BHEL	**CHECK LIST FOR PRESSURE / DIFFERENTIAL PRESSURE GAUGE (MECHANICAL AUXILIARY PACKAGES)**	SPECIFICATION NO.: PE-TS-394-145-I054 VOLUME SECTION REV. NO. 00 DATE: 27.09.2013 SHEET 13 OF 19

SL NO	TESTS/CHECKS	QUANTM OF CHECK	REFERENCE DOC. ACCEPTANCE NORMS	AGENCY P	AGENCY W	AGENCY V	REMARKS
1.0	CHECK FOR		APPROVED TECHINCAL REQUIREMENT/ DATA SHEET				MFR TO CARRY OUT ROUTINE TEST ON 100%. WHEN MATL CORELATION ARE NOT AVAILABLE MFR'S COMPLIANCE TO BE PROVIDED
	1.1 DIAL SIZE	100%		M	C	C	
	1.2 MODEL NO/TAG NO	100%		M	C	C	
	1.3 RANGE/SCALE	100%		M	C	C	
	1.4 END CONNECTION	100%		M	C	C	
	1.5 SWITCH CONTACT RATING & NOS	100%		M	C	C	
2.0	CALIBRATION						
	2.1 ACCURACY	100%		M	C	B	
	2.2 REPEATABILITY (FOR SWITCH)	100%		M	C	B	
	2.3 SET POINT ADJUSTMENT FOR SWITCH	100%		M	C	C	
3.0	OVER PRESSURE & LEAK TEST	100%		M	C	C	
4.0	OPERATION OF PR. RELEIF DEVICE	ONE PER TYPE		M	C	C	
5.0	REVIEW OF T.C. FOR MATERIAL OF--						
	5.1 SENSOR	FOR LOT		-	-	B	
	5.2 MOVEMENT			-	-	B	
	5.3 PROCESS CONNECTION			-	-	B	
	5.4 HOUSING			-	-	B	
6.0	REVIEW OF T.C. FOR DEGREE OF PROTECTION	TYPE TEST		-	-	B	
7.0	REVIEW OF T.C. FOR CONTACT RATING OF SWITCH	ONE PER TYPE		-	-	B	
8.0	ACCESSORIES AS APPLICABLE	100%		M	C	C	

LEGEND:
M: MANUFACTURER/ SUB CONTRACTOR, C: CONTRACTOR/ NOMINATED INSP AGENCY, B: BHEL. P: PERFORM, W: WITNESS, V: VERIFICATION.

NOTE:
CONTRACTOR TO PROVIDE COMPLIANCE CERTIFICATE FOR TESTS/CHECKS VERIFIED BY CONTRACTOR AND SUBMIT THE SAME ALONGWITH TEST CERTIFICATES TO BE VERIFIED BY BHEL.

8. PROGRAMMABLE LOGIC CONTROLLER (PLC)

This section covers the minimum specification for the PLC for TG auxiliaries as specified in clause 7.9 & for the offsite packages such as Emergency DG System & HVAC system.

8.1 General Technical & Design Requirements

1. Programmable Logic Controller (PLC) shall be microprocessor-based system. The PLC shall be versatile, expandable, user friendly and latest state of art technology. The system shall be envisaged for the purpose of sequential operation, protection and interlock, data acquisition system, alarm functions, closed loop control and data archiving for fully automatic operation. Logic controller shall be provided with adequate and reliable protection safeguard for various equipments and to assist the operator for easy safe and efficient starting and stopping of various drives in the process. The system shall be designed by selecting high-grade components of proven quality and proper design of system electronics. The system shall be able to operate satisfactorily with reference to the specified environmental conditions as indicated in the specification.
2. The system shall be modular in construction and expandable in future by adding additional electronic modules, which shall be easily accessible for maintenance and repair. The modules shall preferably be Rack/Rail mounted. The types of modules shall be kept to minimum possible in order to have interchangeability and spares inventory.
3. The system shall have extensive self-diagnostic hardware and software features for easy and fast maintenance of the PLC. Safety barriers shall be provided for intrinsically safe input / output circuits.
4. The PLC shall have very high noise immunity in order to ensure safe and reliable operation when subjected to electrical radio frequency interference and electromagnetic disturbances expected in a power plant.
5. The system shall be programmed as per the logic requirements required for the functioning of the systems and equipment. Contractor shall prepare their own logic / ladder diagrams depending upon the capability of the programmable logic controller offered by them.
6. Operation of the PLC shall be completely unaffected by a momentary power loss of the order of 20 milliseconds.
7. On-line replacement of any module shall be possible in such a way that the removal and addition of the module shall be possible without de-energizing the system or causing any interruption in the system while replacing a faulty module except for the inputs /outputs which are being handled by that module. However, in case of triple modular

redundant or dual PLC configurations, there shall not be any process upset while replacement.

8. PLC shall be provided with 20% hard wired installed spares and 20% I/O channels.
9. The system shall be capable of handling the long-term storage of data for 15 days and retrieval.
10. The system shall be provided with programming and diagnostic facility. Each PLC shall be provided with one no. Laptop of latest configuration with programming software & communication cable.

8.2 PLC System Configuration

PLC shall consist of following sub systems:

8.2.1 Input/Output Sub system

1. I/O subsystem shall be suitable for accepting discrete inputs, BCD inputs and analog inputs. The I/O modules shall be mounted in the I/O racks.
2. Each I/O shall be electrically isolated from external control circuit by suitable means. The minimum isolation level between I/O and logic circuit shall be 500 V DC.
3. Each module shall have LED for each digital I/O channel to indicate the status of each input / output. Redundancy in I/O level shall be maintained as per the process requirement.
4. PLC inputs shall be provided with potential free dry contacts. All the inputs shall be double ended i.e., two wires per input and not common return for all inputs. The contact interrogation voltage for input contacts shall be 24V DC minimum. Each input channel shall be protected by separate fuse.
5. Output contacts from the PLC shall be potential free dry contacts. Each output shall be short-circuit proof and protected by fuse.
6. Visual indication of fuse blown must be provided for each input and output channel and should be alarmed
7. There shall be at least 20% spare capacity available on input & output modules, over and above the system requirement.
8. All input/output cards shall have quick disconnect terminations allowing for card replacement without disconnection of external wiring and without switching of power supply.
9. The Contractor shall provide the following monitoring features:
   - Power supply monitoring.

- Contact bounce filtering.
- Optical isolation between input and output signals with the internal circuits.
- In case of power supply failure or hardware fault, the critical outputs shall be automatically switched to the fail-safe mode. The fail-safe mode shall be intimated to the successful Contractor during detailed engineering.

10. Further, keying-in of individual wire connectors shall be provided to ensure that only the correct card is plugged on the I/O module. It shall be possible to remove I/O module without disconnecting wiring from field inputs or outputs.

8.2.2 Processor Sub system

1. The processor sub system shall include CPU, memory, power supply, communication interface etc.
2. Dedicated PLC's shall be envisaged for each Auxiliary system. The processor shall have capability to implement all the control functions required. The processor shall have sufficient memory for storage of the program instructions as applicable to the logic requirements. CPU shall be of 32/64 bit or upgraded version of microprocessor.
3. Memory shall be non-volatile, preferably EEPROM type. However, in case volatile memory is provided, battery back up shall be provided for a minimum of three months to keep the stored program intact. A battery drain indication shall be provided at least one week before the battery gets drained. Memory shall be provided with adequate capacity with 40% spare capacity under worst loading condition.
4. The healthiness of processor hardware and software shall be continuously monitored by watchdog timer.
5. PLC's shall be provided as a minimum with dual redundant processor subsystem including CPU, memory and power supply. Redundancy shall be provided such that, in case of failure of the main processor, the standby processor shall take over automatically and vice - versa. The changeover shall be bumpless and shall not result any process or system upset.
6. In case of failure of complete processor system i.e., both processors, outputs shall take fail safe state automatically.
7. The scan time of programmable controller shall be of the order of 100 milliseconds or better. Scan time of PLC is defined as the cycle time taken by the system to read input, process input executing logic and update control output for all the logics configured within the system. Other activities like diagnostic routines, output / dump of data to

peripherals, or any other activity which consume processor time shall also be accounted while computing scan time.

8.2.3 Communication Sub system

1. The communication subsystem shall provide reliable and high speed data transfer between the processor subsystem, I/O subsystem, PLC console and other devices connected to the system.
2. Redundancy in communication subsystem shall be provided, such that on the failure of the active device, communication link or bus, the redundant device communication link or bus shall take-over automatically without interrupting the system operation. The communication bus shall be of coaxial / Fibre optic type.
3. Information about the failed device shall be displayed locally as well as on the PLC console. It shall be possible to manually switch-over the communication from main bus device to redundant bus device without interrupting the PLC functions.
4. The offered PLC shall have provisions of communication interface facility with Plant DCS system in order to make the entire system operational from CCR. Bi-directional, Redundant OPC links shall be provided in the PLC for the connectivity with the Plant DCS. All the required redundant Fibre Optic Cable Interface Modules on PLC side are included in the Contractor's scope.
5. Following are also in the scope of supply & work of the Contractor:
   - Cables required for interfacing with Plant DCS.
   - Implementation of Tags and establishing the Link.
   - Any other software/hardware required.

8.3 System Power Supply

1. For PLC system, redundant 24 V DC power supply shall be provided by the Contractor. The required power supply cable shall be provided by Contractor from the UPS DCDB & ACDB as explained in clause 6.2.14 for TG integral control system
2. For separately mounted I/O racks, separate power supplies shall be provided. Power supply module shall be of ample capacity to supply all modules. In addition 20% spare capacity for future shall be provided. All the drives shall be switched ON/OFF through 24V DC coupling relays to be provided in HT/LT SWGR panels. The exact power supply scheme shall be as approved by Owner during detailed Engineering stage.
3. For the Operator Stations and Engineering Station the power supply shall be from the 220 V, AC, UPS system.

8.4 PLC Console

1. PLC Console or operating panel/display panel shall be provided as operator Interface station for control and monitoring of the plant. This shall be done through dynamic mimic displays and control displays.
2. PLC console shall also be used for program storage, display, fault diagnostic and alarm monitoring. It shall be possible to modify, add or delete the application program on-line without affecting the outputs. It should be possible to modify or create new displays from PLC Console.
3. Isolation shall be provided between programming terminal and related subsystems, if there is any possibility of high voltage from TFT being transmitted to other subsystems.
4. The offered PLC system shall have provision to shift the Operator Station/Engineering Station to the CCR in future with third party interactive communication facility.

8.5 Displays

The system shall be capable of reading the status of equipments, acquiring the analog signals, displaying the status in the form of mimic diagram, video trend, bar graph, periodic display, alarm display, alarm overview display, logs such as hourly/shift/daily logs, alarm logs etc.

Displays include plant mimic diagrams, which shall include the complete auxiliary plant system indicating each major components of the system and the operating status of individual equipment and devices

8.6 Alarms

1. The system shall display history of alarms in chronological order of occurrence on the Operator Station TFT. At least three (3) levels of alarm priority shall be available which shall be displayed in different color. It should be possible to display and print alarms. System shall have all alarm related functional keys like acknowledge, reset etc. Other design features like set point / dead band adjustment, alarm priority, manual and automatic inhibition based on predefined logic etc. shall be provided, which shall be as finalized during detail engineering.
2. The alarm display shall be built bottom up with the most recent alarm at the top of the list. When a point returns to normal, the associated alarm line shall change color suitably and on acknowledgement, the line shall be blanked out.
3. The alarms below the blank lines shall move upward to fill the empty lines. If the capacity of the OWS display page is exceeded, alarm

history shall be stored in memory to accept the over- flow. This alarm history shall be displayed upon operator demand. The format and details of alarm displays shall be finalized during detail engineering.

4. When a point goes into an alarm state and appears on the alarm screen, the time of alarm will flash until acknowledged by the operator. Acknowledgement by the operator will cause the time to stop flashing. All alarm initiations and return to normal, shall be logged on a printer.

8.7 System Software

1. Complete licensed software for PLC based system including the communication software system shall be supplied and implemented to meet completely the specification requirements.
2. Application software shall be built based on approved logic diagram, graphics etc and shall include controls, graphics, logs, trends, historization, report generation etc.
3. The system software shall include all programs for the PLC and PLC console which are required to perform all the PLC functions including communication and self-diagnostics.
4. Diagnostic software shall have the capability to provide information about the failed module / system either in the form of a system configuration display or provide information in the form of a statement.
5. The Contractor shall provide software license for all the software provided for the project. The software's shall not be machine specific. All software licenses shall be valid for the continuous service life of the plant and equipment.
6. Password security shall be provided in order to ensure security level to the plant operation.

8.8 Peripherals

1. All peripherals shall conform to the minimum requirements indicated in the specification, the exact make and model number shall be as approved by the Owner/consultant during detailed engineering stage.
2. VDU/ TFT shall be multi-sync, 21" colour monitor with intelligent terminal and key board. TFT shall be provided with graphic and mimic capabilities with minimum 64 distinct colors. The graphic resolution shall be 600x 1280 dots minimum with 0.25 mm dot pixel and refresh rate shall be 85 Hz or better.
3. Suitable optical filter for minimum secondary glare shall be provided.
4. The color laser printer shall be automatic duplex printing type suitable for printing A4 size paper. Printing speed shall be minimum 6 ppm for

color and 24 ppm for black and white. The printer shall be heavy-duty type with minimum 50,000 pages/month printing capability, 600 dpi resolution, 128 MB memory and 3000 sheet input capability.

