



TITLE

COMPRESSED AIR SYSTEM
MARIB GTPS 400 MW

SPECIFICATION NO. PE-TS-372-555-A001

VOLUME

SECTION

REV 00

DATE 20/07/2012

SHEET

SECTION-C4

TECHNICAL SPECIFICATION (C&I PORTION)

4 X 100MW MARIB-II GTPS

**Technical Specifications (C&I)
for Mechanical Auxiliaries Packages**

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- 6. Data sheet and wiring diagram for motorized valve actuator**
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Notes:

1. The requirements given below are to be read in conjunction with detailed Technical specification & data sheets-A&B (applicable for PLC, LCP and motorized valve actuator), enclosed elsewhere in the specification. Further in case of any discrepancy in the requirement within the specification noted by the bidder, the same shall be brought to the notice of BHEL in the form of pre-bid clarification. In absence of any pre-bid clarification, the more stringent requirement as per interpretation of customer shall prevail without any commercial implication.
2. PLC shall be connected to DCS through serial link with MODBUS connection on TCP/IP Protocol compliant for monitoring.
3. PLC shall have the facility to synchronize its time with GPS. Necessary hardware/software for same at PLC end to be provided by bidder.
4. Dual redundant fiber optic cable (single/multi mode) from PLC to DCS shall be in bidders' scope.
5. All instrumentation/signal cables shall be provided by BHEL as free issue whereas cable schedule, cable interconnections and wiring diagram for the same shall be in bidders' scope.
6. Each PLC shall be provided with LIU (Light interface unit and patch chord) which has single / multi mode SC couplers / adapters at PLC end. Same shall be in bidders' scope.
7. Mounting of all interfacing hardware (information outlets, LIU/Patch Panel) and connectivity from PLC to LIU/patch panel (cabling, all interfacing etc) at PLC end, shall be in bidders' scope.
8. The bidder to furnish the list of instruments and list of drives / loads along with their bid.
9. Control valves shall have pneumatic actuators.
10. The UPS output power supply shall be 230V AC with 60 min. battery backup. For further detail, please refer to **UPS scheme**, given under title **"Technical specifications, data sheet and quality plan for PLC & PLC configuration diagram"**
11. PLC based local panels shall have redundant processors, power supply and communication. The I/O card redundancy is required only for critical control loops. PLC's shall be hooked to DCS via data link monitoring and hardwire (as per spec.). It shall have CRT, keyboard (preferably Laptop) for operator interface.
12. PG/DPG/PS/PT shall have chemical/diaphragm seal as per requirement.

Control Philosophy for Auxiliary Packages

CONTROL SYSTEM FOR AUXILIARY PACKAGES


400 MW MARIB PHASE-II GTPP, YEMEN

S.N o.	System / Package	Control System	Control from		Interface with DCS (for monitoring only)	Interface
			Local Control	CCR		
1.	Air Conditioning System	Relay based Control cum Annunciation panel with solid state annunciation windows along with product integrated microprocessor panel for the Chilling unit.	YES	NO	None	
2.	Ventilation System	Local control	YES	NO	None	
3.	Fire Detection & Protection System+ Fire Water Pumps	Microprocessor based detection, PLC based pump controls and solid state annunciation	YES	NO	CRITICAL H/W & SOFT	PLC with OEWS. Separate OEWS for microprocessor based Fire Detection and Alarm System.
4.	Compressed Air System	Microprocessor for individual compressors.	YES	NO	CRITICAL H/W & SOFT	All drive logics in microprocessor based LCP which is part of individual compressor skid.
5.	Sewage Treatment + ETP	PLC based	YES	NO	CRITICAL H/W & SOFT	
6.	Pre-Treatment Plant + RO DM PLANT	PLC based	YES	NO	CRITICAL H/W & SOFT	
7.	Misc. pumps(WATER SYS)	DCS			N.A.	

NOTES:-

- (1) OEWS indicates Operating & Engineering Work Station (in vendor scope)
- (2) PLC system without OEWS shall have panel mounted pushbuttons, lamps, HW annunciation and MIMIC etc. (in vendor scope)
- (3) All PLC shall be with Hot Redundant Processor.

Technical specifications, Quality plan and Data sheet for PLC

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1. SCOPE

This specification covers the Design, Manufacture, Assembly, Inspection and Testing at manufacturer's works, proper packing and delivery to Mumbai port CHA Godown of the PLC Control & Monitoring System comprising PLC Control panel/Remote I/O panel (housing Processors, I/O cards, power supply packs etc.), Operator workstations(OWS), Printers, Annunciation system, UPS, cables and all other equipments and accessories required for completeness of the system as mentioned in different sections of this specification.

2. GENERAL


- 2.1. The PLC shall perform protection logic, interlock and sequential control functions such as binary logic operation, set/reset operation, timers, counters, logic blocks, math functions, input quality checking engineering unit conversion, Boolean functions & PID control (Analog logic function).
- 2.2. The system shall be redundant in processor, power supply and communication interfaces unless otherwise specified. The system shall have self-diagnostic features. The control of all drives and equipment shall be effected through the keyboard/mouse / panel mounted push button / control switches as per Data sheets-A&B.
- 2.3. The system shall have facility for connecting to Main Plant's Distributed control system (DCS) using hardware / software interface for two-way transfer of signals.
- 2.4. The mimic shall be displayed on the OWS screen and may also be provided on the control desk/panel (as per Data sheets).
- 2.5. In case OWS is provided, HMI functions like Trends, Curves, Bar charts, Historical storage of Data, Logs and reports etc. shall be provided in addition to Plant-schematics. The necessary catalogue / literature elaborating the features of HMI shall be supplied along with the bid.
- 2.6. It shall be possible to use the same OWS as programming station.
- 2.7. The PLC system shall be sized to meet process/system requirements as per the approved P&IDs and Control write-up.
- 2.8. The PLC system shall be designed to ensure that no single device failure should result in failure of any other device.
- 2.9. Signal multiplication where required shall be done in PLC. Use of relays for multiplication of contacts (for control, monitoring and alarm) is not acceptable. The control/ monitoring components on the control panel/ desk shall be driven through I/O modules.

3. TECHNICAL REQUIREMENTS

Details of various PLC system components shall be inclusive of but not limited to the following:

3.1. CODES AND STANDARDS

- 3.1.1. The equipment covered under this specification shall meet the requirements of latest edition of all applicable codes and standards like ANSI, NEMA, IEEE, IEC, NEC & IS.

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3.1.2. PLC shall conform to IEC: 1131

3.1.3. The offered PLC shall **comply with safety standards as per Data sheet-A&B.**

3.2. CONTROL PANEL

3.2.1. PLC control panel shall be freestanding type with provision for mimic display, push-button stations, control switches, indicating lamps, metering instruments like Indicators, ammeters etc. and facia windows for critical alarms.

3.2.2. The salient features of construction shall be:

Sheet material: Cold rolled sheet steel

Frame thickness: Not less than 3.0mm

Enclosure thickness: Not less than 2.0 mm for load bearing sections (mounted with instruments) and Not less than 1.6 mm for others

Gland plate thickness: 3.0mm

Base channel: ISMC 100 with anti-vibration mounting & foundation bolts.


3.2.3. Each panel shall be identified by a name plate, which shall be of non-rusting metal or three ply lamicold, with engraved lettering.

3.2.4. 25 x 6 mm Copper ground bus to be provided for each panel.

3.2.5. 240V AC single phase, thermostatically controlled space heaters shall be provided. Each free standing panel shall have a door switch operated fluorescent lamp and a 240V AC plug point.

3.2.6. Painting treatment shall be as per IS: 6005. Two coats of lead oxide primer shall be followed by powder coating. Paint shade shall be as specified in the "Data sheet for PLC system"-Data Sheet-A&B.

3.2.7. The annunciation system shall be facia window type, driven by the PLC. Audible alarm, Acknowledge, Reset and lamp test facility shall be provided as per ISA sequence – S18.1, M.

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3.3. PROCESSORS

3.3.1. The microprocessors shall be 32 bit, and Hot redundant.

3.3.2. Hot redundancy: PLC shall be provided with two processors (Main processing unit and memories) one for normal operation and one as hot standby. In case of failure of working processor, there shall be an appropriate alarm and simultaneously the hot standby processor shall take over the complete operation automatically. This transfer from main processor to standby processor shall be bump less and shall not cause any disturbance whatsoever. In the event of both processors failing, the system shall revert to fail safe mode. It shall be possible to keep any of the processor as master and other as standby.

3.3.3. An authorized forcing facility shall be provided for changing the status of inputs and outputs, timers and flags to facilitate fault finding and other testing requirements.

3.3.4. The standby processor shall be updated automatically in line with the changes made in the working processor.

3.3.5. In the event of any replacement of the processor, synchronization of the replaced processor shall be automatic upon live insertion.

3.3.6. The cycle time for input scanning, execution of logics, overheads and output scan shall not exceed 120 m sec.

3.3.7. The processor & memory shall be loaded up to 50% at normal conditions and maximum up to 60% under worst loading conditions.

3.3.8. The memories shall be field expandable.


3.4. INPUT / OUTPUT Modules

3.4.1. Input/output card assignments shall be modular i.e. no single card shall be assigned with more than one drive of a particular sub-system. The maximum number of channels per I/O module shall be as follows.

- Analog Input Module: 16
- Analog Output Module: 16
- Binary Input Module: 32
- Binary Output Module: 32
- Analog Input/output combined: 16
- Binary Input/output combined: 32

3.4.2. On line I/O replacement: All I/O cards shall have quick disconnect terminations allowing for card replacement without disconnection of external wiring and without switching off the power supply.

3.4.3. 10% spare capacity shall be ensured in each card channel assignment. Overall minimum 20% spare channels shall be provided.

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3.4.4. Output command to MCC/Switchgear shall be through coupling relays, whose mounting location shall be as per "Data sheet A & B for PLC System". In case coupling relays are located in PLC Panel, the same shall be in PLC vendor's scope of supply.

3.4.5. Status feedback from MCC shall be in the form of potential free contact.

3.5. DATA BUS/ I/O BUS

3.5.1. The Data bus connecting PLC and HMI work stations shall be TCP/IP on Ethernet.

3.5.2. The Data bus and I/O bus communication medium shall be twisted pair shield copper conductor for indoor locations and those areas not subjected to induced signals. Repeaters/signal amplifiers shall not be used. Copper conductor cable used shall be Category-5 or better. The communication medium shall be Fibre optic cable in the event any portion of communication cable run is in outdoor or where distances are beyond 500 meters.

3.6. OPERATOR WORK STATION (OWS)


3.6.1. The OWS and Keyboard shall be desktop mounted and shall be used for controlling, monitoring and programming function.

3.6.2. Colour CRT(s) with keyboard and mouse shall be as per Data Sheet-A&B. CRT shall have graphic display facility.

3.6.3. The OWS shall be with Windows based operating system having necessary Engineering/Configuring software.

3.7. PRINTER

Printers shall be provided as per Data Sheet-A&B.

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3.8. COMMUNICATION WITH PLANT DCS

- 3.8.1. The PLC system shall be provided with hardwired/serial interface for communication with plant DCS.
- 3.8.2. Serial communication to / from DCS where provided shall be engineered to ensure that signal communication time from / to DCS shall not exceed 1 seconds for control / feedback.
- 3.8.3. Serial communication to DCS shall be MODBUS connection on Ethernet based TCP/IP Protocol.
- 3.8.4. Data transmitted from PLC to DCS shall include all information necessary for the DCS graphic displays to monitor and control the process equipment and PLC. Such data may include pertinent analog and digital status information, interlock, alarms and maintenance conditions. Data transmitted from DCS to the PLC shall include necessary signals to provide operator control interface from DCS for the process/equipment being controlled by PLC.
- 3.8.5. Bidder to include 'Light interface units, converters, Ethernet switch, accessories at PLC end for connectivity to other system. The bidder's terminal point shall be Ethernet port in case of copper medium connection to DCS or LIU in case of Fiber optic medium for connectivity with plant DCS. In case distance between PLC & DCS is greater than 1.8 Km, single mode of optical fiber cable with compatible accessories shall be used. For distance less than 1.8 Km multimode optical fiber ports shall be used.


3.9. POWER SUPPLY Scheme

- 3.9.1. PLC Panel and I/O Cabinets: PLC system shall be provided with 2x100% UPS fed from Two Nos. redundant 415V, 3-ph feeders, as per the scheme PE-SD-999-145-001, sh-08 of 08. Each UPS shall have 60 minutes back up. Input feeder failure shall be monitored in the PLC system. Necessary redundant power pack and transformers shall be provided (in the PLC panel) to derive the power supply for control desk, PLC panel and input / output cabinets etc
- 3.9.2. Remote I/O panels: Similar power supply arrangement as for PLC panels shall be provided if it is not possible to extend the power cable form UPS of PLC panels.
- 3.9.3. Each OWS and associated HMI peripherals shall be provided with a feeder from either one of the UPS

4. DRAWING/DOCUMENT AND DATA TO BE FURNISHED AFTER AWARD OF THE CONTRACT:

4.1. For Approval:

- PLC system configuration drawing along with functional write-up.
- Input/Output signal list.
- BOM of PLC
- List of PLC controlled devices
- Control panel/control desk GA drawings.
- Control desk/panel component layout drawing.
- Control panel/control desk Foundation detail and cutout drawings
- Power distribution scheme.

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- Block logic diagrams.
- Annunciation list.
- PLC control room layout drawing.
- List of soft signal exchange with Plant DCS.
- List of mandatory spares
- Quality plan
- Data Sheet-C
- CRT display
- Power supply scheme for PLC system, HMI & peripherals, Remote I/O etc.

4.2. For Information:

- Cable schedule and cable interconnection drawing(in BHEL approved format)
 - Between Field and PLC
 - Between Field and MCC
 - Between MCC and PLC
- Electronic earthing requirements.
- Panel Heat dissipation data
- Product/component catalogues.
- Operation & Maintenance Manual on CDs.
- Softcopy of Final/As-built drawings on CDs.
- Calculation for Processor, Memory & Data bus loading


The above list is the minimum requirements. Additional documents/calculations required shall be finalized during contract stage.

5. DRAWINGS AND DOCUMENTS TO BE SUBMITTED ALONG WITH THE BID

- Proposed PLC system configuration drawing with write-up
- Product catalogues and specifications for PLC as well as HMI application.
- Proposed power supply schemes for PLC system, peripherals, and Remote I/O panels.

6. TESTING AND INSPECTION

- 6.1. The bidder shall adopt suitable quality assurance program to ensure that the equipments offered will meet the specification requirements in full.
- 6.2. BHEL's standard Quality Plan for PLC is enclosed with the specification. The bidder shall furnish his acceptance to BHEL's QP and submit the signed and stamped copy of QP along with the offer.
- 6.3. The complete PLC system, including all instrument and devices shall be subjected to standard factory tests (i.e. Type Tests and Routine Tests) as per relevant IS, NEMA, IEEE, IEC.
- 6.4. Factory Acceptance Test-FAT (Functional Tests) shall be performed prior to shipment and Owner/Purchaser shall be notified 15 days before the schedules dates of the test.
- 6.5. The certificates for following type tests, as per IEC Standard, shall be submitted: -
 - Surge protection test as per IEC-225-4
 - Dry heat test as per IEC-68-2-2
 - Damp Heat test as per IEC-68-2-3

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- Vibration Heat test as per IEC-68-2-6
- Electrostatic discharge test as per IEC-801-2 or equivalent
- Radio frequency Immunity test as per IEC-801-6 or equivalent
- Electromagnetic Immunity test as per IEC-801-3 or equivalent

7. SPARES AND CONSUMABLES

7.1. Commissioning Spares and consumables

The bidder shall supply all commissioning spares and consumables 'as required' during Start-up, as part of the main equipment supply.

~~7.2. Mandatory Spares~~

NOT APPLICABLE

The bidder shall offer alongwith main offer, the Mandatory Spares as specified elsewhere in the specification. The Mandatory Spares offered shall be of the same make and type as the main equipment.

7.3. Recommended Spares

The bidder shall furnish a list of Recommended Spares indicating the normal service expectancy period and frequency of replacement; quantities recommended for 3 years operation alongwith unit rate against each item to enable BHEL/BHEL's Customer to place a separate order later, if required.

7.4. Special Tools & Tackles

The bidder shall supply all Special Tools & Tackles 'as required' during Start-up and further maintenance of the system, as part of the main equipment supply.

7.5. Spares, Service support

Bidder shall provide availability of spares and service support for minimum 10 years after guarantee period.

8. MARKING AND PACKING


8.1. Marking:

A stainless steel name-plate shall be permanently fixed on each equipment giving its Tag/serial Number and salient technical specification.

8.2. Packing:

Sea worthy packing capable of performing all necessary functions like prevention of damage to the contents, sufficient to support frequent handling and lengthy period of outdoor storage in adverse weather conditions are required. Workmanship and materials used shall be of high standard meeting the technical requirements and in accordance with best commercial export packing practices. Vendor shall be responsible for sea worthy export packing. Equivalent or better packing methods may be deployed subject to approval of the BHEL. Vendor shall submit the packing procedure for its equivalent for BHEL's approval during detailed engineering.

9. PERFORMANCE AND GUARANTEE

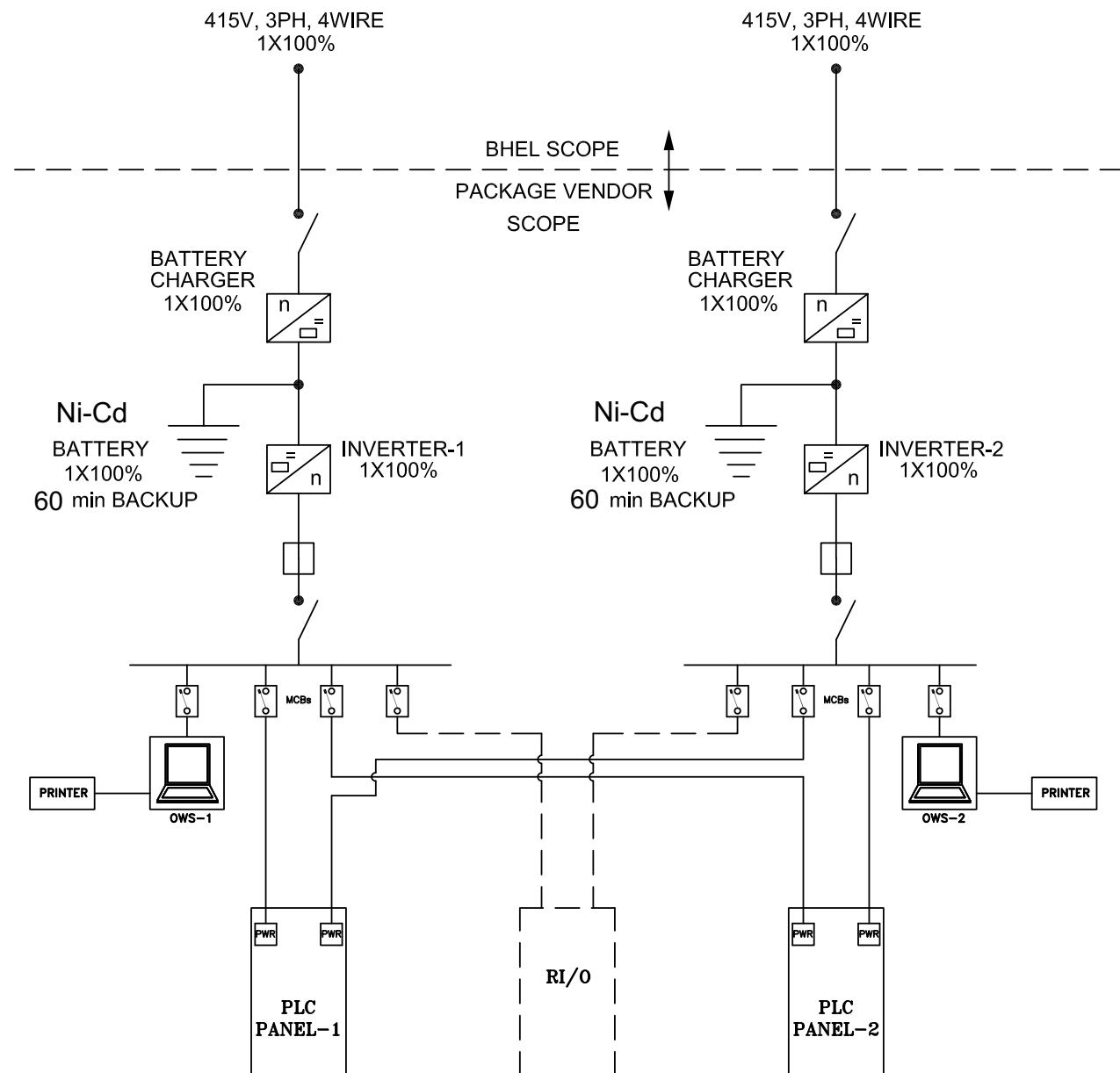
	TITLE: SPECIFICATION FOR PROGRAMMABLE LOGIC CONTROLLER SYSTEM	SPECIFICATION NO. PES-145-36	
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The PLC system shall be guaranteed to meet the performance requirement as specified and also for trouble-free continuous operation for 12 months from the date of commissioning or 18 months from the date of delivery at site whichever is later unless specified otherwise in Vol-IIB Section - B or Section - C.

10. APPLICABLE DATA SHEET FORMS

This document shall be read with the following data sheet forms :

- Data Sheet A & B for PLC system - PES-145-36-DS1-0
- Data Sheet C for PLC system - PES-145-36-DS2-0



NOTE: This configuration is typical for two PLCs and one RI/O. Consider only PLC Panel-1 configuration in case RI/O is not applicable.

UPS SCHEME

TYPICAL POWER SUPPLY ARRANGEMENT FOR PLC BASED CONTROL SYSTEM



BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECTS ENGINEERING MANAGEMENT
NEW DELHI

DEPT CODE	NAME	SIGN	DATE
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DSGN	SSB		26.08.07
CHD	AK		26.08.07
APPD	AK		26.08.07

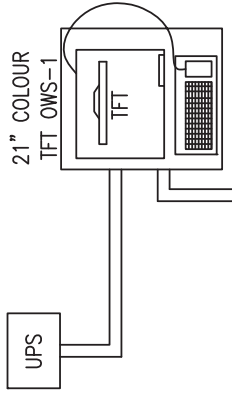
DRG. NO. PE-SD-999-145-001

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SYSTEM CONFIGURATION DRAWING

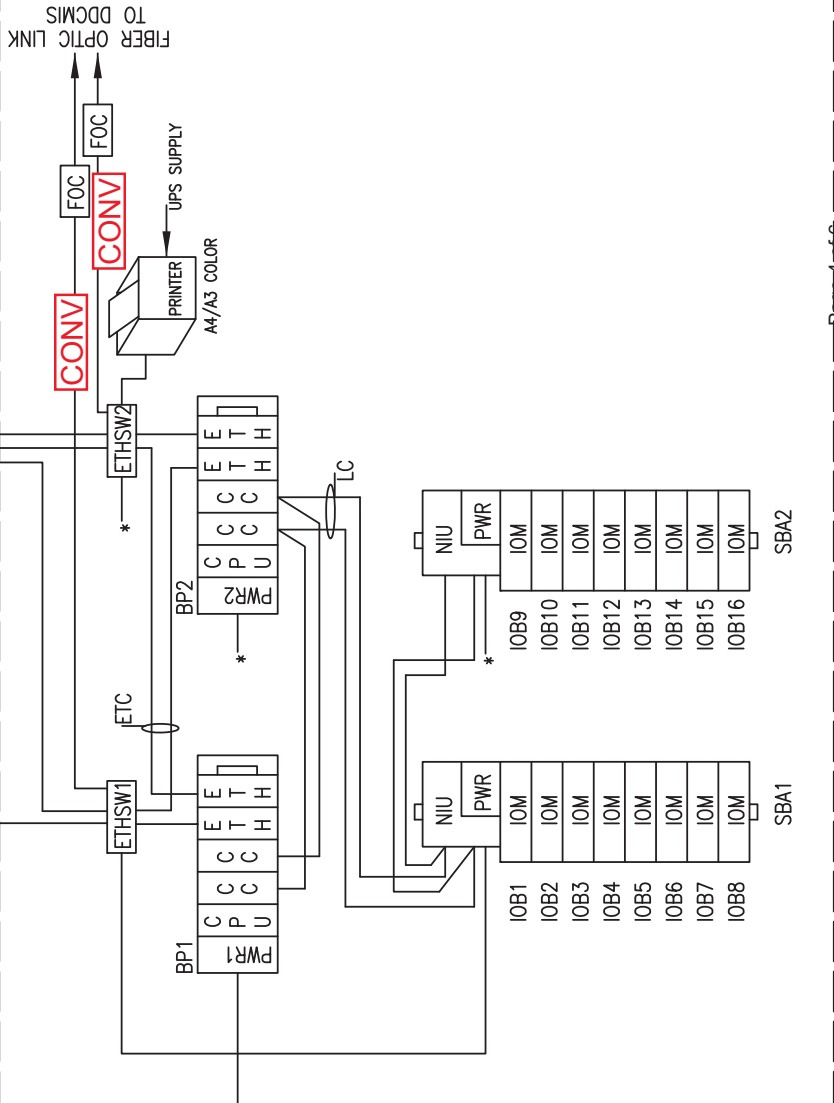
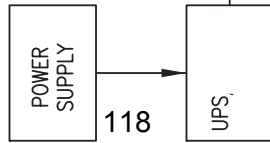
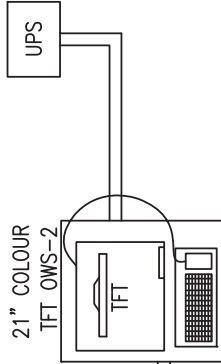
CRT-1

ENGINEERING/OPERATING
STATION



CRT-2

OPERATING STATION



NOTES:

- 1) All fiber optic patch chord shall be terminated to LIU .
- 2) PLC shall have the provision to accept time synchronization signal from GPS and vendor to inform the type of signal required.
- 3) PLC shall have dual redundant link with main DDCMIS. The necessary hardware/software at PLC end shall be in vendor's scope.
- 4) CONV indicates combination of LIU and Patch Chord (LIU + PATCH CHORD)


* Power supply from UPS.


PROJECT:

4X100MW GTPS
MARIB-II, YEMEN

TITLE:

SYSTEM CONFIGUARATION
GEN

	DATA SHEET FOR PLC SYSTEM		SPECIFICATION NO.:	
			VOLUME II B	
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			SHEET 1	OF 1
Data Sheet No.: PES-145-36-DS1-0				
Data Sheet A & B				
DATA SHEET-A FOR PLC SYSTEM (TO BE FILLED BY PURCHASER)			DATA SHEET – B (TO BE FILLED BY BIDDER)	
GENERAL	PROJECT	4X100MW MARIB GTPS-II		
	SERVICE			
	QUANTITY	<input type="checkbox"/> UNITISED <input checked="" type="checkbox"/> COMMON		
	LOCATION	<input type="checkbox"/> INDOOR <input type="checkbox"/> OUTDOOR		
PLC EQUIPMENT	MAKE / MODEL NO.	BIDDER TO INDICATE		
	PROCESSOR	REDUNDANT WITH HOT STANDBY		
	DATA BUS (HMI)	<input type="checkbox"/> COPPER WIRE <input type="checkbox"/> FIBRE OPTIC		
	DATA BUS (I/O - CPU)	<input type="checkbox"/> COPPER WIRE <input type="checkbox"/> FIBRE OPTIC		
	DATA BUS (REMOTE I/O - CPU)	<input type="checkbox"/> COPPER WIRE <input type="checkbox"/> FIBRE OPTIC		
	FIELD CONTACTS INTERROGATION VOLTAGE	<input checked="" type="checkbox"/> 24 V <input type="checkbox"/> 48 V		
	LOCATION OF COUPLING RELAYS	<input checked="" type="checkbox"/> MCC <input type="checkbox"/> PLC PANEL		
	DESKTOP OWS QUANTITY	<input type="checkbox"/> ONE <input checked="" type="checkbox"/> TWO <input type="checkbox"/> _____		
	DESKTOP MONITOR TYPE	<input type="checkbox"/> 19" <input checked="" type="checkbox"/> 21" TFT/CRT MONITOR		
	PRINTER (A4) - QUANTITY	INKJET LASER B/W COLOR INKJET COLOR LASER A-3 size color laser-1 No.		
	PRINTER (A4) - MODEL	INKJET LASER B/W _____ COLOR INKJET _____ COLOR LASER _____		
	PROGRAMMING / CONFIGURATION FACILITY	A) <input type="checkbox"/> HAND HELD B) <input type="checkbox"/> ENGINEERING SOFTWARE <input checked="" type="checkbox"/> ONE OWS <input type="checkbox"/> ALL OWS <input type="checkbox"/> _____		
	SAFETY STANDARD	_____		
	COMPUTER FURNITURE	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO		
PANEL	QUANTITY	BIDDER TO INDICATE		
	CLASS OF PROTECTION	<input type="checkbox"/> _____		
	REMOTE I/O PANEL	<input type="checkbox"/> YES <input type="checkbox"/> NO As required		
	COLOUR	AS PER IS-5 SHADE _____		
	BACK-UP DESK	<input type="checkbox"/> YES <input checked="" type="checkbox"/> NO		
	MIMIC	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO		
	CONTROL HARDWARE	<input type="checkbox"/> PB <input type="checkbox"/> INDICATORS <input type="checkbox"/> FACIAS _____ Nos. <input checked="" type="checkbox"/> OTHERS OWS & EWS		
COMMUNICATION TO OTHER SYSTEM	HARDWIRED	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO Critical only & rest through soft link		
	PURPOSE	<input type="checkbox"/> CONTROL <input checked="" type="checkbox"/> MONITORING		
	MEDIUM	<input type="checkbox"/> UTP <input checked="" type="checkbox"/> FIBRE OPTIC <input type="checkbox"/> OTHERS		
	TIME SYNCHRONIZATION SIGNAL FORMAT	<input type="checkbox"/> PULSE <input type="checkbox"/> RS-485 <input checked="" type="checkbox"/> IIRIG-B		
	SOFTLINK	<input checked="" type="checkbox"/> MODBUS <input type="checkbox"/> OPC		
	SERIAL LINK	COMMUNICATION PORT TYPE _____		
POWER SUPPLY INPUT FEEDER	PLC PANEL	BIDDER TO INDICATE LOAD DATA		
	REMOTE I/O PANEL	BIDDER TO INDICATE LOAD DATA		

	DATA SHEET FOR PLC SYSTEM		SPECIFICATION NO.:	
			VOLUME II B	
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Data Sheet No.: PES-145-36-DS2-0				
Data Sheet C				
DATA SHEET – C (TO BE FILLED BY BIDDER AFTER AWARD OF CONTRACT)				
GENERAL *	PROJECT			
	SERVICE			
	QUANTITY			
	LOCATION			
PLC EQUIPMENT	MAKE / MODEL NO.			
	PROCESSOR			
	DATA BUS (HMI)			
	DATA BUS (I/O - CPU)			
	DATA BUS (REMOTE I/O - CPU)			
	FIELD CONTACTS INTERROGATION VOLTAGE			
	LOCATION OF COUPLING RELAYS			
	DESKTOP OWS QUANTITY			
	DESKTOP MONITOR TYPE			
	PRINTER (A4) - QUANTITY			
	PRINTER (A4) - MODEL			
	PROGRAMMING / CONFIGURATION FACILITY			
	SAFETY STANDARD			
		COMPUTER FURNITURE		
PANEL	QUANTITY			
	CLASS OF PROTECTION			
	REMOTE I/O PANEL			
	COLOUR			
	BACK-UP DESK			
	MIMIC			
	CONTROL HARDWARE			
COMMUNICATION TO OTHER SYSTEM	HARDWIRED			
	PURPOSE			
	MEDIUM			
	TIME SYNCHRONIZATION SIGNAL FORMAT			
	SOFTLINK			
	SERIAL LINK			
POWER SUPPLY INPUT FEEDER	PLC PANEL			
	REMOTE I/O PANEL			

**STANDARD QUALITY PLAN
FOR
PROGRAMMABLE LOGIC CONTROLLER**

QUALITY PLAN NO.: PE-QP-999-145-I036			
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FACTORY ACCEPTANCE TEST (FAT) PROCEDURE

This document covers procedure to conduct/witness PLC system functional tests in order to demonstrate conformity to purchase specifications and related engineering documents. The test shall be conducted at the system suppliers works. The system supplier shall conduct all functional tests before commencing FAT and test results shall be made available during FAT. Vendor must furnish following relevant drawings, duly approved by BHEL Engineering, for reference during FAT.

