contractor prepares the engineering level definition on a PC using Supplier's engineering software. The Supplier will receive the definition on diskette and shall complete the configuration using this definition as a basis. The Supplier shall state the conditions for early delivery of all software packages required to enable the Principal to complete the definition on a PC.

17.1.2.3 The Supplier receives FLDs as drawings.

17.2 PRICING OF EQUIPMENT

17.2.1 A quantitative breakdown per complete assembled IPS cabinet, inclusive hardware, software, configuration, Supplier testing etc.; shall be provided in the quotation.

17.2.2 Itemised prices for all standard hardware components (cards), with model numbers, part numbers etc. and for spare parts offered, shall be provided in the quotation.

17.2.3 Itemised prices for all standard software packages, configuration (programming) and other engineering support prices shall be provided in the quotation.

17.2.4 As an option, itemised prices for each I/O type referred to in the I/O list. These prices shall be such that if a tag number is added, the additional cost can be calculated irrespective of the configuration attached to this tag number.

17.2.5 Itemised prices for all hardware and software optionally available shall be provided in the quotation. The Supplier shall indicate what the extra facilities would be.

17.2.6 The Supplier shall include in his quotation hourly rates for carrying out modifications to the configuration (and documentation) after the hardware/software freeze dates. These rates only apply if the modifications are extra to the above scope and to the information provided.

17.2.7 The Supplier shall include configuration activities in the quotation.

17.2.8 Prices of any special tools needed for calibration, tuning or maintenance at site shall be provided in the quotation.

17.2.9 Prices for the FAT shall be provided in the quotation.

17.2.10 Prices for the Supplier's labour-related fees shall be provided in the quotation.

17.2.11 Prices for spare parts shall be provided in the quotation.

17.2.12 Prices for packing and transport shall be provided in the quotation. Prices shall be separated into
(a) from the Supplier to the DCS Supplier and
(b) from the DCS Supplier to the delivery location.

17.2.13 The Supplier shall state the conditions, if any, for accepting repeat orders under similar conditions of purchase.

17.2.14 After placement of the order a full and complete review of the bid shall take place with the purpose of finalising the system requirements in an order revision. A period of one month shall be given to finalise and freeze hardware.

17.2.15 The Supplier shall additionally quote the costs for site support, e.g. cost of travel and daily allowances. This shall include assistance during the start-up and commissioning of the system.

17.2.16 The Supplier shall outline in the quotation how the spare capacity requirements have been implemented.

17.2.17 In the quotation the Supplier shall list, in a ranked order, 10 requirements of this DEP that are not commonly applied and which have the greatest impact on quoted cost. The intention is to avoid system supplies that are not cost effective over the life time of the system.

17.3 PAYMENT TERMS

17.3.1 Payment terms shall be as indicated in the requisition.

17.3.2 The specific amounts and dates will be agreed upon before order acceptance. Changes in the scope of supply shall not influence the payment schedule and shall be invoiced separately.

18. 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.

SHELL STANDARDS

Index to DEP publications and standard specifications	DEP 00.00.05.05-Gen.
Requisitioning (binder)	DEP 30.10.01.10-Gen.
System cabling	DEP 32.37.20.31-Gen.
Classification and implementation of instrumented protective functions	DEP 32.80.10.10-Gen.
Data/requisition sheet for instrumented protective systems NOTE Data/requisition sheets are contained in the Requisitioning binder, DEP 30.10.01.10-Gen.	DEP 32.80.10.93-Gen.
Spare parts	DEP 70.10.90.11-Gen.

AMERICAN STANDARDS

Annunciator Sequences and Specifications	ISA S18.1

Issued by:
Instrument Society of America
400 Stanwix Street, Pittsburgh
Pennsylvania 15222
USA.

U.S. Military Handbook: Reliability prediction of electronic equipment	MIL-HDBK-217

Issued by:
Superintendent of Documents
Government Printing Office
Washington DC 20402
USA.

GERMAN STANDARDS

Principles for Computers in Safety Related Systems.	DIN V VDE 0801
Control Technology; Fundamental Safety Aspects to be Considered for Measurement and Control Equipment.	DIN V 19250

Issued by:
Beuth Verlag GmbH
Burggrafenstrasze 4 - 10
D-1000 Berlin 30
Germany.