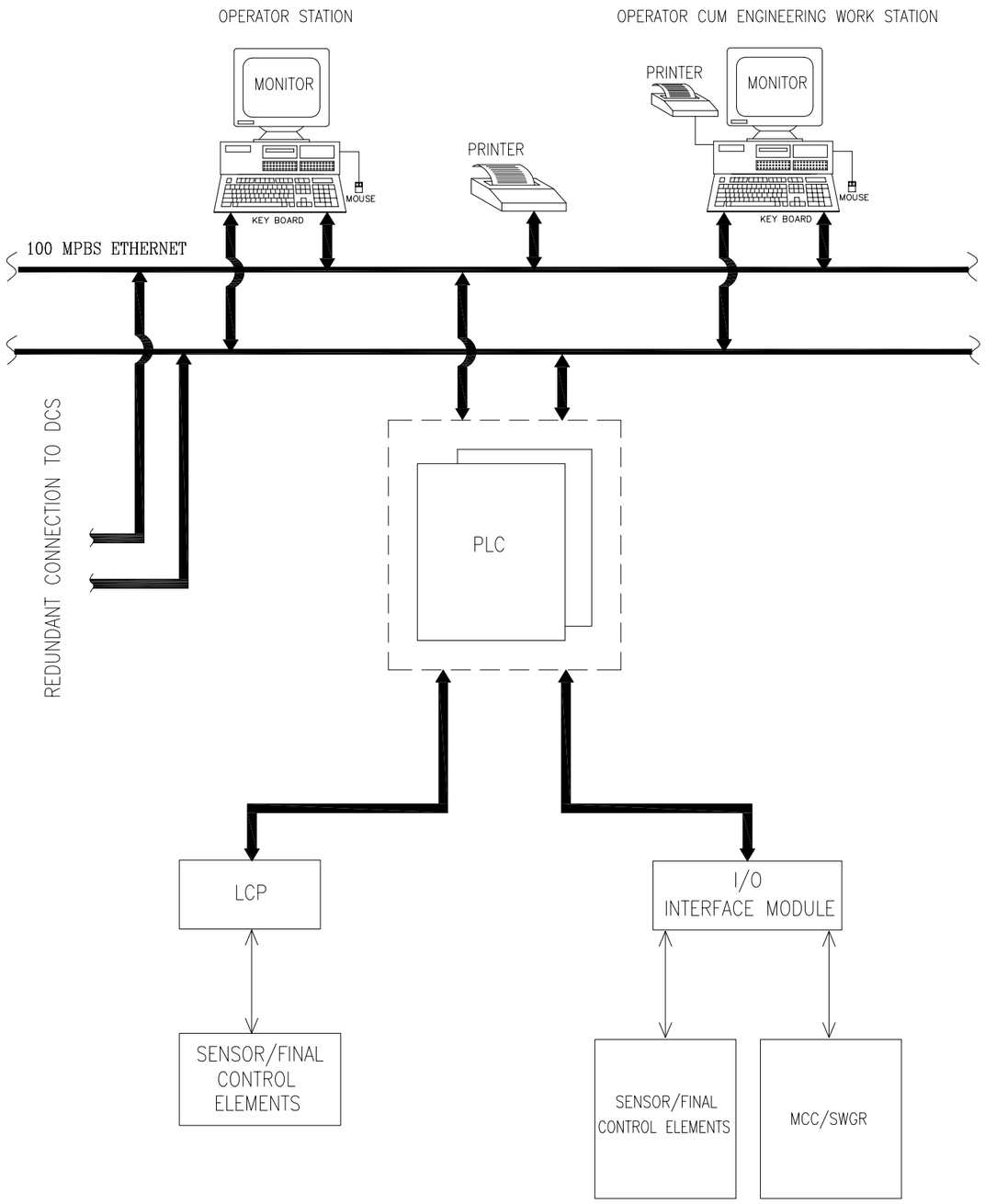
8.9 Inspection & Testing

The Contractor shall furnish the complete FAT procedure to Owner/consultant for approval during detail engineering and shall inform Owner the schedule of FAT to enable Owner/Consultant to witness the same. The following tests shall be performed as a minimum:

1. System pre-test: This shall be of physical check of all modules, racks, cabinets etc.
2. System power-up test: This shall test functionally all hardware and software.
3. Functional testing which shall include the following as a minimum

- Complete system configuration function check and loading.
- Demonstration of all PLC system functions.
- 100% checking of logics configured in the PLC.
- Checking of scan time.
- Checking of all PLC console functions and operation in association with peripherals.
- System redundancy checks including correct changeover of the back up unit in case of failure of main unit and vice versa.
- System diagnostic checking for all subsystems, including checking of the testing software for I/O modules signal conditioning modules, CPU, Memory etc.
- Checking of output status on processor failure.
- Simulation of power failure and system restart.
- Auto boot up of system configuration and program after power restoration.

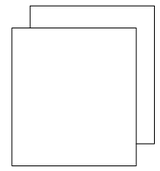
The PLC system shall be tested at site after installation and commissioning with all inputs and output connected. All the tests conducted during FAT shall be carried out during site testing.



NOTES:–

1. PLC SYSTEM SHALL BE PROVIDED WITH DUAL REDUNDANT POWER SUPPLY, CPU & COMMUNICATION.
2. PLC SYSTEM SHALL BE INTERFACED WITH DCS FOR MONITORING FROM CCR THROUGH REDUNDANT OPC LINK BY FIBER OPTIC CABLE.

ABBREVIATION:–



DUAL REDUNDANT

DCS	DISTRIBUTED CONTROL SYSTEM
I/O	INPUT/ OUTPUT
PLC	PROGRAMMABLE LOGIC CONTROLLER
MCC	MOTOR CONTROL CENTER
SWGR	SWITCHGEAR

FOR REFERENCE ONLY

REV. No.	DATE	DEM	DEC	DEE	DEI	DESCRIPTION
		CHECKED				
02	25.06.11				AJV	
01	27.05.11				AJV	
00	06.05.11				AJV	

NEYVELI LIGNITE CORPORATION LTD, NEYVELI, TAMILNADU

LAHMEYER INTERNATIONAL INDIA

LAHMEYER INTERNATIONAL (INDIA) PVT. LTD.
CONSULTING ENGINEERS, GURGAON, INDIA

CONTRACT NO :		
PREPARED	NAME	DATE
DRAWN BY	PS	06-MAY-11
DESIGNED BY	SM	06-MAY-11
CHECKED BY	AJV	06-MAY-11
APPROVED BY	UJR	06-MAY-11
SHEET SIZE	A3	
SCALE	NTS	

PROJECT : 2 X 500 MW NEYVELI NEW THERMAL POWER STATION

DRAWING TITLE : TYPICAL PLC BASED CONTROL SYSTEM CONFIGURATION BLOCK DIAGRAM

DRAWING NO : LII-GEOE11019-G-00172-325 | REV. 02 | SHEET 1 OF 1

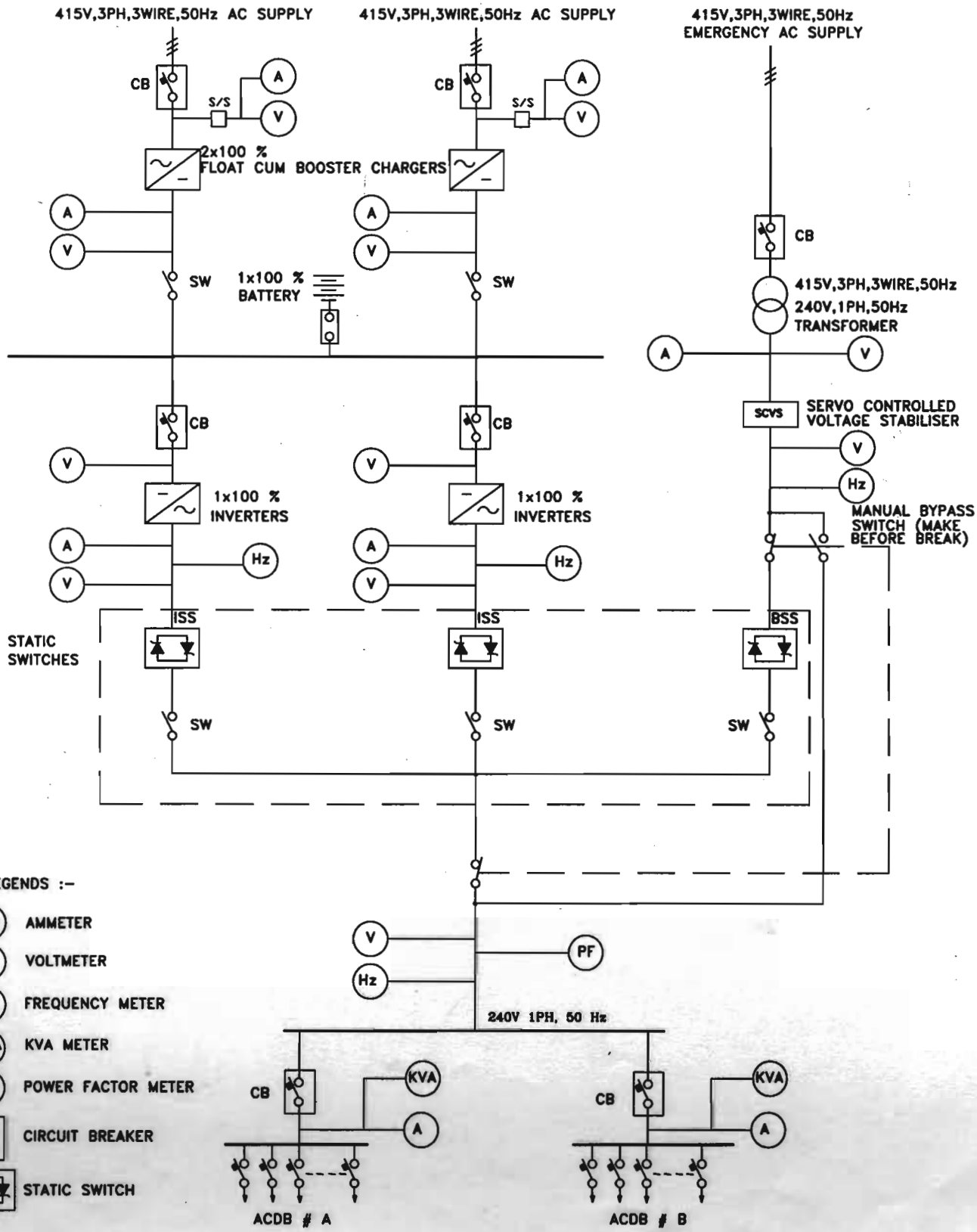
FORM NO. PEM - 6666-0

BHEL

TITLE :-

UPS SCHEME

SPECIFICATION NO. PE-SS-999-145-I035	
VOLUME II B	
SECTION D	
REV. NO. 00	DATE
SHT 11 OF 11	



LEGENDS :-

- A — AMMETER
- V — VOLTMETER
- Hz — FREQUENCY METER
- KVA — KVA METER
- PF — POWER FACTOR METER
- CIRCUIT BREAKER
- STATIC SWITCH
- SWITCH
- MCB
- LINK

NOTE:-

1. MIMIC PANEL SHALL BE PROVIDED.
2. TRANSDUCERS FOR VARIOUS METERS SHALL BE PROVIDED FOR GIVING 4-20mA ISOLATED SIGNALS FOR DAS.
3. FEEDERS IN ACDB SHALL BE PROVIDED WITH MCB's ON PHASE AND LINKS ON NEUTRAL.

G:\CI\COMMON\STANDARD\GENUSE\SPEC\UPSSCH

SECTION – D

STANDARD TECHNICAL SPECIFICATION

SECTION D1 : CONDENSER ONLOAD TUBE CLEANING SYSTEM

SECTION D2 : ELECTRICAL SYSTEMS

SECTION D3 : C&I SYSTEM

SECTION D1

STANDARD TECHNICAL SPECIFICATION FOR CONDENSER ONLOAD TUBE CLEANING SYSTEMS

1.00.00 **GENERAL**

This specification covers the design, performance and operational requirements, configuration and constructional features, manufacture, assembly, inspection and testing at the manufacturer's and/or his sub-contractor's works and painting for delivery of condenser on-load tube cleaning system (sponge rubber balls type) complete with all accessories as specified hereinafter. Each half of the condenser shall be provided with an independent tube cleaning system.

2.00.00 **CODES AND STANDARDS**

2.01.00 The design, materials, manufacture, inspection and testing of the condenser on-load tube cleaning system complete with all accessories, shall comply with the requirements of the latest versions of the following appropriate codes and standards.

2.01.01 IS/BS/DIN/US Standards regarding pressure vessels, pumps, piping, flanges and others as necessary.

2.01.02 IS/BS/DIN/ASTM Standards for materials specification and testing procedures.

2.01.03 IS/BS/DIN/AWWA Standards for valves and the testing.

2.02.00 In case of any conflict between the above codes/standards and this specification, the later shall prevail and in case of any further conflict in the matter, the interpretation of the specification by the Engineer shall be final and binding.

3.00.00 **DESIGN AND CONSTRUCTION**

3.01.00 General Requirements

3.01.01 Unless otherwise necessary, manufacturer's standard and proven models of the tube cleaning system shall be supplied.

3.01.02 The tube cleaning system shall be capable of safe, continuous and trouble-free operation for removal of fouling and scaling materials from condenser tubes. Vibration, noise, mechanical stresses shall be kept within allowable limits specified by relevant codes/standards. In design, due attention shall be given to ease of maintenance, repair and cleaning.

3.01.03 Suitable Corrosion allowance shall be provided whenever necessary. Adequate provision for future installation of cathodic protection shall be provided.

3.01.04 The tube cleaning system shall consist of ball separator at condenser outlet, recirculating pump, ball collector, differential pressure measuring system for ball separator, ball monitoring system, cleaning balls, piping valves, distributors, injection nozzles, instrumentations, control panel, interconnecting cables and others as necessary. The configuration of the tube cleaning system shall be as described in section C and / or as per the scheme enclosed.

3.02.00 **Performance Requirements.**

3.02.01 The tube cleaning system with all accessories shall be designed and guaranteed to meet the following requirements :

The tube cleaning system shall perform satisfactorily under the flow and pressure drop conditions (in the condenser) specified in Data Sheet - A and shall be capable of removing the various forms of fouling and scaling from condenser tubes.

3.02.02 The ball separator at the condenser outlet, shall be designed such that the pressure drop across the ball separator under clean conditions shall not be more than that specified in Data Sheet - A. The performance of the ball separator shall be continuous with minimum number of backwashing operations.

3.02.03 The power consumption by ball recirculation pump during various operations shall be minimum possible.

The quantity of cleaning balls worn out and / or lost, shall be minimum possible.

3.03.00 **Operational Requirements**.

The tube cleaning system and other accessories shall be designed for the following operation modes :

3.03.01 Complete automatic start-up of tube cleaning system initiated by pressing the push button (manual command).

3.03.02 Complete automatic shut-down of tube cleaning system with ball collection, effected by the following :

- Push button (manual command).
- Adjustable timer (after a defined cleaning period).
- Ball monitoring system (when the number of oversized balls falls below a set value).

3.03.02 Complete automatic backwashing of ball separator with ball collection, effected by the following :

- Differential pressure measuring system at a pre-determined differential across the ball separating strainer/ screen.
- Adjustable timer
- Push button

3.03.04 Complete automatic emergency backwashing of ball separator with alarm indication, effected by differential pressure measuring system.

3.03.05 Manual operation for start-up, shut-down with ball collection backwashing of ball separator, flushing of differential pressure measuring system etc., in case of failure of control system.

3..04.00 **Ball Separator**

3.04.01 Ball separator body shall be of rigid construction and shall be designed and manufactured as per the applicable codes for pressure vessels. It shall house the ball separating screen / strainer and shall have flanged inlet, outlet, ball extraction opening and pressure measuring tappings etc. Body shall be designed and manufactured as per the applicable codes for pressure vessels and to take care of forces and moments as enclosed in the specification. However in no case thickness of housing/body shall be less than the connecting pipe thickness as specified in data sheet A

3.04.02 The ball separator shall be provided with manhole with bolted cover and sight glass to observe its internals.

3.04.03 If specified in Data Sheet -A, ball separator body shall be Epoxy lined.

3.04.04 The ball seperating screen / strainer shall be designed for the maximum differential pressure across the separator and shall be securely mounted in the body. Screen / strainer shaft shall be sized adequately considering the overloading of screens / strainer due to debris accumulation.

3.04.05 The ball separating strainers / screens shall have electric actuators for swivelling to allow for their backwashing. Also suitable handwheels shall be provided to enable manual swivelling of strainers / screens.

3.05.00 **Ball Recirculating Pump**

3.05.01 The ball recirculating pump shall be horizontal centrifugal type. The casing shall be designed to withstand 1.5 times the shut-off pressure or twice the operating pressure, whichever is higher.