- a) Technical Specification of PLC.
- b) PLC System Configuration
- c) General Assembly Drawings.
- d) Panel Wiring Diagrams.
- e) Bill of Quantity for PLC System.
- f) Logic Diagram.
- g) HMI Schematics.
- h) Input / Output List.

Further the vendor shall furnish applicable product specification, datasheets, catalogues, test-certificates, and internal inspection records to enable FAT. Vendor shall also submit, [to the inspecting agency](#), his standard test procedure, for clauses given below; where vendor's standard practice has been referred.

APPLICABLE TEST PROCEDURE:

1. Input/Output Functional Verification.

Check for correctness of addressing of racks, slots and I/O modules as per applicable PLC configuration diagram. Appropriate signal generators shall be used to simulate Inputs and outputs to check operation and SCAN time. [Check online replacement of cards, processors, power supply etc.](#)

2. Processor Verification

PLC Configuration drawing to be referred for ascertaining

- i) Redundancy

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ii) Type (Hot or Cold)

Both the processors are to be checked for healthiness in case of redundant configuration as per vendor's standard practice. In case of hot redundancy, switchover of control from primary processor to standby processor shall be demonstrated for uninterrupted control and data processing as per vendor's standard practice. Switchover shall be witnessed, by manual power off or resetting the Primary CPU or simulating failure of primary processor. Checking should be by witnessing the lighting up of Processor's LEDs as per manufacturer's product standard.

Vendor shall demonstrate, as per Vendor's standard practice, adequate Loading (Spare Capacity) of Processors, as mentioned in contract specs. This shall be done, by simulating worst load operation of fully integrated PLC system.

3. Power Supply Module Verification

Check if PSM is in redundant mode as per specification. Check the healthiness of power supply from both the modules' lamp indication/measurement. Simulate failure of one PSM and verify that standby PSM has taken over without any interruption.

4. Communication System Verification

Communication system has to be in line with approved PLC Configuration Diagram. Verify that both the communication buses are intact and connected. Communication between PLC processors, I/O rack, OWS etc. is to be checked through simulation of input data. Simulate the bus failure by disconnection of working bus. Check that the communication continues without interruption or loss of data.

Following response times are to be demonstrated as per vendor's standard practice for conformance to contract specifications:

1. Screen update time
2. I/O scan time
3. SOE resolution time
4. Data transfer time with third party system using Communication Protocol as per Contract specification and as per quantum of data as per approved signal exchange list.

5. Diagnostic Verification

Product Catalogue/Literature shall be referred for checking of all diagnostic features. Hardware failure to be simulated by removing an I/O

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6. Control Panel /Desk Verification

- i) PLC driven annunciation system should be checked by alarm signal simulation.
- ii) Push Button and selector switch operation should be checked by verification of corresponding change of status of Data Base point.
- iii) Indicating lamp / MIMIC should be checked by corresponding Data Base point simulation.

7. Software Verification

- i). Control Logics:– Software switches, lamps and Analog sources shall be used for simulation of field conditions .Control logics shall be checked for its correct functionality as per approved logic schemes
- ii). Engineering features:-
 - a) Online changing of parameters, set points.
 - b) Online modification in Control Logic Diagrams.
 - c) Online configuration of Graphics, Trends, Logs, HSR.
- iii). HMI features:-
Check for configuration & operation of Graphics, Trends, Logs, HSR and Alarms, in the form of Displays and Printouts, by simulation of Inputs as per approved documents.

8. Burn in Elevated Temperature test

Electronic equipments shall be subjected to Burn in elevated temperature test as per the procedure detailed below:

- a) (i) PLC modules are kept at 50 Deg c under continuous energized condition for 48 hours.

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ii) 48 hours test period shall be divided into 4 equal time segment of 12 hours duration each. For every 12 hours duration segment, after lapse of first 11 hours 110% of nominal voltage shall be applied to the panel under test for a period of 30 minutes followed by application of 90% of nominal voltage for the next 30 minutes.


b) Assembled Panels with complete wiring shall be kept under continuous energized condition for 120 hours at ambient temperature. Temperature rise in panels should be below 10 Deg C above ambient.

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Sl. No.	Component / operation	Characteristics Checked	* Cate gory	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks			
1.0	Materials /Components								P	W	V				
1.1	Panels & Control Desks	Physical Inspection for Dimensions, Painting, Cutouts, Lifting / Locking Arrangements, Components, Drawing Pocket, Mounting accessories, Plinth & AV Pads, Cable Gland Plates, Hardwares, Hinges, Louvers & Filters, Fans & Panel Lamps	MA	Visual	100%	Contract specifications, Approved GA Drawings, BOQ	As per ref documents. No physical damage.	BHEL Quality Inspection Report.	3/2	2	1				
1.2	Power Supply/Packs, Battery & Battery charger, Transformer, UPS.	Physical Inspection Physical Damages Dimensions Mounting Accessories	MA	Visual	100%	Contract specifications, BOQ.	As per reference documents, Test Report	BHEL Quality Inspection Report.	3/2	2	1				
1.3	Indicating Lamp, Annunciator, Meters, Transducers, Signal Converters, Instruments, Single Loop Controllers	Physical Verification Physical Damages Dimensions Accessories	MA	Visual	100%	Contract specifications, BOQ.	As per ref documents No physical damage. Test/ Calibration report.	BHEL Quality Inspection Report	3/2	2	1				
1.4	PLC processors, I/O modules, Power Supply modules, Communication modules, Mounting Racks, Ethernet	Physical Inspection <ul style="list-style-type: none">Identification LabelsPhysical DamagesQuantitySpare Capacity	MA	Visual	100%	Product Catalogue, Data sheets, Approved Configuration diagram, BOQ	As per ref documents. Test Certificates	BHEL Quality Inspection Report.	3/2	2	1				


LEGEND: * CR - Critical characteristics
MA - Major characteristics
MI - Minor characteristics

\$ P - Agency Performing the Test.
W - Agency Witnessing the Test.
V - Agency Verifying the Test.

1 - BHEL
2 - Vendor
3 - Sub-vendor


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Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks					
									P	W	V						
1.5	CPU, Monitor, Keyboard, Mouse, CD Drives, Printers, OS, System Software, Engineering software in the form of Licensed CD.	Physical Inspection Identification Labels, Tech. Specification Physical Damages Accessories Installation arrangements for Computers & Printers	MA	Visual	100%	Contract specifications, Product Catalogue, Approved GA / Configuration drawing, BOQ.	As per reference documents.	BHEL Quality Inspection Report.	3/2	2	1						

LEGEND:	* CR	- Critical characteristics		\$	P	- Agency Performing the Test.	1	- BHEL
	MA	- Major characteristics			W	- Agency Witnessing the Test.	2	- Vendor
	MI	- Minor characteristics			V	- Agency Verifying the Test.	3	- Sub-vendor

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Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks					
									P	W	V						

2.0	Assembly											
2.1	Functional Test for HMI/OWS devices such as Monitors, Keyboards, Mouse, Printers etc.	Operation	MA	Functional	100%	Approved Configuration Diagram & BOQ and FAT	Correct Operation of interconnected Devices of HMI system.	BHEL Quality Inspection Report.	2	1	1	
2.2	Hardware Functional Verification.	Physical arrangement, Wiring check & labeling, Continuity Checking, IR & HV test	MA	Visual/ Electrical	100%	Approved GA Drawing, Panel Wiring Diagram, IR & HV as per relevant International standard	Test Certification	BHEL Quality Inspection Report.	2	2	1	
2.3	Powering Up	Healthiness of all the modules/equipment, associated with Powering of PLC system	MA	Visual /Electrical	100%	Approved power supply scheme	All equipment to be healthy on power ON	BHEL Quality Inspection Report.	2	1	1	
2.4	Burn in test for PLC modules	Healthiness of PLC modules on Continuous Energisation, Temperature maintenance	MA	Visual/ Electrical	100%	FAT Procedure	Test certification as per FAT	BHEL Quality Inspection Report.	2	2	1	

LEGEND:	* CR	- Critical characteristics	\$	P	- Agency Performing the Test.	1	- BHEL
	MA	- Major characteristics	W	W	- Agency Witnessing the Test.	2	- Vendor
	MI	- Minor characteristics	V	V	- Agency Verifying the Test.	3	- Sub-vendor

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												SECTION		D			
												REV. NO.		01		DATE: 24.08.2007	
												SHEET		4		OF 8	
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks					
									P	W	V						

3.0	Factory Acceptance Test (FAT)											
3.1	Input Output Functional Verification	I/O configuration, I/O operation	MA	Visual/Eletrical	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2	1	1	
3.2	Processor Verification	Processor configuration, Powering up, standby operation (as applicable) and Loading	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2	1	1	
3.3	Power Supply Module Verification	Redundancy Operation	MA	Electrical	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2	1	1	
3.4	Communication System Verification	Redundancy operation of Communication System, Measurement of Response Time, Communication with third party system	MA	Electrical	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2	1	1	
3.5	Diagnostic Verification	Self Diagnostic features of PLC system	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2	1	1	
3.6	Control Panel/Desk Verification	Operation of PLC driven annunciation system, Mosaic, Push buttons & selector switches, Indicating lamps	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2	1	1	
3.7	Software Verification	(i) Control Logics (ii) Engineering Features (iii) HMI Features	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2	1	1	

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Technical Specifications and Quality plans for Instruments

4 X 100MW MARIB GTPS - II

Technical Specifications (C&I) for Auxiliary packages

General Instrumentation Design Requirements

• Field Instruments

- a. Analog outputs signals from field instrumentation to the control systems are 4-20 mA dc signals. Instrumentation can be self-powered, or loop powered from the control systems. Self-powered analog signals shall be true "isolated from ground" signals.
- b. Switch contacts for control system inputs shall be snap acting type, potential free with a maximum contact rating of 230V AC, 5A.
- c. Transmitters will be used to provide the required 4 to 20mA signals for all controllers and receivers. Transmitters will be of the electronic, two-wire type, capable of driving an output impedance of 600 ohms minimum at 24 V dc, and will be generally powered from the control system I/O cards.
- d. SMART transmitters' calibration shall be carried out through a PC based System to be located in the computer room.
- e. Pressure, flow, differential pressure, level, temperature, and other miscellaneous transmitter accuracy shall be within 0.1% of calibrated span and shall have repeatability of +0.1% of span or better. Errors caused by change in ambient temperature shall not exceed 0.01% of span per °C change. Temperature variations of +55°C shall not affect the 0.1% accuracy rating nor the 0.1% repeatability.
- f. The plant instrument air supply pressure shall be:
 - 1. Maximum supply pressure 7 kg/cm² (To be confirmed by PEC)
 - 2. Minimum supply pressure 4.5 kg/cm²
- g. All instruments and analysers shall employ RF protection in the system design.
- h. Instrument tags should be permanently attached to the device. If this is not possible, the instrument tag should be fastened to the instrument with stainless steel wire. The wired instrument tag should be supplied as ¾ inch by 3 inch, stainless steel instrument tags. Tag thickness is 1/16 of an Inch and stamped with instrument tag number. Tag number characters are 3/8 inch in height.

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Technical Specifications (C&I) for Auxiliary packages

- i. Speed switches and the actual device should drive transducers, if possible.
 - j. All instrumentation mounted inside, away from direct exposure to the elements, shall be as a minimum NEMA 4 construction unless it is in an environmentally controlled environment (e.g the control room). If the instrument is mounted in an environmentally controlled environment the instrument shall be as a minimum NEMA 1 construction.
 - k. All instrumentation mounted outside, exposed to the elements, shall be as a minimum NEMA 4X construction, unless it is enclosed in a heated instrument enclosure. If the instrument is mounted in a heated instrument enclosure the instrument shall be as a minimum NEMA 4 construction.
 - l. Transmitters and switches shall be grouped and mounted in open racks depending on the location. Individual instruments shall be mounted on stanchion or pipe mounted.

All field instruments junctions boxes & local panels located in hazardous area shall be explosion proof as per the area classification drawing.
 - m. The following metric engineering units shall be used for all instrumentation devices :
 - 1. Pressure – bar (g)
 - 2. Temperature - °C
 - 3. Steam flow – kg/hr
 - 4. Liquid flow – m³/hr
 - 5. Distance – meters (m) or millimeters (mm)
 - 6. Differential pressure – mmH₂O
- **Control Valves**
 - a. Control Valves are defined as Pneumatic operated modulating valves.
 - b. Instrument air shutoff valve shall be provided on each control valve assembly.
 - c. The following end connections shall be used when weld type connections are specified in the piping line specification:
 - 1. Socket weld end connections: 2 inch and under control valve bodies.
 - 2. Butt weld end connection : 2-1/2 inch and over control valve bodies.
 - d. Valve bodies shall be Globe, single – port unless otherwise required and shall be not more than two nominal sizes smaller than the line in which they are installed.
 - e. Valve body material shall be as specified in the piping line specifications.

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Technical Specifications (C&I) for Auxiliary packages

- f. All integrally mounted instrumentation (control rollers, positioners, regulators, etc.) to be designed for a maximum instrument air supply pressure of 7kg/cm²g. Minimum instrument air supply pressure is 4.5kg/cm²g. Separate air filter regulators with inlet and outlet gauges shall be provided for each control valve.
 - g. Electro-pneumatic positioners shall be integrally mounted to the control valves. The I/P transducer shall be integral to the positioner.
 - h. Pneumatic controllers for control valves will be limited to control loops that do not require any interface with any receiver installed in the main control room. Pneumatic temperature controllers will have filled bulb type sensing elements. Pneumatic pressure controllers will have Bourdon tube sensing elements.
 - i. It is the intent that the valves shall fail either open or closed or fail lock in the event of failure of air signal or electric signal from any valve component (controller or positioner), as well as failure of the main control air supply or voltage to the solenoid.
 - j. Position transmitters of non-contact, 2-wire 4-20mA DC type shall be provided for modulating control valves. Also in general limit switches shall be provided for control valves.
 - k. Pilot solenoid valves for on-off service control valves are to be designed for 24 Vdc with a minimum orifice size of 1/4 inch.
 - l. Instrument tubing is to be stainless steel, in accordance with the tubing line specifications. Minimum tubing size is 1/4 inch, SS-316.
 - m. Control valve limit switches to be designed to operate at 24 VDC.
 - n. The control valves shall generally have the max. flow handling capacity of 120% and the limit of valve travel shall generally be between 10% and 80%.
 - o. The following shall be specified for control valves.

Max. noise – 85 dBA from 1m. distance.
 - p. The max. permissible outlet velocity shall be as per ISA-S75.01 based on service (liquid, steam or flashing services).
 - q. Whenever fire safe requirement is specified for a Emergency shutdown valve, the valve body as well as the actuator shall meet the testing requirements API 617 latest revision. In addition to above, air volume tank shall also be provided for a storage of air volume with minimum two full strokes of valves. All valve accessories like solenoid valve, limit switches and volume tank etc shall also be enclosed in a certified fireproof enclosure. The cable used for the actuation of the valve shall also be fire resistant (Fire survival to IEC 331). For shutdown valves leakage class VI shall be considered. No by-pass valve or hand wheel shall be used for shutdown valves.
- **Flow Instrumentation**
 - a. Flow Orifice plates will be used for Natural Gas flow to turbine and other critical measurements where weld-in construction is required. Positive displacement flow meters and totaliser will be used for oil flow.
 - b. Orifice plates shall conform to requirements of ASME "Fluid Meters".

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Technical Specifications (C&I) for Auxiliary packages

- c. Flow nozzles shall be of the weld-in holding ring type ASME long radius, with dual wall taps and shall be of stainless steel. Flow nozzles shall be furnished complete with metered runs in accordance with ASME PTC 6.1. Metered pipe run and nozzle shall match the pipe material and size that metered section is to be installed in.
- d. Orifice plates shall be 316SS, sharp square edge thin plate, and paddle type suitable for installation between raised face orifice flanges. Orifice flanges, gaskets and jacketing screws shall be furnished by the Supplier. Paddle shall be stamped with the orifice ID bore diameter on the upstream side. Orifice flanges will be of the raised face, weld-neck type with 2 or 3 sets of taps as required for redundancy.
- e. Beta ratios shall be between 0.2 and 0.7. Flow elements (flow nozzle & orifice) sizing shall as per BS-1042/ISO-5167.
- f. Differential type flow transmitters shall be supplied with three valve manifolds directly mounted to the transmitter.
- g. Differential type flow transmitters shall be electronic, analog 2-wire transmitters with isolated 4-20 mA dc output signals.
- h. Square root extraction of the flow signal is performed in the DCS.
- i. Positive displacement type flow meters shall be used for oil flow measurement.

• Pressure Instrumentation

- a. Pressure transmitters are electronic, analog 2-wire transmitters with isolated 4-20mA dc output signals.
- b. Pressure transmitters will be supplied with integral mounted two valve manifolds.
- c. All pressure transmitters shall be capable of withstanding their body rating conditions without permanent damage or loss of calibration.
- d. Differential pressure transmitters of the capacitance type, regardless of the applied service, shall be capable of withstanding a differential pressure equal to full process pressure on either side of the measurement element without damage or loss of calibration.
- e. Differential pressure transmitters will be supplied with integral mounted three valve manifolds.
- f. Pressure gauges will be generally 150mm dial, solid front safety case type with blowout back, 1/2" NPT bottom connection, drawn stainless steel case, 316SS bourdon and socket, stainless steel movement, micrometer pointer. Pulsation dampers will be provided for pulsating pressure services. Liquid filled gauges shall be used for all pump discharges, vibrating or pulsating services.
- g. Pressure switches will generally be snap acting type, DPDT action, with individual "on" and "off" points to be on a calibrated scale or dial.

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Technical Specifications (C&I) for Auxiliary packages

- h. Dual type control switches such as pressure switches having two sets of contacts with independently adjustable set points shall not be used where set point adjustment and deadband are a problem (e.g. low pressure and vacuum applications). If a potential problem exists, two single purpose switches shall be used.
- i. The gauges shall have $\pm 1\%$ accuracy and over range protection of 125%.
- j. The switches shall have the following :
- | | | |
|---------------------|---|-----------------|
| Max. Contact rating | : | 230V AC, 5A |
| Repeatability | : | $\pm 0.5\%$ FSR |

• Temperature Instrumentation

- a. For temperature up to 300°C 3-wire RTD duplex type, PT 100 type shall be used. For temperature beyond 300°C thermocouples shall be used. Thermocouples shall be manufactured in accordance with the ISA Standard MC96.1, Temperature Measurement Thermocouples. All thermocouples shall be Chromel Alumel (Type K) for $300^{\circ}\text{C} \leq T < 850^{\circ}\text{C}$. R or S type for $T > 850^{\circ}\text{C}$.
- b. The mV signal of thermocouple shall be used as input to the DCS. Cold junction compensation shall be achieved in the DCS
- c. Thermocouples shall have duplex elements and grounded measuring junction.
- All thermowell in a high velocity line or duct shall have an ASME PTC 19.3 calculation for determination of the wells resonant frequency. Thermowells that do not meet the acceptance criteria shall be resized or relocated as necessary.
- d. An extension nipple / union / nipple of sufficient length to extend beyond lagging and connection head shall be furnished for each thermocouple assembly. Terminal blocks shall be marked with polarity and connectors shall be resistant to heat, vibration and galling. The cap shall provide a weather tight enclosure and a chain shall be provided to prevent loss of cap. The cap shall be made of cast aluminium.
- e. RTDs of Duplex type furnished by the Supplier shall be of the three-wire type made with 100 ohm platinum resistance elements. They shall be certified to meet the requirements of the International Temperature Scale, calibrated to the IEC-751 standard ($\text{Alpha} = 0.00385 \text{ Ohms/Ohm}^{\circ}\text{C}$), and be guaranteed to an accuracy to within $+1.1^{\circ}\text{C}$ of this standard. The RTDs shall be contained in an insulated material and a sheath or sleeve of stainless steel SS-316 and shall be so mounted that they can withstand the greatest shocks and vibrations that can be imposed upon them in the system piping without deterioration. Specific information shall be furnished concerning type and accuracy of bridge circuits to be used with the RTDs. RTDs shall be directly connected to DCS without any transmitters.
- f. Unless specified otherwise, each temperature element and thermometer shall be provided with a 1" socket weld type, 316 stainless steel tapered thermowell suitable for the requirements of the given application.
- g. Thermowell immersion length will generally be between 1/3 and 1/2 the distance to the center of the pipe. Where thermowells are installed in lines smaller than 4 inches,

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Technical Specifications (C&I) for Auxiliary packages

the piping shall be expanded to 4 inch size to accommodate the thermowell. Thermowell shall be drilled from solid bar stock.

- h. All thermowell in a high velocity line or duct shall have an ASME PTC 19.3 calculation for determination of the wells resonant frequency. Thermowells that do not meet the acceptance criteria shall be resized or relocated as necessary.
- i. Thermocouple extension wire is to be solid, shielded, twisted pairs.
- j. If intermediate terminal blocks are required in a thermocouple measuring circuit, they need not be the same material as the thermocouple.
- k. Dial thermometers shall be bimetallic, minimum 150mm dial, every angle form, hermetically sealed with external recalibration adjustment, 1/4" OD SS stem, 1/2" NPT connection and SS case.
- l. Temperature switches shall be actuated by filled bulb-type elements equipped with standard-length armored capillary tubing.
- m. Temperature gauges shall have $\pm 1\%$ accuracy and average protection of 125%.
- n. Switches shall have the following:
 - Max. contact rating : 230V AC, 5A
 - Repeatability : $\pm 0.5\%$ FSR
 - Contact type : snap acting

• Level Instrumentation

- a. Differential pressure transmitters will be used for general service level measurement of all tanks and other pressurized vessels.
- b. Differential pressure type level transmitters are electronic, analog 2-wire transmitters with isolated 4-20 mA dc output signals. Displacer and ultrasonic level transmitters will be 24V DC powered, with isolated 4-20 mA dc output signals powered from the transmitters. Displacer type level transmitters are of torque tube type. Displacer type level transmitters shall be used for lub oil tanks.
- c. Constant head chambers shall be furnished for all differential pressure-type level transmitters used with pressurized vessels. Reservoir piping connections shall be 1/2 inch outlet and a 1/2 inch inlet socket-welded type suitable for the pressure and temperature encountered.
- d. Transparent gauge glasses will be used for low-pressure applications. Transparent or reflex gauges will be used for high-pressure applications. All gauge glasses will be equipped with gauge valves, including a safety ball check. Color less liquid shall be provided with reflex type level Gauges.
- e. Level switches shall generally be cage float type, rated for ANSI B31.1 requirements.
- f. DP Level transmitters : Accuracy- $\pm 0.1\%$
Level switch : Contact type – snap acting
Contact rating – 230 V AC, 5A,
Repeatability - $\pm 0.5\%$ FSR

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Technical Specifications (C&I) for Auxiliary packages

- **Stack Emission Monitoring System**

The use of individual or multiple prefabricated analyser installations shall be used to reduce site installation work. This prefabrication shall include sample conditioners, analysers, air and electrical distribution, cooling water distribution or coolant circulating system all piped and wired on a common frame. Interconnecting pipe work and accessories shall be of stainless steel. The arrangement shall permit testing of the entire assembly before dispatch to site and shall be arranged for convenient removal from on-line operation to facilitate routine maintenance and calibration.

- **Analysis of flue gas / Stack Analysers**

Appropriate analysers of proven type shall perform the analysis of SOX, NOX, CO, etc. in the flue gas.

The equipment shall be constructed for operation in dusty and humid environments at high ambient and flue gas temperatures. The use of equipment capable of multi-parameter measurement shall be considered.

Analysers provided shall have auto-calibration for zero and span as well as self-diagnostic functions.

If sampling of flue gas is used, sampling probes shall preferably be vertically installed on the top of horizontal flue gas ducts, in order to avoid blockages.

In order to keep the sampling lays to acceptable limits the analysers shall be located close to their sample take-off point, so that easy access to the sample take-off point and to the analysers shall be provided for maintenance.

The flue gas sampling lines shall be heated to prevent condensation and shall not form a siphon in the case where condensate may be collected during heater failure. Condensate drainage facilities shall be provided at the analysers.

Generally, the analysers and the sampling probe equipment shall be suitable for mounting in ambient plant conditions, e.g. within a standard cubicle. However, if not feasible, the equipment shall be mounted in an air-conditioned room or container.

Power failure and system failures of analysers shall be monitored in the central control room by a group alarm.

All the stack analyzers output signals shall be repeated in DCS for alarm & monitoring.

- **Vibration Monitoring System**

Online vibration monitoring system shall be provided with vibration transducers, low noise flexible cables in flexible conduits, terminated in JB's, all interconnecting cables, racks/cabinets, power supplies, calibration equipment, indicators, integrating units, signal conditioning devices and all accessories required for completeness of work.

This shall be also placed in local control center and the signals shall be hard wired /serial connected to turbine control panel for interlock and monitoring purpose.

These vibration parameters shall also be communicated to DCS for control and monitoring purpose.

- **Instrument Cables Design Criteria:**

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Technical Specifications (C&I) for Auxiliary packages

All cables shall be FRLS outer sheath, armoured, 7 standard copper conductor, cable (for power cable -solid conductor).

Signal cable	:	Blue colour outer sheath, screened 1.0 Sq.mm for single pair 0.75 Sq.mm for 8/12 pair, individual pair and overall shielded
RTD cable	:	Black colour outer sheath, screened 1.0 Sq.mm for single triad 0.75 Sq.mm for 8 triad, individual triad & overall shielded
Control cable	:	Black colour outer sheath, screened 1.0 Sq.mm for 2 cores 0.75 Sq.mm for 8/12/24/48 cores
Power cable	:	Black colour outer sheath 2.5 Sq.mm For 2/ 3 cores.
Compensating cable	:	Type – KX, yellow colour outer sheath, screened individual and overall, 16 AWG 1/8/12 pair

9.5.0 Documentation

The following documents shall be furnished along with the bid:

- Detailed description of Turbine control panel and DCS offered
- Reference list for the system application in power plants
- Description of closed loop control with block diagram of hardware configuration
- Description of open loop control with block diagram of hardware configuration
- Description of standard software modules for open loop and closed loop control
- Description of data bus system and bus control
- Description of redundancy and back-up/System availability
- Description of Plant Shutdown Procedure
- Description of control room equipment, control desks, VDUs, keyboards etc., remaining conventional instrumentation (important indicators, alarms etc.)
- Description of VDU displays
- Description of power supply
- Detailed listing of all options available within the system and which of these options are included in the offered scope.
- Description of programming aids (configuration) and fault finding (system diagnosis)

4 X 100MW MARIB GTPS - II

Technical Specifications (C&I) for Auxiliary packages

- List with the detailed scope of equipment offered
- List of spare parts
- Requested modifications of the contract specification text.
- DCS, Turbine control system configuration drawings
- Tentative layout of the CCR
- Filled up technical data sheets (Refer clause 9.9.0 of this volume).

The following documents shall be furnished after award of Contract:

- Layout of CCR with operator consoles and panels
- Layout of CER showing distribution of cabinets and racks
- Detailed layout of auxiliary consoles and panels
- Instrument list
- I/O list (DCS)
- Logic diagrams, interlocking diagrams
- Block diagrams and description of main closed-loop control
- Display sheets (Hard copy)
- Technical specifications of all the field Instruments, DCS, PLC, cables, all erection hardware, panels, analysers, etc including the datasheets
- Manufacturers data sheets of all instruments / modules
- List of Alarms & Trips
- Schedule of SER inputs
- Installation drawings
- Instrument Loop diagrams
- Wiring diagrams / Interconnection schedule
- Terminal diagrams
- Cable Schedule (Signals / control / power)
- Users manuals and other reference manuals
- DCS loading details
- Data base configuration
- Factory acceptance test procedure

4 X 100MW MARIB GTPS - II

Technical Specifications (C&I) for Auxiliary packages

- Test certificates
- Certificates from statutory bodies
- Logs and report formats
- Instrument Location Layout drawings (area/elevation wise)
- Junction box schedule
- All other lists and drawings as required
- DCS vendor drawings/documents
- All the above drawings as applicable for the mechanical packages

The Contractor shall ensure that the final draft of all schedules, lists or data sheets for C&I equipment are produced to a uniform format irrespective of whether the source of the above schedules, lists and data sheets is in the main Contractor or a Sub-contractor of the main Contractor. All documents shall carry a uniform numbering system.