3.05.02 The impeller shall be non-clog type and shall be contoured suitably to avoid damage to the cleaning balls. The impeller shall be secured suitably to the shaft and shall be retained against circumferential movement by keys, pins or lock rings. Loctite compound shall be applied after tightening of locknuts to prevent dislocation of impeller.

3.05.03 Replaceable type wearing ring shall be provided to prevent damage to the casing and impeller.

3.05.04 Pumps shall be provided with mechanical seals to the extent feasible. If Gland packing is provided it should be of good quality to be provided to prevent leakage of water from pump glands.

3.05.05 Shaft size selected shall take into Consideration the critical speed which shall be away from the operating speed as recommended in applicable codes / standards. Renewable type fine finished shaft sleeves shall be integral with water thrower plates at the end and the length must extend beyond the outer faces of gland packing so as to distinguish between the leakage between shaft and the shaft sleeve and that past the seals / glands.

3.05.06 Bearings of adequate design shall be provided for taking the entire pump load arising from all probable conditions of continuous operation through its range of operation. The bearings shall be designed on the basis of 20,000 working hours minimum for the load corresponding to the duty point. Proper lubricating element does not contaminate the liquid being pumped. Bearings shall be easily accessible without disturbing the pump assembly

3.05.07 Stuffing box of suitable design to permit replacement of packing without removing any part other than the gland shall be provided. The stuffing boxes shall be sealed / cooled by the fluid being pumped.

3.05.08 Pumps shall be of self-lubricated, self - sealed and self-cooled type. All pipework, fitters etc., for sealing, cooling and lubricating purpose shall be supplied and no external cooling/lubricating/sealing water will be supplied. Pump capacity shall take into account the cooling/lubricating/sealing water requirement.

3.05.09 All rotating components shall be statically and dynamically balanced.

3.05.10 The pump shall be designed such that pump impellers and other accessories of the pump, are not damaged due to flow reversal.

3.05.11 The pump shall be capable of developing the required total head at rated capacity for continuous operation. Also the pumps shall be capable of being operated to give satisfactory performance at any point on the head Vs. flow characteristic curve over a range or 40% of rated flow to 120 -130 % of rated flow.

3.05.12 The pump shall preferably be non-overloading type. The total head Vs. capacity curve shall be continuously rising from the maximum flow point towards shut-off without any zone of instability.

3.05.13 The pump shall run smoothly without undue noise and vibration. Peak to peak vibration limits and noise level shall be within the acceptable values of applicable codes/standards.

3.05.14 The pump and motor shafts shall be connected through a pin and rubber bush flexible type of couplings. Suitable coupling guards shall be provided for the couplings.

3.05.15 The pump shall be capable of being started with discharge valve fully opened. Motor rating shall be adequate for this condition. The output KW rating of the pump drive motor shall not be less than the larger of the following :

a) Maximum power input to the pump over the entire range for maximum flow to shut-off condition.
b) 125% of power input to the pump at duty point corresponding to 103% of the rated speed.

3.06.00 **Ball Collector**

3.06.01 The body of the ball collector shall be designed to withstand 2.0 times the operating pressure or 1.5 times the recirculating pump shut-off pressure, whichever is higher.

The ball collector shall be designed and manufactured as per the applicable codes for pressure vessels.

3.06.02 Ball collector shall be provided with an inspection window/sight glass for visual inspection of the cleaning balls.

3.06.03 Ball collector shall be provided with suitable ports with covers for ball feeding and removal.

3.06.04 The ball collector shall be provided with vent and drain connections with isolating valves.

3.06.05 Provision shall be made in the ball collector for separating the undersized balls and ball collector shall have a separate chamber for collecting the undersized balls.

3.06.06 If specified in Data Sheet -A, ball collector body shall be lined with suitable resilient material.

3.06.07 The differential pressure measuring system shall be provided with D.P. transmitter ,DPS & DPGof remote seal arrangement.

3.07.00 **Differential Pressure Measuring System.**

3.07.01 The ball separator shall be provided with a measuring system for differential pressure across the ball separating strainer/screen, to check debris accumulation and to initiate ball catching and backwashing operations. This shall consist of a differential pressure switch/transmitter for automatic backwashing operation, a differential pressure guage for manual observation with adequate number of tappings with isolating valves.

3.07.02 The contacts for differential pressure switch/transmitter and for differential pressure guage shall be independent so that in the event of failure of one, the other is available.

3.07.03 The differential pressure measuring system shall be with remote seal arrangement .

3.08.00 **Ball Monitoring System**

3.08.01 Ball monitoring system shall be provided for continuously monitoring the quantity and size of the cleaning balls in circulation. The monitoring system shall perform the following functions :

a) Continuously counting the oversize balls in circulation and giving an alarm calling for investigation of ball losses, when the number of oversize circulating balls falls below a set valve.

b) Continuously measuring the size of the balls in circulation and initiating the shut-down of the tube cleaning system with alarm calling-for replacement of balls when the number of oversized balls falls below a set valve.

c) Bidder's if not manufacturing ball oversized monitor,can supply automatic ball sorter in lieu of same for automatic sorting of the undersized balls.

3.08.02 The monitoring system shall be of proven and reliable design and shall be complete with necessary transducers, amplifiers, transmission lines, power cables and electronic processor etc.

3.08.03 The electronic processor of the ball monitoring system shall be housed in the control panel and shall consist the following : -

a) Indicators for
- required basic ball charge.
- recirculating ball quantity.
- oversized ball quantity.

b) Time counters for
- total cleaning system operating hours.
- cleaning system operating hours with sufficient number of oversized balls.

c) Recorder for ball consumption.

3.08.04 The ball monitoring system shall have provisions for self-testing and self-calibration.

3.09.00 **Cleaning Balls**

3.09.01 The sponge rubber cleaning balls shall be slightly oversized to the internal diameter of condenser tubes and should be able to remove all fouling and scaling deposits in the condenser tubes.

3.09.02 The specific gravity of the cleaning balls shall be such that good distribution of balls across the tube sheet and cleaning of all tubes are ensured.

3.09.03 The composition of the cleaning balls shall be based on natural rubber and shall be suitable for temperature upto 100^0C. Hardness of the cleaning balls shall be compatible to tube material and corrosion/fouling behaviour. If cleaning balls consist of abrasive coated balls, the abrasive material shall also be compatible for use with the tube material.

3.09.04 Calculations and basis for selection of cleaning balls circulation quantity, type, size, hardness, cleaning frequency etc., shall be furnished during contract stage.

3.10.00 **Piping, Valves, Distributors and Injection Nozzles.**

3.10.01 Interconnecting piping, valves, injection nozzles and other fittings shall be designed to withstand 2.0 times the operating pressure or 1.5 times the pump shut-off pressure whichever is higher.

3.10.02 Interconnecting piping shall be sized and routed optimally. Velocity in the pipe work shall be less than 1.5 m/s for pump suction and less than 2.2 m/s in other pipe work.

3.10.03 Necessary isolation valves, vent and drain valves for various equipments shall be provided. Valves shall conform to appropriate standards. Valves provided in ball transport piping shall be ball type. Gland packing of all valve shall be of superior quality to avoid leakage. All valves upto 150 Nb shall be ball valves. For higher sizes ,

gate / globe /B.F. valves shall be provided. All instrument valves shall be needle valves.

3,10.04 Adequate number of ball injection nozzles shall be provided for proper distribution of cleaning balls in condenser inlet. Ball injection nozzles shall be flanged type and shall have two sets of flanges, one for connecting to ball transport pipe and other for connecting to the stub on condenser inlet pipe for ease of removal during repairs or checking.

3.10.05 Distributors (if applicable) with sight glass shall be provided wherever ball transport piping branching out or joining together for proper guidance of cleaning balls.

3.10.6 Type of valves shall be ball valves, no diaphragm type valve shall be used.

3.11.00 **Actuators**

3.11.00 Tube cleaning system shall be provided with actuators wherever necessary for various automatic operations. The actuators shall be electric motor operated and shall meet the requirements of the enclosed specification. The actuator shall be provided with auxiliary handwheel for manual operation in the event of control system failure.

3.12.00 **Electric Motors**

The drive motors for recirculating pump and differential pressure measuring system flushing pump shall conform to the requirements of the enclosed specification.

3.13.00 **Instrumentation and Control System.**

3.13.01 Complete instrumentation and control system for automatic operation of tube cleaning system, protection, interlocking, indication / annunciation of differential pressure and other malfunctions etc., shall be provided. This shall consist of adequate operational hardware, local control panel (As applicable) and interconnecting control and power cabling between the control panel and various equipments in the tube cleaning system.

3.13.02 The control panel shall house all necessary instruments, indicating / annunciation lamps, alarms, differential pressure indicator, timer, function selection switches, ball monitoring system processor, relays, protection and interlocking systems, start / stop push button etc., and shall be complete with internal wiring. The control panel shall meet the requirements of the enclosed specification.

3.13.03 Pressure guages shall be provided at recirculating pump suction and discharge. All instrumentation shall be of reputed make and shall meet the requirements of the enclosed specifications.

3.14.00 **Other Accessories.**

3.14.01 Counter flanges, complete with gaskets, bolts and nuts etc., shall be supplied for ball separator inlet, outlet connections and all other terminal points Fabrication, dimensions and drilling of the flanges shall conform to the codes/standards specified in

Data Sheet-A / Section -C.

3.14.02 Ball recirculating pump, ball collector with interconnecting piping and valves, shall be mounted on a frame. For fixing the frame, necessary foundation plates, bolts, nuts etc. shall be provided.

3.14.03 Suitable lifting arrangement shall be provided for various equipments of the tube cleaning system, for handling during erection and maintenance.

3.15.00 **Materials of Construction**

Materials of various equipments in the tube cleaning system shall be corrosion resistant and consistant with the fluid handled. However, material specification for various components shall be equal to or superior to those specified in Data Sheet-A.

4.00.00 **PAINTING**

4.01.00 The surface preparation of the various equipments / components of the tube cleaning system shall be done as per the standard mentioned in Data Sheet - A and shall include the following :

a) Removal of oil, grease, dirt and swarf etc.

b) Removal of rust and scale etc.

c) Sand blasting / shot blasting.

4.02.00 All internal surfaces of the various equipments / components of the tube cleaning system, which are subjected to immersion or water spray and which are not made of stainless steel or other corrosion resistant materials after surface preparation, shall be coated with epoxy paint of approved make and quality over a coat of zinc chromite primer, unless otherwise specified in Data Sheet - A.

4.03.00 The external surfaces of the various equipments / components of the tube cleaning system after surface preparation, shall be coated with synthetic enamel paint of approved make and quality over two coats of red oxide primer, unless otherwise specified in Data Sheet -A.

5.00.00 **SHOP INSPECTION AND TESTS**

5.01.01 **General**

5.01.01 Manufacturer shall conduct all tests and stage inspections as per the approved

quality plan to ensure that the various equipments and other accessories of the tube cleaning system shall conform to the requirements of this specification and of the applicable codes / standards.

5.01.02 All materials used for manufacture /fabrication of the various equipments of the tube cleaning system shall be of tested quality. Relevant test certificates for chemical analysis, mechanical tests and heat treatment shall be made available before the final shop inspection. In case the relevant test certificates are not available, the manufacturer shall arrange to carry out the necessary tests as per the approved quality plan and applicable codes at his cost for which samples shall be identified by BHEL's representative.

5.01.03 All shop tests shall be conducted as per approved quality plan and test certificates / reports for the same shall be furnished to BHEL for approval.

5.01.04 Qualification of welding procedures and welders shall be as per ASME B&PV code, Section - IX / applicable codes.

5.2.00 **Ball Separator**

5.02.01 Chemical analysis, mechanical tests shall be carried out on materials used for body, strainer / screen, strainer / screen shaft and other appurtenances as per the applicable material specification standards.

5.02.02 All butt welded joints shall be subjected to radiographic/ ultrasonic testing as per applicable codes. However, all welded joints shall be subjected to 100% magnetic particle / penetrant testing to ensure freedom from defects.

5.02.03 Strainer / screen shaft shall be subjected to ultrasonic test as per ASTM-A388 for subsurface defects with acceptance norms as per ASME B&PV code, Section VIII, Division 1.

5.03.00 **Ball Recirculating Pump**

5.03.01 Chemical analysis, mechanical tests shall be carried out on materials used for casing, impeller, shaft, sleeves, wear rings etc., as per the applicable material specification standards.

5.03.02 The casting used for pump casing and impeller shall be sound, clean and free from porosity, blow holes, hard spots, cold shuts, distortion and other harmful defects. All accessible surfaces of the impeller shall be subjected to penetrant test as per ASTM-E165 for surface defects with acceptance norms as per ASME B&PV code, Section VIII, Division 1. No welding or repairs shall be carried out without prior permission of BHEL.

5.03.03 Pump shaft and sleeves shall be subjected to ultrasonic test as per ASTM - A388 for sub-surface defects and penetrant test after finish machining as per ASTM-E165 for surface defects.

5.03.04 Wear rings shall be subjected to penetrant test as per ASTM-E165.

5.03.05 Pump impellers and rotor assembly shall be statically and dynamically balanced as

per ISO-1940

5.04.00 **Ball Collector**

5.04.01 Chemical analysis, mechanical tests shall be carried out on materials used for body and other appurtenances / accessories as per the applicable material specification standards.

5.04.02 All but welded joints shall be subjected to radiographic / ultrasonic testing as per applicable codes. However, all welded joints shall be subjected to 100% magnetic particle / penetrant testing to ensure freedom from defects.

5.05.00 **Piping, Valves, Distributors, and Injection Nozzles.**

5.05.01 Chemical analysis, mechanical tests shall be carried out for materials used for piping, fittings, valves, distributors and injection nozzles.

5.05.02 All welded joints of distributors & injection nozzles shall be subjected to penetrant test as per ASTM-E165 for surface defects with acceptance norms as per ASME B&PV code, Section VIII, Division 1.

5.05.03 Inspection and testing of valves including leakage test shall be carried out as per the requirements of the applicable standards. Valve stem and ball shall be subjected to penetrant test as per ASTM-E165.

5.05.04 All materials for various nozzles, stubs, gaskets, nuts, bolts etc. shall be of tested quality and correlating test certificates for chemical and mechanical properties shall be furnished.

5.06.00 **Rubber Lining (as applicable)**

Rubber lining shall be subjected to surface crack test, 100% spark and hardness tests and shall be checked for layer thickness, defects etc.

5.07.00 **Flanges**

5.07.01 Chemical and mechanical test certificates shall be furnished for flange materials.

5.07.02 In case of fabricated flanges, all the welds shall be subjected to 100% radiography as per ASME B&PV code, Section VIII, Division 1.

5.07.03 In case of forged flanges, ultrasonic testing shall be carried out as per ASTM-A 388.

5.07.04 If the thickness of the plate used for flanges is 40mm or more, the same shall be checked ultrasonically as per ASTM-A435 to demonstrate the absence of lamination and lack of fusion etc.

5.07.05 Flanges shall be checked for edge preparation, fit up and satisfactory working with matching parts.

5.08.00 **Dimensional Checks.**

Dimensional checks for various equipments/components of the tube cleaning system shall be carried out as per assembly drawing approved by BHEL. Alignment and fit up of movable parts shall be checked.

5.09.00 **Hydrostatic Test**

Hydrostatic test shall be conducted on various assemblies / equipments / components of the tube cleaning system at a pressure of 1.5 times and design pressure. The duration of the test shall be minimum 30 minutes.

5.10.00 **Leakage Test**

Leakage test shall be conducted at the design pressure on all assemblies of the tube cleaning system to demonstrate that the assemblies are leak tight and no water seepage shall take place at various nozzles and valve connections.

5.11.00 **Performance Test on Recirculating Pump**

Performance test on recirculating pump with drive motor shall be conducted as per BS-599 / ASME PTC 8.0. Performance curves i.e., discharge flow Vs head, discharge flow Vs power consumption and discharge flow Vs efficiency shall be plotted and acceptance norms shall be as per BS-599 / ASME PTC 8.0. Vibration and noise shall be measure and acceptance norms shall be as per Hydraulic Institute (USA) standard.

5.12.00 **Functional Tests**

Various assembles / equipments / components of the tube cleaning system shall be subjected to functional tests and the following shall be checked.

5.12.01 Smooth and free operation of all movable parts.

5.12.02 Interlock and sequential operation.

5.12.03 Satisfactory operations of ball monitoring system.

5.12.04 Satisfactory operations of actuators torque switches, limit switches etc.

6.00.00 **TESTING AT SITE**

After completion of installation at site, the tube cleaning system will be tested to check that the tube cleaning system performance meets the requirements of this specification. Rectification of all defects shall have to be done by the supplier at no extra cost to the owner / purchaser. However, the owner / purchaser reserves the right to reject the equipments / parts not meeting the requirement if the deficiency still persists.

7.0.0 Performance Guarantee and Bid Evaluation criteria for Condenser on Load Tube Cleaning System.

The Tube Cleaning Systems shall be guaranteed to meet the performance requirements specified in Section-D , Data Sheet A and Guarantee schedule and also for trouble free operation after commissioning. Schedule of performance guarantees (enclosed in Volume III) duly filled and signed shall be furnished with the bid.

The Performance guarantees of equipments shall stand valid till the satisfactory completion of performance testing & its acceptance by BHEL/ Customer. If the guarantee period specified in the Commercial Specification is higher, same shall prevail.

7.01.00 Performance Parameters to be guaranteed by bidders shall be as under :

i) Pressure drop in ball separator in clean condition viz. after back washing.

ii) Percentage recovery of balls (min. 95% recovery)

iii) Life of Sponge Rubber Ball (Min. 4 weeks)

7.02.00 Bidder to note that bids shall be evaluated on account of pressure drop across ball collecting strainer (in clean condition) and liquidated damages on account of not meeting the same during PG test shall be in accordance with following :

A) Bid Evaluation Criteria & Liquidated Damages:

The bids received shall be evaluated for Pressure drop across balls collecting strainers :

- The permissible limit of pressure drop across balls collecting strainers in clean condition shall be 0.15 MWC.
- If the pressure drops quoted are higher than above limit, the bids shall be technically loaded @ indicated in Data Sheet A .
- However no advantage shall be given for pressure drops quoted less than above permissible limit.
- The maximum acceptable limit for pressure drop across balls collecting strainer shall be (with technical loadings) 0.2 MWC.

The bids will be technically rejected for pressure drops quoted higher than above maximum limit.

- The guaranteed pressure drops shall be demonstrated at site by bidder and if found higher shall be subject to LD @ twice the bid evaluation factor as above.

7.03.00 **OtherGuaranteed Parameters to be demonstrated at site**

i) Life of sponge rubber balls shall be minimum 4 weeks.
ii) Percentage recovery of balls shall be minimum 95%.

Any deviation to above balls life and percentage recovery will not be accepted.

Bidder to indicate the life of sponge rubber ball and nos. of balls lost during 1000 hours of plant operation in the Guarantee schedule and shall demonstrate same at site.

In case the successful bidder fails to demonstrate any of these parameters he shall carry out modifications at his own cost, to purchasers approval.

In case bidder fails to demonstrate above parameters to purchaser's satisfaction even after modification carried by him at site, the purchaser has the right to reject the equipment out rightly.

8.00.00 **QUALITY ASSURANCE & QUALITY PLAN**

8.01.00 The tube cleaning system and other accessories to be supplied, shall have assured quality and workmanship.

8.02.00 Typical quality plans are enclosed herewith this specification for bidder's guidance. The bidder shall furnish his own quality plan based on materials, equipments and components of the tube cleaning system being offered.

9.00.00 **NAME PLATE AND TAG NUMBERS**

9.01.00 Ball separator, recirculating pump, ball collector shall be provided with a permanently attached brass or stainless steel plate indicating the following details :-

a) Design and maximum flow rates.
b) Design and test pressures.
c) Design temperature.
d) Empty and operating weights.

9.02.00 Each valve in the tube cleaning system shall be provided with a name plate indicating the following :-

a) Service.
b) Design and test pressures.
c) Maximum flow and flow direction.
d) Size.
e) Tag Number.

Tag Numbers will be indicated on the drawings submitted for approval during contractstage.

9.03.00 Each motor shall be provided with a name plate indicating the following details :

a) Supply conditions.
b) KW Rating.
c) Make.

10.00.00 **DRAWING, DATA & INFORMATION TO BE SUBMITTED AFTER THE AWARD OF CONTRACT.**

The drawings, data and other documents as required in Data Sheet-C shall be furnished after the award of contract.

1	**GENERAL**		
1.1	Nos. of tube cleaning systems sets required for station	NOS.	Four (04) Nos. for 2 units viz. One independent set for each half of condenser
1.2	Liquid handled		*Clarified Water as per Analysis* Attached along with project information in section B.
1.3	Size of COLTCS	Nb	*2200 NB*
2.0	**DESIGN**		
2.1	Operating pressure at Condenser inlet flange	kg/cm2 (g)	Approx 1.5 to 2.0
2.2	Design Pressure for ball separator	kg/cm2 (g)	5.0 kg/cm² (g) & vacuum 0.1 kg/cm² (abs)
2.3	Design Mechanical Temperature	Deg. C	60
2.4	Condenser Details		
	a) Type of condenser		*Double pass*
	b) No. of Condenser sections	Nos.	2 (Two)
	c) No. of passes per condenser section (viz. condenser half)	Nos.	2 (Two)
	d) No. of tubes per condenser	Nos.	24398
	• Top two rows		400
	• Remaining		23998
	e) Tube Dia. OD x Thickness		
	• Top two rows	mm x mm	31.75 x 0.889
	• Remaining	mm x mm	31.75 x 0.7112
	f) Length of tubes between ends.	mm	*13300*
	g) Tube material		*Welded SS: ASTM A 249 TP 304*
	h) Pressure drop across condenser - At Normal flow (between Inlet and Outlet flanges of condenser)	MWC	*3.8 MWC* *(However the actual value can vary +/-10% of the design value)*
2.5	CW flow rate through each ball separator		
	- Normal	cu.m/hr	26590
	- Maximum	cu.m/hr	31908
2.6	Design differential pressure for ball separator strainer/screen	$Kg/cm^2(g)$	0.2

2.7	Pressure drop across ball separator i.e. between inlet & outlet flanges in clean condition at normal flow.	MWC	0.15
2.8	Pressure drop across ball separator in choked condition when strainer backwashing starts	MWC	Not to exceed 0.30
2.9	No. of balls required for COLTCS per condenser section	Nos.	Minimum 10% of number of condenser tubes
3	**CONNECTING PIPE DETAILS**		
3.1	Condenser inlet pipe		
	a) Material		*Carbon Steel to IS – 2062 Gr. B rolled & welded conforming to IS:3589*
	b) O.D. X Thickness	mm x mm	*2235 X 18*
3.2	Condenser outlet pipe		
	a) Material	CS	*Carbon Steel to IS – 2062 Gr. B rolled & welded conforming to IS:3589*
	b) O.D. X Thickness	mm x mm	*2235 X 18*
3.3	Manhole		Yes, 600 NB size
4.0	**MATERIALS OF CONSTRUCTION**		
4.1	BALL SEPARATOR		
	a) Body / housing		Carbon Steel to IS -2062 Gr.B. with epoxy painted inside (with minimum housing thickness same as connecting pipe thickness)
	b) Screen / Strainer		SS-316
	c) Strainer shaft		SS-316
	e) Internal Hardware including nuts, bolts , etc.		SS-316
	f) Site Glass provision		Yes
4.2	BALL RECIRCULATING PUMP		Non Clog type
	a) Casing		CI to IS 210 FG 260
	b) Impeller		SS-316
	c) Shaft		SS-316
4.3	**BALL COLLECTOR**		
	a) Body / housing		Carbon steel-IS 2062 Gr. B with epoxy painted inside
	b) Screen / Strainer		SS-316
	c) Site Glass Provision		Yes

4.4	Differential pressure measuring system		SS-316
4.5	Injection nozzle		SS-316
4.6	Valves		
4.6.1	Check Valves (65 NB & Above)		For sizes 65 NB and above-Swing check type or dual plate type.
	a) Body & Bonnet		Cast Carbon Steel (WCB), Flanged Ends
	b) Disc for Check Valve		Cast Carbon Steel (WCB)
	c) Stem		ASTM A182 Gr F6a
4.6.2	Check Valves (50 NB & Below)		For size 50 NB and below-Piston type
	a) Body & Bonnet		Forged Carbon Steel (A105), Screwed Ends
	b) Disc for Check Valve		Forged Carbon Steel (A105)
	c) Stem		ASTM A182 Gr F6a
4.6.3	Gate/ Globe Valves 50 Nb & Below		
	Body & Bonnet		Forged Carbon Steel (A105), Screwed Ends
4.6.4	➢ BF/Gate Valves (65 NB & above)		
	➢ Body & Disc		ASTM A216 WCB
	➢ Shaft		ASTM A 182 F304
	➢ Stem		ASTM B132 Gr-A/ IS 320 HT2/ ASTM A182 Gr F6a
	➢ Sealing, Retaining segment & internals		18 – 8 SS
	➢ Bearings		Self lubricating
	➢ Companion Flange		IS 2062, Gr. B
	C) Ball valves i) Body ii) Ball iii) Stem		 SA 351 CF8M SA 351 CF8M SS 316

4.7	Interconnecting Piping		By Bidder
	Material		a) Upto 150NB - Carbon steel ERW, IS:1239 (Heavy Grade) b) Greater than 150NB – CS to IS 2062 Gr. B, rolled & butt welded, conforming to IS 3589
5	**COUNTER FLANGES for Ball Separator**		
	a) Flanges		Carbon Steel to IS 2062 Gr. B or eq for thickness, drilling etc refer Annexure II in section C1
	b) Fasteners		A 193 & A 194 (In Bidder's scope).
	c) Gaskets		Min 4 mm thick rubber (In Bidder's scope).
6	**OTHER COUNTER FLANGES (for interconnecting piping)**		In Bidder's scope
6.1	MATERIALS		
	a) Flanges		Carbon Steel to IS 2062 Gr. B
	b) Fasteners		A 193 & A 194
	c) Gaskets		Min 4 mm thick rubber
7.0	Material of Other components not specified above		Suitable for intended duty and shall be subject to Purchasers approval during detailed engg. In the event of order.
8.0	**PAINTING**		
8.1	**INTERNAL SURFACE**		
	a) Surface preparation		SA - 2.5 of Swedish Specn. SIS-05-59-00-1967
	b) Primer		Two coat of Epoxy Resin based Zinc Phosphate epoxy primer
	c) Final paint		Adequate no. of coats of coal tar epoxy paint to achieve total dry film thickness of 200 to 250 microns
8.2	**EXTERNAL SURFACE**		
	a) Surface preparation		SA-2.5 of Swedish Specn. SIS-05-5900-1967
	b) Primer		Two coat of Epoxy resin based zinc phosphate epoxy primer
	a) Intermediate		Epoxy based TiO2 pigmented coat
	d) Final paint		Two coats of Chlorinated rubber paint to achieve total DFT of 175 to 200 microns.

9.0	Adequate provision for future installation of cathodic protection (Sacrificial type anodic protection by Purchaser)		YES
10.0	Flow straightner for streamlining the CW flow in ball collecting strainer		If required as per bidder's design – the same to be incorporated by bidder in its constructional feature.
11.0	Performance Guarantee & Bid Evaluation		
11.1	Performance Parameters to be Guaranteed		
	❖ Pressure drop in ball separator in clean condition		As per Guarantee schedule of bidder
	❖ Percentage recovery of balls		Min. 90 % recovery
	❖ Life of sponge Rubber Balls		Min. 3 weeks
11.2	Bid evaluation Criteria & Liquidated damages		As per clause no 8.00.00 of Section C1
11.3	Bid evaluation rate		@ Rs. 9.0 Lacs per 0.05 MWC pr. drop across each balls collecting strainer
11.4	Liquidated damages		Twice the bid evaluation rate
12.0	The tube cleaning system shall be designed for following operation modes		
	a) Automatic start up initiated by push button		YES
	b) Automatic shut down with ball collection effected by : i. Push button ii. Adjustable timer iii. Ball monitoring system		YES
	c) Automatic backwashing of ball seperator with ball collection effected by : a. Push button b. Adjustable timer c. Diff. Pressure measuring system		YES
	d) Automatic emergency backwashing of ball seperator effected by diff. Pressure measuring system		YES
	e) Automatic ball sorting initiated by push button		YES
	f) Provision for manual operation of complete tube cleaning system in case of control system failure		YES
	g) Whether the contacts for DPG, DPS and DPT are independent		YES
	h) Timer for Backwashing		YES

	i) Whether the ball monitoring system is designed to perform the following functions : i. Continuously counting the balls in circulation and giving an alarm calling for investigation of ball losses when the number of balls falls below a set value ii. Continuously measuring the size of the balls in circulation and initiating the shutdown of the tube cleaning system with alarm calling for replacement of balls when the no. of oversized balls falls below a set value		YES
	j) Whether the electronic processor of the ball monitoring system is provided with the following : i. Indicators for required basic ball charge ii. Indicators for recirculating ball quantity iii. Indicators for oversized ball quantity iv. Time counters for total cleaning system operating hours v. Time counters for cleaning system operating hours with sufficient no. of oversized balls vi. Recorders for ball consumption		YES
	k) Whether provision for self testing and self caliberation are made		YES
13.0	Mandatory Spares to be supplied under this specification.		Quantity for two units
1	Sponge Balls	Charges	50 Charges (1,22,000 Balls)
2	Abrasive Balls	Charges	20 Charges (48,800 Balls)
3	Worm gear assembly for Ball separator Screen	Set	1 Set
4	Ball Separator Screen	Set	1 Set
5	**DP Measuring System**		
5.1	Connecting Board	No.	1 No.
5.2	O Ring	No.	1 No.
5.3	Micro Switch Assembly	Set	1 Set
5.4	DPG		