9.6.0 Spares

The below spares philosophy is to be read in conjunction with the C&I spares given in this document. Special tools and equipment for the maintenance, inspection and repair of the individual main equipment and auxiliary equipment shall be supplied by the Contractors in sufficient quantity to equip the shift personnel, maintenance personnel and workshop craftsman.

The special tools and equipment for maintenance and repair shall be delivered by the contractor in lockable steel boxes and they shall be marked in an approved manner for identification purposes and a corresponding tool chart shall be supplied with the steel boxes.

10% spare instrument for each type and each range, with a minimum of one, for instruments like field transmitters, field switches, pressure and temperature gauges, solenoid valves etc. shall be provided.

For control valves, float level switches, displacer type level transmitters, level gauges etc. only critical parts shall be provided as spare.

20% or minimum 1 No. of each type of module shall be provided for DCS and Turbine control panel systems.

This spare philosophy shall be applicable for main systems as well as auxiliary systems.

Apart from the above spares, the Contractor shall furnish the list of spares recommended by him for 2 years of trouble free operation of the plant.

9.7.0 Commissioning

The Contractor shall be responsible for installing, checking / calibrating of all the instruments and systems, laying and connecting of all interconnecting cables right from the field to the respective local control panel or central control / electronics rooms, termination of all cables, laying and connecting data high ways, testing the system, loop checking from field to receiver instruments / system and commissioning the instruments and systems.

4 X 100MW MARIB GTPS - II

Technical Specifications (C&I) for Auxiliary packages

C&I Spares :

The Contractor must indicate and include in his scope of supply the following:

- a) All the necessary start up spares
- b) Recommended spares for two (2) years of normal operation of the plant with unit & total prices.

Furthermore the contractor shall also provide a list of recommended spares for five (5) years operation including major overhaul along with the price schedules.

The Purchaser reserves the right to finalise the exact quantities of the recommended spare parts and effect price adjustment on the basis of the unit rates quoted by the Contractor.

The spares ordered by the Purchaser shall be delivered at the site not later than the date of issue of Taking over Certificate.

Price of the recommended spares will not be taken into consideration for the evaluation of the bids. They shall remain firm up to Twelve (12) months from the date of finalisation of EPC contract for the power plant. Purchase of these spares parts will be covered by a separate order which will be issued only after the receipt of the complete instruction manuals for the equipment from the Contractor. Instruction manuals for major plant / equipment shall be submitted by contractor within Six (6) months from date of finalisation of contract. If the submission of O & M manuals are delayed the validity of offer for recommended spares shall be correspondingly extended The bidder should confirm that the recommended spares shall be delivered at site within three months of the placement of order.

All spares supplied under this Contract shall be strictly interchangeable with the parts for which they are intended for replacements. The spares shall be treated and packed for long storage under the climatic conditions prevailing at site e.g small item shall be packed in sealed transparent plastic bags with dessicator packs as necessary.

Each spare shall be clearly marked or labelled on the outside of the packing with its description. When more than one spare part is packaged in a single case, a general description of the contents shall be shown on the outside of such case and a detailed list should be enclosed. All cases, containers and other packages must be suitably marked and numbered for the purpose of identification.

In the schedule of the recommended spares, the bidder shall clearly state and identify separately the spare parts manufactured by the supplier, the spare which are bought out locally from the indigenous manufacturers and the spares which are imported from other countries. The sources of the supplier of the spares not manufactured by the supplier shall be furnished. The complete details of such spares to enable the Purchaser to place orders directly for his future requirements, shall also be furnished.

All spare parts supplied shall be new and unused.

General Requirements

(1) Tendering procedure of spare parts

The tenderer shall prepare in his tender a complete list of recommended spares required for two (2) years of normal operation. The list shall give for each spare part, the number of equipment installed in the plant, the number of spares supplied, the unit price and the total price as well as the grand total. Also, the tenderer shall provide a list of recommended spares for five (5) years operation along with the price schedules.

4 X 100MW MARIB GTPS - II

Technical Specifications (C&I) for Auxiliary packages

(2) Criteria for selection of Spare Parts

The Tenderer shall recommend and propose spares for equipment parts in accordance with the following three categories :

Category - I - Spare parts that are subject to:

- (a) Wear, tear, erosion and corrosion during normal operation.
- (b) Failure that would result in shut down of the equipment.
- (c) Failure that would cause troublesome operation of the equipment.

Category - II - Small parts that are subject to:

- (a) Damage or breakage during routine maintenance or inspection such as gaskets, packings, bolts, t, etc. of general use (mechanical parts)
- (b) Same, such as fuses, lamps, etc. of general use (electrical and instrument parts).

In preparing the spare parts list, the Tenderer shall critically examine the equipment Vendor's recommended spare parts list both to ensure completeness and eliminate items which combine low wear and breakage factors based on anticipated operating conditions (continuous, intermittent or occasional, severe or mild) and short delivery time.

Category - III - Recommended spare parts required for major overhaul, combustion path inspections.

Also the possible interchangeability of parts of similar equipment (pumps, motor, instruments, electrical, etc.) shall be given due consideration.

Fast consumable items like indicating lamps, fuses, etc. shall be easily replaceable by local sources.

(3) Start - up Spare Parts:

Start - up spares are those spares, which may be required during the start-up and commissioning of the equipment and/or system. All spares used until the plant is handed over to the Purchaser shall come under this category. The Contractor shall provide for adequate stock of such start-up spares to be brought by him to the site during the plant erection and commissioning. They must be available at site well in time and can be taken back from there only after the receipt of the Taking Over Certificate.

(4) Spare Parts management System :

It is the Purchaser's intention to implement a general spare part management system for phase-I & II plants . The basis for setting up the data base of this spare part management system is the "SPIR" form (Spare Parts list and Interchangeability Record).

The Contractor shall carefully prepare / fill in the SPIR forms for all spare parts supplied under this contract. Particular emphases shall be placed on :

- (a) Indicating the prime manufacture's real part number.

4 X 100MW MARIB GTPS - II

Technical Specifications (C&I) for Auxiliary packages

(b) Attaching all manufacturer's drawings to the SPIR forms

(c) Providing a true interchangeability record.

(d) Giving realistic price information.

SPIR Forms shall be submitted in required copies at least four months before spare parts delivery. They shall be subject to the Purchaser's approval.

It is recommended that the forms are completed by the equipment manufacturer, for example, on the following items :

(a) Equipment registration number of tag number for each piece of equipment as stated in requisitions and/or purchase orders.

(b) Manufacturer's model, type or other positive identification reference of the equipment / instruments, ordered.

(c) Total number of pieces of identical equipment / instrument as quoted.

(d) Purchasing company's order reference number.

(e) List of all parts which should be carried in stock for normal operation and also list of slow-wearing parts. If an item is interchangeable between two or more units it should be listed once only.

(f) Drawing number of spare parts

(g) Reference numbers/letters or other information which identical each part. Interchangeability with identical parts within the manufacturer's range should be indicated.


(h) Material specification in terms of international codes standards and accepted conventions, not manufacturer's or sub-manufacturer's references.

(i) For each unit or group of identical units, the number of parts fitted in each unit of equipment of instrumentation.

(j) The total number of identical parts in all equipment specified.

(k) Approximate ex-works price per piece of each part in the currency shown at the top of the column.


STANDARD QUALITY PLAN FOR PRESSURE AND DIFFERENTIAL PRESSURE GAUGES													QUALITY PLAN NO.: PE-QP-999-145-1026			
													VOLUME IIB			
													SECTION D			
													REV. NO. 01			
													DATE: 16.05.2007			
SHEET 1 OF 2																
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks				
									P	W	V					
1.0	Material / Components															
1.1	Casing, Bourdon tube, and Movement	1. Chemical composition	MA	Chemical Test	One Sample from each lot	Approved drg. / data sheet / BHEL Spec.	Relevant raw material std.	Test Certificate	3/2	---	2,1#	# Compliance certificate to be verified.				
		2. Workmanship, finish and dimensions	MA	Visual, Measurement	100%	Approved drg. / data sheet / BHEL Spec.	Approved drg. / data sheet / BHEL Spec.	Inspection Report / Log Book	3/2	---	2,1#					
1.2	Switch⊕	Contact type & number	MA	Visual	100%	Approved drg. / data sheet / BHEL Spec.	Approved drg. / data sheet / BHEL Spec.	Test Certificate/ Inspection Report	3	---	2,1#	⊕Applicable for gauge with switch device				
2.0	Assembly	1. Marking – Tag No., Model, Range	MA	Visual	100%	- do -	- do -	Inspection Report	2	1	---					
		2. Workmanship	MA	Visual	100%	- do -	- do -	- do -	2	1	---					
		3. Dial size, scale graduation	MA	Visual	100%	- do -	- do -	- do -	2	1	---					
		4. End connections	MA	Measurement	100%	- do -	- do -	- do -	2	1**	1	**10% of total quantity with minimum of 2 piece / type & size				
		⊕5. Switch – contact type & nos.	MA	Visual	100%	- do -	- do -	Inspection Report	2	1	---					
3.0	Routine Test	1. Calibration, accuracy, Hysteresis, overload, set point adjustment⊕ / repeatability	CR	Measurement	100%	- do -	- do -	- do -	2	1**	1					
LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics													\$- P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test. 1 - BHEL 2 - Vendor 3 - Sub-vendor			

 PEM :: C&I		STANDARD QUALITY PLAN FOR PRESSURE AND DIFFERENTIAL PRESSURE GAUGES										QUALITY PLAN NO.: PE-QP-999-145-1026 VOLUME IIB SECTION D REV. NO. 01 DATE: 16.05.2007 SHEET 2 OF 2			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks			
									P	W	V				
		2. Hydraulic Test	CR	Measurement	100%	Approved drg. / data sheet / BHEL Spec.	No Leakage	Inspection Report	2	1**	1				
		⊕3. IR, HV	CR	Measurement	100%	Relevant standard	Relevant standard	- do -	2	1**	1				
4.0	Type Test	1. Enclosure Protection Class	CR	Verification	Each type	Approved drg. / data sheet / BHEL Spec.	Approved drg. / data sheet / BHEL Spec.	Test Certificate	2	---	1•	•Type Test Certificate to be verified			
		2. Blow out disc	CR	Verification	Each type	- do -	- do -	- do -	2	---	2•				
		⊕3. Switch contact rating	CR	Verification	Each type	- do -	- do -	- do -	2	---	2•				
5.0	Painting	Shade & Finish	MA	Visual	100%	Approved drg. / data sheet / BHEL Spec. / Manufacturer's std.	Approved drg. / data sheet / BHEL Spec. / Manufacturer's std.	Inspection Report	2	---	2				
6.0	Packing	Soundness	MA	Visual	100%	- do -	- do -	- do -	2	---	---				


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1 - BHEL
 2 - Vendor
 3 - Sub-vendor

<div> PEM :: C&I</div>		STANDARD QUALITY PLAN FOR PRESS AND DIFF PRESS SWITCHES										QUALITY PLAN NO.: PE-QP-999-145-I031					
												VOLUME		IIB			
												SECTION		D			
												REV. NO.		01		DATE: 16.05.2007	
												SHEET		1		OF 3	
Sl. No.	Component / operation	Characteristics Checked	* Cate gory	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks					
									P	W	V						
1.0	Raw Material/ Component	1. Chem. Composition	MA	Chemical Analysis	1 sample from each lot	BHEL Spec. / Approved data sheet	Relevant material standard	Test Report	3/2	---	2,1	Relevant compliance certificate to be verified.					
		2. Make, Marking, Damage and Cracks	MA	Visual	100%	BHEL spec. / manufacturer standard	BHEL spec. / manufacturer standard	Log Book	2	---	---						
		3. Leakage (Element Conn.)	MA	Pressure Test	100%	Manufacturer standard	No Leak	Log Book	2	---	---						
	Micro Switch	1. No. and type of contacts	MA	Visual	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Log Book	3/2	---	2,1						
		2. Continuity	CR	Electrical	100%	Manufacturer standard	To have continuity	Log Book	3/2	---	2,1						
2.0	Final Inspection																
2.1	Assembly	1. Marking: Range, Model, Tag No. Sl.No.	MA	Visual	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection Report	2	1	---	10% to be witnessed by BHEL					
		2. Correct assembly, workmanship and finish	MA	Visual	100%	Manufacturer standard	Manufacturer standard	Log Book	2	1	---	- do -					

LEGEND:	* CR	- Critical characteristics	\$	P	- Agency Performing the Test.	1	- BHEL
	MA	- Major characteristics		W	- Agency Witnessing the Test.	2	- Vendor
	MI	- Minor characteristics		V	- Agency Verifying the Test.	3	- Sub-vendor

<div> PEM :: C&I</div> <div>STANDARD QUALITY PLAN FOR PRESS AND DIFF PRESS SWITCHES</div>		QUALITY PLAN NO.: PE-QP-999-145-1031											
		VOLUME IIB											
		SECTION D											
		REV. NO. 01 DATE: 16.05.2007											
		SHEET 2 OF 3											
Sl. No.	Component / operation	Characteristics Checked	* Cate gory	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks	
									P	W	V		
2.2	Routine Test	3. Connection	MA	Visual & Measurement	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection Report	2	1	---	10% to be witnessed by BHEL	
		4. Scale Marking	MA	Visual	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection Report	2	1	---	- do -	
		5. Cleanliness	MA	Visual	100%	Manufacturer standard	Free from scratches dirt etc.	Log Book	2	1	---	- do -	
		6. Overall Dimension	MA	Measurement	100%	BHEL Spec. / Approved drg.	BHEL Spec. / Approved drg.	Inspection Report	2	1	---	- do -	
		1. Overload	CR	Measurement	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Test Report	2	1	1	- do -	
		2. Repeatability	CR	Measurement	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Test Report	2	1	1	- do -	
		3, Set point adjustment	CR	Measurement	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Test Report	2	1	1	- do -	
		4, Differential	CR	Measurement	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Test Report	2	1	1	- do -	


LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics		\$	P	- Agency Performing the Test.	1	- BHEL
			W	- Agency Witnessing the Test.	2	- Vendor
			V	- Agency Verifying the Test.	3	- Sub-vendor

<div> PEM :: C&I</div>		STANDARD QUALITY PLAN FOR PRESS AND DIFF PRESS SWITCHES										QUALITY PLAN NO.: PE-QP-999-145-I031 VOLUME IIB SECTION D REV. NO. 01 DATE: 16.05.2007 SHEET 3 OF 3				
Sl. No.	Component / operation	Characteristics Checked	* Cate gory	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks				
									P	W	V					
		5. Contact Rating	CR	Measurement	100%	BHEL Spec. / Approved data sheet Relevant standard	BHEL Spec. / Approved data sheet Relevant standard	Inspection Report	2	---	1	Manufacturer compliance certificate to be verified.				
		6. Insulation Resistance & HV	CR	Electrical	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Test Report	2	1	1	10% to be witnessed by BHEL				
		7. Calibration Test	CR	Measurement	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Test Report	2	1	1	- do -				
		8. Accuracy Test	CR	Measurement	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Test Report	2	1	1	- do -				
2.3	Type Test	1. Weatherproofness	CR	Measurement	1 sample / design	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Test Report	3/2	---	1	Vendor to furnish test report for verification				
3.0	Packing	Soundness of packing	MA	Visual	100%	BHEL Spec.	BHEL Spec.	Log Book	3/2	2	---					

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1 - BHEL
 2 - Vendor
 3 - Sub-vendor

<div> PEM :: C&I</div>		STANDARD QUALITY PLAN FOR RESISTANCE TEMPERATURE DETECTOR AND THERMOWELL										QUALITY PLAN NO.: PE-QP-999-145-1025 VOLUME IIB SECTION D REV. NO. 00 SHEET 1 OF 2 DATE: 15.03.99			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks			
									P	W	V				
1.0	Raw Material / Component														
1.1	Resistance sheath	Material composition	CR	Chemical testing	Sample	Approved data sheet, BHEL Spec.	Relevant material std.	Test Certificate	3,2	---	2,1▲	▲ Relevant compliance certificate to be verified.			
1.2	Protective Sheath	Material composition	MA	Chemical testing	Sample	Approved data sheet, BHEL Spec.	Relevant material std.	Test Certificate	3,2	---	2,1▲				
1.3	Terminal Head	Material composition	MA	Chemical testing	Sample	Approved data sheet, BHEL Spec.	Relevant material std.	Test Certificate	3,2	---	2,1▲				
1.4	Thermowell⊕	1. Chemical properties	CR	Chemical composition	One sample / Lot	Approved data sheet, BHEL Spec.	Relevant material std.	Test Certificate	3,2	---	2,1				
		2. Dimensions (wall thickness concentricity of bore, OD & length)	MA	Measurement	100%	Approved drg., BHEL Spec.	Approved drg., BHEL Spec.	Inspection report	2	1▲	1	◆ BHEL to witness 25% Samples			
		3. Threading	MA	Thread matching	100%	Approved data sheet/drg., BHEL Spec.	Approved data sheet/drg., BHEL Spec.	Inspection Report	2	2,1▲	1				
		4. Leak Test	CR	Hydro test at 1.5 times design press.	100%	Approved drg., BHEL Spec.	Approved drg., BHEL Spec.	Inspection Report	3,2	2/1	---	⊕ IBR certificate wherever specified to be verified.			
2.0	Final Inspection														
2.1	RTD Assembly	1. Workmanship	MA	Visual	100%	BHEL Spec.	BHEL Spec.	Log Book	2	2,1▲	1				
		2. Marking	MA	Visual	100%	BHEL Spec.	BHEL Spec.	Log Book	2	2,1▲	1				

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<div></div> <div>PEM :: C&I</div>		STANDARD QUALITY PLAN FOR RESISTANCE TEMPERATURE DETECTOR AND THERMOWELL										QUALITY PLAN NO.: PE-QP-999-145-1025				
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												SECTION D				
												REV. NO. 00				
												DATE: 15.03.99				
												SHEET 2 OF 2				
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks				
									P	W	V					
2.2	Routine Tests	3. Dimensions	MA	Measurement	100%	BHEL Spec.	BHEL Spec.	Log Book	2	2,1*	1					
		1. Calibration (Resis Vs. Temp.)	CR	Measurement	100%	Approved drg. IS:2848	BHEL Spec. IS:2848	Test Report	2	2	1					
		2. Insulation Resistance	MA	Electrical	100%	IS:2848	IS:2848	Test Report	2	1	---					
		3. Resistance Tolerance	MA	Thermal Elect.	100%	IS:2848	IS:2848	Test Report	2	1	---					
		4. Thermal Response time	CR	Measurement	Sample	IS:2848	IS:2848	Test Certificate	2	1	---					
2.3	Type Test	1. Immersion error Test	MA	Measurement	Sample	IS:2848	IS:2848	Test Certificate	3/2	---	1					
		2. Thermoelectric Effect	MA	Measurement	Sample	IS:2848	IS:2848	Test Certificate	3/2	---	1					
		3. Vibration Test	CR	Measurement	Sample	IS:2848	IS:2848	Test Certificate	3/2	---	1					
		4. Enclosure protection test	CR		Sample	BHEL Spec.	BHEL Spec., Approved data sheet.	Test Certificate	3/2	---	1	• Test certificates to be verified.				
3.0	Packing	Soundness of packing	MA	Visual	100%	BHEL Spec.	BHEL Spec.	Log Book	3/2	2	---					

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1 - BHEL
 2 - Vendor
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• Test certificates to be verified.

<div> PEM :: C&I</div>		STANDARD QUALITY PLAN FOR LEVEL SWITCHES						QUALITY PLAN NO.: PE-QP-999-145-I033					
								VOLUME	IIB				
								SECTION	D				
								REV. NO.	00		DATE: 15.03.99		
								SHEET	1	OF	3		
Sl. No.	Component / operation	Characteristics Checked	* Cate gory	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks	
									P	W	V		
1.0	Raw Material/ Component												
1.1	Non Wetted Parts	Physical, Chemical properties	MA	Physical, Chemical Analysis	1/ Cast	BHEL Spec/ Approved drg. / data sheet	Relevant material standard	Test Report	3/2	---	2,1*	*Relevant compliance certificate to be verified.	
1.2	Float Assembly & Wetted Parts	Physical for float only & chemical properties for all wetted parts including float assembly	MA	Physical, Chemical Analysis	1/Batch	AISI:316 / BHEL spec. / drg. / Approved data sheet	AISI:316 / BHEL spec. / drg. / Approved data sheet / Relevant material std.	Test Certificate	3/2	---	2,1*		
1.3	Chamber	Dimensions & leak tightness	MA	Measurement, visual, hyd. test	100%	BHEL Spec/ Approved drg. / data sheet	BHEL Spec/ Approved drg. / data sheet	Internal inspection report	3/2	2	1		
1.4	Float	Leak tightness	MA	Hyd. test	100%	BHEL Spec/ Approved drg. / data sheet	No leakage	Internal inspection report	3/2	2	1		
1.5	Switch	1.. Make, type and rating 2. Contact Continuity	MA CR	Visual Electrical	100% 100%	BHEL / Mfr. spec. BHEL / Mfr. spec.	BHEL / Mfr. spec. BHEL / Mfr. spec.	Internal inspection report To have continuity	3/2 3/2	--- ---	2,1 2,1		
2.0	Final Inspection												
2.1	Assembly	1. Marking: Range, Model, Tag No. SI.No.	MA	Visual	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection Report	2	1	---		


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1 - BHEL
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<div></div> <div>PEM :: C&I</div>		STANDARD QUALITY PLAN FOR LEVEL SWITCHES										QUALITY PLAN NO.: PE-QP-999-145-1033					
												VOLUME		IIB			
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												REV. NO.		00		DATE: 15.03.99	
												SHEET		2		OF 3	
Sl. No.	Component / operation	Characteristics Checked	* Cate gory	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks					
									P	W	V						
2.2	Routine Test	2. Correct assembly, workmanship and finish	MA	Visual	100%	Manufacturer standard	Manufacturer standard	Log Book	2	1	---		❖BHEL to witness 25% sample.				
		3. Connection	MA	Visual & Measurement	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection Report	2	1	---						
		4. Scale Marking	MA	Visual	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection Report	2	1	---						
		5. Cleanliness	MA	Visual	100%	Manufacturer standard	Free from scratches dirt etc.	Log Book	2	1	---						
		6. Overall Dimension	MA	Measurement	100%	BHEL Spec. / Approved drg.	BHEL Spec. / Approved drg.	Inspection Report	2	1	---						
		1. Overload	CR	Measurement	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Test Report	2	1❖	1						
		2. Repeatability	CR	Measurement	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Test Report	2	1❖	1						
	3. Set point adjustment	CR	Measurement	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Test Report	2	1❖	1							


LEGEND: *		CR	- Critical characteristics	\$	P	- Agency Performing the Test.	1	- BHEL
		MA	- Major characteristics		W	- Agency Witnessing the Test.	2	- Vendor
		MI	- Minor characteristics		V	- Agency Verifying the Test.	3	- Sub-vendor

<div> PEM :: C&I</div>		STANDARD QUALITY PLAN FOR LEVEL SWITCHES							QUALITY PLAN NO.: PE-QP-999-145-1033						
									VOLUME		IIB				
									SECTION		D				
									REV. NO.		00		DATE: 15.03.99		
									SHEET		3		OF		3
Sl. No.	Component / operation	Characteristics Checked	* Cate gory	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks			
									P	W	V				
2.3	Type Test	4, Differential	CR	Measurement	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Test Report	2	1❖	1	Manufacturer compliance certificate to be verified.			
		5. Contact Rating	CR	Measurement	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection Report	2	---	1				
		6. Insulation Resistance & HV	CR	Electrical	100%	Manufacturer standard	Manufacturer standard	Test Report	2	1❖	1				
		1. Weatherproofness	CR	Measurement	1 sample / design	BHEL Spec. / Approved data sheet	IS : 2147 / NEMA-4	Test Report	3/2	---	1				
3.0	Packing	Soundness of packing	MA	Visual	100%	BHEL Spec.	BHEL Spec.	Log Book	3/2	2	---	Vendor to furnish test report			


LEGEND: *		CR	- Critical characteristics	\$	P	- Agency Performing the Test.	1	- BHEL
		MA	- Major characteristics		W	- Agency Witnessing the Test.	2	- Vendor
		MI	- Minor characteristics		V	- Agency Verifying the Test.	3	- Sub-vendor


<div></div> <div>PEM :: C&I</div>		STANDARD QUALITY PLAN FOR THERMOCOUPLE WITH THERMOWELL										QUALITY PLAN NO.: PE-QP-999-145-1003							
												VOLUME			IIB				
												SECTION			D				
												REV. NO.			00		DATE: 15.03.99		
												SHEET			1		OF 2		
Sl. No.	Component / operation	Characteristics Checked	* Cate gory	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks							
									P	W	V								
1.0	Raw Material / Component																		
1.1	Thermocouple wires	Material composition	CR	Chemical testing	Sample	BHEL Specs. / Appd. data sht.	Relevant material standards	Test Certificate	3/2	---	2, 1▲	▲ Relevant compliance certificate to be verified.							
1.2	Protective Sheath	Material composition	MA	Chemical testing	Sample	BHEL Specs. / Appd. data sht.	Relevant material standards	Test Certificate	3/2	---	2, 1▲								
1.3	Terminal Head	Material composition	MA	Chemical testing	Sample	---	Relevant material standards	Test Certificate	3/2	---	2, 1▲								
1.4	Thermowell ⊕	1. Chemical properties	CR	Chemical test	Sample	BHEL Specs / Approved data sheet	Relevant material standard	Test Certificate	3/2	---	2, 1▲								
		2. Dimensions (wall thickness concentricity of bore, OD and length)	MA	Measurement	100%	BHEL Specs / Approved drgs.	BHEL Specs / Approved drgs.	Log Book	2	1♦	1								
		3. Threading	MA	Thread matching	100%	BHEL Specs / Approved data sheet.	BHEL Specs / Approved data sheet.	Inspection Report	2	2, 1♦	1								
		4. Leak Test	CR	Hyd. test at 1.5 times design press.	100%	BHEL Specs / Approved data sheet.	BHEL Specs / Approved data sheet.	Inspection Report	3/2	2, 1	---	⊕ IBR certificate if specified to be verified.							

LEGEND:	* CR	- Critical characteristics	\$	P	- Agency Performing the Test.	1	- BHEL
	MA	- Major characteristics		W	- Agency Witnessing the Test.	2	- Vendor
	MI	- Minor characteristics		V	- Agency Verifying the Test.	3	- Sub-vendor

 PEM :: C&I		STANDARD QUALITY PLAN FOR THERMOCOUPLE WITH THERMOWELL										QUALITY PLAN NO.: PE-QP-999-145-1003 VOLUME IIB SECTION D REV. NO. 00 SHEET 2 OF 2 DATE: 15.03.99			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks			
									P	W	V				
2.0	Final Inspection														
2.1	Thermocouple Inspection	Workmanship	MA	Visual	100%	BHEL Specs	BHEL Specs.	Log Book	2	2,1	1	• BHEL to witness 25% samples.			
		Marking	MA	Visual	100%	BHEL Specs	BHEL Specs / Approved drgs.	Log Book	2	2,1	1				
		Dimensions	MA	Measurement	100%	BHEL Specs / Approved drgs.	BHEL Specs / Approved drgs.	Log Book	2	2,1	1				
2.2	Routine Tests	1. Continuity and Polarity	MA	Measurement	100%	-----	Compliance	Test Report	2	2,1	---				
		2. Accuracy Test (EMF vs. Temp.	CR	Thermal & Elect	100%	BHEL Specs	Relevant standards	Test Report	2	2,1	---				
		3. Insulation resistance between Element and sheath	MA	Thermal & Elect	100%	-----	Relevant standards	Test Report	2	1	---				
		4. Response Time Test	MA	Thermal & Elect	10%	BHEL Specs / Approved data sheet	Relevant standards	Test Report	2	2	1				
2.3	Type Tests	Enclosure protection test for Head	CR	Testing	Sample	BHEL Specs	BHEL Specs / Approved data sheet	Test Certificate	3/2	----	1				
3.0	Packing	Soundness of packing	MA	Visual	100%	BHEL Spec.	BHEL Spec.	Log Book	3/2	2	---				

LEGEND: *		CR	- Critical characteristics	\$	P	- Agency Performing the Test.	1	- BHEL
		MA	- Major characteristics		W	- Agency Witnessing the Test.	2	- Vendor
		MI	- Minor characteristics		V	- Agency Verifying the Test.	3	- Sub-vendor


 PEM :: C&I		STANDARD QUALITY PLAN FOR PRESSURE / DP/LEVEL TRANSMITTER										QUALITY PLAN NO.: PE-QP-999-145-1001 VOLUME IIB SECTION D REV. NO. 00 SHEET 1 OF 7 DATE: 12.10.99			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks			
									P	W	V				
1.0	RAW MATERIAL INSPECTION														
1.1	Body/Casing, Cable Gland and Mounting Bracket	1. Chemical & Mech. Properties 2. Dimensions 3. Visual	MA MA MA	Analysis Measurement Visual	1 / Lot 10% Min. 3 Nos. 100%	Tech. Specn. Data Sheet, Mfr. standard Manufacturer drg. BHEL Spec. / Approved data sheet	Tech. Specn. Data Sheet, Mfr. standard Manufacturer drg. BHEL Spec. / Approved data sheet	Test certificate Log Book Log Book	3 2 2	---	---	2			Compliance report verification by BHEL.
1.2	Sensor (Diaphragm, Capsule, Bellows, Strain, Gauge, Capacitance etc.)	4. Degree of Protection (If applicable)	CR	IS-2147 IS-2148	1 / Type	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Test certificate	3	---	---	2			
		5. Leak Tightness	MA	Hydro Test	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Log Book	2	---	---	---			
		1. Material Properties (Chemical & Mechanical)	MA	Analysis	1 / Lot	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Test certificate	3/2	---	---	2			
		2. Dimension	MA	Measurement	1 / Lot	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Test certificate	2	---	---	---			
		3. Performance	CR	Function	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Test certificate	2	---	---	---			
		4. Type Test	CR	Mech. & Elect.	1/Type	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Test certificate	3/2	---	---	2			
LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics															
\$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.															
1 - BHEL or their agent 2 - Vendor 3 - Sub-vendor															

<div> PEM :: C&I</div> <div>STANDARD QUALITY PLAN FOR PRESSURE / DP/LEVEL TRANSMITTER</div>		QUALITY PLAN NO.: PE-QP-999-145-1001										
		VOLUME IIB										
		SECTION D										
		REV. NO. 00 DATE: 12.10.99										
		SHEET 2 OF 7										
Sl. No.	Component / operation	Characteristics Checked	* Cate gory	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks
									P	W	V	
1.3	Gasket	1. Dimension	MA	Measurement	Sample	Manufacturer standard	Manufacturer standard	Test certificate	3/2	---	2	
1.4	Electrical & Electronic Components	2. Sheer Hardness	MA	Analysis	Sample	Manufacturer standard	Manufacturer standard	Test certificate	3/2	---	2	
		1. Marking & Rating	MA	Visual	10%	Manufacturer standard	Manufacturer standard	Log Book	2	---	---	
		2. Electrical Parameters	CR	Electrical Tests	10%	Manufacturer standard	Manufacturer standard	Log Book	2	---	---	
		3. Dimensions	MA	Measurement	10%	Manufacturer standard	Manufacturer standard	Log Book	2	---	---	
1.5	PCBs	4. Solderability	MA	Electrical	3 / Type	Manufacturer standard	Manufacturer standard	Log Book	2	---	---	
		1. Visual	MA	Visual	100%	---	---	---	3/2	---	2	
		2. Dimensions	MA	Measurement	10%	Manufacturer standard	Manufacturer standard	Log Book	3/2	---	2	
		3. Type Test	CR	Mech. & Elect. Tests	1 / Type / Batch	IS:7405 BS:4025	IS:7405 BS:4025	Test certificate	3/2	---	2	


LEGEND: * CR - Critical characteristics
 MA - Major characteristics
 MI - Minor characteristics

\$ P - Agency Performing the Test.
 W - Agency Witnessing the Test.
 V - Agency Verifying the Test.

1 - BHEL or their agent
 2 - Vendor
 3 - Sub-vendor

 PEM :: C&I		STANDARD QUALITY PLAN FOR PRESSURE / DP/LEVEL TRANSMITTER							QUALITY PLAN NO.: PE-QP-999-145-1001 VOLUME IIB SECTION D REV. NO. 00 DATE: 12.10.99 SHEET 3 OF 7			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks
									P	W	V	
2.0	In-Process Inspection											
2.1	Electrical Unit											
2.1.1	Etched PCB	1. Dimension – Trade width, Gap etc. 2. Defect of undercuts 3. Quality and plating of plating through holes. 4. Screen printing	MA MA CR CR	Measurement Visual Visual Visual	Sample Sample 100% 100%	Manufacturer standard Manufacturer standard Manufacturer standard Manufacturer standard	Manufacturer standard Manufacturer standard Manufacturer standard Manufacturer standard	Inspection report Inspection report Inspection report Inspection report	2	---	---	Compliance verification report by BHEL
2.1.2	Component Mounting and soldering	1. Correctness of components 2. Mounting and orientation 3. Soldering defects and finish	MA MA CR	Visual Visual Visual	100% 100% 100%	Manufacturer standard Manufacturer standard Manufacturer standard	Manufacturer standard Manufacturer standard Manufacturer standard	Inspection report Inspection report Inspection report	2	---	---	
2.1.3	Assembled PCBs	Functional check	CR	Electrical checks before & after soaking*	100%	Manufacturer standard	Manufacturer standard	Inspection report	2	---	---	
*Soaking means subjecting PCB (Assembled) at 70 Deg. C for 72 hours at energised condition and rapid temperature cycle test at 70 Deg. C and (-) 20 Deg. C for 30 minutes at each temp. (Five such cycles).												


LEGEND:				\$	P	-	Agency Performing the Test.	1	-	BHEL or their agent
					W	-	Agency Witnessing the Test.	2	-	Vendor
					V	-	Agency Verifying the Test.	3	-	Sub-vendor

 PEM :: C&I		STANDARD QUALITY PLAN FOR PRESSURE / DP/LEVEL TRANSMITTER										QUALITY PLAN NO.: PE-QP-999-145-1001 VOLUME IIB SECTION D REV. NO. 00 SHEET 4 OF 7 DATE: 12.10.99			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks			
									P	W	V				
2.1.4	Conformal coating	Uniformity and finish of conformal coating on both sides	CR	Visual	100%	Manufacturer standard	Manufacturer standard	Inspection report	2	---	---	Compliance verification report by BHEL			
2.2	Mounting, Fitting, Assembly of various mechanical parts	1. Correct Mounting	MA	Visual	100%	Manufacturer standard	Manufacturer standard	Log Book	2	---	---				
		2. Defects	MA	Visual	100%	Manufacturer standard	Manufacturer standard	Log Book	2	---	---				
		3. Dimensions	MA	Measurement	100%	Manufacturer standard	Manufacturer standard	Log Book	2	---	---				
2.3	Interconnection – Sensor to Electronic unit	Correctness of Interconnection	MA	Visual	100%	Manufacturer standard	Manufacturer standard	Log Book	2	---	---				
2.4	Interconnection – Pneumatic unit / Electronic unit and output / Local indicator.	Correctness of Interconnection	MA	Visual	100%	Manufacturer standard	Manufacturer standard	Log Book	2	---	---				


LEGEND: * CR - Critical characteristics
 MA - Major characteristics
 MI - Minor characteristics

\$ P - Agency Performing the Test.
 W - Agency Witnessing the Test.
 V - Agency Verifying the Test.


1 - BHEL or their agent
 2 - Vendor
 3 - Sub-vendor

<div> PEM :: C&I</div>		STANDARD QUALITY PLAN FOR PRESSURE / DP/LEVEL TRANSMITTER										QUALITY PLAN NO.: PE-QP-999-145-1001 VOLUME IIB SECTION D REV. NO. 00 SHEET 5 OF 7 DATE: 12.10.99				
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks				
									P	W	V					
3.0	Complete Transmitter	1. Workmanship	MA	Visual	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report / Log Book	2	1	---					
		2. Dimension	MA	Measurement	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report / Log Book	2	1	---					
		3. Type / Model	CR	Visual	10%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report / Log Book	2	1	---					
		4. Range	CR	Visual	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report / Log Book	2	1	---					
		5. Calibrated Range	CR	Visual	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report / Log Book	2	1	---					
		6. Local Indicator / Scale marking	MA	Visual	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report / Log Book	2	1	---					
		7. Process connection type	CR	Measurement	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report / Log Book	2	1	---					
		8. Wetted parts material	MA	Analysis (Chemical, Mechanical)	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report / Log Book	2	---	1					
		9. Mounting bracket type	MA	Visual / Dimension	10%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report / Log Book	2	1	---					
		10. Calibration	CR	Electrical / Pneumatic	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report / Log Book	2	1	---					
		11. Soaking	CR	Electrical	100%	BHEL Spec	BHEL Spec.	Inspection report / Log Book	2	1	---					


LEGEND:		* CR - Critical characteristics MA - Major characteristics MI - Minor characteristics		\$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.		1 - BHEL or their agent 2 - Vendor 3 - Sub-vendor	
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 PEM :: C&I		STANDARD QUALITY PLAN FOR PRESSURE / DP/LEVEL TRANSMITTER										QUALITY PLAN NO.: PE-QP-999-145-1001 VOLUME IIB SECTION D REV. NO. 00 SHEET 6 OF 7 DATE: 12.10.99			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks			
									P	W	V				
3.2	Acceptance Tests	1. Accuracy	CR	Electrical	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report	2	1	1				
		2. Repeatability	CR	Electrical	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report	2	1	1				
		3. Dead Band	CR	Electrical	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report	2	1	1				
		4. Hysteresis	CR	Electrical	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report	2	1	1				
		5. HV & IR	CR	Electrical	100%	Manufacturer standard	Manufacturer standard	Inspection report	2	1	1				
		6. Linearity	CR	Electrical	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report	2	1	1				
		7. Supply voltage variation effect	CR	Electrical	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report	2	1	1				
		8. Temperature variation effect over range	CR	Electrical	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report	2	1	1				
		9. Over range	CR	Electrical	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report	2	1	1				


LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics		\$	P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.	1 - BHEL or their agent 2 - Vendor 3 - Sub-vendor
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 PEM :: C&I		STANDARD QUALITY PLAN FOR PRESSURE / DP/LEVEL TRANSMITTER										QUALITY PLAN NO.: PE-QP-999-145-1001 VOLUME IIB SECTION D REV. NO. 00 SHEET 7 OF 7 DATE: 12.10.99			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks			
									P	W	V				
3.3	Type Test	1. Surge withstand capability 2. Radio frequency interference 3. Vibration effect 4. Electro Magnetic field effect 5. Degree of protection 6. Explosion proofness (If applicable) 7. Dry Heat 8. Damp Heat	CR	Elect. & Mech	1 / Type	ANSI-C.37	ANSI-C.37	Inspection Report	3	---	2,1				
			CR	Elect. & Mech	1 / Type	ANSI-C.37	ANSI-C.37	Inspection Report	3	---	2,1				
			CR	Elect. & Mech	1 / Type	BHEL Spec.	BHEL Spec.	Inspection Report	3	---	2,1				
			CR	Elect. & Mech	1 / Type	BHEL Spec.	BHEL Spec.	Inspection Report	3	---	2,1				
			CR	Mech. & Elect.	1 / Type	IS:2147	BHEL Spec.	Inspection Report	3	---	2,1				
			CR	Mech. & Elect.	1 / Type	IS:2148	BHEL Spec.	Inspection Report	3	---	2,1				
			CR	Thermal	1 / Type	IS:9000	ANSI-C.37	Inspection Report	3	---	2,1	85 Deg. C for 16 Hrs.			
			CR	Thermal	1 / Type	IS:9000	ANSI-C.37	Inspection Report	3	---	2,1	40 Deg. C; 6 cycle			
4.0	Packing	1. Packing Material	MA	Visual	100%	Manufacturer standard	Manufacturer standard	Log Book	2	---	2				
		2. Packaging and Marking	MA	Visual & Measurement	100%	Manufacturer standard	Manufacturer standard	Log Book	2	---	2				

LEGEND:		\$													
* CR	- Critical characteristics	P	- Agency Performing the Test.	1	- BHEL or their agent										
MA	- Major characteristics	W	- Agency Witnessing the Test.	2	- Vendor										
MI	- Minor characteristics	V	- Agency Verifying the Test.	3	- Sub-vendor										

 PEM :: C&I		STANDARD QUALITY PLAN FOR LEVEL GAUGES							QUALITY PLAN NO.: PE-QP-999-145-1028 VOLUME IIB SECTION D REV. NO. 00 DATE: 01.11.2000 SHEET 2 OF 2			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks
									P	W	V	
4.0	Painting	Shade & Finish	MA	Visual	100%	Approved drg. / data sheet / BHEL Spec.	Approved drg. / data sheet / BHEL Spec.	Inspection Report	2	1**	1	
5.0	Packing	Soundness	MA	Visual	100%	- do -	- do -	- do -	2	---	---	


LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics	\$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.	1 - BHEL 2 - Vendor 3 - Sub-vendor
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 PEM :: C&I		STANDARD QUALITY PLAN FOR TEMPERATURE GAUGE AND THERMOWELL										QUALITY PLAN NO.: PE-QP-999-145-1027	
		VOLUME		IIB									
		SECTION		D									
		REV. NO.		01		DATE: 16-05-2007							
		SHEET		1		OF		4					
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks	
									P	W	V		
1.0	Raw Material / Component												
1.1	Capillary Bulb and Thermowell	1. Chemical composition	CR	Chemical analysis	one sample/ lot	BHEL spec. / approved data sheet	Relevant raw material std.	Test report	3/2	---	2,1	Relevant compliance certificate to be verified by BHEL	
		2. Marking,	MA	Visual	100%	BHEL spec. / Mfr. Standard	BHEL spec. / Mfr. Standard	Log Book	2	---	---		
		3. Dimensions	MA	Measurement	100%	BHEL spec. / approved doc	BHEL spec. / approved doc	Log Book	2	---	---		
1.2	Casing and Bezel	1. Material	MA	Chemical analysis	Sample	BHEL spec.	BHEL spec.	Test report	3/2	---	2,1	Relevant compliance certificate to be verified by BHEL	
		2. Defects	MA	Visual	100%	Mfr. Standard	Mfr. Standard	Log Book	2	---	---		
		3. Dimension	MA	Measurement	Sample	BHEL spec. / approved doc.	BHEL spec. / approved doc.	Log Book	2	---	---		
		4. Threading	MA	Thread matching	100%	do	do	Log Book	2	---	---		
1.3	Dial	1. Size, range, scale length, least-count, spacing and graduation.	MA	Measurement and Visual	Sample	BHEL spec.	BHEL spec.	Log Book	2	---	---		
		2. Colour	MA	Visual	100%	BHEL spec.	BHEL spec.	Log Book	2	---	---		
		3. Resistance to dry heat and hot water	MA	Oven & Bath	Sample	Mfr. Standard	Mfr. Standard	Test report	3/2	---	---		

LEGEND: * CR - Critical characteristics
 MA - Major characteristics
 MI - Minor characteristics

\$ P - Agency Performing the Test.
 W - Agency Witnessing the Test.
 V - Agency Verifying the Test.


1 - BHEL
 2 - Vendor
 3 - Sub-vendor

<div> PEM :: C&I</div>		STANDARD QUALITY PLAN FOR TEMPERATURE GAUGE AND THERMOWELL										QUALITY PLAN NO.: PE-QP-999-145-1027				
Sl. No.		Component / operation	Characteristics Checked	* Cate gory	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks			
										P	W	V				
1.4	Complete sensing element	1. Correct assembly and workmanship. 2. Dimensions 3. Welding & other defects	MA	Visual	100%	Mfr. Standard drawing	Mfr. Standard drawing	Log Book	2	---	---					
1.5	Thermowell ⊕		MA	Measurement	100%	BHEL spec. / approved data sheet / Drg.	BHEL spec. / approved data sheet / Drg.	Log Book	2	1	1		BHEL to witness 10 % random samples.			
			CR	Hyd. test at 1.5 times of design pressure.	100%	BHEL spec. / approved data sheet / Drg.	BHEL spec. / approved data sheet / Drg.	Inspection report	3/2	2,1	1	⊕ IBR cert. wherever specified to be verified.				
2.0	Final Inspection		MA	Thread matching	100%	BHEL spec. / approved data sheet / Drg	BHEL spec. / approved data sheet / Drg	Inspection report	2	2,1	1		BHEL to witness 10% samples.			
2.1	Assembly	1. Correct assembly, workmanship and finish	MA	Visual	100%	BHEL spec. / approved data sheet	BHEL spec. / approved data sheet	Inspection report	2	1	---					

LEGEND: * CR - Critical characteristics
 MA - Major characteristics
 MI - Minor characteristics

\$ P - Agency Performing the Test.
 W - Agency Witnessing the Test.
 V - Agency Verifying the Test.


1 - BHEL
 2 - Vendor
 3 - Sub-vendor

<div><div>PEM :: C&I</div></div> <div>STANDARD QUALITY PLAN FOR TEMPERATURE GAUGE AND THERMOWELL</div>		QUALITY PLAN NO.: PE-QP-999-145-1027												
		VOLUME IIB												
		SECTION D												
		REV. NO. 01 DATE: 16-05-2007												
		SHEET 3 OF 4												
Sl. No.	Component / operation	Characteristics Checked	* Cate gory	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks		
									P	W	V			
		2. Mounting and connection	MA	Visual ad measurement	100%	-----do-----	-----do-----	Inspection report	2	1	---			
		3. Dial Scale	MA	Visual	100%	-----do-----	-----do-----	Log Book	2	1	---			
		1. Cleanliness	MA	Visual	100%	-----do-----	Free from scratches, dirt etc.	Log Book	2	---	2			
		5. Marking (S.No., Tag No.)	MA	Visual	100%	BHEL spec. / approved data sheet	BHEL spec. / approved data sheet	Log Book	2	1	---			
		2.2	Routine Test	1. Accuracy	MA	Measurement	100%	BHEL spec. / Approved data Sheet.	BHEL spec. / Approved data Sheet.	Test Report	2	1	1	BHEL to witness 10% random Samples.
		2. Overload	CR	Measurement	10%	125% of FSD for range upto 400 Deg. C. 110% of FSD for range between 400 to 500 Deg. C. 100% of FSD for range above 500 Deg. C.	No Damage	Test Report	2	1	---			

LEGEND: * CR - Critical characteristics
 MA - Major characteristics
 MI - Minor characteristics

\$ P - Agency Performing the Test.
 W - Agency Witnessing the Test.
 V - Agency Verifying the Test.

1 - BHEL
 2 - Vendor
 3 - Sub-vendor


<div> PEM :: C&I</div>		STANDARD QUALITY PLAN FOR TEMPERATURE GAUGE AND THERMOWELL										QUALITY PLAN NO.: PE-QP-999-145-1027							
												VOLUME		IIB					
												SECTION		D					
												REV. NO.		01		DATE: 16-05-2007			
												SHEET		4		OF		4	
Sl. No.	Component / operation	Characteristics Checked	* Cate gory	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks							
									P	W	V								
		3. Response Time	MA	Measurement	10%	ASME PTC19.3	ASME PTC19.3	Test Report	2	1	1	BHEL to witness 10% random samples.							
2.3	Type Test	1. Ambient temperature compensation 0-60 Deg. C	MA	Measurement	Sample	Bulb at constant temp. & case temp varied 0-60 Deg. C	No variation in measurement	Test Certificate	2	---	1	Existing test certificate (Not more than 5 year old) shall be furnished.							
		2. Weather proofness	CR	Measurement	Sample	BHEL spec. / Approved data sheet.	BHEL spec. / Approved data sheet.	Test Certificate	3/2	---	1	---do---							
3.0	Packing	Soundness of packing	MA	Visual	100%	BHEL Spec.	BHEL Spec.	Log Book	3/2	2	---	Refer Note-1							

Note: 1. In the absence of BHEL specification for painting, vendor to obtain BHEL's approval on their painting specification / procedure.


LEGEND: * CR - Critical characteristics
MA - Major characteristics
MI - Minor characteristics

\$ P - Agency Performing the Test.
W - Agency Witnessing the Test.
V - Agency Verifying the Test.


1 - BHEL
2 - Vendor
3 - Sub-vendor

 PEM :: C&I		STANDARD QUALITY PLAN FOR TEMPERATURE SWITCH							QUALITY PLAN NO.: PS-QP-999-145-I032 VOLUME IIB SECTION D REV. NO. 00 DATE: 02.11.2000 SHEET 1 OF 2			
Sl. No.	Component / operation	* Category	Characteristics Checked	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks
									P	W	V	
1.0	Material / Components											
1.1	Casing, Sensing Element and Thermowell	MA	1. Physical, Chemical Properties	Physical, Chemical Test	One Sample from each lot	Approved drg. / data sheet / BHEL Spec.	Approved drg. / data sheet / BHEL Spec.	Test Certificate	3/2	---	2,1#	# Compliance certificate to be verified.
		MA	2. Workmanship, finish and dimensions	Visual, Measurement	100%	Manufacturing standards / drgs.	Manufacturing standards / drgs.	Inspection Report / Log Book	3/2	---	2,1#	
1.2	Switch	MA	Contact type & no.	Visual	100%	Approved drg. / data sheet / BHEL Spec.	Approved drg. / data sheet / BHEL Spec.	- do -	3	---	2,1#	
2.0	Assembly	MA	1. Marking – Tag No., Model, Range	Visual	100%	- do -	- do -	Inspection Report	2	1	---	
		MA	2. Workmanship	Visual	100%	- do -	- do -	- do -	2	1	---	
		MA	3. Scale graduation	Visual	100%	- do -	- do -	- do -	2	1	---	
		MA	4. Dimensions and end connections	Measurement	100%	- do -	- do -	- do -	2	1**	1	**25% quantity with minimum of 1 piece / type & size
3.0	Routine Test	MA	5. Switch – contact type & nos.	Visual	100%	Approved drg. / data sheet / BHEL Spec.	Approved drg. / data sheet / BHEL Spec.	Inspection Report	2	1**	1	
		CR	1. Calibration, accuracy, repeatability, overload, set point adjustment, differential	Measurement	100%	- do -	- do -	- do -	2	1**	1	

LEGEND: * CR - Critical characteristics
 MA - Major characteristics
 MI - Minor characteristics
 \$ P - Agency Performing the Test.
 W - Agency Witnessing the Test.
 V - Agency Verifying the Test.
 1 - BHEL
 2 - Vendor
 3 - Sub-vendor

 PEM :: C&I		STANDARD QUALITY PLAN FOR TEMPERATURE SWITCH							QUALITY PLAN NO.: PS-QP-999-145-I032 VOLUME IIB SECTION D REV. NO. 00 DATE: 02.11.2000 SHEET 2 OF 2			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks
									P	W	V	
4.0	Type Test	2. HydroTest 3. IR, HV 1. Enclosure Protection Class (weather proof-ness, explosion proof-ness, etc.) 2. Ambient temperature compensation (0 - 60°C) 3. Switch contact rating Shade & Finish Soundness	CR	Measurement	100%	Approved drg. / data sheet / BHEL Spec.	No Leakage	Inspection Report	2	1**	1	
			CR	Measurement	100%	- do -	Approved drg. / data sheet / BHEL Spec.	- do -	2	1**	1	
			CR	Verification	Each type	- do -	- do -	Test Certificate	2	---	1•	•Type Test Certificate to be verified
			CR	Verification	Each type	- do -	- do -	- do -	2	---	1•	
			CR	Verification	Each type	- do -	- do -	- do -	2	---	1•	
5.0	Painting		MA	Visual	100%	- do -	- do -	Inspection Report	2	1**	1	
6.0	Packing		MA	Visual	100%	- do -	- do -	- do -	2	---	---	


LEGEND: * CR - Critical characteristics
 MA - Major characteristics
 MI - Minor characteristics
 \$ P - Agency Performing the Test.
 W - Agency Witnessing the Test.
 V - Agency Verifying the Test.
 1 - BHEL
 2 - Vendor
 3 - Sub-vendor

 PEM :: C&I		STANDARD QUALITY PLAN FOR FLOW NOZZLE ASSEMBLY										QUALITY PLAN NO.: PE-QP-999-145-I005 VOLUME IIB SECTION D REV. NO. 04 SHEET 1 OF 3 DATE: 12.09.2011		
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency [§]			Remarks		
									P	W	V			
1.0	RAW MATERIAL Flow Nozzle, pipe, adapter	Physical, Chemical properties Ultrasonic testing (nozzle only)	MA MA	Physical, Chemical tests Ultrasonic test	One / Heat 100%	AP / DP / SP ASTMA388 & ANSI B 16.34	AP / DP / SP ASTMA388 & ANSI B 16.34	TC TC	3/2 3	--- 2	2, 1 1	Refer Note-1		
2.0	IN PROCESS													
2.1	Welding procedure specification (WPS)	Correctness	MA	Scrutiny	100%	IS:7307 / ASME IX	IS:7307 / ASME IX	Format of IS / ASME	3/2	---	2, 1	IBR certification to be verified by BHEL, if applicable		
2.2	Procedure Qualification Record(PQR) & Welders qualification	Weld soundness	MA	Physical test / Radiographic Test	IS:7307/ IS:7310/ ASME IX	IS:7307/ IS:7310/ ASME IX	IS:7307/ IS:7310/ ASME IX	Format of IS / ASME	3/2	2	1	Welding to be done by qualified welders.		
2.3	Weld FIT-UPS	Dimension, Alignment, Orientation.	MA	Measurement & Visual	100%	WPS/Approved drg.	WPS/Approved drg.	IR / Log Book	3/2	---	2	Refer Note-3		
2.4	Weldments final run	1. Surface defects 2. Sub Surface defects(After PWHT)	MA MA	Penetrant Test Radiographic Test	100% 100%	IS:3658 / ASTM 165/ ASME VIII Div. I ASME SEC. V	ASTM / 165ASME VIII Div I ASME SEC. VIII	IR / Log Book IR	3/2 3/2	2 2	1 1	100% by Vendor, 10 % by BHEL Films to be reviewed by BHEL.		

LEGEND: * CR - Critical characteristics
 MA - Major characteristics
 MI - Minor characteristics
 IR - Inspection Reports
 TC - Test Certificates
 AP - Approved Drawings/doc
 DS - Data Sheet
 SP - Tech. Spec.
 MR- Manufacturer records
 MS- Manufacturer standards

[§] P - Agency Performing the Test.
 W - Agency Witnessing the Test.
 V - Agency Verifying the Test.
 1 - BHEL
 2 - Vendor
 3 - Sub-vendor


STANDARD QUALITY PLAN FOR FLOW NOZZLE ASSEMBLY												QUALITY PLAN NO.: PE-QP-999-145-1005			
PEM :: C&I												VOLUME IIB			
												SECTION D			
												REV. NO. 04			
												DATE: 12.09.2011			
												SHEET 2 OF 3			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks			
									P	W	V				
2.5	Machining 1. Flow Nozzle (machined)	3 Heat Treatment	MA	Review of HT Chart	100%	ASME SEC. VIII	ASME SEC. VIII	HT Chart	3/2	2	1	100% by Vendor, 10% by BHEL			
		1. Dimensions	MA	Measurement	100%	AP / DS	AP / DS	IR	3/2	2	1				
		2. Profile	MA	Measurement	100%	AP / DS	AP / DS	IR	3/2	2	1				
		3. Surface finish	MA	Visual	100%	-----	Mirror finish.	IR / Mfd Records	3/2	2	1				
	2. Pipe, Adapter	1. Machining of pipe ID	MA	Measurement	100%	AP / DS	AP / DS	IR	3/2	2	1				
3.0	ROUTINE TEST	2. Dimensions	MA	Measurement	100%	AP / DS	AP / DS	IR	3/2	2	1				
		3. Surface flaw on weld edge preparation (for shop welding)	MA	Penetrant Test	100%	ASTM 165/ IS-3658	ASTM 165/ IS-3658	IR /TC	3/2	2	1				
		4. IBR Clearance	MA	Review	100%	IBR Compliance	IBR Compliance	Form III C	3/2		1				
		1. Leak tightness	CR	Hydraulic test(1.5 times Design pressure)	100%	AP / DS	No Leakage	Test Certificate	3/2	2,1	---	Minimum time duration of test shall be ½ hours.			
LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics IR - Inspection Reports TC - Test Certificates AP - Approved Drawings/doc DS - Data Sheet SP - Tech. Spec. MR- Manufacturer records MS- Manufacturer standards \$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test. 1 - BHEL 2 - Vendor 3 - Sub-vendor															


<div></div> <div>STANDARD QUALITY PLAN FOR FLOW NOZZLE ASSEMBLY</div>		QUALITY PLAN NO.: PE-QP-999-145-1005													
		Sl. No.		Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency §			Remarks
												P	W	V	
SHEET		3	OF	3	REV. NO. 04		DATE: 12.09.2011		VOLUME IIB		SECTION D				
PEM :: C&I															
			2. Calibration	CR	Measurement	1 per type per size	-----	Tech Spec.	TC	2	---	1	Refer note-4		
4.0	FINAL ASSEMBLY	1. Marking – Tag No., direction of flow	MI	Visual	100%	AP / DS	AP / DS	AP / DS	IR	2	---	1			
		2. Workmanship, surface flaw on weld edge preparation on end of pipe (for site welding)	MA	Visual, Penetrant test	100%	ASTM165 / IS: 3658	No Surface Flaw	TC /IR	3/2	2	1				
		3. Dimensions and end connection	MA	Measurement	100%	AP / DS	AP / DS	IR	3/2	2	1	Refer Note-2 before dispatch			
5.0	PACKING & DISPATCH	Soundness of Packing against transit damage	MA	Visual	100%	SP / MS	SP / MS	SP /MS		2	---	---	Refer Note-5		

NOTE:

1. Test Certificates to be verified by BHEL at final inspection stage.
2. Minimum 2 coats of primer paint to be applied before dispatch.
3. In case of NTPC / LLOYDS / BHEL qualified welders available, then prequalification and WPS, PQR not required, only TC to be verified.
4. CALIBRATION Test to be carried out at IIT-DELHI / IIT- MUMBAI / FCRI or BHEL approved laboratory.
5. Sea Worthy packing ,if applicable
6. Qualification records of the Vendors can be verified.
7. For P91 & P22 material welding should be continuously done. No interruptions shall be allowed.