5.4.1	Glass Window	No.	1 No.
5.4.2	Gasket	No.	1 No.
5.4.3	Pointer	No.	1 No.
6	**Ball recirculating pump for tube cleaning system**		
6.1	Rotating Assembly	Set	1 Set (Rotating Assembly consists of all the rotating parts except bearings)
6.2	Shaft with sleeves	Set	1 Set
6.3	Wearing Rings (if applicable)	Set	1 Set
6.4	Bearings	Set	1 Set
6.5	Impeller	No.	1 No.
6.6	Ball recirculating pump motor	No.	1 No.
6.7	Bearings for recirculating pump motor	Set	1 Set
7	Diff. Pr. Transmitter of each type	Nos.	2 Nos.
8	Diff. Pr. Indicators of each type	Nos.	2 Nos.
9	Pressure Gauges of each type	Nos.	2 Nos.
10	Ball counter of each type	Nos.	2 Nos.
11	Valves, of each type	Nos.	2 Nos.
12	Diff. Switches of each type	Nos.	2 Nos.
13	Motor operated valves and actuators	Set	2 Sets
14	PLC cards (All types of cards/modules of PLC including CPU, power supply modules, interface modules, converter modules, I/O modules, relays, MCBs, fuses, terminal blocks, converters etc.)	%	10 %
15	Power Supply unit of each type	%	10 %

16	Graphic Interface Unit of each type	No.	1 No.
17	Cooling Fan in PLC system/Cabinet	Nos.	2 Nos.
	Notes for Mandatory Spares: 1. In case the description / nomenclature of any of the items of spares/tools and tackles is differing from the description / nomenclature indicated in the list of mandatory spares/tools and tackles, the bidder shall offer functionally equivalent part in lieu of the listed item. 2. In case if such items of spares indicated as “not applicable”, are found applicable at a later date during execution of the project, such items of spares are to be supplied within the ordered cost of the mandatory spares. 3. If any of the items of spares ordered is found to be not applicable during detailed engineering stage/execution stage, the supplier shall have to supply alternative items of spares. The alternative items of spares are to be mutually agreed between the BHEL & Vendor. 4. Wherever % is indicated for the mandatory spares, the quantity shall be calculated for % of supply for total quantity for 2 units of 2 x 500 MW, unless otherwise specified. The quantity to be reckoned for % indicated shall be rounded off to the next higher whole number. For example if the % arrived is 0.2 the quantity to be supplied shall be 1 and if the % arrived is 5.1 the quantity to be supplied shall be 6. 5. In respect of quantity mentioned as 'Set' means the total quantity of all the components/items used in particular equipment unless otherwise specified.		
14.0	Documents enclosed for bidder’s reference		
	❖ Water Analysis		Indicated in project information in Section B.
	❖ GA of CW piping in TG hall		Attached as per Annexure-III

1.00.00 **DRAWING, DATA & INFORMATION TO BE SUBMITTED AFTER THE AWARD OF CONTRACT**.

After the award of contract, the following drawings, data and information is to be submitted for review / approval of BHEL as per the distribution schedule given in Section - C.

1.01.00 Within 2 (two) weeks of the date of LOI, the following shall be submitted,

1.01.01 Data sheet (s) - B.

1.01.02 Final versions of the following drawings to enable BHEL to finalise the layout and to design foundations and structures :-

a) General arrangement / installation drawings of ball separator, ball recirculating unit, control panel each complete with all accessories, incorporating the principal dimensions and weights of equipment offered, size and location of various nozzle connection, supporting arrangement (wherever applicable) and scope of supply etc.

b) Foundation arrangement drawings (wherever applicable) showing load data on supports, size and location of anchor bolts etc.

c) General arrangement drawing indicating the layout of the equipments and interconnecting piping with pipe supports.

1.01.03 Bar chart and inspection schedule.

1.02.00 Within the stipulated time period as per Vendor's drawing /document list, the following shall be submitted.

1.02.01 Cross Sectional/ detailed drawing of ball separator, recirculating pump, ball collector, differential pressure measuring system, ball monitoring system distributors, injection nozzles actuators, motors, control panel etc, indicating bill of quantities and materials of construction.

1.02.02 Final versions of calculations and basis for selection of cleaning balls circulation quantity, type, size, hardness, cleaning frequency etc.

12.2.03 Flow and control logic diagrams for various operations of the tube cleaning system.

1.02.04 Detailed schedule of valves indicating Tag numbers, type, make size, pressure and temperature ratings, materials etc.

1.02.05 Detailed schedule of instruments indicating tag numbers, type, make, materials , of construction, range and accuracy etc.

1.2.6 Detailed schedule of piping and fittings indicating sizes, materials, maximum working pressure and temperatures etc.

1.02.07 Control panel layout and list of instruments provided on control panel.

1.02.08 List of annunciations, protections and interlocks provided.

1.02.09 Detailed drawings of flanges.

1.02.10 Ball recirculating pump performance characteristic curves.

1.02.11 Write-up and instruction manuals for erection, operation and maintenance.

1.02.12 Storage instructions.

1.02.13 Vendor to send 3 sets of final documents (O&M manual, GA drg, P&ID) direct to site under intimation to PEM.

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Manufacturer's Name & Address	STANDARD QUALITY PLAN	BHEL Doc No.:	PE-QP-999-165-N008 REV-01
	Vendor Q.P. NO.	PROJECT:	
	INDEX	PACKAGE : COLTCS	CUSTOMER:
		Date :	PURCHASER:
		Page 01 of 15	CONSULTANT:
			P.O. No.

SL. NO.	DESCRIPTION	PAGE NO.
1	**BALL SEPARATOR**	2 TO 5
	WORM GEAR	6
	ACTUATORS	6
2	**BALL RECIRCULATION SKID**	7
	BALL VESSEL	7,8
	BALL INJECTION NOZZLE	8
	BALL RECIRCULATING PUMP	9
	BALL VALVE	10
	RECIRCULATING PUMP MOTOR	11
3	**V.- PIECE**	11
4	**BALL OVERSIZE MONITOR**	12
5	**PRESSURE GAUGE,DP GAUGE,DP SWITCH & DP TRANSMITTER**	13
6	**CLEANING BALLS**	13
7	**ALL COMPONENT & EQUIPMENT**	13
8	**STARTER PANEL**	14
9	**FASTENERS**	15

Note :Items not included in quality plan to be inspected as per approved data sheet/drawings

ANNEXURES

DRY RUN TEST PROCEDURE FOR BALL SEPERATOR

HYDRO STATIC TEST PROCEDURE

LEAK TIGHTNESS TEST PROCEDURE

PACKING PROCEDURE

LEGEND

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Manufacturer / Sub-Contractor	Contractor	Reviewed By	Name & Sign. Of approving authority & Seal
Signature			

	Manufacturer's Name & Address	**STANDARD QUALITY PLAN**	BHEL Doc No.: PE-QP-999-165-N008
		Vendor Q.P. NO:	PROJECT:
		Item : Ball Separator PACKAGE : COLTCS	CUSTOMER:
	P.O. No.		PURCHASER:
		Date :	CONSULTANT:

Sl. No.	Component / Operation	Characteristics Checked	Class	Type of Check	Quantum of Check	Reference Documents	Acceptance Norms	Format of Record		Agency			Remarks
										M	C	O	
1	2	3	4	5	6	7	8	9	D*	**	10		11
1.0.0	**Ball Separator**												
1.1.0	Raw Material												
[a]	Housing Shell, Nozzle flanges	Chemical properties & Physical properties	Major	Chemical Analysis & Mechanical test	One sample/cast / heat / batch	Approved drg/Data sheet	Approved drg/Data sheet	Mill Test Certificate / Lab test report/Raw material flow sheet	*	P	V	V	
		Surface defects	Minor	Visual	100%	Approved drg/Data sheet	Approved drg/Data sheet	Inspection report/ Raw material Flow sheet	--	P	V	V	
		Sub Surface Defects	Major	Ultrasonic test	100%	ASME SA 435	ASME SA 435	Inspection report	*	P	V	V	Plates > 20mm Thk only (UT - Full Volume)
[b]	Nozzle Pipes	Chemical properties & Physical properties	Major	Chemical Analysis & Mechanical test	One sample/heat	Approved drg/Data sheet	Approved drg/Data sheet	Mill.Test Certificate / Lab test report/Raw material flow sheet	*	P	V	V	
		Surface defects	Minor	Visual	100%	Approved drg/Data sheet	Approved drg/Data sheet	Inspection report/ Raw material Flow sheet	--	P	V	V	
		Leak Tightness	Major	Hydrostatic test	100%	Approved drg/Data sheet	Approved drg/Data sheet	Mill Test Certificate	*	P	V	V	
[c]	Main Flange	Chemical properties & Physical properties	Major	Chemical Analysis & Mechanical test	One sample/cast / heat / batch	Approved drg/Data sheet	Approved drg/Data sheet	Manufacturer's Test Certificate	*	P	V	V	
		Heat treatment (Normalising)	Major	Verification	HT Chart	Approved drg/Data sheet	Approved drg/Data sheet	Manufacturer's Test Certificate	*	P	V	V	if casting
		Surface defects	Critical	Magnetic particle test	100%	Approved drg/Data sheet	Approved drg/Data sheet	Inspection report	*	P	V	V	if casting
		Sub-surface defects	Critical	Ultrasonic test	100%	ASME SA609 / SA 435	ASME SA609 Level II / SA 435 / SA 388	Inspection report	*	P	V	V	
[d]	Screen Shaft	Chemical properties & Physical properties	Major	Chemical Analysis & Mechanical test	One sample/heat	Approved drg/Data sheet	Approved drg/Data sheet	Mill Test Certificate / Lab test report/Raw material flow sheet	*	P	V	V	

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Signature			

Manufacturer's Name & Address	**STANDARD QUALITY PLAN**	BHEL Doc No.:	PE-QP-999-165-N008
	Vendor Q.P. NO:	PROJECT:	
P.O. No.	**Item : Ball Separator** / PACKAGE : COLTCS	CUSTOMER:	
	Date :	PURCHASER:	
	Page 03 of 15	CONSULTANT:	

Sl. No.	Component / Operation	Characteristics Checked	Class	Type of Check	Quantum of Check	Reference Documents	Acceptance Norms	Format of Record	D*	Agency M	Agency C	Agency O	Remarks
1	2	3	4	5	6	7	8	9	D*	**	10		11
		Surface defects on machined area	Critical	Penetrant test	100%	ASME Sec.VIII Div.1	ASME Sec.VIII Div.1 Appendix 8	Inspection report	*	P	V	V	
		Sub-surface defects	Critical	Ultrasonic test	100%	ASME SA745	ASME SA745	Inspection report	*	P	V	V	
[e]	Screen ribs	Chemical properties & Physical properties	Major	Chemical Analysis & Mechanical test	One sample / heat	Approved drg/Data sheet	Approved drg/Data sheet	Mill Test Certificate / Lab test report/Raw material flow sheet	*	P	V	V	
		Corrosion Resistance	Major	IGC	One/Heat	ASTM A 923	ASTM A 923	Test Report/Lab test report	*	P	V	V	
		Surface Defects	Minor	Visual	100%	Approved drg/Data sheet	Approved drg/Data sheet	Inspection report/ Raw material Flow sheet	_	P	V	V	
[f]	Ball Extraction Nozzle Pipe [Duplex Stainless Steel]	Chemical properties & Physical properties	Major	Chemical Analysis & Mechanical test	One sample / cast/heat/ batch	Approved drg/Data sheet	Approved drg/Data sheet	Mill Test Certificate / Lab test report/Raw material flow sheet	*	P	V	V	
		Surface Defects	Minor	Visual	100%	Approved drg/Data sheet	Approved drg/Data sheet	Inspection report/ Raw material Flow sheet	_	P	V	V	
		Leak Tightness	Major	Hydrostatic Test	100%	Approved drg/Data sheet	Approved drg/Data sheet	Manufacturer's Test Certificate	*	P	V	V	
1.2.0	**Inprocess Quality Control**												
1.2.1	Welding procedure specification	Correctness	Critical	Scrutiny	100%	ASME Sec.IX	ASME Sec.IX	QW 482 of ASME Sec.IX	*	P	V	V	
1.2.2	Welding procedure qualification	Weld soundness	Critical	Physical test	100%	ASME Sec.IX	ASME Sec.IX	QW 483 of ASME Sec.IX	*	P	V	V	Welding procedure already approved by BHEL/LRQA/GL/DNV/TUV shall be employed for this job.
1.2.3	Welder performance qualification	Weld soundness	Critical	Radiography	100%	ASME Sec.IX	ASME Sec.IX	QW 484 of ASME Sec.IX	*	P	V	V	Welders already qualified by BHEL/LRQA/GL/DNV/TUV shall be employed for this job.
1.2.4	Fit-up of butt weld	Alignment.and dimensions	Major	Template, visual	100%	Manufacturing Drawing	ASME Sec VIII Div.1	Log book		P	W/V	--	BHEL to witness > 20mm thick butt joint
1.2.5	Fit-up of shell flange and nozzle assembly to shell	Orientation,alignment and dimensions	Major	Template, visual	100%	Manufacturing Drawing	ASME Sec VIII Div.1	Log book		P	--	--	

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Manufacturer / Sub-Contractor	Contractor	Reviewed By	Name & Sign. Of approving authority & Seal
Signature			

Manufacturer's Name & Address	**STANDARD QUALITY PLAN**		BHEL Doc No.:	PE-QP-999-165-N008
		Vendor Q.P. NO:	PROJECT:	
P.O. No.	**Item : Ball Separator**	PACKAGE : COLTCS	CUSTOMER:	
		Date :	PURCHASER:	
		Page 04 of 15	CONSULTANT:	

Sl. No.	**Component / Operation**	**Characteristics Checked**	**Class**	**Type of Check**	**Quantum of Check**	**Reference Documents**	**Acceptance Norms**	**Format of Record**		**Agency**			**Remarks**
										M	**C**	**O**	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**D***	**	**10**		**11**
1.2.6	**Weld quality for Pressure Parts**												
	[a] Root run	Surface defects	Major	Penetrant test / Visual	100%	ASME Sec.VIII Div.1	ASME Sec.VIII Div.1 Appendix 8	Operation Process Sheet	--	P	V	V	
1.2.7	[a] Completed butt welds	1.Surface defects	Major	Penetrant test	100%	ASME Sec.VIII Div.1	ASME Sec.VIII Div.1 Appendix 8	Inspection report	*	P	V	V	
		2.Sub-surface defects	Critical	Radiography test	10% of total weld length & 100% T Joints	ASME Sec.VIII Div.1	ASME Sec.VIII Div.1 Appendix 4 / UW 52	Radiographs & inspection report	*	P	V	V	RT films will be reviewed by BHEL
	[b] Completed fillet welds	Surface defects	Major	Penetrant test	100%	ASME Sec.VIII Div.1	ASME Sec.VIII Div.1 Appendix 8	Inspection report	*	P	V	V	
1.2.8	Fabricated Shell (Prior to sand blasting)	1.Dimensions, Orientation	Major	Measurement by visual	100%	Manufacturing Drawing	Manufacturing Drawing	Inspection report	*	P	V	V	
		2. Hydro test	Critical	Hydrostatic Pr. @ 1.5 times design pr. (positive) Duration 30 minutes	100%	ASME Sec.VIII Div.1	No Leakage	Inspection report	*	P	W	V	
1.2.9	Pickling and Passivation	Protection Layer	Major	Visual	100%	IS : 10117	IS : 10117	Log Book	--	P	--	--	
1.2.10	Final tests (completed equipments) - After assembly	1.Dimensions, orientation, workmanship & finish	Major	Measurement by visual	100%	G.A.drawing	G.A.drawing	Inspection report	*	P	W	W	
		2.Leak tightness for assembly	Critical	Leak Tightness @ design pr. (positive) Duration 30 minutes	100%	ASME Sec.VIII Div.1	No Leakage	Inspection report	*	P	W	W	
		3.Dry function test for Ball Separator	Critical	Operational test	100%	Approved procedure	Approved procedure	Inspection report	*	P	W	W	

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Manufacturer / Sub-Contractor	Contractor	Reviewed By	Name & Sign. Of approving authority & Seal
Signature			

(BHEL logo)	Manufacturer's Name & Address	**STANDARD QUALITY PLAN**	BHEL Doc No.:	PE-QP-999-165-N008
		Vendor Q.P. NO:	PROJECT:	
	P.O. No.	**Item : Ball Separator** / PACKAGE : COLTCS	CUSTOMER:	
		Date :	PURCHASER:	
		Page 05 of 15	CONSULTANT:	

Sl. No.	Component / Operation	Characteristics Checked	Class	Type of Check	Quantum of Check	Reference Documents	Acceptance Norms	Format of Record	D*	Agency M **	Agency C	Agency O	Remarks
1	2	3	4	5	6	7	8	9	D*	**	10		11
1.3.0	**Rubber Lining for ball Seperator Shell, V-Piece & skid IC Pipe.**												
1.3.1	Rubber formulation	Tensile elongation and hardness	Major	Physical test	One per lot	Manufacturer's procedure	BS 6374/Equivalent	Manufacturer's test certificate		P	V	V	
		Polymer Identification	Major	Flame test	One per lot	For Semi Ebonite	For Semi Ebonite	Inspection report	*	P	V	V	
						Ebonite Polymer catches fire; catches fire and On removal from fire it continues to burn	Ebonite Polymer catches fire; catches fire and On removal from fire it continues to burn						
		% Change in weight after 24 hrs immersion in sea water at 70 degrees	Major	Immersion test (bleeding test)	One per lot	ASTM D 471	+ / - 1 %	Inspection report	*	P	V	V	
1.3.2	Surface preparation of items to be lined	Free from rust , scale, dust and grease	Major	Visual	100%	SA 2.5	SA 2.5	Manufacturer"s Internal inspection		P	-		
1.3.3	Vulcanising	Temperature, Pressure and time	Major	Process monitoring	100%	Manufacturer's procedure	Manufacturer's procedure	Process Procedure		P	-	-	
1.3.4	Vulcanised rubber lined items	a) Chip test	Major	Chip test	One per lot	Approved drawing and BS 6374/Equivalent	BS 6374/Equivalent	Inspection report	*	P	V	V	
		b)Adhesion, Visual defects, thickness and hardness	Major	Measurement,visual inspection	100% visual. Thickness0hardness at random	Approved drawing and BS 6374/Equivalent	BS 6374/Equivalent	Inspection report	*	P	V	V	
		c)Spark test for Pin holes at 5 kv/mm	Major	Spark test for Pin holes	100%	Approved drawing and BS 6374/Equivalent	BS 6374/Equivalent	Inspection report	*	P	V	V	

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Signature				

		Manufacturer's Name & Address			STANDARD QUALITY PLAN				BHEL Doc No.:				PE-QP-999-165-N008	
							Vendor Q.P. NO:		PROJECT:					
		P.O. No.			Item : WORM GEAR & ACTUATORS		PACKAGE : COLTCS		CUSTOMER:					
							Date :		PURCHASER:					
							Page 06 of 15		CONSULTANT:					

Sl. No.	Component / Operation	Characteristics Checked	Class	Type of Check	Quantum of Check	Reference Documents	Acceptance Norms	Format of Record		Agency			Remarks
										M	C	O	
1	2	3	4	5	6	7	8	9	D*	**	10		11
1.4.0	**Complete Unit of Worm gear**	Reduction Ratio	Critical	Functional Test	100%	Approved Data Sheet	Approved Data Sheet	Manufacturer test certificate	*	P	V	V	
		Angle of Rotation											
		Input Torque											
		Output Torque											
		Degree of protection	Critical	Water & Dust ingress tests	Type test	Approved Data Sheet	Approved Data Sheet	Type test certificate	*	V	V	V	
1.5.0	**Actuators**	Routine Test	Major	Electrical test	100%	Supplier catalogue	Supplier catalogue / ADS	Manufacturer TC	*	V	V	V	Review of TCs
		Make, Range, Model	Major	Visual	100%								
		Assembly check alongwith ball valves	Major	Visual	100%	Supplier catalogue	Supplier catalogue / ADS	Inspection Report	_	P	--	–	
		Functional check alongwith settings/auxillary contacts	Major	Visual	100%								

Note: ADS - APPROVED DATA SHEET

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Manufacturer / Sub-Contractor	Contractor		Reviewed By	Name & Sign. Of approving authority & Seal
Signature				

		Manufacturer's Name & Address			STANDARD QUALITY PLAN				BHEL Doc No.:				PE-QP-999-165-N008	
							Vendor Q.P. NO:		PROJECT:					
		P.O. No.			Item : Ball Recirculation Skid & Ball Vessel		PACKAGE : COLTCS		CUSTOMER:					
							Date :		PURCHASER:					
							Page 07 of 15		CONSULTANT:					
Sl. No.	Component / Operation	Characteristics	Class	Type of	Quantum of	Reference	Acceptance	Format of		Agency				Remarks
		Checked		Check	Check	Documents	Norms	Record		M	C	O		
1	2	3	4	5	6	7	8	9	D*	**	10			11
2.0.0	**Complete Skid**													
	Recirculating Skid with ball vessel and ball oversize monitor	Completeness, Correctness, Orientation, Dimensions	Major	Visual & Measurement	100%	Approved Drawing	Approved Drawing	Inspection report	*	P	V	V		
	Ball Vessel													
2.1.0	Raw Material													
[a]	Housing Shell, Nozzle flanges and dished end	Chemical properties & Physical properties	Major	Chemical Analysis & Mechanical test	One sample/heat	Approved drg/Data sheet	Approved drg/Data sheet	Mill Test Certificate / lab test report / raw material flow sheet	*	P	V	V		
		Surface defects	Minor	Visual	100%	Approved drg/Data sheet	Approved drg/Data sheet	Mill TC/Inspection report	*	P	V	V		
		Sub-surface defects	Major	Ultrasonic test	100%	ASME SA 435	ASME SA 435	Inspection report	–	P	V	V	Plates > 20mm Thk only (UT - Full Volume)	
2.2.0	**Inprocess Quality Control**													
2.2.1	Welding procedure specification	Correctness	Critical	Scrutiny	100%	ASME Sec.IX	ASME Sec.IX	QW 482 of ASME Sec.IX	*	P	V	V		
2.2.2	Welding procedure qualification	Weld soundness	Critical	Physical test	100%	ASME Sec.IX	ASME Sec.IX	QW 483 of ASME Sec.IX	*	P	V	V	Welding procedure already approved by BHEL/LRQA/GL/DNV/TUV shall be employed for this job.	
2.2.3	Welder performance qualification	Weld soundness	Critical	Radiography	100%	ASME Sec.IX	ASME Sec.IX	QW 484 of ASME Sec.IX	*	P	V	V	Welders already qualified by BHEL/LRQA/GL/DNV/TUV shall be employed for this job.	
2.2.4	Dished end for ball vessel	Dimensions	Major	Template	100%	Manufacturing Drawing	ASME Sec VIII Div.1	Inspection report	–	P	V	V		
		Surface defects	Critical	Penetrant test	100%	ASME Sec VIII Div.1	ASME Sec VIII Div.1 Appendix 8	Inspection report	–	P	V	V		
			LEGEND											
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Manufacturer / Sub-Contractor		Contractor	Indicate : "P" - Perform, "W" - Witness and "V" - Verification											
Signature								Reviewed By		Name & Sign. Of approving authority & Seal				

Manufacturer's Name & Address	STANDARD QUALITY PLAN		BHEL Doc No.:	PE-QP-999-165-N008
		Vendor Q.P. NO:	PROJECT:	
P.O. No.	Item : Ball Vessel & Ball Injection Pipe	PACKAGE : COLTCS	CUSTOMER:	
		Date :	PURCHASER:	
		Page 08 of 15	CONSULTANT:	

Sl. No.	Component / Operation	Characteristics Checked	Class	Type of Check	Quantum of Check	Reference Documents	Acceptance Norms	Format of Record	D*	Agency M	Agency C	Agency O	Remarks
1	2	3	4	5	6	7	8	9	D*	**	10		11
2.2.5	Fit-up of butt weld	Alignment.and dimensions	Major	Measurement	100%	Manufacturing Drawing	ASME Sec VIII Div.1	Log book	--	P	W/V	--	BHEL to witness >20mm thick butt joint.
2.2.6	Fit-up of shell flange and nozzle assembly to shell	Orientation,alignment and dimensions	Major	Template, visual	100%	Manufacturing Drawing	ASME Sec VIII Div.1	Log book	--	P	--	--	
2.2.7	**Weld quality for Pressure Parts**												
	[a] Root run	Surface defects	Major	Penetrant test / Visual	100%	ASME Sec.VIII Div.1	ASME Sec.VIII Div.1 Appendix 8	Operation Process Sheet	*	P	V	V	
2.2.8	[a] Completed butt welds	1.Surface defects	Major	Penetrant test	100%	ASME Sec.VIII Div.1	ASME Sec.VIII Div.1 Appendix 8	Inspection report	*	P	V	V	
		2.Sub-surface defects	Critical	Radiography test	10% of total weld length & 100% T Joints	ASME Sec.VIII Div.1	ASME Sec.VIII Div.1 Appendix 4 / UW 52	Radiographs and inspection report	*	P	V	V	RT films will be reviewed by BHEL
	[b] Completed fillet welds	Surface defects	Major	Penetrant test	100%	ASME Sec.VIII Div.1	ASME Sec.VIII Div.1 Appendix 8	Inspection report	*	P	V	V	
2.2.9	Fabricated Shell	1.Dimensions, Orientation	Major	Measurement	100%	Manufacturing Drawing	Manufacturing Drawing	Inspection report	*	P	V	V	
		2. Hydro test for Ball Vessel	Critical	Hydrostatic Pr. @ 1.5 times design pr. (positive) [Duration 30 minutes]	100%	ASME Sec.VIII Div.1	No leakage	Inspection report	*	P	W	V	Hydrostatic test shall be conducted along with Recirculating skid Assly for Ball Vessel.
2.2.10	Pickling and Passivation	Protection Layer	Major	Visual	100%	IS : 10117	IS : 10117	Log Book		P	--	--	
2.2.11	**Ball Injection Pipe**	Chemical & Physical properties	Major	Chemical & mechanical tests	One sample/heat	Approved drg/Data sheet	Approved drg/Data sheet	Mill Test Certificate / lab test report / raw material flow sheet	*	P	V	V	
		Surface defects	Minor	Visual	100%	Approved drg/ Data sheet	Approved drg/ Data sheet	MTC / Inspection report	--	P	V	V	
		Leak Tightness	Major	Hydrostatic test	100%	Approved drg/Data sheet	Approved drg/Data sheet	Manufacturer's Test Certificate	*	P	V	V	

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		Manufacturer's Name & Address			STANDARD QUALITY PLAN				BHEL Doc No.:				PE-QP-999-165-N008
							Vendor Q.P. NO:		PROJECT:				
		P.O. No.			Item : RECIRCULATING PUMP		PACKAGE : COLTCS		CUSTOMER:				
							Date :		PURCHASER:				
							Page 9 of 15		CONSULTANT:				

Sl. No.	Component / Operation	Characteristics Checked	Class	Type of Check	Quantum of Check	Reference Documents	Acceptance Norms	Format of Record		Agency			Remarks
										M	C	O	
1	2	3	4	5	6	7	8	9	D*	**	10		11
2.3.0	**Raw material control**												
2.3.1	Casing	Chemical,Physical properties	Major	Chemical & Physical analysis	One Sample/Cast / Heat	Approved drg/ Data sheet	Approved drg/ Data sheet	Manufacturer's Test Certificate	*	P	V	V	
		Surface defects	Minor	Visual	100%	Approved drg/ Data sheet	Approved drg/ Data sheet	MTC / Inspection report	–	P	V	V	
2.3.2	Impeller, Sleeve	Physical,and Chemical properties	Major	Physical and Chemical analysis	One Sample/Cast / Heat	Approved drg/ Data sheet	Approved drg/ Data sheet	Manufacturer's Test Certificate	*	P	V	V	
2.3.3	Shaft	Physical,and Chemical properties	Major	Physical and Chemical analysis	One Sample/Cast / Heat	Approved drg/ Data sheet	Approved drg/ Data sheet	Manufacturer's Test Certificate	*	P	V	V	
		Sub-Surface defects	Major	Ultrasonic Test	100%	ASME SA 745	ASME SA 745	MTC / Inspection report	*	P	V	V	Only for shaft >= 50mm
2.3.4	**In-process control**												
2.3.5	Casing	Leak tightness	Critical	Hydro,test @ 1.5times design pr. (positive) (Duration 30 minutes)	100%	Manufacturing Standard	No Leakage	Inspection report	*	P	V	V	
2.3.6	Shaft	Surface defects	Critical	Penetrant test	100%	ASME Sec.VIII Div.1	ASME Sec.VIII Div.1 Appendix 8	Inspection report	*	P	V	V	
2.3.7	Impeller	Residual,static, dynamic unbalance	Major	Static,dynamic balancing	100%	ISO:1940	ISO:1940, Gr 6.3	Inspection report	*	P	V	V	
2.3.8	All components	Workmanship, finish and dimensions	Major	Measurement, visual examination	100%	Manufacturing drawing	Manufacturing drawing	Log book / job card	–	P	--	–	
2.3.9	**Assembly, control, final inspection / test**												
	Performance Test	a) Q Vs. Head, Q Vs. Pumps efficiency / overall efficiency, Q Vs. Power, Vibration and Noise	Critical	Performance test	100%	Approved curve, approved data sheet, IS:5120	Approved data sheet	Inspection report, plotted curves	*	P	V	V	
		b) Dimensions, workmanship and finish	Major	Measurement, visual	100%	Data sheet	Data sheet						
		c) Noise level	Major	–	–	–	85 db at 1 meter distance						
2.3.10	Complete pump	Completeness, correctness, cleanliness	Major	Visual examination	100%	Approved data sheet / Mfg. Drg.	Approved data sheet / Mfg. Drg.	Check list / inspection report	*	P	V	V	

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Manufacturer / Sub-Contractor	Contractor	Reviewed By	Name & Sign. Of approving authority & Seal
Signature			

		Manufacturer's Name & Address			STANDARD QUALITY PLAN				BHEL Doc No.:				PE-QP-999-165-N008	
		P.O. No.			Item : BALL VALVES		Vendor Q.P. NO:		PROJECT:					
							PACKAGE : COLTCS		CUSTOMER:					
							Date :		PURCHASER:					
							Page 10of 15		CONSULTANT:					