LEGEND:		* CR	- Critical characteristics	IR	- Inspection Reports	DS	- Data Sheet	MR	- Manufacturer records	[§] P - Agency Performing the Test.		
	MA	- Major characteristics	TC	- Test Certificates	SP	- Tech. Spec.	MS	- Manufacturer standards		W	- Agency Witnessing the Test.	1 - BHEL
	MI	- Minor characteristics	AP	- Approved Drawings/doc						V	- Agency Verifying the Test.	2 - Vendor
												3 - Sub-vendor


 STANDARD QUALITY PLAN FOR FLOW ORIFICE PLATE		QUALITY PLAN NO.: PE-QP-999-145-1024											
		VOLUME IIB											
		SECTION D											
		REV. NO. 04 DATE: 12.09.2011											
SHEET 1 OF 2													
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency *			Remarks	
									P	W	V		
1.0	MATERIAL												
1.1	Orifice Plate	1. Physical, Chemical properties	MA	Physical, Chemical Tests	One / Plate OR One/ Heat	AP / DS / SP	AP / DS / SP	Lab Report	3/2	---	2,1	IBR certification (if applicable) to be verified by BHEL	
		2. Dimensions	MA	Measurement	100%	AP	AP	IR	3/2	---	1		
1.2	Flanges												
	A. Forgings	Chemical, Mech Properties, UT & Heat Treatment	MA	Chem & Mech UT test	Sample	Material Spec as per ASTM A 388 for UT	ANSI B 16.34	MTC, UT cert, HT cert	3/2	---	1		
	B. Machining	Dimensions	MA	Measurement	100 %	AP / DS	AP / DS	IR	3/2	---	1		
2.0	IN PROCESS												
	Machine	1. Dimension	MA	Measurement	100%	AP	AP	IR	3/2	2	2		
		2. Surface finish	MA	Visual	100%	-----	Mirror Finish	-----	3/2	2	---		
		3. Surface flaw on machined surface	MA	Penetrant test	100%	ASTM 165 / IS:3658	No surface flaw	IR / TC	3/2	2	1		
3.0	ASSEMBLY and FINAL INSPECTION												
		1. Overall dimensions	MA	Measurement	100%	AP	AP	IR	3/2	2,1	---		
		2. Marking, Tag no. Direction of flow	MA	Visual	100%	AP / DS	AP / DS	IR	3/2	2	1		
		3. Calibration	MA	Performance Test	One per type	-----	SP	TC	3/2	---	1		
		4. Painting	MA	Visual	100%	SP / MS	SP / MS	IR / MR	3/2	---	1		
LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics IR - Inspection Reports TC - Test Certificates AP - Approved Drawings/doc DS - Data Sheet SP - Tech. Spec. MR- Manufacturer records MS- Manufacturer standards P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test. 1 - BHEL 2 - Vendor 3 - Sub-vendor													

 STANDARD QUALITY PLAN FOR FLOW ORIFICE PLATE		QUALITY PLAN NO.: PE-QP-999-145-1024										
		VOLUME IIB										
		SECTION D										
		REV. NO. 04 DATE: 12.09.2011										
		SHEET 2 OF 2										
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency [§]			Remarks
									P	W	V	
4.0	PACKING	Soundness of Packing against transit damage	MA	Visual	100%	SP / MS	SP / MS		3/2			


NOTE:

1. All test reports & dimension reports shall be verified by BHEL wherever verification is by BHEL at the time of Final Inspection.
2. Minimum 2 coats of primer paint to be applied before dispatch.
3. CALIBRATION Test to be carried out at IIT-DELHI / IIT- MUMBAI / FCRI or BHEL approved laboratory.
4. Sea Worthy packing ,if applicable

LEGEND:		* CR - Critical characteristics MA - Major characteristics MI - Minor characteristics	IR - Inspection Reports TC - Test Certificates AP - Approved Drawings/doc	DS - Data Sheet SP - Tech. Spec.	MR- Manufacturer records MS- Manufacturer standards	[§] P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.	1 - BHEL 2 - Vendor 3 - Sub-vendor
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 PEM :: C&I		STANDARD QUALITY PLAN FOR CONTROL VALVE (PNEUMATIC)							QUALITY PLAN NO.: PE-QP-999-145-I 006 VOLUME IIB SECTION D REV. NO. 05 DATE: 24.07.2010 SHEET 1 OF 6				
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks	
									P	W	V		
1.0	MATERIAL												
1.1	Body & Bonnet casting / forgings, plug, stem.	1. Physical, Chemical properties	MA	Physical, Chemical tests	One/ Heat(HT Batch)	Approved drg. / data sheet / BHEL specn.	Approved drg. / data sheet / BHEL specn.	Test Certificate	3	---	2,1		
		2. Heat Treatment	MA	Review of H. T. Chart	Each H. T.	Approved drg. / data sheet / BHEL specn.	Approved drg. / data sheet / BHEL specn.	Test Certificate	3/2	2	1	IBR Certification (if applicable) to be verified by BHEL	
		3. Internal quality of castings	MA	RT for Body & UT for Bonnet(NDT)	100%	ASME B 16.34	ASME B 16.34	Test Report / FILM	3/2	2	1	Only for rating ANSI 900 and above. Applicable for Body and Bonnet only. For Lower rating only if called for in specification.	
		4. Surface Quality	MA	1. Visual	100%	MSS-SP-55	MSS-SP-55	Test Certificate	3/2	---	2,1		
				2. MT/PT	100%	ASME B 16.34	ASME B 16.34	Test Certificate	3	2	1	After Machining on machined surface only	
		5. Pressure test for shell	MA	Hyd. Test	100%	ISA-S-75.19/ ASME B 16.34	ISA-S-75.19/ ASME B 16.34	Test Certificate	2	2	1	For Body & Bonnet after machining	

LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics	RT- Radiographic Test UT - Ultrasonic Test	PT - Dye penetrant Test MT- Magnetic Test	\$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.	1 - BHEL 2 - Vendor 3 - Sub-vendor
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<div></div> <div>PEM :: C&I</div>		STANDARD QUALITY PLAN FOR CONTROL VALVE (PNEUMATIC)										QUALITY PLAN NO.: PE-QP-999-145-I 006				
		VOLUME		IIB												
		SECTION		D												
		REV. NO.		05		DATE: 24.07.2010										
		SHEET		2		OF		6								
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks				
									P	W	V					
1.2	Diaphragm	1. Surface Quality	MA	Visual	100%	Mfr. standard	Mfr. standard	Test Certificate	3/2	---	2,1					
		2. Hardness	MA	Measurement	100%	Mfr. standard	Mfr. standard	Test Certificate	3/2	---	2,1					
		3. Endurance / Life cycle	MA	Cyclic test 10,000 cycles	One / Type	10,000 cycles/ Mfr. standard.	No damage	Test Certificate	3/2		2,1					
1.3	Spring	1. Composition	MA	Chemical-Analysis	One sample/ Heat	Material spec. / Mfr. standard	Material spec. / Mfr. standard	Test Certificate	3	---	2,1					
		2. Mech. Properties	MA	Mech. Test	One sample/ Heat	Material spec. / Mfr. standard	Material spec. / Mfr. standard	Test Certificate	3	---	2,1					
		3. Performance	MA	1. Stiffness ratio 2. Scragging 3. Cyclic test (Endurance) 4. Dimension (Measurement)	100% 100% One / type One sample/ Lot	Material spec. / Mfr. standard Material spec. / Mfr. standard 10,000 cycles Mfr. standard	Material spec. / Mfr. standard Material spec. / Mfr. standard Appd Drg	Test Certificate Test Certificate Test Certificate Record	3 3 3 3	---	2,1 2,1 2,1 2,1					
1.4	Electrical items [Limit switches, Solenoids, Position Transmitter(if provided externally)]	1. Routine Test	MA	HV, IR, Continuity function	100%	Rele. Standards	Rele. Standards	Test Certificate	3	---	2,1	In case TC is not available, Actual test shall be conducted				
		2. Degree of protection	MA	IP/NEMA Tests	One sample / type	Approved Data sheet	Approved Data sheet	Test Certificate	3	---	2,1					
<div>LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics</div> <div>RT- Radiographic Test UT – Ultrasonic Test PT – Dye penetrant Test MT- Magnetic Test</div> <div>\$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.</div> <div>1 - BHEL 2 - Vendor 3 - Sub-vendor</div>																



STANDARD QUALITY PLAN FOR CONTROL VALVE (PNEUMATIC)

QUALITY PLAN NO.:	PE-QP-999-145-I 006
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VOLUME	IIB
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SECTION D

REV. NO.	05	DATE: 24.07.2010
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SHEET 3 OF 6

Sl. No.	Component / operation	Characteristics Checked	* Cate gory	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency ^s			Remarks
									P	W	V	
1.5	Pressure Gauges	1. Performance	MA	Review of calibration certificates	100%	Mfr. Standard	Mfr. Standard	Test Certificate	3	---	2,1	
		2. Marking	MA	Visual	100%	Mfr. standard	Mfr. standard	Records	3	---	2,1	
2.0	IN PROCESS INSPECTION											
2.1	Body & Bonnet after machining, Plug with actuator stem	1. Surface flaws	MA	Visual & MT/PT	100% (on accessible surfaces)	ASME B 16.34	ASME B 16.34	Test Records	2	---	1	Butt weld ends shall be included.
		2. Dimensional checks	MA	Measurement	100%	Mfr. Standard	Mfr. Standard	Records	2	---	1	
		3. Hard facing (wherever applicable)	MA	Hardness Measurement	One sample/Lot	Mfr. Standard	Mfr. Standard	Records	2	---	1	
2.2	Lapping	Machining surface contact	MA	Blue Matching	One sample/lot	-----	Proper Physical Contact	Test Records	2			
3.0	TESTS ON COMPLETED VALVE											
3.1	Actuator Chamber	Leakage & Strength	MA	Pneumatic test	100%	Mfr. Standard	No Leakage	Test Certificate	2	1	1	Refer Note-4
3.2	Body	Leakage and Pressure test (Body Mount Leakage)	MA	Hydro test	100%	ISA - S-75.19	No Leakage	Test Certificate	2	1	1	Refer Note-4
3.3	Seat leakage test for completed valve	Seat Leakage	MA	Pneumatic Test	100%	FCI-70.2	FCI-70.2	Test Certificate	2	1	1	Refer Note-4
4.0	OPERATION TEST ON COMPLETED VALVE (Final inspection)	1. Valve Travel	MA	Measurement	100%	Approved drg. / data sheet	Approved drg. / data sheet	Test Report	2	1	1	Refer Note-4
		2. Opening/Closing time	MA	Measurement	100%	Approved drg. / data sheet	Approved drg. / data sheet	Test Report	2	1	1	Refer Note-4

LEGEND:

- CR - Critical characteristics
- MA - Major characteristics
- MI - Minor characteristics

RT- Radiographic Test
UT – Ultrasonic Test
PT – Dye penetrant Test
MT- Magnetic Test


\$ P - Agency Performing the Test.
W - Agency Witnessing the Test.
V - Agency Verifying the Test.


1 - BHEL
2 - Vendor
3 - Sub-vendor

STANDARD QUALITY PLAN FOR CONTROL VALVE (PNEUMATIC)												QUALITY PLAN NO.: PE-QP-999-145-I 006												
												VOLUME IIB												
												SECTION D												
												REV. NO. 05												
												DATE: 24.07.2010												
SHEET 4 OF 6																								
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks												
									P	W	V													
		3. Linearity/cam characteristic	MA	Measurement	100%	Approved drg. / data sheet	Approved drg. / data sheet	Test Report	2	1	1	Refer Note-4												
		4. Repeatability	MA	Measurement	100%	Approved drg. / data sheet	Approved drg. / data sheet	Test Report	2	1	1	Refer Note-4												
		5. Hysteresis	MA	Measurement	100%	Approved drg. / data sheet	Approved drg. / data sheet	Test Report	2	1	1	Refer Note-4												
		6. Sensitivity	MA	Measurement	100%	Approved drg. / data sheet	Approved drg. / data sheet	Test Report	2	1	1	Refer Note-4												
		7. Accuracy (Overall)	MA	Measurement	100%	Approved drg. / data sheet	Approved drg. / data sheet	Test Report	2	1	1	Refer Note-4												
		8. Control Valve characteristics / CV Test	MA	Measurement (Press. vs. discharge and discharge vs. opening 0-100% in steps of 10%)	One per type	As per specs/ Approved drg. / data sheet	As per specs/ Approved drg. / data sheet	Test Certificate	2	--	1	♦ Size = Body & port size Or Body size & CV for non std port. Refer Note 1.												
		9. Operation of limit switch & solenoids and other accessories	MA	Function	100%	Approved drg. / data sheet	As per specs/ Approved drg. / data sheet	Test Report	2	1	1	On assembled valve Refer Note-4												
		10. Overall dimensions	MI	Visual and dimensional	100%	Approved drg. / data sheet	As per specs/ Approved drg. / data sheet	Records	2	1	1	Refer Note-4												
		11. Pre defined valve position in case of air failure	MA	Visual	100%	As per spec & Appd drg	As per spec & Appd drg	Test Certificate	2	1	1													
		12. Cleanliness, painting, stamping (for direction of flow), Tag No.	MA	Visual and dimensional	100%	Approved drg. / data sheet	As per specs/ Approved drg. / data sheet	Test Certificate	2	1	1													
LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics												\$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.												
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LEGEND: * CR - Critical characteristics
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 PT - Dye penetrant Test
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1 - BHEL
 2 - Vendor
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STANDARD QUALITY PLAN FOR CONTROL VALVE (PNEUMATIC)										QUALITY PLAN NO.: PE-QP-999-145-I 006									
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										SECTION D									
										REV. NO. 05 DATE: 24.07.2010									
										SHEET 5 OF 6									
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks							
									P	W	V								
5.0 AUXILIARY ITEMS																			
5.1	Positioner	Overall leakage after assembly including Nozzles leakage	MA	Leak Test (in the steady state input signal)	100 %	Mfr. Standard	No leakage	Test Certificate	3/2	---	1			Overall leakage including tubing					
5.2	Air filter regulator	1. Normal air consumption	MA	Measurement	Each type	Mfr. Standard	No leakage	Test Certificate	3/2	---	1								
		2. Overall leakage	MA	Visual (soap solution)	100 %	Mfr. Standard	No leakage	Test Certificate	3/2	---	1								
5.3	Air lock relay	Performance Test	MA	Leakage test	100%	Mfr. Standard	No leakage	Test Certificate	3/2	---	1								
5.4	Electronic position transmitter(not applicable if provided integral to smart positioner)	1. Accuracy	MA	Operation	100%	Approved data sheet /	Approved data sheet /	Test Certificate	2	1	1			On completed valve					
5.5	Current to Pneumatic converter(not applicable for smart positioner)	1. Physical Verification Make/Model	MA	Visual	100%	Approved drg. / data sheet	Approved drg. / data sheet	Test Certificate	2	---	2,1								
		2. Degree of Protection	MA	IP/NEMA test	Each type	Relevant Standard	Relevant Standard	Test Certificate	3	---	2,1								
		3. Linearity	CR	Measurement	100%	Approved drg. / data sheet / BHEL specn.	Approved drg. / data sheet / BHEL specn.	Inspection Report	2	---	1								
		4. Hysteresis	CR	Measurement	100%	Approved drg. / data sheet / BHEL specn.	Approved drg. / data sheet / BHEL specn.	Inspection Report	2	---	1								
LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics																			
\$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.																			
1 - BHEL 2 - Vendor 3 - Sub-vendor																			

<div></div> <div>PEM :: C&I</div>		STANDARD QUALITY PLAN FOR CONTROL VALVE (PNEUMATIC)										QUALITY PLAN NO.: PE-QP-999-145-I 006					
												VOLUME		IIB			
												SECTION		D			
												REV. NO.		05		DATE: 24.07.2010	
												SHEET		6		OF	
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks					
									P	W	V						
5.6	Smart Positioner (As Applicable)	1. Physical Verification Make/Model	MA	Visual	100%	Approved drg. / data sheet	Approved drg. / data sheet	Test Certificate	2	---	2,1						
		2. Degree of Protection	MA	IP/NEMA test	Each type	Relevant Standard	Relevant Standard	Test Certificate	3	---	2,1						
		3. Linearity	CR	Measurement	100%	Approved drg. / data sheet / BHEL specn.	Approved drg. / data sheet / BHEL specn.	Inspection Report	2	---	1						
		4. Hysteresis	CR	Measurement	100%	Approved drg. / data sheet / BHEL specn.	Approved drg. / data sheet / BHEL specn.	Inspection Report	2	---	1						
		5. Calibration with Hand Held Communicator	MA	Measurement	Each type	Approved data sheet / Mfr. Standard	Approved data sheet / Mfr. Standard	Test Certificate	2	1	1						
6.0	PAINTING	Soundness of Painting	MA	Visual and Measurement	100%	BHEL specn. / Mfr. Standard	BHEL specn. / Mfr. Standard	Inspection Report	2	---	1	Refer Note-2					
7.0	PACKING	Soundness of Packing against transit damage	MA	Visual	100%	Mfr. Standard	Mfr. Standard	Inspection Report	2	---	---	Refer Note-3					


NOTES:

1. Cv test will be conducted if Test Certificate for a similar Model / Size / Cv is not available. Validity of the certificate considered as last 3 years. Cv test conducted at IIT/FCRI/any govt. approved laboratory shall not be witnessed by BHEL.
2. In the absence of BHEL spec. for painting, vendor to obtain BHEL's approval on their painting specification / procedure.
3. Sea worthy packing, if applicable.
4. The quantum of check shall be 100% for manufacturer and 10% for BHEL/BHEL nominated inspection agency.
5. IBR certificates in Form III-C shall be submitted if called for in the specification/datasheet.
6. Copies of all TC's/Test Certificates for materials duly correlated with Heat Nos., TC's for electrical items and mechanical tests(Leak/Operation) shall be submitted to BHEL for verification and acceptance.

LEGEND:

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MI	- Minor characteristics			V	- Agency Verifying the Test.	3 - Sub-vendor

**Technical Specifications, Quality plan and
Data Sheet for
Local Control Panel**

	Technical specification for Local Control Panel	SPECIFICATION NO.	
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1.

SCOPE

This specification covers the Design, Manufacture, Inspection and Testing at the Manufacturers works, proper packing for transportation and delivery to Mumbai port CHA Godown of the Local Panels required for control and monitoring of the Auxiliary plant & Equipment.

2.

CODES AND STANDARDS

2.1

All equipment specified herein shall comply with the requirements of the latest issue of the National and International Standards.

2.2

As minimum requirements the panels shall comply with the following Indian Standards.

a)

IS-6005:1970

-

Code of Practice for Phosphating of iron and steel

b)

IS-5:1978

-

Colours for ready mixed paints & enamels.

c)

IS-1248:1983

-

Direct Acting Indicating Instruments.

d)

IS-13947 (Part-III):1993

-

Rotary Cam Switches.

e)

IS-6875:1973

-

Auxiliary relays.

f)

IS-8828:1993

-

Circuit breaker for household and similar installations.

g)

IS-13947 (Part-I):1993

-

Low Voltage switchgear & control gear: Part-I (General Rules)

h)

NFPA-196:1974

-

Purged & Pressurised Enclosure for Electrical Equipment in Hazardous Locations.

3.0

TECHNICAL REQUIREMENTS

3.1


Panel Construction

3.1.1

The local panels shall house the instruments, annunciation system, Programmable Logic Controller (PLC). Single loop controller, Control switches/push buttons, indicating lamps, relays, timers and other devices required for operation and monitoring of the equipment locally.

3.1.2

The panels shall be of free standing type either welded construction on angle iron (minimum section of 50 x 50 x 4 mm) structure or folded construction by sheet metal formation depending upon the equipments to be mounted on it. The panels shall be robustly built and stiffeners as necessary shall be provided.

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3.1.3 The panel shall be suitably reinforced adequate support for all instruments mounted thereon. All welds on exposed panel surfaces shall be ground smooth. The panels shall be mounted on a channel base frame via suitable anti-vibration mountings.

3.1.4 The material of the sheet steel for front, top, bottom and doors shall be Cold Rolled Cold Annealed (CRCA). The sheet thickness shall be 2.5 mm for front sheet and 2.0 mm for top & side of the panel. The panel's shape and size shall be required for mounting operation and maintenance of the specified equipment on the panel. However, its height shall be 2365 mm including the height of the base frame, pedestal and anti-vibration mounting. In case of skid mounted panels, its total height including the height of the skid not exceeds 2365 mm.

3.1.5 The panel shall be provided with rear doors with integral key lockable handle. The door when locked shall be held at minimum three places. The doors shall be minimum 1.6 mm thick, not more than 550 mm wide and be provided with suitable stiffeners to prevent buckling. The handle shall be on the right side of the door. The door should be capable of being opened through a maximum of 90 deg. The door shall be removable type with concealed hinges to facilitate maintenance work. Suitable pocket inside the door shall be provided for keeping the drawings/documents.

3.1.6 Suitable neoprene gasket shall be provided on all doors and removable covers. Suitable ventilation louvers shall be provided at bottom and top of the doors covered with removable wire mesh.

3.1.7 The class of protection shall be in accordance with IP-54 unless otherwise specified in the data sheet-A (No. PES-145-54A-DSI-0).

3.1.8 All steel surfaces shall be cleaned by sand/pellet blasting, treated for pickling, degreasing and phosphating etc. by seven tank method. The panels shall have a high quality finish and appearance. The panel shall be painted with two coats of primer followed by two coats of epoxy/synthetic enamel based final paint of color shade and finish as given in data sheet-A (No. PES-145-54A-DSI-0). Minimum thickness of the paint shall be 85 microns for external paint and 70 microns for internal paint.

3.1.9 The Panel shall be supplied complete with foundation bolts, anchoring fasteners, base channel, anti-vibration mountings, pedestals, removable lifting eye bolts and undrilled gland plate etc.

3.1.10 The undrilled cable gland plates of minimum 3 mm sheet thickness shall be mounted at panel bottom. The cable glands of the required size and type as given in data sheet-A (No. PES-145-54A-DSI-0) shall be supplied along with the Panel.

3.1.11 Instruments, alarm annunciator, PLC, operable and indicating devices, relays, timers, MCBs etc. shall be provided as per the approved scheme. Necessary temperature scanners for monitoring HT motor winding & bearing temp. It shall be housed in the panel. All



Technical specification for
Local Control Panel

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valve position feedback indication (Pneumatic / Motor operated valves) shall be displayed in the panel.

- 3.1.12** All operable and indicating devices shall be mounted on the front of the panel while aux. Relays/timers MCBs required for realization of control logics shall be mounted on a mounting plate inside the panel. Auxiliary relays and timers etc. shall be grouped according to the control function.

No operable or indicating device shall be mounted below 750 mm and above 1800 mm (w.r.t. finished ground level). The devices shall be located in such a way so as to ensure easy access for operation/maintenance. This is also applicable for mounting of aux. Relays timer4s MCB's etc.


- 3.1.13** Single/dual control power supply feeders of voltage class as specified in the data sheet as given in data sheet-A (No. PES-145-54A-DSI-0) shall be provided by BHEL. Where DC control power supply is specified an additional 240V AC supply feeder for powering of space heater and lighting shall be provided by BHEL. Suitable arrangement shall be provided inside the panel to receive and terminate the power supply feeder(s). For this purpose MCBs of suitable current rating shall be provided by the vendor. A supervisory relay along with a pilot lamp to indicate control supply 'ON' shall be provided on the panel. Any power supply required for the operation of the devices mounted in the panel shall be arrangement by the vendor.

- 3.1.14** The internal wiring shall be carried out with 1100 volt grade PVC insulated copper multi strand wire/flexible of 1.5 mm² size. In case of PLC based systems, size & grade of internal wiring shall be decided by the purchaser on the basis of manufacturers recommendation. AC & DC wires shall be kept separate from each other. Separate coloured wires to be used for AC and DC circuits. All wires shall be properly numbered and identified with ferrules as per the Control scheme/wiring diagram. Wires shall be routed and run through PVC troughs.

- 3.1.15** Terminal blocks shall be clip on type, 1100 volts grade. Separate terminal blocks shall be used for AC & DC circuits. The terminals shall be suitable for terminating 0.5 mm² to 2.5 mm² external cables. The terminals for ammeters shall be provided with removable links for shorting CTs. Each terminal strip shall be provided with identification strip. The terminals shall be not be mounted below 250 mm. The panel shall have twenty (20) percent spare terminals.

- 3.1.16** The interior of each panel shall be suitably illuminated through fluorescent lamps operable on 240V 50 Hz AC power supply through panel door switch. A 15 Amp., 3-pin Power receptacle shall be provided. The panel shall also be provided with a Telephone Jack of 6.3 mm size.

- 3.1.17** Suitable heaters operable on 240 volts 50 Hz AC power system shall be provided at the panel bottom. It shall be so designed to maintain the panel temperature five (5) deg. C above the ambient temperature during maintenance shutdown. Suitable isolating and

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control devices comprising of MCB, thermostat etc. shall be provided for the space heater.

3.1.18 The panel shall be provided with a copper earth bus of 25x3 mm size running throughout the width of the panel. It shall be terminated internally with 10 mm bolts at extreme ends for connection to main station earth. The panel-mounted equipments/devices shall be connected to earth bus through green coloured PVC insulated stranded copper conductor of 2.5 mm² size.

3.1.19 Local Panel shall be provided with main name plate of 150 mm x 40 mm size having inscription of 20 mm height. The individual instruments/devices on the panels shall be as provided with separate nameplate with inscription of 3 mm height. The instrument/devices shall be provided stick on labels inside the panel by indelible ink. The material of the main and individual labels shall be 2 mm Anodized Aluminum Plate. The inscription shall be with white letters on black background.. The labels shall be fixed by self-tapping non-rusting screws.

3.2 Hazardous Area Panel Requirement


3.2.1 The Local Panel located in hazardous area shall be pressurized as per NFPA-196 requirements to render it non-hazardous. Alarms shall be provided for local and remote annunciation when pressurization falls down 2.5 mm of water column. Protection shall be of type Z of NFPA-196. It shall not be possible to switch ON the power of purged section unless it is purged as per the recommendation of NFPA-196. Vendor must provide a protective device on the panel to protect the panel from over pressurization.

3.2.2 Vendor shall supply pressurization kit consisting of valves, restriction orifices, dual filter regulation, pressure gauges, pressure switches, rota meter etc. pressurization kit shall be surface mounting on a metal board and located outside the local panel. Pressurization kit shall further consist of solenoid valves flow switch, timer, blow off safety device etc., so as to make purging fully automatic. However, final start shall be manual. Panel protection against over pressure to be provided as per NFPA-196.

3.2.3 Pressurized local control panel pressurization kit assembly design shall provide minimum leakage flow through the Local Control Panel. Panel venting shall be as per NFPA-196.

3.2.4 All components in the local panel like indicating instruments, push buttons switches, lamps etc. which are required to be energized without panel pressurization or before completion of purge cycle shall be explosion proof as per NEMA-7 & suitable for area classification.

3.2.5 All push buttons etc., requiring frequent operation during machine running shall have good positive sealing. Weatherproof housing or cover to be provided wherever necessary. Vendor shall provide pressurization bypass switch outside explosion proof enclosure of pressurized panel with lamp indication. This shall be used only during maintenance. All hinges, screws, other non-painting metallic parts shall be of stainless steel material.

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3.2.6 Provision to switch off manually all types of power shall be provided in the panel. In addition, it shall also be possible to switch off power circuits/components which are powered from motor control center or control room manually in case of pressurization failure. All such cables from MCC and main control room shall be terminated in explosion proof boxes (NEMA-7).

3.3 Control & Monitoring Devices

3.3.1 Instruments like indicators, recorders, single loop controllers PLC etc. as applicable are specified elsewhere for the plant/equipment shall be supplied and mounted on the panel.


3.4 Alarm Annunciator System:
It shall be solid state discrete facia type having a sequence of ISA-S18.1A or as specified, opaque facia windows of 70 mm x 50 mm size, having two (2) lamps per window, and hooter of 10W, and provision for repeat group alarm at remote. The annunciator shall be provided with ten (10) per cent spare windows or minimum two (2) windows along with electronics.


3.5 Relays:
The relays shall be electromagnetic type suitable for specified control supply. Its contact configuration and rating shall be suitable for the specified control function. However minimum contact rating shall be 5 Amp AC & 2 Amp DC as applicable. There shall be ten (10) percent spare contacts.

3.6 Timers:
The timers shall be electronic or electro pneumatic type suitable for specified control supply, Its contact configuration and ratings shall be suitable for the specified control function. However minimum contact rating shall be 5 Amp AC & 2 Amp DC as applicable.

3.7 Control/Selector Switches:
Switches shall be Rotary Cam type with minimum of 5 Amps AC & 2 Amp DC continuous current rating. Selector switches shall be stay put type while control switches shall be spring-return-to-neutral type. Contact configuration and rating shall be as per the control function requirement. The switches shall be lockable type wherever specified. Each switch shall be provided with engraved plates indicating the switch position/function.

3.8 Push Buttons/indicating Lights:
The push buttons shall be momentary action self resetting type, however stop P.B. for unidirectional drives shall be provided with manual reset facility. Its contact configuration & rating shall be as required for the control function but minimum 2 NO + 2 NC of 5 Amp. AC rating. It shall have round coloured projecting tab and engraved escutcheon plate/inscription plate. Colour coding of push buttons shall be as under:

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RED	Motor OFF/Valve CLOSE	YELLOW	Alarm acknowledge
GREEN	Motor ON/Valve OPEN	BLACK	Lamp test
<p>Indicating lights shall be suitable for direct connections across specified power supplies. It shall be fitted with built in resistance to prevent circuit tripping on shorting of lamp filament. It shall be fitted with 7W/10W filament type lamp replaceable from front and giving good visibility from front. Colour coding of lights shall be :</p>			
GREEN	Motor OFF/Valve condition	CLOSED AMBER	Motor TRIPPED condition
RED	Motor ON/Valve condition	OPEN WHITE	Normal/healthy condition.
3.9 Ammeters:			
<p>Ammeters shall be 96 x 96 mm size, 90 deg deflection, 1.5% accuracy, 1 Amp. CT operated and Flush mounting type Ammeters for motors shall have six (6) times folded scale at upper end enable motor starting current indication.</p>			
3.10 Miniature Circuit Breaker (MCB):			
<p>These shall be of instantaneous magnetic trip type for short circuit in addition to current time inverse delayed thermal feature for over current protection. The housing of MCB shall be made of non-ignitable high impact material. It shall have minimum short circuit rating of 9 KA for AC Voltages and 4 KA for DC Voltages.</p>			
3.11 Makes of various instruments/devices shall be as given below:			
1.	Alarm Annunciators	:	Procon / IIC
2.	Ammeters	:	AEP / IMP / L&T
3.	Control/Selector Switches	:	GEC Alsthom / Kaycee / Siemens / L&T
4.	Push Buttons/Indicating Lamps	:	Siemens/L&T/Teknic /GEC Alsthom
5.	Auxiliary Relays	:	Jyoti/Siemens/L&T/OEN
6.	Timers	:	L&T/GEC Alsthom/Bhartiya Cutler Hammer
7.	MCBs	:	S&S Power Engg/Indo Asian/MDS/Havells/L&T
8.	Terminal Blocks	:	Connectweli/Elmex
4.0 TESTING AND INSPECTION			
4.1 The bidder shall adopt Quality Assurance Programme to ensure that the equipment offered will meet the specification requirement in full.			

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4.2 The vendor shall conduct the following tests as a minimum requirement:

4.2.1 Routine Tests :

1. High Voltage Test
2. I.R. Test
3. Functional Test

4.2.2 Type Tests

1. Enclosure Class Test

4.3 Inspection will be conducted by BHEL and/or their Customer as per the agreed inspection schedule. The inspection schedule will be submitted by the bidder for BHEL’s approval at contract stage. The cost of all tests inspections will be deemed to have been included in the bid. For all the items. “Type Test Certificates” for Enclosure Class Test as per agreed Quality Plan for similar/Panel shall be furnished. In the absence of the same, such Type Tests shall be arranged at the Vendor’s works in the presence of BHEL and/or Customer or in Government Test House/ Government approved Test House.

4.4 Test Certificate for Routine tests carried out by the Manufacturer shall be sent to the Purchaser before the request for inspection by BHEL or his authorized representative.

5.0 SPARES AND CONSUMABLES

5.1 The bidder shall include the commissioning spares & consumables required during commissioning.

6.0 DRAWING AND DOCUMENTS

6.1 The bidder shall furnish the following documents in required number of copies along with bid:

1. Data sheet no. PES-145A-DS1-0
2. General Arrangement Drawing.
3. Catalogue and technical information for instruments and devices.
4. Quality Plans.

6.2 The vendor shall furnish the following documents in required number as agreed after the award of contract.

1. Data Sheet No. PES-145A-DS2-0
2. GA Drg indicating layout of instruments, construction details, foundation details,



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cable gland plate alongwith cable glands and all details mentioned in this specification including BOM .

3. Panel Wiring Diagram alongwith grouping of different terminals for various functions.
4. Catalogue and technical information for instruments and devices with selected options clearly marked.
5. O&M Manuals.
6. 'As Built' Drawing.
7. Relay logic scheme / PLC logic diagram
8. All the drawings/ Documents shall be furnished to DVC by BHEL for approval / information as the case may be.

All the drawings/ Documents shall be furnished to DVC by BHEL for approval / information as the case may be.


7.0 PACKING:


Sea worthy capable of performing all necessary functions like prevention of damage to the contents, sufficient to support frequent handling and lengthy period of outdoor storage in adverse weather conditions are required. Workmanship and materials used shall be of high standard meeting the technical requirements and in accordance with best commercial export packing practices. Vendor shall be responsible for sea worthy export packing. Equivalent or better packing methods may be deployed subject to approval of the BHEL. Vendor shall submit the packing procedure for its equivalent for BHEL's approval during detailed engineering.


8.0 APPLICABLE DATA SHEET FORMS


This document shall be read with one or more of the following data sheet forms :


- Data sheet A&B for Local Panels : Data sheet no. PES-145A-DS1-0
- Data sheet C for Local Panels : Data sheet no. PES-145A-DS2-0


	DATA SHEET FOR LOCAL PANELS			SPECIFICATION NO.:	
				VOLUME	
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TAG No. Qty.....				Data Sheet No.: PES-145A-DS1-0	
Data Sheet A & B					
DATA SHEET-A FOR LOCAL PANEL (TO BE FILLED BY PURCHASER)				DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
GENERAL	MANUFACTURER				
	CONSTRUCTION		<input checked="" type="checkbox"/> FOLDED <input type="checkbox"/> WELDED (As per requirement)		
TECHNICAL	INPUT POWER SUPPLY		<input type="checkbox"/> 240V 50 Hz AC <input type="checkbox"/> 220V DC <input type="checkbox"/> 415V 3 PHASE (4 wires)		
	NO. OF FEEDERS		<input type="checkbox"/> ONE <input type="checkbox"/> TWO		
	CONTROL SUPPLY		<input type="checkbox"/> 110V AC <input type="checkbox"/> 220V AC <input type="checkbox"/> 220V DC <input type="checkbox"/> (As per requirement)		
	ALARM ANNUNCIATOR WINDOW (EXCLUDING SPARES)		_____ NOS. (AS REQUIRED)		
	PAINT TYPE		<input type="checkbox"/> EPOXY <input type="checkbox"/> SYNTHETIC ENAMEL <input type="checkbox"/> POWER COATED		
	PANEL COLOUR (EXTERNAL)		<input type="checkbox"/> LIGHT GREY (Shade 631 IS-5) <input type="checkbox"/> OPALINE GREEN (Shade 275) <input type="checkbox"/>		
	FINISH		<input type="checkbox"/> SEMI MAT <input type="checkbox"/> MATT <input type="checkbox"/> GLOSSY <input checked="" type="checkbox"/> SEMI GLOSSY		
	PANEL COLOUR (INTERNAL)		<input checked="" type="checkbox"/> WHITE <input type="checkbox"/> CREAM <input type="checkbox"/> OFF WHITE		
	FINISH		<input type="checkbox"/> SEMI MAT <input type="checkbox"/> MATT <input type="checkbox"/> GLOSSY <input checked="" type="checkbox"/> SEMI GLOSSY		
	CLASS OF PROTECTION		<input checked="" type="checkbox"/> IP-54 <input type="checkbox"/> _____		
	CONTROL HARDWARE		<input checked="" type="checkbox"/> RELAY BASED <input type="checkbox"/> PLC As per Requirement		
	FOUNDATION ARRANGEMENT		<input checked="" type="checkbox"/> FOUNDATION BOLTS <input type="checkbox"/> ANCHOR FASTENERS		
	WEIGHT OF PANEL (Kg.)				
	PANEL TYPE		<input type="checkbox"/> PRESSURISED <input type="checkbox"/> UNPRESSURISED As per Requirement		
	CABLE GLAND		<input type="checkbox"/> SINGLE COMPRESSION <input checked="" type="checkbox"/> DOUBLE COMPRESSION		
NAME SIGNATURE DATE	PREPARED BY		CHECKED BY		COMPANY SEAL NAME SIGNATURE DATE

	DATA SHEET FOR LOCAL PANELS			SPECIFICATION NO.:		
				VOLUME		
				SECTION		
				REV. NO.	DATE:	
				SHEET 1	OF 2	
TAG No. Qty.....			Data Sheet No.: PES-145A-DS1-0			
Data Sheet C						
DATA SHEET-C FOR LOCAL PANEL (TO BE FILLED BY CONTRACTOR AFTER AWARD OF CONTRACT)						
GENERAL	MANUFACTURER					
	CONSTRUCTION					
TECHNICAL	INPUT POWER SUPPLY					
	NO. OF FEEDERS					
	CONTROL SUPPLY					
	ALARM ANNUNCIATOR WINDOW (EXCLUDING SPARES)					
	PAINT TYPE					
	PANEL COLOUR (EXTERNAL)					
	FINISH					
	PANEL COLOUR (INTERNAL)					
	FINISH					
	CLASS OF PROTECTION					
	CONTROL HARDWARE					
	FOUNDATION ARRANGEMENT					
	WEIGHT OF PANEL (Kg.)					
	PANEL TYPE					
	CABLE GLAND					
NAME SIGNATURE DATE	PREPARED BY		CHECKED BY		APPROVED BY	
COMPANY SEAL						
NAME						
SIGNATURE						
DATE						

<div></div> <div>PEM :: C&I</div>		STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL										QUALITY PLAN NO.: PE-QP-999-145-1056				
				VOLUME		IIB										
				SECTION		D										
				REV. NO.		01		DATE: 18-05-2007								
				SHEET		1		OF		7						
Sl. No.	Component / operation	Characteristics Checked	* Cate gory	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks				
									P	W	V					
1.0	INCOMING Sheet Steel (CRCA & HR)	1. Chemical Composition	MA	Chemical analysis	Sample	IS:1079 IS:513	IS:1079 IS:513	Test Certificate	3	---	2					
		2. Bend Test	CR	Mech. test	Sample	IS:1079 IS:513	IS:1079 IS:513	Log Book	2	---	---					
		3. Surface finish	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---					
		4. Waviness	MA	Visual	100%	Factory Standard	No Waviness	Log Book	2	---	---					
		5. Thickness	MA	Measurement	100%	BHEL Spec.	BHEL Spec.	Log Book	2	---	---					
		6. Mill marking	MA	Visual	100%	BHEL Spec.	BHEL Spec.	Log Book	2	---	1					
2.0	Flats / Angles / Channels	1. Dimensions	MA	Measurement	Sample	IS:2062	IS:2062	Log Book	2	---	---					
		2. Surface Defects	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---					
		3. Straightness	MA	Measurement	100%	Factory Std.	Factory Std.	Log Book	2	---	---					
		4. Mill marking	MA	Visual	100%	IS:2062	IS:2062	Log Book	2	---	1					
3.0	Cables / Wires	1. Visual / Surface defects	MA	Visual	100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	2	---	---					
		2. IR and HV	MA	Electrical	100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	2	---	---					
<div>LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics</div> <div>\$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.</div> <div>1 - BHEL 2 - Vendor 3 - Sub-vendor</div>																

<div></div> <div>STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL</div>		QUALITY PLAN NO.: PE-QP-999-145-1056												
		VOLUME IIB			SECTION D			REV. NO. 01			DATE: 18-05-2007			
		SHEET 2			OF 7									
		Sl. No.	Component / operation	Characteristics Checked	* Cate gory	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks
											P	W	V	
		3. Conductor a) Resistance b) Size c) Sheet colour	MA MA MA	Electrical Measurement Visual	100% 100% 100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	2	---	---			
		4. Type / Routine Test Certificates	MA	Verification	100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	3	---	2			
4.0	Electrical Components like Annunciator Transformers Lamps Switches PBs Contactors Relays Timers Space Heaters Thermostat Indicating meters etc.	1. Verification at make and Type 2. Verification of Test Certificates 3. Operation / Functional check 4. I.R. 5. H.V. 6. Calibration 7. Pick up / Drop off Voltage	CR CR CR MA MA MA MA	Visual Scrutiny of Type / Routine T.Cs. Electrical Electrical Electrical Electrical	Sample 100% Sample+ 100% 100% 100% 100%	BHEL Spec. and BOM Relevant IS Relevant Indian Std & Catalogue Relevant Indian Std & Catalogue Relevant Indian Std & Catalogue Relevant Indian Std & Catalogue Relevant Indian Std & Catalogue	BHEL Spec. and BOM Relevant IS Relevant Indian Std & Catalogue Relevant Indian Std & Catalogue Relevant Indian Std & Catalogue Relevant Indian Std & Catalogue Relevant Indian Std & Catalogue	Log Book Log Book Log Book Log Book Log Book Log Book Log Book	2 2 2 2 2 2 2	--- --- --- --- --- --- 1	---	+ for relay & contactors only @ for all components except relays & contactors.		
LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics														
\$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.														
1 - BHEL 2 - Vendor 3 - Sub-vendor														


 PEM :: C&I		STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL										QUALITY PLAN NO.: PE-QP-999-145-1056 VOLUME IIB SECTION D REV. NO. 01 SHEET 3 OF 7 DATE: 18-05-2007			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks			
									P	W	V				
5.0	Misc. Components like Gaskets , Terminal Blocks etc.	1. Verification of Type / Make 2. Surface defects 3. IR / HV on Terminal Blocks	MA MA MA	Visual Visual Electrical	Sample Sample Sample	BHEL Spec. & Mfrs. Catalogue BHEL Spec. & Mfrs. Catalogue BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue BHEL Spec. & Mfrs. Catalogue BHEL Spec. & Mfrs. Catalogue	Log Book Log Book Log Book	2 2 2	---	---	---			
6.0	IN PROCESS Blanking / Bending / Forming	1. Dimensions 2. Surface defects after bending	MI MA	Measurement Visual	100% 100%	Approved Mfr. drgs. Factory Standard	Approved Mfr. drgs. Factory Standard	Log Book Log Book	2 2	---	---	---			
7.0	Nibbling / Punching	1. Cutout Sizes 2. Deburring	MI MA	Measurement Visual	100% 100%	Approved Mfr. drgs. Approved Mfr. drgs.	Approved Mfr. drgs. Approved Mfr. drgs.	Log Book Log Book	2 2	---	---	---			
8.0	ASSEMBLY Frame Assembly & Sheet fixing	1. Dimensions 2. Alignment 3. Welding Quality 4. Surface defects	MA MA MA MA	Measurement Measurement Visual Visual	100% 100% 100% 100%	Approved drg. / Mfr. Standards Approved drg. / Mfr. Standards Approved drg. / Mfr. Standards Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards Approved drg. / Mfr. Standards Approved drg. / Mfr. Standards Approved drg. / Mfr. Standards	Log Book Log Book Log Book Log Book	2 2 2 2	---	---	---	2 2 2 2		
LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test. 1 - BHEL 2 - Vendor 3 - Sub-vendor															


<div></div> <div>PEM :: C&I</div>		STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL							QUALITY PLAN NO.: PE-QP-999-145-1056						
									VOLUME		IIB				
									SECTION		D				
									REV. NO.		01		DATE: 18-05-2007		
									SHEET		4		OF 7		
Sl. No.	Component / operation	Characteristics Checked	* Cate gory	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks			
									P	W	V				
9.0	Pre-treatment and Painting	1. Pretreatment Process 2. Process parameters like bath temp. concentration etc. 3. Dipping / Removal Time 4. Surface quality after every dip 5. Primer after phosphating 6. Putty Application & Rubbing after primer 7. Paint first coat 8. Putty Application and Rubbing after first coat of paint 9. Paint second coat	MA MA MA MA MA MA MA	Visual Measurement Measurement Visual Visual, Thickness Visual Visual, Thickness Visual Visual, Thickness, Scratch test Colour adhesion	100% Periodic 100% 100% 100% 100% 100% 100%	Factory Standard & IS: 6005 Factory Standard & IS: 6005 Factory Standard & IS: 6005 Factory Standard & IS: 6005 Factory Standard & IS: 6005 Factory Standard & IS: 6005 Factory Standard & IS: 6005 Factory Standard & IS: 6005	Factory Standard & IS: 6005 Factory Standard & IS: 6005 Factory Standard & IS: 6005 Factory Standard & IS: 6005 Factory Standard & IS: 6005 Factory Standard & IS: 6005 Factory Standard & IS: 6005	Log Book Log Book Log Book Log Book Log Book Log Book Log Book Log Book	2 2 2 2 2 2 2 2	--- --- --- --- --- --- --- ---	1 1 1 1 1 1 1 1				
LEGEND: *		CR - Critical characteristics MA - Major characteristics MI - Minor characteristics	\$	P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.	1 - BHEL 2 - Vendor 3 - Sub-vendor										

LEGEND: * CR - Critical characteristics
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 PEM :: C&I		STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL										QUALITY PLAN NO.: PE-QP-999-145-1056 VOLUME IIB SECTION D REV. NO. 01 SHEET 5 OF 7 DATE: 18-05-2007				
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks				
									P	W	V					
10.	Panel Wiring	1. Wiring Layout 2. Wiring Termination (Crimped Lugs) 3. Ferrule numbers 4. Colour of wiring 5. Size of Conductor	MA MA MA MA MA	Visual Visual Visual Visual Measurement	100% 100% 100% 100% 100%	Approved drgs. & Specs. Approved drgs. & Specs. Approved drgs. & Specs. Approved drgs. & Specs. Approved drgs. & Specs.	Approved drgs. & Specs. Approved drgs. & Specs. Approved drgs. & Specs. Approved drgs. & Specs. Approved drgs. & Specs.	Log Book Log Book Log Book Log Book Log Book	2 2 2 2 2	--- --- --- --- ---	--- --- --- 1 1					
11.	Component Mounting	1. Correct components 2. Fixing	MA MA	Visual Visual	100% 100%	Approved drgs., Specs. & BOM Approved drgs., Specs. & BOM	Approved drgs., Specs. & BOM Approved drgs., Specs. & BOM	Log Book Log Book	2 2	--- ---	--- ---					
12.	FINAL Final Inspection	1. Workmanship 2. Component layout (neatness, accessibility & safety) 3. Components identification Marking / Name plates	MA MA MA	Visual Visual Visual	100% 100% 100%	Factory Standard BHEL approved drg. / Spec. BHEL approved drg. / Spec.	Factory Standard BHEL approved drg. / Spec. BHEL approved drg. / Spec.	Inspection Report Inspection Report Inspection Report	2 2 2	1 1 1	1 1 1	At Random by BHEL, based on 100 % internal test reports by Mfr.				
LEGEND: *		CR - Critical characteristics MA - Major characteristics MI - Minor characteristics		\$	P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.							1 - BHEL 2 - Vendor 3 - Sub-vendor				

<div></div> <div>PEM :: C&I</div>		STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL								QUALITY PLAN NO.: PE-QP-999-145-1056						
										VOLUME			IIB			
										SECTION			D			
										REV. NO.			01		DATE: 18-05-2007	
										SHEET			6		OF 7	
Sl. No.	Component / operation	Characteristics Checked	* Cate gory	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks				
									P	W	V					
		4 Mounting / Proper fixing of all components	MA	Visual	100%	BHEL approved drg. / Spec., BOM	BHEL approved drg. / Spec., BOM	Inspection Report	2	1	1	At Random by BHEL, based on 100 % internal test reports by Mfr.				
		5. Dimensions	MA	Measurement	100%	BHEL approved drg. / Spec., BOM	BHEL approved drg. / Spec., BOM	Inspection Report	2	1	1					
		6. Door functioning	MA	Functional	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1					
		7. Paint Shade	CR	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1					
		8. Paint Thickness	CR	Measurement	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1					
		9. Workmanship of Gaskets	MA	Visual	100%	Factory Standard	Factory Standard	Inspection Report	2	1	1					
		10. Wiring Layout	MA	Visual	100%	BHEL approved drg.	BHEL approved drg.	Inspection Report	2	1	1					
		11. Wire Termination	MA	Pulling manually	Sample	-----	Firm termination	Inspection Report	2	1	1					
		12. Continuity	MA	Electrical	100%	-----	Continuity OK	Inspection Report	2	1	1					

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 2 - Vendor
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<div> PEM :: C&I</div>		STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL										QUALITY PLAN NO.: PE-QP-999-145-1056							
												VOLUME		IIB					
												SECTION		D					
												REV. NO.		01			DATE: 18-05-2007		
												SHEET		7			OF 7		
Sl. No.	Component / operation	Characteristics Checked	* Cate gory	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$				Remarks						
									P	W	V	V							
13.	TYPE TEST	Degree of Protection	CR	Mech. Protection	Sample	BHEL approved spec., drg relevant IS-13947 Part-1, IS-2148.	BHEL approved spec., drg relevant IS-13947 Part-1, IS-2148.	Type Test Certificate	3	---		1							
14	ROUTINE TEST	IR before & after HV Test	CR	Electrical	100%	BHEL approved spec., drg., BOM & relevant IS.	BHEL approved spec., drg., BOM & relevant IS.	Test Report	2	1		1							
15	FUNCTIONAL TEST	1. Control Logic Operation	CR	Electrical	100%	BHEL approved spec. / drg.	BHEL approved spec. / drg.	Inspection Report	2	1		1							
		2. Instrument Calibration	CR	Electrical	10%	BHEL approved spec. / drg.	BHEL approved spec. / drg.	Inspection Report	2	1		1							
		3. Temperature rise	CR	Electrical	100%	BHEL approved spec/drg. & relevant IS.	BHEL approved spec/drg & relevant IS.	Inspection Report	2	1		1							

LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics		\$		P	- Agency Performing the Test.	1	- BHEL
				W	- Agency Witnessing the Test.	2	- Vendor
				V	- Agency Verifying the Test.	3	- Sub-vendor

**Data sheet and Wiring Diagram
for
Motorized Valve Actuator**



SPECIFICATION FOR MOTORISED VALVE ACTUATOR

SPECIFICATION NO.: PE-SS-999-145-I007

VOLUME II B

SECTION D

REV. NO. 02

DATE: 17.09.07

SHEET 1


OF 3


Data Sheet A & B

DATA SHEET-A
(TO BE FILLED BY PURCHASER)

DATA SHEET-B
(TO BE FILLED-UP BY BIDDER)

GENERAL*	* PROJECT	400 MW MARIB GTPS-II		
	OFFER REFERENCE			
	* TAG NO. SERVICE			
	* DUTY	<input type="checkbox"/> ON / OFF <input type="checkbox"/> INCHING		
	* LINE SIZE (inlet/outlet): MATERIAL			
	* VALVE TYPE	<input type="checkbox"/> GLOBE <input type="checkbox"/> GATE <input type="checkbox"/> REG. GLOBE <input type="checkbox"/> BUTTERFLY		
	* OPENING / CLOSING TIME			
	* WORKING PRESSURE			
	AMBIENT CONDITION	SHALL BE SUITABLE FOR CONTINUOUS OPERATION UNDER AN AMBIENT TEMP. OF 0-55 DEG C AND RELATIVE HUMIDITY OF 0-95%		
	VALVE SEAT TEST PRESS	BIDDER TO SPECIFY		
	REQUIRED VALVE TORQUE	BIDDER TO SPECIFY		
	ACTUATOR RATED TORQUE	BIDDER TO SPECIFY		
CONSTRUCTION AND SIZING	CONSTRUCTION	TOTALLY ENCLOSED, WEATHER PROOF, IP:55		
	MECHANICAL POSITION INDICATOR	TO BE PROVIDED FOR 0-100% TRAVEL		
	BEARINGS	DOUBLE SHIELDED, GREASE LUBRICATED ANTI-FRICTION.		
	GEAR TRAIN FOR LIMIT SWITCH/TORQUE SWITCH OPERATION	METAL (NOT FIBRE GEARS). SELF-LOCKING TO PREVENT DRIFT UNDER TORQUE SWITCH SPRING PRESSURE WHEN MOTOR IS DE-ENERGIZED.		
	SIZING	OPEN/CLOSE AT RATED SPEED AGAINST DESIGNED DIFFERENTIAL PRESSURE AT 85% OF RATED VOLTAGE. FOR ISOLATING SERVICE THREE SUCCESSIVE OPEN-CLOSE OPERATIONS OR 15 MINS. WHICHEVER IS HIGHER. FOR INCHING(REGULATING) SERVICE 150 STARTS/HR MINIMUM		
HANDWHEEL	* REQUIRED	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO		
	* ORIENTATION	<input type="checkbox"/> TOP MOUNTED <input type="checkbox"/> SIDE MOUNTED		
	TO DISENGAGE AUTOMATICALLY DURING MOTOR OPERATION.			
ELECTRIC ACTUATOR	ACTUATOR MAKE/MODEL	BIDDER TO SPECIFY		
	MOTOR MAKE / MODEL / TYPE / RATING (KW)	BIDDER TO SPECIFY		
	MOTOR TYPE	SQUIRREL CAGE INDUCTION MOTOR, STARTING CURRENT LIMITED TO SIX TIMES THE RATED CURRENT.		
	ACTUATOR APPLICABLE WIRING DIAGRAM	<input checked="" type="checkbox"/> ENCLOSED (BIDDER TO CONFIRM) A: <input type="checkbox"/> DRG. NO. 3-V-MISC-24227 R00 B: <input type="checkbox"/> DRG. NO. 3-V-MISC-24550 R00 C: <input type="checkbox"/> DRG. NO. 3-V-MISC-24283 R00 D: <input checked="" type="checkbox"/> DRG. NO. 4-V-MISC-90271 R11		
	COLOUR SHADE	<input type="checkbox"/> BLUE (RAL 5012) ENAMEL <input type="checkbox"/>		
	SHAFT RPM	BIDDER TO SPECIFY		
	OLR SET VALUE	BIDDER TO SPECIFY		
	STARTING / FULL LOAD CURRENT	BIDDER TO SPECIFY		
	NO. OF REV FOR FULL TRAVEL	BIDDER TO SPECIFY		
	@ PWR SUPP TO MTR / STARTER	415V, 3PH, AC		
	@ CONTROL VOLTAGE REQUIREMENT	TO BE DERIVED FROM THE POWER SUPPLY TO THE STARTER <input type="checkbox"/> 230 V <input type="checkbox"/> 110 V		
	@ ENCLOSURE CLASS OF MOTOR	<input type="checkbox"/> IP 65 <input type="checkbox"/> IP 67 <input type="checkbox"/> FLAME PROOF <input type="checkbox"/> IP 55, TOTALLY ENCL, SELF VENTILATED.		
	@ INSULATION CLASS	<input type="checkbox"/> CLASS-B <input type="checkbox"/> CLASS-F		
	@ WINDING TEMP PROTECTION	<input checked="" type="checkbox"/> THERMOSTAT (3 Nos., 1 IN EACH PHASE) <input type="checkbox"/> -----		

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR		SPECIFICATION NO.: PE-SS-999-145-I007		
			VOLUME II B		
			SECTION D		
			REV. NO. 02	DATE: 17.09.07	
			SHEET 2	OF	3
Data Sheet A & B					
DATA SHEET-A (TO BE FILLED BY PURCHASER)				DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
	SINGLE PHASE / WRONG PHASE SEQUENCE PROTECTION	REQUIRED			
INTEGRAL STARTER	INTEGRAL STARTER	<input type="checkbox"/> REQUIRED <input checked="" type="checkbox"/> NOT REQUIRED			
	TYPE OF SWITCHING DEVICE	<input type="checkbox"/> CONTACTORS <input type="checkbox"/> THYRISTORS			
	TYPE	<input type="checkbox"/> CONVENTIONAL <input type="checkbox"/> SMART (NON-INTRUSIVE)			
	IF SMART				
	a) SERIAL LINK INTERFACE	<input type="checkbox"/> INTEGRAL <input type="checkbox"/> FIELD MOUNTED			
	b) SERIAL LINK PROTOCOL	<input type="checkbox"/> FOUNDATION FIELD-BUS <input type="checkbox"/> PROFI-BUS <input type="checkbox"/> TCP/IP <input type="checkbox"/>			
	c) SERIAL LINK MEDIA	<input type="checkbox"/> TWISTED PAIR Cu-CBL <input type="checkbox"/> CO-AXIAL Cu-CBL <input type="checkbox"/> OFC			
	d) HAND HELD PROGRAMMER	<input type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED			
	e) MASTER STATION	<input type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED			
	f) MASTER STN INTRFACE WITH DCS	<input type="checkbox"/> MODBUS <input type="checkbox"/> TCP/IP			
	g) DETAILS OF SPECIAL CABLE	<input type="checkbox"/> ENCLOSED <input type="checkbox"/> NOT REQUIRED			
	STEP DOWN CONT. TRANSFORMER	<input type="checkbox"/> REQUIRED			
	OPEN / CLOSE PB	<input type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED			
	STOP PB	<input type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED			
	INDICATING LAMPS	<input type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED			
	LOCAL REMOTE S/S	<input type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED			
	STATUS CONTACTS FOR MONITORING	<input type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED			
INTEGRAL STARTER DISTURBED SIGNAL	REQUIRED (O/L RELAY OPERATED, CONT./POWER SUPPLY FAILED, S/S IN LOCAL, TORQUE SWITCH OPTD. MID WAY)				
INTERPOSING RELAY (Applicable for integral Starter)	INTERPOSING RELAYS	REQUIRED			
	INTERPOSING RELAY (QUANTITY)	<input type="checkbox"/> 2 Nos. <input type="checkbox"/> 3 Nos.			
	DRIVING VOLTAGE	<input checked="" type="checkbox"/> 20.5 – 24V DC <input type="checkbox"/> _____ V DC			
	DRIVING CURRENT	<input checked="" type="checkbox"/> 125mA MAX <input type="checkbox"/> _____ mA MAX			
	LOAD RESISTANCE	<input checked="" type="checkbox"/> > 192 ohms - <25 k ohms <input type="checkbox"/> > _____ ohms - < _____ ohms			
TORQUE SWITCH (Not Applicable for Smart Actuator)	MFR & MODEL NO.	BIDDER TO SPECIFY			
	OPEN / CLOSE	<input checked="" type="checkbox"/> 1 No. <input type="checkbox"/> 2Nos. / <input checked="" type="checkbox"/> 1 No. <input type="checkbox"/> 2Nos			
	CONTACT TYPE	2 NO + 2 NC			
	RATING	5A 240V AC AND 0.5A 220V DC			
	CALIBRATED KNOBS(OPEN&CLOSE TS)	REQUIRED FOR SETTING DESIRED TORQUE			
	ACCURACY	+3% OF SET VALUE			
LIMIT SWITCH (Not Applicable for Smart Actuator)	MFR & MODEL NO.	BIDDER TO SPECIFY			
	OPEN : INT : CLOSE	<input checked="" type="checkbox"/> 1 No. <input type="checkbox"/> 2 Nos.	2 Nos. (ADJ.)	<input checked="" type="checkbox"/> 1 No. <input type="checkbox"/> 2Nos.	
	CONTACT TYPE	2 NO + 2 NC			
	RATING (AC / DC)	5A 240V AC AND 0.5A 220V DC			

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR	SPECIFICATION NO.: PE-SS-999-145-I007		
		VOLUME	II B	
		SECTION	D	
		REV. NO.	02	DATE: 17.09.07
		SHEET	3	OF 3
Data Sheet A & B				
DATA SHEET-A (TO BE FILLED BY PURCHASER)		DATA SHEET-B (TO BE FILLED-UP BY BIDDER)		

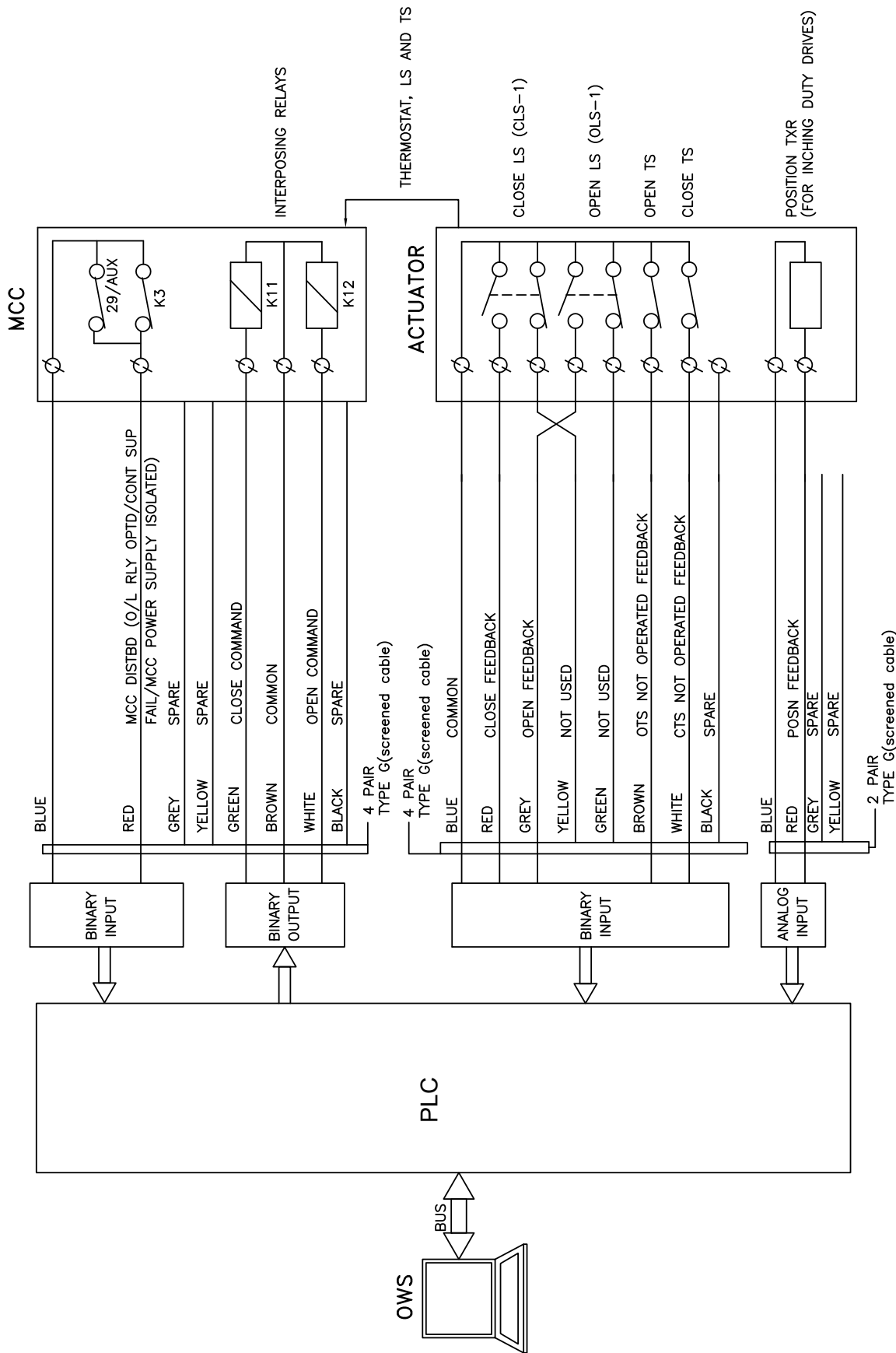
POSITION TRANSMITTER	POSITION TRANSMITTER (For inching duty)	REQD FOR INCHING DUTY		
	MFR & MODEL NO.	BIDDER TO SPECIFY		
	TYPE	<input checked="" type="checkbox"/> ELECTRONIC (2 WIRE) R/I CONVERTER <input type="checkbox"/> ELECTRONIC (2 WIRE) CONTACTLESS		
	SUPPLY	<input checked="" type="checkbox"/> 24V DC <input type="checkbox"/>		
	OUTPUT	<input checked="" type="checkbox"/> 4-20mA		
	ACCURACY	$\pm 1\%$ FS		
SPACE HEATER	@SPACE HEATER	REQUIRED		
	@ POWER SUPPLY			
	@ RATING			
TERMINAL BOX	MOTOR TERMINAL BOX	REQUIRED		
	ACTUATOR TERMINAL BOX	REQUIRED		
	ENCL CLASS MTR T.B. / ACTUATOR T.B.	@ <input type="checkbox"/> IP 65 @ <input type="checkbox"/>	<input type="checkbox"/> IP65 <input type="checkbox"/>	
	@ EARTHING TERMINAL	REQUIRED		
	PLUG & SOCKET(9 PIN) (FOR COMMD, LS/TS FEED BACK, PoT)	<input type="checkbox"/> REQUIRED <input checked="" type="checkbox"/> NOT REQUIRED <input type="checkbox"/> 2 NOS. <input type="checkbox"/>		
CABLE GLANDS	@ POWER CABLE GLAND	SIZE:-----		
	@ SPACE HEATER CABLE GLAND	SIZE:-----		
	OTHER CONTROL CABLE GLANDS-1	<input type="checkbox"/> 1No. for BFV of CW PUMP(Cable size 2Px1.5mm2)		
	OTHER CONTROL CABLE GLANDS-2	QUANTITY & SIZE :-----		
WEIGHT	TOTAL WEIGHT (ACTUATOR + ACCESSORIES)	BIDDER TO SPECIFY		_____ Kg.