Sl. No.	Component / Operation	Characteristics Checked	Class	Type of Check	Quantum of Check	Reference Documents	Acceptance Norms	Format of Record		Agency				Remarks
										M	C	O		
1	2	3	4	5	6	7	8	9	D*	**	10			11
2.4.0	**Ball valves**													
2.4.1	**Materials**													
	Body and Tail end pieces	Chemical,Physical properties	Major	Chemical & Physical analysis	One Sample/Cast / heat	Approved drg/ Data sheet	Approved drg/ Data sheet	Manufacturer's T.C.	*	P	V	V		
2.4.2	Ball	Chemical,Physical properties	Major	Chemical & Physical analysis	One Sample/Cast / heat	Approved drg/ Data sheet	Approved drg/ Data sheet	Manufacturer's T.C.	*	P	V	V		
2.4.3	Stem	Chemical,Physical properties	Major	Chemical & Physical analysis	One Sample/Cast / heat	Approved drg/ Data sheet	Approved drg/ Data sheet	Manufacturer's T.C.	*	P	V	V		
2.4.4	**In-process inspection**													
2.4.5	Machining of body, end, pieces, ball	Dimension	Major	Measurement	100%	Approved drg/Data sheet	Approved drg/Data sheet	Log book	–	P	V	V		
2.4.6	Ball	a) Surface defects	Critical	Penetrant test	100%	ASME Sec.VIII Div.1	ASME Sec.VIII Div.1 Appendix 8	Inspection report	*	P	V	V		
		b) Hardness	Major	Hardness testing	Random	Approved drg/Data sheet	Approved drg/Data sheet	Inspection report	*	P	V	V		
2.4.7	**Assembly**	a) Dimensions	Major	Measurement	100%	EN ISO 17292	EN ISO 17292	Manufacturer's T.C.	*	P	V	V		
		b) Opening / Closing	Major	Operation	100%	—	As per approved data sheet	–	–	P	V	V		Test at works for opening / closing time of actuator operated valves.
2.4.8	**Testing**													
	[a] Body	Leakage	Critical	Hydraulic test	100%	EN 12266-1&2/API 598/Appd data sheet	EN 12266-1&2/API 598 & Appd. Data sheet	Manufacturer's T.C.	*	P	V	V		
	[b] Seat test	Leakage	Critical	Hydraulic test	100%	EN 12266-1&2/API 598/Appd data sheet	EN 12266-1&2/API 598 & Appd. Data sheet	Manufacturer's T.C.	*	P	V	V		
	[c] Seat	Leakage	Critical	Air test	100%	EN 12266-1&2/API 598/Appd data sheet	EN 12266-1&2/API 598 & Appd. Data sheet	Manufacturer's T.C.	*	P	V	V		

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Manufacturer / Sub-Contractor	Contractor	Reviewed By	Name & Sign. Of approving authority & Seal
Signature			

		Manufacturer's Name & Address			STANDARD QUALITY PLAN				BHEL Doc No.:				PE-QP-999-165-N008
							Vendor Q.P. NO:		PROJECT:				
		P.O. No.			Item : RECIRCULATING PUMP MOTOR		PACKAGE : COLTCS		CUSTOMER:				
					V PIECE		Date :		PURCHASER:				
							Page 11 of 15		CONSULTANT:				

Sl. No.	Component / Operation	Characteristics Checked	Class	Type of Check	Quantum of Check	Reference Documents	Acceptance Norms	Format of Record		Agency M	Agency C	Agency O	Remarks
1	2	3	4	5	6	7	8	9	D*	**	10		11
2.5.0	**Motor**	Routine test, No Load test & IR	Major	Electrical test	100% test	IS:325	IS:325	Manufacturer test certificate	*	P	V	V	Review of supplier TC
		Make , Rating	Major	Verification	100%	Appd drg/Data sheet	Appd drg/Data sheet	Inspection report	*	V	V	V	
		Degree of Protection	Critical	Verification	Type test	IP 55	IP 55	Manufacturer's test Certificate	*	V	V	V	
3.1.0	**V - Piece**												
	Raw material inspection	Chemical & Physical properties	Major	Chemical & mechanical tests	One sample/heat	Approved drg/Data sheet	Approved drg/Data sheet	Mill Test Certificate / lab test report / raw material flow sheet	*	P	V	V	
	In process inspection	b) Surface defects	Major	Visual	100%	Approved drg/ Data sheet	Approved drg/ Data sheet	MTC / Inspection report	*	P	V	V	
		c)Sub-surface defects	Critical	Radiography test	10% of total butt weld length	ASME Sec.VIII Div.1	ASME Sec.VIII Div.1 Appendix 4	Radiographs and inspection report	*	P	V	V	
		d) Hydro Static Test	Critical	Hydrostatic Pr. @ 1.5 times design pr. (positive) [Duration 30 minutes]	100%	ASME Sec.VIII Div.1	No leakage	Inspection report	*	P	V	V	

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Manufacturer / Sub-Contractor	Contractor		Reviewed By	Name & Sign. Of approving authority & Seal
Signature				

		Manufacturer's Name & Address			STANDARD QUALITY PLAN				BHEL Doc No.:				PE-QP-999-165-N008	
							Vendor Q.P. NO:		PROJECT:					
		P.O. No.			Item : BaIII Monitoring System (Ball Oversize Monitor)		PACKAGE : COLTCS		CUSTOMER:					
							Date :		PURCHASER:					
							Page 12 of 15		CONSULTANT:					

Sl. No.	Component / Operation	Characteristics Checked	Class	Type of Check	Quantum of Check	Reference Documents	Acceptance Norms	Format of Record		Agency				Remarks
										M	C	O		
1	2	3	4	5	6	7	8	9	D*	**	10			11
4.1.0	**Raw Material** Housing shell, Flanges	Chemical properties	Major	Chemical Analysis	One sample/heat	Approved drg/Data sheet	Approved drg/Data sheet	Mill test Certificate / lab test report/raw material flow sheet	*	P	V	V	if fabricated type	
		Physical properties	Major	Physical test	One sample / cast/heat/ batch	Approved drg/Data sheet	Approved drg/Data sheet	Mill test Certificate / lab test report/raw material flow sheet	*	P	V	V		
		Surface defects	Minor	Visual	100%	Approved drg/Data sheet	Approved drg/Data sheet	Mill Test Certificate/Inspection report	*	P	V	V		
		Sub-surface defects	Major	Ultrasonic test	100%	ASME SA 435	ASME SA 435	Mill Test Certificate	*	P	V	V	Plates > 20mm Thk only (UT - Full Volume)	
4.2.0	**Inprocess Quality Control**													
4.2.1	Welding procedure specification	Correctness	Critical	Scrutiny	100%	ASME Sec.IX	ASME Sec.IX	QW 482 of ASME Sec.IX	*	P	V	V		
4.2.2	Welding procedure qualification	Weld soundness	Critical	Physical test	100%	ASME Sec.IX	ASME Sec.IX	QW 483 of ASME Sec.IX	*	P	V	V	Welding procedure already approved by BHEL/LRQA/GL/DNV/TUV shall be employed for this job.	
4.2.3	Welder performance qualification	Weld soundness	Critical	Radiography	100%	ASME Sec.IX	ASME Sec.IX	QW 484 of ASME Sec.IX	*	P	V	V	Welders already qualified by BHEL/LRQA/GL/DNV/TUV shall be employed for this job.	
4.2.4	Fabricated Shell	1.Surface defects (fillet welds)	Major	Penetrant test	100%	ASME Sec.VIII Div.1	ASME Sec.VIII Div.1 Appendix 8	Inspection report	*	P	V	V		
		2.Dimensions, Orientation	Major	Measurement by visual	100%	Approved doc./ Data sheet	Approved documents / Data sheets	Inspection report	*	P	V	V		
		3. Hydro test	Critical	Hydrostatic Pr. @ 1.5 times design pr. (positive) [Duration 30 minutes]	100%	ASME Sec.VIII Div.1	No leakage	Inspection report	*	P	W	V	Hydrostatic test shall be conducted alongwith Recirculating skid assembly	
		4. Functional Test	Major	Functional	100%	Approved procedure	Approved procedure	–	–	P	V	V	Functional test to be done at site	

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Signature				

		Manufacturer's Name & Address			**STANDARD QUALITY PLAN**				BHEL Doc No.:				PE-QP-999-165-N008	
							Vendor Q.P. NO:		PROJECT:					
					Item : Pressure Gauge, DP Gauge, DP Switch, DP Transmitter		PACKAGE : COLTCS		CUSTOMER:					
		P.O. No.					Date :		PURCHASER:					
									CONSULTANT:					
					Cleaning Balls									
					All components & Equipments		Page 13 of 15		**PACKAGE : COLTCS**					

Sl. No.	Component / Operation	Characteristics	Class	Type of	Quantum of	Reference	Acceptance	Format of		Agency			Remarks
		Checked		Check	Check	Documents	Norms	Record		M	C	O	
1	2	3	4	5	6	7	8	9	D*	**	10		11
5.0.0	**In process quality control**	Make, Range and Model	Critical	Visual	100%	Approved Data Sheet	Approved Data Sheet	Manufacturer test certificate	*	P	V	V	
		Calibration	Critical	Calibration test	100%	Approved Data Sheet	Approved Data Sheet	Manufacturer test certificate	*	V	V	V	
		Degree of Protection	Critical	-	Type.Test Certificate	Approved Data Sheet	Approved Data Sheet	Manufacturer test certificate	*	V	V	V	For Pressure guage, DP Guage, DP Switch
6.0.0	**Cleaning Balls**												
	-- Normal balls -- Abrasive balls	Dimensions	Critical	Measurement	Random	Approved Data Sheet	Approved Data Sheet	Manufacturer's test certificate	*	P	V	V	Quantity and type of balls to be checked with datasheets
		Type											
		Size											
7.0.0	**All Components / Equipments**	Painting Dry film thickness and visual	Major	Measurement	Random	Painting schedule	Painting schedule	Inspection report	*	P	V	V	
		Packing	Major	Measurement	100%	MFG. Procedure	MFG. Procedure	Inspection report	*	P	V	_	

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Signature				

		Manufacturer's Name & Address			STANDARD QUALITY PLAN					BHEL Doc No.:				PE-QP-999-165-N008
					Item : Starter Panel		Vendor Q.P. NO:			PROJECT:				
							PACKAGE : COLTCS			CUSTOMER:				
		P.O. No.					Date :			PURCHASER:				
							Page 14 of 15			CONSULTANT:				
Sl. No.	Component / Operation	Characteristics Checked	Class	Type of Check	Quantum of Check	Reference Documents	Acceptance Norms	Format of Record		Agency M	Agency C	Agency O	Remarks	
1	2	3	4	5	6	7	8	9		**	10		11	
8.0.0	**Starter panel**													
08.1.0	**Incoming Material**													
08.1.1	Fabricated & Painted Panel	Dimension	Major	Measurement	100%	Approved Drgs.	Approved Drgs.	Inspection report	_	P	--	--		
		Panel G.A.	Major	Measurement	100%	Approved Drgs.	Approved Drgs.	Inspection report	_	P	--	--		
		Paint colour	Major	Visual	100%	Approved Drgs.	Approved Drgs.	Inspection report	_	P	--	--		
		Paint thickness	Major	Measurement	100%	Approved Drgs.	Approved Drgs.	Inspection report	_	P	--	--		
		Paint Shade, Adhesion	Major	Visual	Sample	Approved Drgs.	Approved Drgs.	Inspection report	_	P	--	--		
08.1.2	Wire	Size / Colour / Rating / Surface Defects	Major	Visual / Dimension	Sample	IS 694	Specification / drawings	Inspection report	_	P	--	--	ISI Marked wire	
08.1.3	Panel Mounting	Make, Functional, Type & Rating	Major	Visual / Electrical	100%	Approved BOM	Approved BOM	---		P	V	V		
08.2.0	**In Process Inspection**													
10.2.1	Name Plate, Component Mounting, Etc.	Workmanship, Finish, Correctness	Major	Visual	100%	Approved Drgs.	Approved drawings	Inspection report	_	P	--	--		
08.2.2	Electrical Wiring of Panels	Continuity, Colour of wires, Bunching and Grouping	Major	Visual	100%	Mounting Drawing	Approved drawings	Inspection report	_	P	--	--		
08.2.3	Ferruling of Cables	Start & End	Major	Visual	100%	Manufacturer's drawing	Manufacturer's drawing	Inspection report	_	P	--	--		
08.3.0	**Final Inspection**									P	--	--		
08.3.1	Workmanship, Finish & Paint shade / Thickness	Visual	Major	Visual	100%	G.A Drawing	Approved drgs.	Inspection report	*	P	W	V		
08.3.2	Overall Dimension, G.A of starter panel	Measurement	Major	Visual	100%	G.A Drawing	Approved drgs.	Test Certificate	_	P	W	V		
08.3.3	Component Identification	Visual	Major	Visual	100%	G.A Drawing	Approved drgs.	Inspection report	_	P	W	V		
08.3.4	Degree of Protection	Ingress Protection IP55	Critical	Environmental	Verification	Approved drgs.	IS 2147	Inspection Report		P	V	V	for enclosure	
08.3.5	IR - HV - IR	Electrical	Critical	Electrical	100%	Approved Procedure	Approved Pocedure	Inspection report	_	P	V	V		
08.3.6	Functional & Continuity	Functional	Major	Functional	100%	Appd Drawing	Appd Drawing	Inspection report	*	P	W	W		

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Manufacturer / Sub-Contractor	Contractor	Name & Sign. Of approving authority & Seal
Signature		

Manufacturer's Name & Address	**STANDARD QUALITY PLAN**	BHEL Doc No.:	PE-QP-999-165-N008
	Vendor Q.P. NO:	PROJECT:	
P.O. No.	Item : FASTENERS	PACKAGE : COLTCS	CUSTOMER:
		Date :	PURCHASER:
		Page 15 of 15	CONSULTANT:

Sl. No.	Component / Operation	Characteristics Checked	Class	Type of Check	Quantum of Check	Reference Documents	Acceptance Norms	Format of Record		Agency			Remarks
										M	C	O	
1	2	3	4	5	6	7	8	9	D*	**	10		11
9.1.0	**Internal Fasteners (Duplex Steel)**	Chemical & Physical properties	Major	Chemical & Mechanical analysis	1 Per heat/HT Batch	Approved drg/Data sheet	Approved drg/Data sheet	Mfr TC / Lab report	*	P	V	V	
		Visual & workmanship finish	Major	Visual	Sample	Approved drg/Data sheet	Approved drg/Data sheet		_	P	V	V	
		Dimensions	Major	Measurement	Sample	Approved drg/Data sheet	Approved drg/Data sheet		_	P	V	V	
9.2.0	**Main Fasterners**	Visual	Major	Visual	Sample	Approved drg/Data sheet	Approved drg/Data sheet	Inspection report / Mfr TC	*	P	V	V	
		Dimensions	Major	Measurement	Sample	Approved drg/Data sheet	Approved drg/Data sheet	Inspection report / Mfr TC	*	P	V	V	
		Chemical & Physical properties	--	Chemical & Physical test a) Tensile b) Yield c) Elongation d) Proof load	1 sample per heat	Approved drg/Data sheet	Approved drg/Data sheet	Mfr TC/Lab report	*	P	V	V	

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Manufacturer / Sub-Contractor	Contractor		
Signature		Reviewed By	Name & Sign. Of approving authority & Seal

SECTION D2

STANDARD TECHNICAL SPECIFICATION FOR ELECTRICAL SYSTEMS

GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

SPECIFICATION NO.: PE-SS-999-506-E101 Rev 00

1.0 INTENT OF SPECIFIATION

The specification covers the design, materials, constructional features, manufacture, inspection and testing at manufacturer's work, and packing of Low voltage (LV) squirrel cage induction motors along with all accessories for driving auxiliaries in thermal power station.