NOTES:

- SCOPE:** DESIGN, MANUFACTURE, INSPECTION, TESTING AND DELIVERY TO SITE OF ELECTRIC ACTUATOR FOR INCHING OR OPEN / CLOSE DUTY.
- CODES & STANDARDS:** DESIGN AND MATERIALS USED SHALL COMPLY WITH THE RELEVANT LATEST NATIONAL AND INTERNATIONAL STANDARD. AS A MINIMUM, THE FOLLOWING STANDARDS SHALL BE COMPLIED WITH:
IS-9334, IS-2147, IS-2148, IS-325, IS-2959, IS-4691 AND IS-4722
- TEMPERATURE RISE SHALL BE RESTRICTED TO 70 DEG. C FOR AMBIENT TEMPERATURE OF 50 DEG C.
- CABLE GLANDS OF DOUBLE COMPRESSION TYPE, BRASS MATERIAL SHALL BE PROVIDED.
- THE TORQUE SWITCHES SHALL BE PROVIDED WITH MECHANICAL LATCHING DEVICE TO PREVENT OPERATION WHEN UNSEATING FROM THE END POSITIONS. THE LATCHING DEVICE SHALL UNLATCH AS SOON AS THE VALVE LEAVES THE END POSITION. IF SUCH PROVISION IS NOT POSSIBLE, THE TORQUE SWITCHES SHALL BE BYPASSED BY END-POSITION LIMIT SWITCHES WHICH OPENS ON VALVE LEAVING END POSITION. THESE LIMIT SWITCHES ARE ADDITIONAL TO THE NUMBER OF LIMIT SWITCHES SPECIFIED ELSEWHERE.
- THE MOTOR SHALL OPERATE SATISFACTORILY UNDER THE +/- 10% SUPPLY VOLTAGE VARIATION AT RATED FREQUENCY, -5% TO +3% VARIATION IN FREQUENCY AT RATED SUPPLY VOLTAGE, SIMULTANEOUS VARIATION IN VOLTAGE & FREQUENCY THE SUM OF ABSOLUTE PERCENTAGE NOT EXCEEDING 10%.
- THE MOTOR SHALL BE SUITABLE FOR DIRECT ON LINE STARTING.

NAME SIGNATURE DATE	PREPARED BY	CHECKED BY	APPROVED BY	VENDOR COMPANY SEAL
				NAME
				SIGNATURE
				DATE
NOTES* = TO BE FILLED BY MPL (LEAD AGENCY). @ = TO BE FILLED BY ES				

ANNEXTURE-A PLC INTERFACE FOR BIDIRECTIONAL DRIVE(WITH MCC)

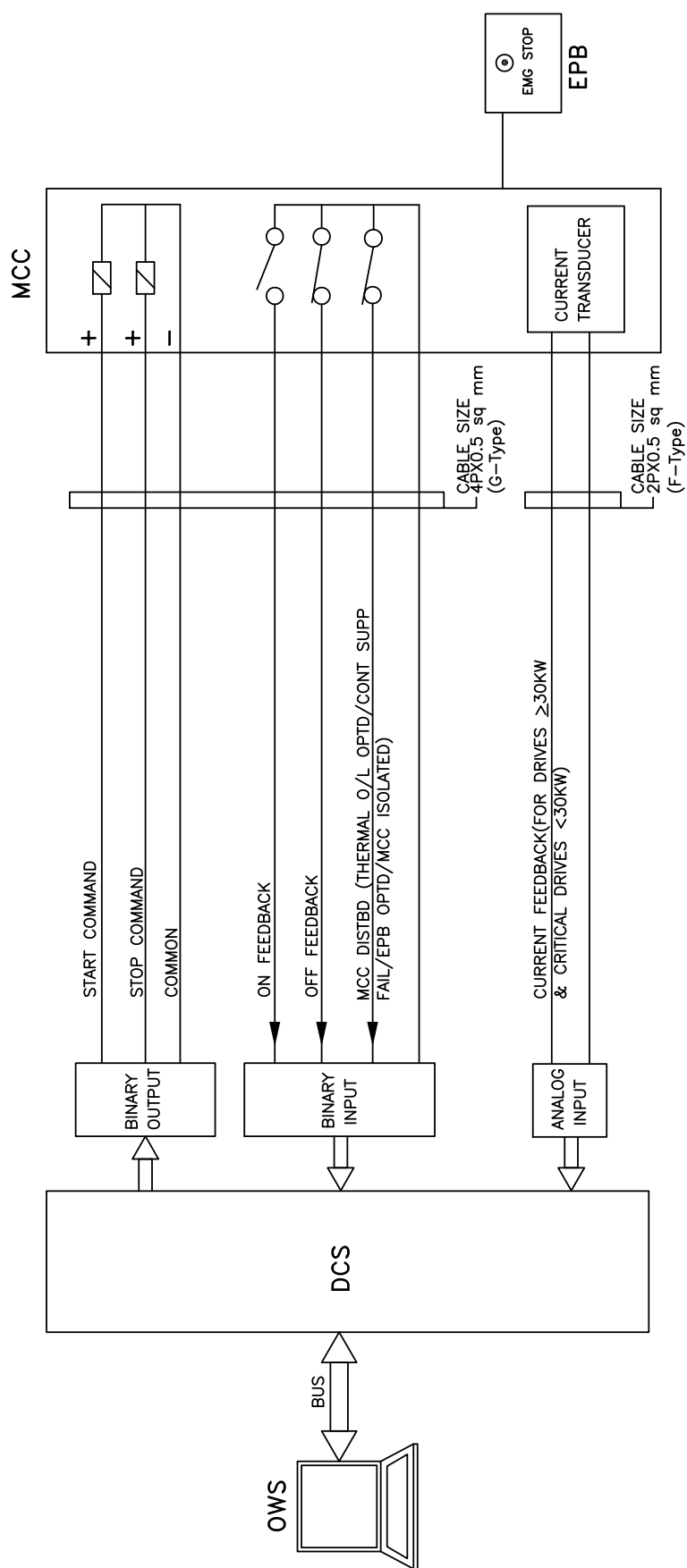





PROJECT: 4X100 MW GTPS, MARIB-II

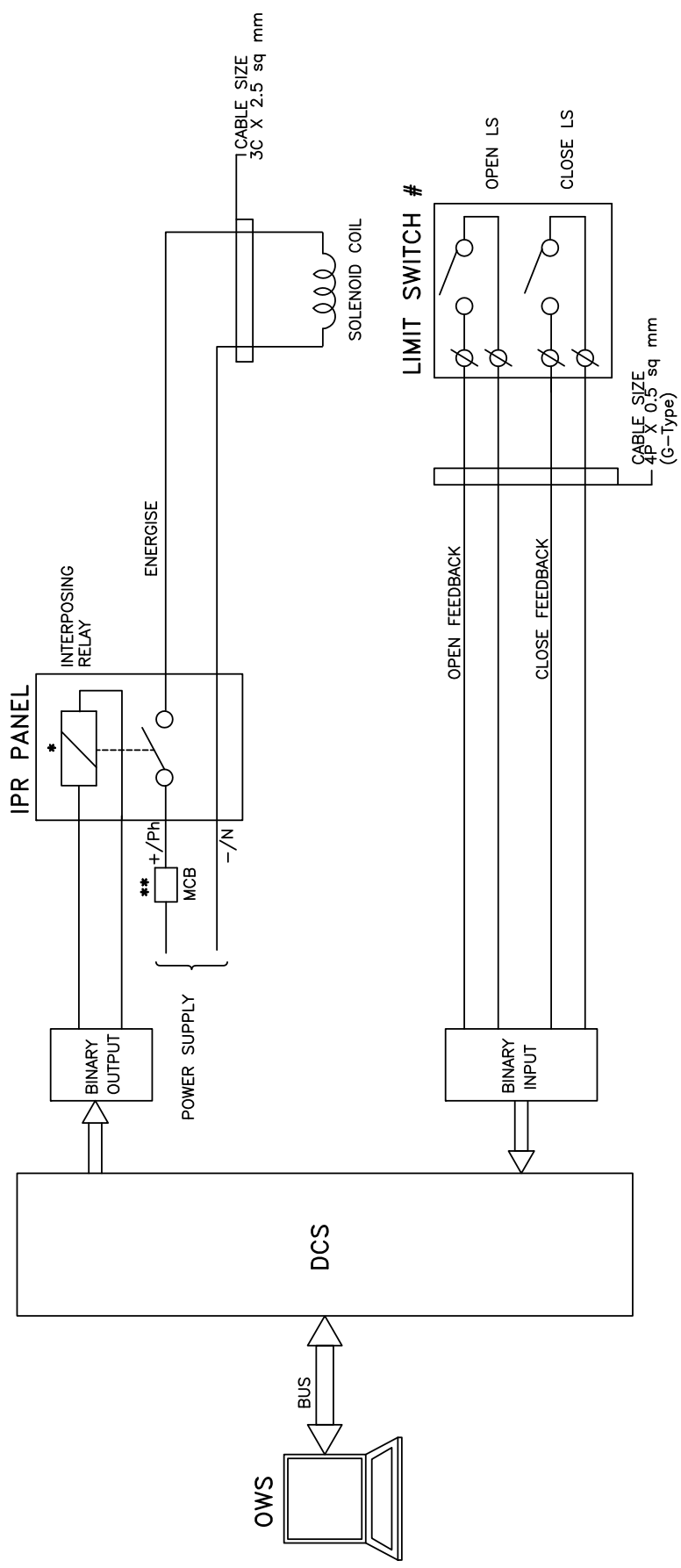
TITLE | PLC INTERFACE FOR
BIDIRECTIONAL DRIVE

DCS INTERFACE FOR UNIDIRECTIONAL LT DRIVE




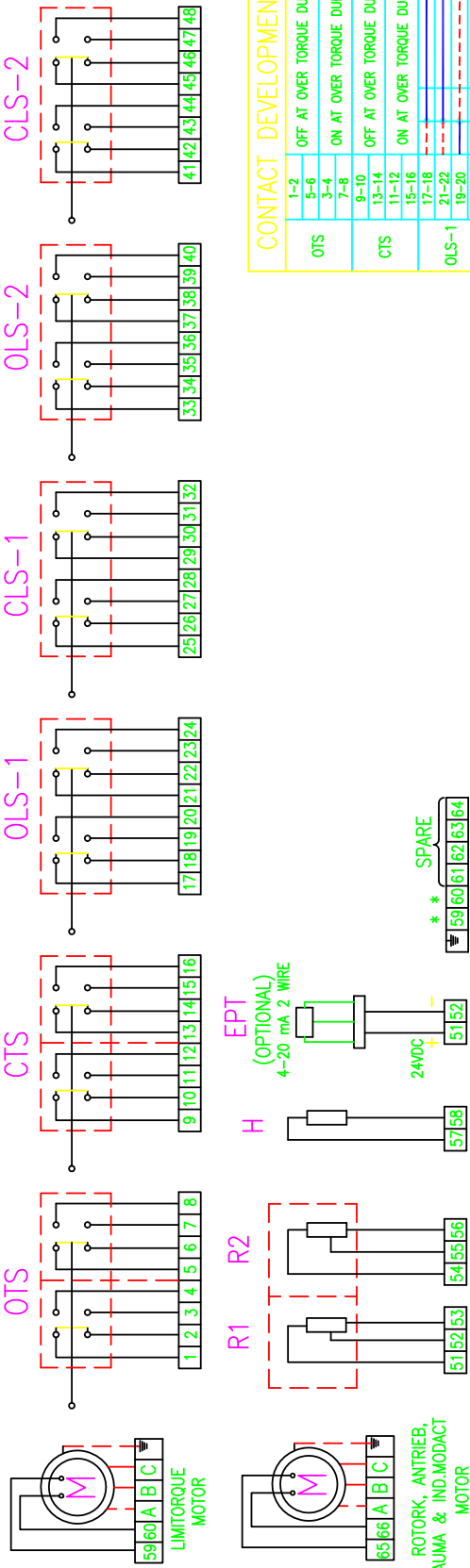
	PROJECT: 4X100 MW GTPS, MARIB-II	
	TITLE	DDCMIS INTERFACE FOR UNIDIRECTIONAL LT DRIVE

DCS INTERFACE FOR SOLENOID DRIVE (24V DC / 240V AC UPS)



- NOTES:
- * TWO INDEPENDENT OUTPUTS FROM CONTROL SYSTEM SHALL BE PROVIDED TO PUSH-PULL TYPE VALVES, WITH DUAL COIL SOLENOIDS.
 - ** MCB SHALL BE PROVIDED FOR EACH SOLENOID
 - # FOR ON/OFF TYPE, SOLENOID ACTUATED CONTROL VALVE.

	<p>PROJECT: 4X100 MW GTPS, MARIB-II</p>
<p>TITLE</p>	<p>DDCMIS INTERFACE FOR SOLENOID DRIVE</p>



* - SPARE FOR ROTORK, AUMA, ANTRIEB & IND.MODACT SWITCHES - ALL ARE POTENTIAL FREE AND TWO PAIR OF CONTACTS CAN BE USED FOR DIFFERENT SUPPLY THERMOSTAT - 65-66 (ROTORK, AUMA, ANTRIEB & IND.MODACT), 59-60 (LIMITORQUE).
 EPT - ELECTRONIC POSITION TRANSMITTER (POTENTIOMETRIC TYPE, FOR INCHING DUTY)
 THERMOSTAT TERMINALS - TERMINATED IN MOTOR TB IN ANTRIEB & IND.MODACT AND IN MAIN TB IN OTHER MAKES
 CTS - TORQUE SWITCHES FOR CW ROTATION (CLOSE) - 2 NO+2 NC
 OTS - TORQUE SWITCHES FOR CCW ROTATION (OPEN) - 2 NO+2 NC
 OLS-1, OLS-2 - LIMITSWITCHES FOR POSITION OPEN - 2 NO+2 NC
 CLS-1, CLS-2 - LIMITSWITCHES FOR POSITION CLOSE - 2 NO+2 NC
 OTS, CTS - TWO INDEPENDENT SWITCHES IN ANTRIEB & LIMITORQUE
 OLS-2 & CLS-2 - CAM DISC IN ROTORK & ANTRIEB
 R1-R2- POTENTIOMETER 2 x 100 OHMS
 H - SPACE HEATER 1ø 240V AC SUPPLY
 M - MOTOR 3ø 415V 50 Hz AC SUPPLY

CONTACT DEVELOPMENT DIAGRAM									
OTS	1-2	OFF AT OVER TORQUE DURING OPENING TRAVEL	CTS	13-14	OFF AT OVER TORQUE DURING CLOSING TRAVEL	OLS-1	21-22	CLS-1	25-26
	5-6	ON AT OVER TORQUE DURING OPENING TRAVEL		15-16	ON AT OVER TORQUE DURING CLOSING TRAVEL		23-24		27-28
	3-4	ON AT OVER TORQUE DURING OPENING TRAVEL		11-12	ON AT OVER TORQUE DURING CLOSING TRAVEL		19-20		31-32
	7-8	ON AT OVER TORQUE DURING OPENING TRAVEL		9-10	ON AT OVER TORQUE DURING CLOSING TRAVEL		23-24		33-34
CLS-2	41-42	OFF AT OVER TORQUE DURING OPENING TRAVEL	CLS-1	25-26	OFF AT OVER TORQUE DURING CLOSING TRAVEL	OLS-2	35-36	CLS-2	37-38
	43-44	ON AT OVER TORQUE DURING OPENING TRAVEL		27-28	ON AT OVER TORQUE DURING CLOSING TRAVEL		39-40		41-42
	45-46	ON AT OVER TORQUE DURING OPENING TRAVEL		29-30	ON AT OVER TORQUE DURING CLOSING TRAVEL		43-44		45-46
	47-48	ON AT OVER TORQUE DURING OPENING TRAVEL		31-32	ON AT OVER TORQUE DURING CLOSING TRAVEL		47-48		49-50
CLS-1	25-26	OFF AT OVER TORQUE DURING OPENING TRAVEL	CLS-2	33-34	OFF AT OVER TORQUE DURING CLOSING TRAVEL	CLS-1	41-42	CLS-2	43-44
	27-28	ON AT OVER TORQUE DURING OPENING TRAVEL		35-36	ON AT OVER TORQUE DURING CLOSING TRAVEL		43-44		45-46
	29-30	ON AT OVER TORQUE DURING OPENING TRAVEL		41-42	ON AT OVER TORQUE DURING CLOSING TRAVEL		45-46		47-48
	31-32	ON AT OVER TORQUE DURING OPENING TRAVEL		43-44	ON AT OVER TORQUE DURING CLOSING TRAVEL		47-48		49-50
CLS-2	33-34	OFF AT OVER TORQUE DURING OPENING TRAVEL	CLS-1	35-36	OFF AT OVER TORQUE DURING CLOSING TRAVEL	CLS-2	41-42	CLS-1	43-44
	35-36	ON AT OVER TORQUE DURING OPENING TRAVEL		37-38	ON AT OVER TORQUE DURING CLOSING TRAVEL		43-44		45-46
	37-38	ON AT OVER TORQUE DURING OPENING TRAVEL		39-40	ON AT OVER TORQUE DURING CLOSING TRAVEL		45-46		47-48
	39-40	ON AT OVER TORQUE DURING OPENING TRAVEL		41-42	ON AT OVER TORQUE DURING CLOSING TRAVEL		47-48		49-50
CLS-1	41-42	OFF AT OVER TORQUE DURING OPENING TRAVEL	CLS-2	43-44	OFF AT OVER TORQUE DURING CLOSING TRAVEL	CLS-1	45-46	CLS-2	47-48
	43-44	ON AT OVER TORQUE DURING OPENING TRAVEL		45-46	ON AT OVER TORQUE DURING CLOSING TRAVEL		47-48		49-50
	45-46	ON AT OVER TORQUE DURING OPENING TRAVEL		49-50	ON AT OVER TORQUE DURING CLOSING TRAVEL		49-50		51-52
	47-48	ON AT OVER TORQUE DURING OPENING TRAVEL		51-52	ON AT OVER TORQUE DURING CLOSING TRAVEL		51-52		53-54
CLS-2	49-50	OFF AT OVER TORQUE DURING OPENING TRAVEL	CLS-1	53-54	OFF AT OVER TORQUE DURING CLOSING TRAVEL	CLS-2	55-56	CLS-1	57-58
	51-52	ON AT OVER TORQUE DURING OPENING TRAVEL		55-56	ON AT OVER TORQUE DURING CLOSING TRAVEL		57-58		59-60
	53-54	ON AT OVER TORQUE DURING OPENING TRAVEL		57-58	ON AT OVER TORQUE DURING CLOSING TRAVEL		59-60		61-62
	55-56	ON AT OVER TORQUE DURING OPENING TRAVEL		59-60	ON AT OVER TORQUE DURING CLOSING TRAVEL		61-62		63-64
CLS-1	57-58	OFF AT OVER TORQUE DURING OPENING TRAVEL	CLS-2	61-62	OFF AT OVER TORQUE DURING CLOSING TRAVEL	CLS-1	63-64	CLS-2	65-66
	59-60	ON AT OVER TORQUE DURING OPENING TRAVEL		63-64	ON AT OVER TORQUE DURING CLOSING TRAVEL		65-66		67-68
	61-62	ON AT OVER TORQUE DURING OPENING TRAVEL		65-66	ON AT OVER TORQUE DURING CLOSING TRAVEL		67-68		69-70
	63-64	ON AT OVER TORQUE DURING OPENING TRAVEL		67-68	ON AT OVER TORQUE DURING CLOSING TRAVEL		69-70		71-72

⊙ - CLS NOT TO BE CONNECTED IN TRIP CIRCUIT
 NOTE:
 1. BYPASS OTS FOR INITIAL 5% OF TRAVEL (FOR GATE VALVES ONLY)
 2. CONNECT THERMOSTAT WITHOUT FAIL IN THE STARTER CIRCUIT

CONTACT RATING: 5A AT 250V AC & 0.5A AT 220V DC

		BHARAT HEAVY ELECTRICALS LTD. UNIT: HIGH PRESSURE BOILER PLANT. TIRUCHIRAPPALLI 620014.		365-139		TITLE INTERNAL WIRING DIAGRAM FOR ELECTRICAL VALVE ACTUATORS (AC) (DRAWN FOR INTERMEDIATE POSITION OF VALVES)		DRAWING No. 4-V-MISC-90271		REV 11
						DRAWN	N.P.ESWAR			
						CHECKED	KARUNACHALAM			
						APPROVED	PLOGANATHAN			
11	09.09.2000					DATE	09.09.2000	CONTACT DEV. FIG.AJDED.	DESCRIPTION	APPD
REV DATE	CHD	APPD	DESCRIPTION							



DOCUMENT TITLE

KKS NUMBERING PHILOSOPHY

4X100MW GTPS, MARIB PHASE-II

KKS NUMBERING PHILOSOPHY

For identifying (tagging) an instrument / equipment in Power plant KKS numbering scheme is used. The purpose is to assign a unique number to every equipment in the power plant. For C&I equipment unique number are to be provided up to the signal level so that a unique number Input / Output exist in DCS for every signal.

Normally KKS number is a 10 digit alpha-numeric code and is typically split into the following:

X	X	X	A	A	Y	Y	B	B	B
---	---	---	---	---	---	---	---	---	---

First three digits indicate the Sub-System. The Code for the major system are given as per **Annexure-1**.

Fourth and Fifth digits are the **Numerical Keys at System Code Level** and used to distinguish between main systems having same Alpha Codes.

Sixth and Seventh digits are the **Equipment / Apparatus / Measuring Circuit Code**. The code of various Equipment / Apparatus / Measuring Circuit is shown in **Annexure-2**

Eight, Nine and tenth digits are the **Numerical Keys at Equipment / Apparatus / Measuring Circuit Code** and used to distinguish between various instruments in the same sub-group. Numerical keys at System / Equipment / Apparatus / Measuring Circuit is shown in **Annexure-3**.

**ANNEXURE-1****List of System / Sub-System Codes used in Power Plant:**

- 1) Compressed air system : QEA, QEC
- 2) Ventilation System : SAA TO SAZ
- 3) Fire Detection & Protection System + Fire Water pumps : SGM, SGN, SGO, SGP
- 4) Sewage Treatment : SJA TO SJZ
- 5) Pre-treatment Plant : GBI, GBM, GBV
- 6) RO DM Plant : GCI, GCM, GBV

ANNEXURE-2**Standard Equipment Codes:**

AA	Valves including drives, also hand operated
AB	Seclusions, Lock, Gates, Doors
AC	Heat Exchanger
AE	Turning, Driving, Lifting equipment
AF	Continuous conveyors, Feeders
AG	Generator Units
AH	Heating and Cooling Units
AK	Pressing and Packaging equipment
AM	Mixer, Stirrer
AN	Blower, Air Pumps / Fans, Compressor Units
AP	Pump Units
AT	Purification, Drying, Filter
AV	Combustion Equipment e.g. grates

Standard Apparatus Codes:

BB	Vessels and Tank
BF	Foundation
BG	Boiler Heating Surfaces
BN	Injector, Ejector
BP	Flow and throughput limitation equipment (Orifice)
BQ	Holder, Carrying Equipment, Support
BR	Piping, Ducts, Chutes, Compensator
BS	Sound Absorber
BU	Insulations, Sheatings



Standard Measuring Circuits Codes:

CD	Density
CE	Electrical Quantities
CF	Flow, throughput
CG	Distance, Length, Position
CK	Time
CL	Level
CM	Humidity
CQ	Analysis (SWAS)
CS	Speed, Velocity, Frequency
CT	Temperature
CY	Vibration, Expansion

ANNEXURE-3

Numerical Keys

A) Numerical Keys at System Code Level

- i) Use 10, 20, 30, To distinguish between main systems having same Alpha Codes. Examples:
 - a) Main Steam (Left) and Main Steam (Right)
 - b) BFP – A/B/C
 - c) ID Fan – A/B, FD Fan A/B, AH – A/B
- ii) For branch off from main system path having code say 10, keep the same alpha code and use 11, 12, 13 etc. Similarly for other branch off from main system path having code say 20, keep the same alpha code and use 21, 22, 23 etc and shall carry on further in the same way.
- iii) If the branch off from main system / sub system path is used for some other system, where different alpha codes can be applied, then in that case the said branch line will be designated by the alpha codes of the system to which it is providing the input.


B) Numerical keys at Equipment Code level:

There are three numerical keys available for each type of equipment code. Following has been agreed upon considering present practice, better flexibility and ease in sorting.

- i) Valves and Dampers --- *Equipment Code – AA*

N1

N2 N3

DOCUMENT TITLE			
	KKS NUMBERING PHILOSOPHY		
	4X100MW GTPS, MARIB PHASE-II		
Motorised (<i>on/off duty</i>)	-	0	01 to 50
Motorised (<i>inching duty</i>)	-	0	51 to 99
Pneumatic (Control)	-	1	01 to 50
Motorised (<i>thyrestor Control</i>)	-	1	51 to 99
Sol. Operated	-	2	01 to 99
(Open / Close duty (Valves, NRVs, Gate)			
Hydraulic	-	3	01 to 99
NRV (Without actuation)	-	4	01 to 99
Manual	-	5	01 to 99
Manual	-	6	01 to 99
Relief & Safety Valves	-	7	01 to 99
Reserve	-	8	01 to 99
Reserve	-	9	01 to 99
ii) Field Instruments			
Field Transmitters & Analog Signals	-	0	01 to 99
Field Switches & Binary Signals	-	1	00 to 99
PG Test Point	-	4	00 to 99
Gauges	-	5	00 to 99
Automatic Turbine Tester (ATT)-HWR	-	2	00 to 99
(Reserved for protection Signals used by Hardwar)			
Example of Numerical Key Usage:			
In line with the philosophy adopted for Valves / Dampers /instruments etc. pumps and fans in the main systems (having different system code) can be numbered as AP/N100 and as AP/N101, 102, Where system code is same.			



TITLE

COMPRESSED AIR SYSTEM
MARIB GTPS 400 MW

SPECIFICATION NO. PE-TS-372-555-A001

VOLUME

SECTION

REV 00

DATE 20/07/2012

SHEET

SECTION-C5

PAINTING SPECIFICATION

PROJECT	SUBJECT	TENDER DOC. NO.	REV	SECTION
REPUBLIC OF YEMEN PEC – ME 400 MW MARIB GTPS – II	TENDER DOCUMENT FOR ENGINEERING, PROCUREMENT & CONSTRUCTION (EPC)	7195-GE-SPC-700-001	C	7.6
				SHEET NO.
				1

(PEC TENDER NO.: 12/2008)

VOLUME IV
SECTION 7.6
CLEANING, PROTECTIVE COATING AND PAINTING

PROJECT	SUBJECT	TENDER DOC. NO.	REV	SECTION
REPUBLIC OF YEMEN	TENDER DOCUMENT FOR			7.6
PEC – ME	ENGINEERING, PROCUREMENT &	7195-GE-SPC-700-001	C	SHEET NO.
400 MW MARIB GTPS – II	CONSTRUCTION (EPC)			2

(PEC TENDER NO.: 12/2008)

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7.6.0 CLEANING, PROTECTIVE COATING AND PAINTING

7.6.1 General

This specification covers the general requirements related to the cleaning protective coating and painting of equipment, components and system. The components and/or equipment shall be mechanically and /or chemically cleaned during the following stages of the Contract.

- Cleaning in workshop
- Cleaning before painting and/or corrosion protection (application of prime coat)
- Cleaning before erection and during installation.

Cleaning of fabricated component items shall be carried out after fabrication and final heat treatment or welding at manufacturer's works or at site, as appropriate.

For cleaning in workshop and before painting mechanical cleaning as opposed to alternative chemical cleaning is the preferred method for works cleaning except where this is precluded by design or access considerations.

Machined surfaces shall be protected during the cleaning operations.

In the event of the surfaces not being cleaned to the purchaser's satisfaction, such parts of the cleaning procedures or agreed alternatives as are deemed necessary to overcome the deficiencies shall be carried out at the supplier's sole expense.

For reclining small areas, hand cleaning by wire brushing may be permitted. Wire brushes used on austenitic steel bristles.

Austenitic stainless steels, copper and aluminium alloys, cast iron, bimetallic and metallic/plastic items, and components fabricated by spot welding or riveting shall not be chemically cleaned. All weld areas shall be suitably stress relieved before chemical cleaning.

Codes and Standards

Internationally recognized codes and standards with purchasers approval shall be followed for the work covered by this contract.

Surface Preparation Standards

The following standards shall be followed for surface preparations:

- Swedish standard Institution - SIS-05 5900-1967 (Surface preparation standards for painting steel surfaces).
- Steel structures painting council, U.S.A. (Surface Preparation Specifications (SSPC-SP).
- British Standards Institution (Surface Finish of Blast cleaned steel for painting) BS-4232.
- National Association of Corrosion Engineers, U.S.A. (NACE).
- Various international standards equivalent to Swedish standard for surface preparation are given in Table-1.

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The contractor shall arrange, at his own cost, to keep a set of latest edition of the above standards and codes at site.

The paint manufacturer's instruction shall be followed as far as practicable at all times. Particular attention shall be paid to the following:

- a) Proper storage to avoid exposure as well as extremes of temperature.
- b) Surface preparation prior to painting.
- c) Mixing and thinning
- d) Application of paints and the recommended limit on time intervals between coats.
- e) Shelf life for storage.

Any painting work (including surface preparation) on piping or equipment shall be commenced only after the system tests have been completed and clearance for taking up painting work is given by the Engineer, who may, however, at his discretion authorise in writing, the taking up of surface preparation or painting work in any specific location, even prior to completion of system test.

Equipment

All tools, brushes, rollers, spray guns, blast material, hand power tools for cleaning and all equipment, scaffolding materials, shot/sand blasting equipment & air compressors etc. shall be arranged by the contractor at the site in sufficient quantity at his own cost. He shall arrange at his own cost, for suitable paint thickness measuring instrument like Elkometers acceptable to the Engineer (with calibration facilities).

Mechanical mixing shall be used for paint mixing operations in case of two pack systems except that the Engineer may allow the hand mixing of small quantities at his discretion.

7.6.2 Mechanical Cleaning at Manufacturer's Works

Mechanical cleaning shall preferably be carried out by abrasive blasting. The Owner is prepared to consider alternative methods provided they achieve the necessary surface condition.

Surface condition:

The Metal surfaces shall be clean and free of mill scale, rust, dirt, grease and any other deleterious matter.

Where metal surfaces are to be painted the surface profiles shall conform with the painting specification requirements.

Where this does not apply surfaces shall have a surface texture not coarser than Grade 80 abrasive paper.

Abrasives:

Abrasives containing silica, silicates or slag residues shall not be used for water/steam side surfaces of plant except for cleaning sand castings, where hydro blasting with sand may be used.

For austenitic materials only, abrasives containing 98% or more of alumina, Al_2O_3 , shall be used.

Removal of abrasive and debris:

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After cleaning, abrasive and debris shall be thoroughly removed from components.

7.6.3 Alternative Chemical Cleaning at Manufacturer's Works

The procedure shall comprise:

Pre-treatment
Acid treatment

To achieve cleanliness equivalent to that specified for mechanical cleaning. The procedure to be adopted must meet with the purchaser's approval.

7.6.4 Protection at Manufacturer's Works

As soon as all items have been cleaned and within four hours of the subsequent drying, they shall be given suitable anti-corrosion protection.

All water, air and steam side surfaces shall be protected by the application of approved water soluble corrosion inhibitors, or vapour phase inhibitors that can be subsequently removed by site water washing or steam blowing.

The rate of application of volatile corrosion inhibitors shall be at least 10 grams per square metre or 35 grams per cubic metre, whichever is the greater, except for pipes up to 300 mm diameter for which the minimum application rates shall be 5 grams per square metre.

Immediately after the protective treatment has been applied all vessels and pipes shall be suitably sealed off by discs or caps or approved alternatives to prevent ingress from the surrounds. Cylindrical plugs shall not be driven into the ends of pipes. These protective covers shall not be removed until immediately before final connection is made to the associated equipment.

7.6.5 Weather Conditions

Painting shall be done only when the surface temperature is above 5°C. surface temperature must be at least 3°C above dewpoint to ensure that condensation does not occur on the surface.

Reasonable protection against precipitation, corrosive fumes and vapours shall be exercised for the painting of outdoor parts.

Precautions shall also be taken against solar radiation to ensure that the specified dry film thickness of priming or finish coats is obtained.

Any prime coat exposed to excess humidity, rain, dust etc., before drying, shall be permitted to dry and the damaged area of primer shall be removed and the surface prepared and primed again.

Sheltered or unventilated horizontal surfaces on which dew may collect require more protection, and to achieve this an additional top coat of paint shall be applied.

7.6.6 Surface Preparation

In preparing any surface to be coated, all loose paint, dirt, grease, rust, scale, weld slag or spatter or any other extraneous material shall be removed and defects repaired, so as to obtain a clean, dry, even surface to receive the priming or finishing coat (s) as called for in the

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painting schedules. Sharp edges should be rounded, especially when tank linings have to be applied.

All machined surfaces, including flange faces, shall be suitably covered to prevent damage during surface preparation.

All surfaces should be blast cleaned whenever possible.

Surface preparation methods

Bare steel surfaces should be prepared by one of the methods described below in order of preference and in accordance with Swedish Standard SIS 05 59 00 or Steel Structures Painting Council, SSPC, Vis 1, or DIN 55928, section 4.

(a) White metal blast cleaning: Sa 3 or SSPC - SP 5

Sa 3 Blast cleaning to bare metal. Mill scale, rust and foreign matter must be removed completely. Subsequently, the surface is cleaned with vacuum cleaner, clean dry compressed air or a clean brush. It must then have a uniform metallic colour and correspond in appearance to the prints designated Sa 3.

(b) Near white metal blast cleaning Sa 2 1/2 or SSPC - SP 10

Sa 2 1/2. Very thorough blast cleaning. Mill scale, rust and foreign matter shall be removed to the extent that the only traces remaining are slight imperfections in the form of spots or stripes. Subsequently, the surface is cleaned with a vacuum cleaner, clean dry compressed air or a clean brush. It must then correspond in appearance to the prints designated sa 2 1/2.

Mechanical cleaning should only be used when procedures (a) and (b) are not practicable.

(c) Commercial Blast Cleaning Sa 2

Sa 2 Blast cleaning until atleast two-thirds of each element of surface area is free of all visible residues. This method of Blasing is suitable for steel required to be painted with conventional paints for exposure to mildly corrosive atmosphere for longer life of the paint systems.

(d) Near white metal blast cleaning P Sa 2 1/2 DIN 55928

Very thorough blast cleaning. Very adhesive coatings remain. From all other surface mill scale and rust are to be removed to such an extent that the only traces remaining are slight imperfections in the form of spots or stripes. Further treatment see Sub b).

The adhesivity of residual coatings in the transition zone has to be tested even after the application of the primer.

(e) very thorough mechanical scraping and wire burshing St 3

St 3 very thorough scraping and wire-burshing - machine brushing - grinding - etc. are to be preferred. Surface preparation as for st 2. But much more thoroughly. After the removal of dust, the surface must have a pronounced metallic sheen and correspond to the prints designated St. 3.

(f) Thorough scraping and wire brushing: St 2

St 2 Thorough scraping and wire-brushing - machine brushing - grinding - etc. The treatment shall remove loose mill scale, rust and foreign matter. Subsequently, the surface is cleaned

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with a vacuum cleaner, clean dry compressed air or a clean brush. It should then have a faint metallic sheen. The appearance must correspond to the prints designated St 2.

Table-1 (Surface Preparation Standards)

Surface preparation method	SIS 055900	DIN 55928, Part 4	BS 4232 only for blasting	SSPC-Vis
blasting acc.to item (a)	Sa 3	first quality	white metal	SP 5
blasting acc. to item (b)	Sa 2 1/2	second quality	near white	SP 10
blasting acc.to item (c)	Sa 2	Third quality	Commercial Blast	SP 6
derusting acc to item (f)	St 2	—	Hand tool/ power tool Cleaning	SP 2
acc. to items (e)	St 3	—	Power tool Cleaning	SP 3
Flame jet cleaning	F1	—	Flame cleaning	SP 4
Pickling	Be	—	Pickling	

Steel structures to be blast cleaned have to be free of pitting and other severely corroded places in accordance with B.S. 4232 and SIS 055900.

The abrasives used for blast-cleaning shall be graded flint, grit, shot or silica sand and shall be such that they will produce an average keying profile on the blast-cleaned surface of not more than 40 microns.

An air pressure of 7 bar g at the nozzle shall be used.

After blast-cleaning, all accumulated grit, sand, dust, etc., must be removed leaving the surface clean, dry and free of mill scale, rust grease and other foreign matter.

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In the event of rusting after completion of the surface preparation, the surface must be cleaned again in the manner specified.

Oil, grease, soil, cement, salts, acids or other corrosive chemicals shall be cleaned from steel surfaces, by the use of solvents, emulsions or cleaning compounds. The final wiping shall be with clean solvent and clean rags or brushes. There shall be no detrimental residue left on the surface.

Primed areas which suffer damage must be spot blasted on site to a degree of cleanliness P Sa 2 1/2 before touching up.

Protective coating must be applied as quickly as possible after the completion of surface preparation no matter what cleaning method has been used.

No blast-cleaned surface shall be allowed to remain uncoated overnight.

Steel work protected by shop primer after arrival on site must be cleaned of salt, sand, oil etc. before the first coat of paint is applied on site. Shop primer damaged during transport must be rectified by blast-cleaning and coating before application of the site coats.

Wood surfaces shall be sanded clean. All nail holes shall be puttied and sanded before priming.

Concrete: If a protective coating is required, concrete shall be allowed to cure before painting.

7.6.7 Rub Down and Touch up of Primer

The shop coated surfaces shall be rubbed down thoroughly with emery paper to remove all dust, rust and other foreign matters, washed, degreased, then cleaned with warm fresh water and air dried. The portions, from where the shop coat has peeled off, shall be touched up and allowed to dry before applying a coat of primer. The compatibility between shop coat and field primer should be ascertained from the paint manufacturer. In case degreasing with white spirit is not effective, the surface should be finally wiped clean with aromatic solvent like xylol or light naphtha.

7.6.8 Non Compatible Shop Coat Primer

The compatibility of finishing coat should be confirmed from the paint manufacturer. In the event of use of primer such as zinc rich epoxy, inorganic zinc silicate etc., the paint system shall depend on condition of shop coat. If the shop coat is in satisfactory condition showing no major defect, the shop coat shall not be removed. The touch up primer and finishing coat(s) shall be identified for application by Engineer.

Shop coated (coated with primer & finishing coat) equipment shall not be repainted unless paint is damaged.

Shop primed equipment and surfaces shall only be 'spot cleaned' in damaged areas by means of power tool brush cleaning or hand tool cleaning and then spot primed before applying one coat of field primer unless otherwise specified. If shop primer is not compatible with field primer then shop coated primer shall be completely removed before application of selected paint system for particular environment.

For package units/equipment, shop primer shall be as per the paint system given for particular environment.

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In case of existing paint, compatibility between finishing coat and new selected finish coat shall be ascertained before application of finish coat. In case the coat is selected for upgrading existing alkyd coating to high performance coating, then surface preparation can be by manual/mechanical means to remove loose rust, peeled off/damaged paint, but sound old coating need not be removed. It should be touched with red oxide zinc chromate primer wherever it has peeled off before application of tie coat. The tie coat shall be applied after 7 days of curing of red oxide zinc chromate primer. If new paint system is not suitable to upgrade existing coating then complete paint shall be removed by mechanical or blast cleaning before application of new coating system.

7.6.9 Paint Materials

Plant and equipment shall be painted according to the colour scheme followed in Phase-I

7.6.10 Storage

All paints and painting material shall be stored only in rooms to be provided by the contractor and approved by Engineer for the purpose. All necessary precautions shall be taken to prevent fire. The storage building shall preferably be separated from adjacent buildings. A signboard bearing the words "PAINT STORAGE - NO NAKED LIGHT - HIGHLY INFLAMMABLE - DANGER - NO SMOKING" shall be clearly displayed outside. All paints should be stored in the safest manner so that no container rolls down and causes accidents. The shelf life of the paints should be ensured so that the paint materials are not in storage and use after the date of expiry.

7.6.11 Preparation of Coating Materials

All container shall remain un-opened until required for use.

Primers and paints which have livered, gelled or otherwise deteriorated shall not be used.

The oldest primer or paint of each kind shall be used first.

All ingredients in any container shall be thoroughly mixed before use, and shall be agitated frequently during application to keep the primer in suspension.

Primer or paint mixed in the original container shall not be transferred until all settled pigment is incorporated into the body of the liquid.

Mixing in open containers shall be done in a well ventilated area.

Primer or paint shall be mixed in a manner ensuring the breakdown of all lumps, complete dispersion of pigment and uniform composition.

Two-component primers shall be mixed in accordance with the manufacturer's instructions.

Thinners shall not be added to primers or paints unless necessary for proper application according to the manufacturer's instructions.

When use of thinners is permitted, it must be added to the primer or paint during mixing.

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7.6.12 Application

Health and safety of work

The supplier has to check all painting work to be carried out according to the specification of the paint supplier further to all relevant prescriptions and regulations concerning the health and safety of work.

The paint supplier has to present a written specification including at least the flash point of the paints, ventilation requirements, handling precautions such as inhalation, eye and skin protection, and first aid procedure, storage requirements, spill or leak procedure, fire precaution, waste disposal.

7.6.13 Safety Requirements

Protection of the blast cleaner operator's eyes and respiratory system should be given prime consideration in any open blast cleaning operation. Airfed helmets, respiratory filters, air conditioned hoods etc. should be provided in sufficient number to the blast cleaning operators to avoid the harmful effect of blast cleaning abrasives. Also, an automatic shut-off device which will shut-off the air supply to the blasting machine should be installed which will prevent the dangerous whipping of an operating blast hose if an operator becomes disabled.

Methods

Temporary corrosion protections are to be completely removed prior to applying the definite one.

All prime coatings shall be applied by brush or airless spray or a combination of these methods, as approved by the coating manufacturer.

All doors, windows, stairways, handrails (if painted), bolts, flanges and equipment supports shall be finish painted by brush.

Spray guns should not be used outside in windy weather or near surfaces of a contrasting colour unless the latter is properly protected.

All cold-spray painting shall be done using standard equipment in accordance with accepted standards and methods.

Care has to be taken not to connect spraying devices for nitro and backelite paints simultaneously to oil based paints.

Paint applied to items that are not be painted shall be removed at the supplier's expense, leaving the surface clean, unstained and undamaged.

7.6.14 Dry Film Thickness (DFT)

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To the maximum extent practicable the coats shall be applied as a continuous film of uniform thickness and free of pores. Overspray, skips, runs, sags and drips should be avoided. The different coats shall not be of the same colour.

Each coat of paint shall be allowed to harden before the next is applied. For epoxy paint the hardening time normally is 12-14 hours. Suppliers' recommendations regarding hardening time of epoxy paints must be followed.

Particular attention must be paid to full film thickness at edges.

The minimum total dry film thickness of the paint systems shall be as recommended in the following table. The dft is given in microns (millionths of a metre).

7.6.15 Protective Coatings and Paint Systems

The type and number of protective coats for any item requiring painting are to be in accordance in the attached tables "Paint Systems" (Annex-1).

Alternative to the 'paint system' specified, are to be presented on the schedule Departure from Specification, as indicated elsewhere.

Generally, all parts shall receive the specified prime coat (s) at the supplier's works to ensure that no corrosion occurs during transport to the site and storage at the site.

Parts which cannot be damaged during transport shall receive the full number of coats.

7.6.16 Colour Code for Piping

The colour code scheme is intended for identification of the individual group of the pipeline. The system of colour coding consists of a ground colour and colour bands superimposed on it. The colour coding for the identification of pipelines should comply with the requirements of Phase-I.

Ground Colour shall be applied throughout the entire length for uninsulated pipes. For insulated pipes, on the metal cladding or on the pipes of material such as non-ferrous metals, austenitic stainless steel etc. Ground colour coating of minimum 2m length or of adequate length not to be mistaken as colour band shall be applied at places requiring colour bands. Colour band(s) shall be applied at the following location.

- At battery limit points
- Intersection points & change of direction points in piping ways.
- Other points, such as midway of each piping way, near valves, junction joints of service appliances, walls, on either side of pipe culverts.
- For long stretch/yard piping at 50 M interval.
- At start and terminating points.

Identification Sign

Flow direction shall be indicated by an arrow in the location stated in Para a,b,c & d and as directed by Engineer.

Colours of arrows shall be black or white and in contrast to the colour on which they are superimposed. The size of the arrows shall confirm to relevant standards.

Product names shall be marked at pump inlet, outlet and battery limit in a suitable size as approved by Engineer.

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Colour Bands

The width of colour band shall conform to the requirements of Phase-I

Whenever it is required by the Engineer to indicate that a pipeline carries a hazardous material, a hazard marking of diagonal stripes shall be made as per the requirements of Phase-I

7.6.17 Identification of Vessels, Piping etc.

Equipment number shall be stenciled in black or white on each vessel, column, equipment & machinery (insulated or uninsulated) after painting. Line number in black or white shall be stenciled on all the pipe lines of more than one location as directed by Engineer, size of letters printed shall be as per applicable codes & standards

Identification of storage tanks: The storage tanks shall be marked as detailed in the respective drawing.

7.6.18 Inspection and Testing

All painting materials including primers and thinners brought to site by the contractor for application shall be procured directly from manufacturer as per specifications and shall be accompanied by manufacturer's test certificates. Paint formulations without certificates are not acceptable.

Engineer at his discretion, may call for tests for paint formulations. Contractor shall arrange to have such tests performed including batchwise test of wet paints for physical & chemical analysis. All costs thereof shall be borne by the contractor.

The paints shall be tested as per applicable codes & standards approved by the Owner.

The painting work shall be subject to inspection by Engineer at all times. In particular, following stagewise inspection shall be performed and contractor shall offer the work for inspection and approval of every stage before proceeding with the next stage. The record of inspection shall be maintained in the registers. Stages of inspection are as follows:

- a. Surface preparation
- b. Primer application
- c. Each coat of paint

In addition to above, record should include type of shop primer already applied on equipment e.g. Red oxide zinc chromate or zinc chromate or Red lead primer etc.

Any defect noticed during the various stages of inspection shall be rectified by the contractor to the entire satisfaction of Engineer before proceeding further. Irrespective of the inspection, repair and approval at intermediate stages of work, contractor shall be responsible for making good any defects found during final inspection/guarantee period/defect liability period as defined in general condition of contract. Dry film thickness (DFT) shall be checked and recorded after application of each coat and extra coat of paint should be applied to make-up the DFT specified without any extra coat to owner.

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7.6.19 Primer Application

After surface preparation, the primer should be worked by brush application to cover the crevices, corners, sharp edges etc. in the presence of inspector nominated by Engineer.

The shades of successive coats should be slightly different in colour in order to ensure application of individual coats, the thickness of each coat and complete coverage should be checked as per provision of this specification. This should be approved by Engineer before application of successive coats.

The contractor shall provide standard thickness measurement instrument with appropriate range(s) for measuring.

Elcometer for measuring the Dry film thickness of each coat, surface profile gauge for checking of surface profile in case of sand blasting, Holiday detectors and pinhole detectors for checking the painted surface discontinuities should be provided by the contractor.

At the request of Engineer, the contractor shall make arrangements for paint manufacturer to provide expert technical service at site as and when required. This service should be free of cost and without any obligation to the Purchaser, as it would be in the interest of the manufacturer to ensure that both surface preparation and application are carried out as per their recommendations.

Final inspection shall include measurement of paint dry film thickness, check of finish and workmanship. The thickness should be measured at as many points/locations as decided by the Engineer and shall be within + 10% of the dry film thickness.

7.6.20 Guarantee

The contractor shall guarantee that the chemical and physical properties of paint materials used are in accordance with the specifications contained herein/to be provided during execution of work.

The contractor shall produce test reports from the manufacturer regarding the quality of the particular batch of paint supplied. The Engineer shall have the right to test wet samples of paint at random for quality of the same. Batch test reports of the manufacturer's for each batch of paints supplied shall be made available by the contractor.

7.6.21 Scope of areas to be Painted and Painting Systems

The paint system adopted shall be suitable for Coastal and Marine environment as given in Annex - 1.

Primers and finish coats for any particular paint system shall be from same manufacturer in order to ensure compatibility.

7.6.22 Galvanizing

Galvanizing works shall conform in all respect to applicable standards and shall be performed by the hot dip process, unless otherwise specified.

It is essential that details of steel members and assemblies which are to be hot-dip galvanized should be designed in accordance with applicable standards.

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Vent-holes and drain-holes should be provided to avoid high internal pressures and air-locks during immersion, which may cause explosions, and to ensure that molten zinc is not retained in pockets during withdrawal.

Careful cleaning of welds is necessary before welded assemblies are dipped. The welds and the surrounding metal should be cleaned separately, preferably by blast-cleaning, because the usual preliminary pickling cannot be relied on to remove the welding slag.

All defects of the steel surface including cracks, surface laminations, laps and folds shall be removed in accordance with relevant applicable standards. All drilling, cutting, welding, forming and final fabrication of unit members and assemblies shall be completed, where feasible, before the structures are galvanized. The surface of the steelwork to be galvanized shall be free from paint, oil, grease and similar contaminants. The weight of zinc coating per unit area has to be noted in the manufacturing documents.

Structural steel items shall be initially grit-blasted to B.S. 4232, second quality, (Sa 21/2) or by pickling in a bath and the minimum average coating weight on steel sections 5 mm thick and over shall be 900 g/m².

On removal from the galvanizing bath, the resultant coating shall be smooth, continuous, free from gross surface imperfections such as bare spots, lumps, blisters and inclusions of flux, ash or dross.

Galvanized contact surfaces to be joined by high-tensile friction-grip bolts shall be roughened before assembly so that the required slip factor is achieved. care shall be taken to ensure that the roughening is confined to the area of the mating faces.

Bolts, nuts and washers, including general grade high-tensile friction grip bolts shall be hot dip galvanized and subsequently centrifuged. Nuts shall be tapped up to 0.4 mm oversize after galvanizing and the threads oiled to permit the nuts to be finger-turned on the bolt for the full depth of the nut. No lubricant, applied to the projecting threads of galvanized high-tensile friction-grip bolt after the bolt has been inserted through the steelwork, must be allowed to come into contact with the mating faces of the steelwork,. A local remelting of the galvanized parts to achieve the nuts to be finger turned on the bolt is to be done as per the relevant standards.

Protected slings must be used for offloading and erection. Galvanized work which is to be stored at the works or on site shall be stacked so as to provide adequate ventilation to all surfaces to avoid wet storage staining (white rust).

Small areas of the galvanized coating damaged in any way shall be restored in accordance with relevant standards.

- Cleaning the area of any weld slag rust and other impurities and by thorough wire brushing to give a metallic clean surface.
- application of suitable number of coats of zinc-rich paint containing more than 90 % w/w of zinc in dried film. The dry film thickness shall exceed at least 50 % the thickness of the desired galvanization. In case of application of a low melting point zinc alloy repair rod, the rods shall be in accordance with applicable codes, the thickness of the alloy shall be at least as of the desired galvanization.

The restored area is not to exceed 1 % of the galvanized surface.

Surface restoration of parts in contact with drinking water is not allowed and the quality of the galvanization is to be in accordance with relevant standards.

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After fixing, bolt heads, washers and nuts shall receive two coats of zinc-rich paint. Connections between galvanized surfaces and copper, copper alloy or aluminum surfaces shall be protected by suitable preferably hydrophobe tape wrappings to the owner's approval.

7.6.23 Sprayed Metal Coatings

Corrosion protection may be also achieved by spraying of suitable metals as zinc and/or aluminium on the surfaces of structures. For special cases tin, copper, lead can be used as well. Methods of surface preparation have to conform to relevant applicable standards. A proper treatment of the surface followed by an immediate spraying is to apply to ensure adhesion of the sprayed metal. The surface has to be clean, free of impurities, rust, millscale and rough enough to have binding properties to ensure good enticulation with the sprayed layer. Suitable roughness can be achieved by blast cleaning acc. to BS 4232. Welds are to be cleaned and prepared with special care. All surfaces to be treated have to be dry and accessible.

Application of coatings, requirements for thickness, adhesion, composition of coating metals, and subsequent treatment have to conform to relevant standards.

Testing of the spray coated layer are to be carried out in accordance with relevant standards.

The contractor has to specify the type, composition and thickness of the sprayed metal and of the sealing coating acc. to relevant applicable standards including the corresponding warranties and tests if sprayed metal coating will be applied.

7.6.24 Safety of Work

All precautions connected with this type of application of corrosion protection have to be in accordance with relevant standards.

Sprayed, unfused coating of metals and metallic compounds applied by combustion gas flame, plasma arc, detonation and similar processes, and the preparation of components, spraying techniques, sealing, finishing and inspection shall be according to relevant standards.

The hot galvanized surface has to be cleaned before the application of the coats to remove corrosion products, dirt, dust, grease.

The cleaning can be achieved by

- brush off
- washing with 1 - 1.5 % ammonia water with up to 0.1 % detergent added and followed by wet grinding using e.g. scotch britt to turn the foam to grey color,
- steam blasting,

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ANNEX - 1
PAINT SYSTEM - COASTAL AND MARINE ENVIRONMENT

SL. NO.	SURFACE/LOCATION	TEMP. °C	SURFACE PREPARATION	COAT	PAINT SYSTEM NO. OF COATS	GENERIC TYPE	PER COAT MICRONS Dft	APPLICATION IN SHOP	ON SITE
1	Structural steel work, piping (oil + water), tanks outside surface, transmiss, towers, cranes, steel floors, galleries, stairways, outdoor.	upto 130°C	Sa 2½	Prime	2	P6	35	x	
				Intermediate	1	P7	35 100	x	x
				Finish	1	F2	50		x
						Total min. dft	220		
2	Structural steel work, piping, indoor and outdoor	130 to 200°C	Sa 2½	Prime	1	F9	75	x	
				Intermediate	1	F9	20		x
				Finish	2	F11	20 20		x x
						Total min. dft	135		
3	Structural steelwork, piping, uninsulated carbon steel, indoor and outdoor	200 to 400°C	Sa 3	Prime	1	F9	75	x	

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SL. NO.	SURFACE/LOCATION	TEMP. °C	SURFACE PREPARATION	COAT	PAINT SYSTEM NO. OF COATS	GENERIC TYPE	PER COAT MICRONS Dft	APPLICATION IN SHOP	APPLICATION ON SITE
				Intermediate	1	F12	20		x
				Finish	1	F12	20 115		x
4	Structural steel work, piping (oil + water), tanks, indoor	upto 130°C	Sa 2½	Prime	2	P6	35	x	
				Finish	1	F6	35	x	
							100		x
						Total min. dft	170		
5 (a)	Structural steel work in the battery rooms,	Ambient	Sa 3	Prime	2	P8	30	x	
							30	x	
				Finish	2	F6	100		x
						Total min. dft	100		x
							260		
(b)	Uninsulated - equipment, tanks and piping etc.	upto 80°C	Sa 3	Prime	2	P3	35	x	
				Finish	2	F6	35	x	
							100		x
						Total min. dft	100		x
							270		

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SL. NO.	SURFACE/LOCATION	TEMP. °C	SURFACE PREPARATION	COAT	PAINT SYSTEM NO. OF COATS	GENERIC TYPE	PER COAT MICRONS Dft	APPLICATION IN SHOP	APPLICATION ON SITE
6	Steel tanks inside surface (total) for oil storage	normal	Sa 2½	Prime	2	P3	35 35	x x	
				Finish	2	F6	100 100		x x
						Total min. dft	270		
7	Steel tanks inside surface (total) for water storage (potable and distilled water)	normal	Sa 2½	Prime	2	P2	50	x	
							50	x	
				Finish	2	F3	30 30		x x
						Total min. dft	160		
8	Cast iron water pipe lines-outside surface, buried in the soil	upto 60°C	Sa 3	Prime	2	P8	30	x	
				Finish	3	F7	30	x	
							125 125 125		x x x
						Total min. dft	435		
9	Steel pipes inside surface such as cooling water lines	upto 60°C	Sa 2½	Finish	4	F7	125 125 125		x x x
						Total min. dft	500		

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SL. NO.	SURFACE/LOCATION	TEMP. °C	SURFACE PREPARATION	COAT	PAINT SYSTEM NO. OF COATS	GENERIC TYPE	PER COAT MICRONS Dft	APPLICATION IN SHOP	APPLICATION ON SITE
10	Water pipelines - outside surface, indoor	upto 60°C	Sa 3	Prime	2	P2	50	x	
				Finish	3	F3	50	x	
						Total min. dft	30		x
							30		x
							30		x
							190		
11	Oil pipelines - outside surface, above ground	upto 90°C	Sa 3	Prime	2	P3	50	x	
				Finish	2	F6	50	x	
							100		x
							100		x
						Total min. dft	300		

* For Details of Primer and Finish coats, refer Annex to paint systems.