Motors having a voltage rating of below 1000V are referred to as low voltage (LV) motors.

2.0 CODES AND STANDARDS

Motors shall fully comply with latest edition, including all amendments and revision, of following codes and standards:

IS:325	Three phase Induction motors
IS : 900	Code of practice for installation and maintenance of induction motors
IS: 996	Single phase small AC and universal motors
IS: 4722	Rotating Electrical machines
IS: 4691	Degree of Protection provided by enclosures for rotating electrical machines
IS: 4728	Terminal marking and direction of rotation rotating electrical machines
IS: 1231	Dimensions of three phase foot mounted induction motors
IS: 8789	Values of performance characteristics for three phase induction motors
IS: 13555	Guide for selection and application of 3-phase A.C. induction motors for different types of driven equipment
IS: 2148	Flame proof enclosures for electrical appliance
IS: 5571	Guide for selection of electrical equipment for hazardous areas
IS: 12824	Type of duty and classes of rating assigned
IS: 12802	Temperature rise measurement for rotating electrical machnines
IS: 12065	Permissible limits of noise level for rotating electrical machines
IS: 12075	Mechanical vibration of rotating electrical machines

In case of imported motors, motors as per IEC-34 shall also be acceptable.

3.0 DESIGN REQUIREMENTS

3.1 Motors and accessories shall be designed to operate satisfactorily under conditions specified in data sheet-A and Project Information, including voltage & frequency variation of supply system as defined in Data sheet-A

3.2 Motors shall be continuously rated at the design ambient temperature specified in Data Sheet-A and other site conditions specified under Project Information
Motor ratings shall have at least a 15% margin over the continuous maximum demand of the driven equipment, under entire operating range including voltage & frequency variation specified above.

3.3 Starting Requirements

3.3.1 Motor characteristics such as speed, starting torque, break away torque and starting time shall be properly co-ordinated with the requirements of driven equipment. The accelerating torque at any speed with the minimum starting voltage shall be at least 10% higher than that of the driven equipment.

3.3.2 Motors shall be capable of starting and accelerating the load with direct on line starting without exceeding acceptable winding temperature.

The limiting value of voltage at rated frequency under which a motor will successfully start and accelerate to rated speed with load shall be taken to be a constant value as per Data Sheet - A during the starting period of motors.

3.3.3 The following frequency of starts shall apply

i) Two starts in succession with the motor being initially at a temperature not exceeding the rated load temperature.

ii) Three equally spread starts in an hour the motor being initially at a temperature not exceeding the rated load operating temperature. (not to be repeated in the second successive hour)

iii) Motors for coal conveyor and coal crusher application shall be suitable for three consecutive hot starts followed by one hour interval with maximum twenty starts per day and shall be suitable for mimimum 20,000 starts during the life time of the motor

3.4 **Running Requirements**

3.4.1 Motors shall run satisfactorily at a supply voltage of 75% of rated voltage for 5 minutes with full load without injurious heating to the motor.

3.4.2 Motor shall not stall due to voltage dip in the system causing momentary drop in voltage upto 70% of the rated voltage for duration of 2 secs.

3.5 **Stress During bus Transfer**

3.5.1 Motors shall withstand the voltage, heavy inrush transient current, mechanical and torque stress developed due to the application of 150% of the rated voltage for at least 1 sec. caused due to vector difference between the motor residual voltage and the incoming supply voltage during occasional auto bus transfer.

3.5.2 Motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torque under above condition.

3.6 Maximum noise level measured at distance of 1.0 metres from the outline of motor shall not exceed the values specified in IS 12065.

3.7 The max. vibration velocity or double amplitude of motors vibration as measured at motor bearings shall be within the limits specified in IS: 12075.

4.0 **CONSTRUCTIONAL FEATURES**

4.1 Indoor motors shall conform to degree of protection IP: 54 as per IS: 4691. Outdoor or semi-indoor motors shall conform to degree of protection IP: 55 as per IS: 4691and shall be of weather-proof construction. Outdoor motors shall be installed under a suitable canopy

4.2 Motors upto 160KW shall have Totally Enclosed Fan Cooled (TEFC) enclosures, the method of cooling conforming to IC-0141 or IC-0151 of IS: 6362.

Motors rated above 160 KW shall be Closed Air Circuit Air (CACA) cooled

4.3 Motors shall be designed with cooling fans suitable for both directions of rotation.

4.4. Motors shall not be provided with any electric or pneumatic operated external fan for cooling the motors.

4.5 Frames shall be designed to avoid collection of moisture and all enclosures shall be provided with facility for drainage at the lowest point.

4.6 In case Class 'F' insulation is provided for LV motors, temperature rise shall be limited to the limits applicable to Class 'B' insulation.
In case of continuous operation at extreme voltage limits the temperature limits specified in table-1 of IS:325 shall not exceed by more than 10°C.

4.7 **Terminals and Terminal Boxes**

4.7.1 Terminals, terminal leads, terminal boxes, windings tails and associated equipment shall be suitable for connection to a supply system having a short circuit level, specified in the Data Sheet-A.

Unless otherwise stated in Data Sheet-A, motors of rating 110 kW and above will be controlled by circuit breaker and below 110 kW by switch fuse-contactor. The terminal box of motors shall be designed for the fault current mentioned in data sheet "A".

4.7.2 unless otherwise specified or approved, phase terminal boxes of horizontal motors shall be positioned on the left hand side of the motor when viewed from the non-driving end.

4.7.3 Connections shall be such that when the supply leads R, Y & B are connected to motor terminals A B & C or U, V & W respectively, motor shall rotate in an anticlockwise direction when viewed from the non-driving end. Where such motors require clockwise rotation, the supply leads R, Y, B will be connected to motor terminals A, C, B or U W & V respectively.

4.7.4 Permanently attached diagram and instruction plate made preferably of stainless steel shall be mounted inside terminal box cover giving the connection diagram for the desired direction of rotation and reverse rotation.

4.7.5 Motor terminals and terminal leads shall be fully insulated with no bar live parts. Adequate space shall be available inside the terminal box so that no difficulty is encountered for terminating the cable specified in Data Sheet-A.

4.7.6 Degree of protection for terminal boxes shall be IP 55 as per IS 4691.

4.7.7 Separate terminal boxes shall be provided for space heaters.. If this is not possible in case of LV motors, the space heater terminals shall be adequately segregated from the main terminals in the main terminal box. Detachable gland plates with double compression brass glands shall be provided in terminal boxes.

4.7.8. Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 90 degree for LV motors.

4.7.9 Cable glands and cable lugs as per cable sizes specified in Data Sheet-A shall be included. Cable lugs shall be of tinned Copper, crimping type.

4.8 Two separate earthing terminals suitable for connecting G.I. or MS strip grounding conductor of size given in Data Sheet-A shall be provided on opposite sides of motor frame. Each terminal box shall have a grounding terminal.

4.9 **General**

4.9.1 Motors provided for similar drives shall be interchangeable.

4.9.2 Suitable foundation bolts are to be supplied alongwith the motors.

4.9.3 Motors shall be provided with eye bolts, or other means to facilitate safe lifting if the weight is 20Kgs. and above.

4.9.4 Necessary fitments and accessories shall be provided on motors in accordance with the latest Indian Electricity rules 1956.

4.9.5 All motors rated above 30 kW shall be provided with space heaters to maintain the motor internal air temperature above the dew point. Unless otherwise specified, space heaters shall be suitable for a supply of 240V AC, single phase, 50 Hz.

4.9.6 Name plate with all particulars as per IS: 325 shall be provided

4.9.7 Unless otherwise specified, the colour of finish shall be grey to Shade No. 631 and 632 as per IS:5 for motors installed indoor and outdoor respectively. The paint shall be epoxy based and shall be suitable for withstanding specified site conditions.

5.0 INSPECTION AND TESTING

5.1 All materials, components and equipments covered under this specification shall be procured, manufactured, as per the BHEL standard quality plan No. PED-506-00-Q-006/0 and PED-506-00-Q-007/2 enclosed with this specification and which shall be complied.

5.2 LV motors of type-tested design shall be provided. Valid type test reports not more than 5 year shall be furnished. In the absence of these, type tests shall have to be conducted by manufacturer without any commercial implication to purchaser.

5.3 All motors shall be subjected to routine tests as per IS: 325 and as per BHEL standard quality plan.

5.4 Motors shall also be subjected to additional tests, if any, as mentioned in Data Sheet A.

6.0 DRAWINGS TO BE SUBMITTED AFTER AWARD OF CONTRACT

a) OGA drawing showing the position of terminal boxes, earthing connections etc.
b) Arrangement drawing of terminal boxes.
c) Characteristic curves:
(*To be given for motor above 55 kW unless otherwise specified in Data Sheet*).

i) Current vs. time at rated voltage and minimum starting voltage.
ii) Speed vs. time at rated voltage and minimum starting voltage.
iii) Torque vs. speed at rated voltage and minimum voltage.
For the motors with solid coupling the above curves i), ii), iii) to be furnished for the motors coupled with driven equipment. In case motor is coupled with mechanical equipment by fluid coupling, the above curves shall be furnished with and without coupling.
iv) Thermal withstand curve under hot and cold conditions at rated voltage and max. permissible voltage.

CLAUSE NO.	LT SWITCHGEAR (Starter Panel).	
1.00.00	CODES AND STANDARDS	
	IEC 947, IS 13947	
2.00.00	TYPE	
	Circuit Breakers	Shall be air break, three pole, spring charged, horizontal drawout type, suitable for electrical operation.
	Switchgear	Fully drawout type single front
	MCC	Fully drawout type single front/Double front.
	ACDB/DCDB	Fixed type single front
3.00.00	SYSTEM PARAMETERS	
	415VAC +/- 10 % (SOLIDLY GROUNDED)	
	50 Hz +3%/-5%	
	45KA RMS / 1 SEC (FAULT LEVEL)	
	220V DC NOMINAL (190V DC-240V DC) ISOLATED TYPE	
4.00.00	TEMPERATURE RISE	
	The temperature rise of the horizontal and vertical busbars and main bus link including all power drawout contacts when carrying 90% of the rated current along the full run shall in no case exceed 55 deg. C with silver plated joints and 40 deg. C with all other types of joints over an ambient of 50 deg C.	
5.00.00	OPERATIONAL REQUIREMENTS	
5.01.00	Breakers	
5.01.01	Breakers shall have anti-pumping feature.	
5.01.02	The incomer and bus coupler breakers for switchgear shall be electrically operated with over current releases or relays.	
5.01.03	Breakers shall have inherent fault making and breaking capacities. They shall have shunt trip coils. In case releases are offered, the same shall have contact for energisation of lockout relay. All breakers Shall have built in interlocks for equipment and personnel safety.	
5.01.04	Paralleling of two supplies shall be avoided by interlocking except for switchgear where auto-changeover is provided. Breaker contact multiplication, if required, shall be through latch relay	

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.01.05	Mechanical tripping shall be through red 'Trip' push button outside the panels for breakers, and through control swtiches for other circuits.
.01.06	Provision of mechanical closing of breaker only in 'Test' and 'Withdrawn' position shall be made. Alternatively, mechanical closing facility should be normally inaccessible, accessibility rendered only after deliberate removal of shrouds.It shall be possible to close the door with breaker in test position.
.07	Clear status indication for each circuit shall be provided through lamps, switch positions or other mechanical means.
.01 08	Supervision relay shall be provided for trip coil monitoring.
.02.00	Switches, Contactors and Fuses
.02.01	Incomers for MCCs and DBs rated upto 630A could be load break isolators.
.02.02	Motor starter contactors shall be of air break, electromagnetic type suitable for DOL starting of motor, and shall be of utilisation category AC-3 for ordinary and AC-4 for reversing starters. DC contactor shall be of DC-3 utilisation category.
.03	Fuses shall be HRC type with operation indicator. Isolating switches shall be of AC 23A category when used in motor circuit, and AC 22A category for other applications. Fuse switch combination shall be provided wherever possible.
.04	Isolating switches and MCCBs shall have door interlocks and padlocking facility.
.0	Panels
	All switchgears, MCCs, DBs, panels, modules, local starters and push buttons shall have prominent engraved indentification plates.
02	Local push button stations shall have metal enclosure of die cast aluminium or rolled sheet steel of 1.6mm thickness & shall have DOP of IP-55. Push buttons shall be of latch type with mushroom knobs.
03	Where breaker/starter module front serves as compartment cover, suitable blanking covers, one for each size of modules per switchboard shall be supplied for use when carriage is withdrawn.
4	All non-current carrying metal work of boards/panels shall be effectively bonded to earth bus of galavanised steel, extending throughout the switchboard/MCC/DB. Positive earthing shall be maintained for all positions of chassis and breaker frame.
	Suitable trolley arrangement shall be provided for breaker/starter modules. Two trolleys per switchgear room shall be provided so that top most breaker module of all types, sizes and rating can be withdrawn on trolley and lowered for maintenance purpose.
	The incoming connection to transformer of more than 1000KVA and inter-connecting sections between switchboards shall preferably be of busducts.The busduct enclosure

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	shall be made of minimum 3mm thick aluminium alloy. The section of the busduct should have adequate strength to withstand internal and external forces resulting from the various operating conditions. Aluminium sheet hood shall be provided for outdoor busduct enclosure joints to provide additional protection against water ingress. The busduct top shall be sloped to prevent retention of water.The busduct shall have DOP of IP55.
5.03.07	It should be possible to carryout maintenance on a feeder with adjacent feeders alive.
5.04.00	Control, Protection & Metering Requirements
5.04.01	Control circuits shall operate at suitable voltage of 110V AC or 220V DC. Necessary control supply transformers having primary and secondary fuses shall be provided for each MCC, 2 x 100% per section. However the breakers shall operate on 220V DC The auxiliary bus bars for control supply shall be segregated from main bus bars. The control supplies shall be monitored.
5.04.02	Contractor shall fully co-ordinate overload and short circuit tripping of breaker with up-stream and down stream breakers/fuses/MCCBs motor starters. Various equipments shall meet requirement of Type-II class of coordination as per IEC.
5.04.03	All relays and timers shall operate on available DC supply and not have any inbuilt batteries. They shall be provided with hand-reset operation indicator (flags) or LEDs with pushbuttons for resetting.
5.04.04	All equipments shall have necessary protections. However, following minimum protections shall be provided: 1) Contactor controlled motor feeders (Motors up to 160 kW) a) Instantaneous short circuit protection on all phases through HRC cartridge type fuses rated for 80 kA rms (prospective breaking capacity at 415V). b) Thermal overload protection. c) Single phasing protection for motors protected by fuses. 2) Breaker controlled motors feeders (motors rated above 160kW) a) Instantaneous short circuit protection on all phases b) Overload protection on two phases c) Over load alarm on third phase d) Earth fault protection e) Under voltage protection