Note :

1) This is an indicative List of test/checks. The manufacturer is to furnish a detailed Quality Plan indicating his practice and procedure along with relevant supporting documents during QP finalisation for all items.
2) All major Bought Out Items will be subject to Customer approval.

2.5.2.9 LT INDOOR TRANSFORMERS

Attributes / Characteristics / Items/Components Sub Systems	Visual & Dimensional check	Mechanical properties	Electrical strength	Thermal Properties	Chemical Properties	Core Loss*, Hot Spot	NDT / DP / MPI	Voltage Ratio, Vector Group & Polarity	Make / Type / Rating / Model /TC / General Physical Inspection	WPS & PQR	Routine Test as per relevant standard	Measurement of capacitance & tan delta between winding	Routine Test
Enclosure door, H.V. & L.V. Cable Box / Flange Throat	Y	Y							Y				
Copper Conductor	Y	Y	Y		Y								
Insulating Material	Y			Y	Y								
CRGO Lamination & Built Core	Y					Y							
Bushing /Insulator (IS:2544 / 5621)	Y								Y		Y		
Gasket	Y								Y		Y		
Off-Circuit Tap Changer	Y								Y				
Core Coil Assembly	Y							Y					
Marshalling Box	Y												
WTI, Thermister, Terminal Connector	Y								Y				

Welding										Y			
Complete Transformer (IS:11171)	Y											Y	Y

- Core Loss for first Job

Notes: 1) This is an indicative List of test/checks. The manufacturer is to furnish a detailed Quality Plan indicating his practice and procedure along with relevant supporting documents during QP finalisation for all item.

2) All major Bought Out Items will be subject to Customer approval.

2.5.2.10 LT SWITCHGEAR & BUSDUCT

LT SWITCHGEAR (MCC, PCC, ACDB, DCDB, FUSE BOARDS, LOCAL PUSH BUTTON STATION, LOCAL MOTOR STARTERS)														
ATTRIBUTES/ CHARACTERISTICS / ITEMS/ COMPONENTS/ SUB SYSTEM ASSEMBLIY	Make, Model, Type, Rating & TC	Dimensions & Finish	Electrical properties	Mechanical Properties	Chemical properties	Functional & Operational Features as per relevant standard & Spec.	Item to conform to relevant Standards	Pre-treatment as per IS 6005	Paint Shade, Adhesion, Thickness & Finish	Functional Checks	Milli-volt drop Test	IR – HV – IR Test	Degree of Protection Routine test as per relevant standard.	All Routine tests as per spec. & IS
Sheet Steel (IS : 513)	Y	Y		Y	Y		Y							
Aluminium Bus bar Material (IS : 5082)	Y	Y	Y	Y	Y		Y							
Copper Bus bar Material (IS : 613)	Y	Y	Y	Y	Y		Y							
Support Insulator (IS : 9431,IS : 10912, IEC : 660)	Y	Y	Y	Y			Y							

LT SWITCHGEAR (MCC, PCC, ACDB, DCDB, FUSE BOARDS, LOCAL PUSH BUTTON STATION, LOCAL MOTOR STARTERS)														
ATTRIBUTES/ CHARACTERISTICS / ITEMS/ COMPONENTS/ SUB SYSTEM ASSEMBLIY	Make, Model, Type, Rating & TC	Dimensions & Finish	Electrical properties	Mechanical Properties	Chemical properties	Functional & Operational Features as per relevant standard & Spec.	Item to conform to relevant Standards	Pre-treatment as per IS 6005	Paint Shade, Adhesion, Thickness & Finish	Functional Checks	Milli-volt drop Test	IR – HV – IR Test	Degree of Protection Routine test as per relevant standard.	All Routine tests as per spec. & IS
Air Circuit Breaker (IS: 13947)	Y	Y				Y	Y			Y	Y			Y
Energy Meters (IS : 722)	Y	Y				Y	Y			Y				Y
Power & Aux. Contactors (IS : 13947)	Y	Y				Y	Y			Y				Y
Protection & Aux. Relays (IS : 3231)	Y	Y				Y	Y			Y				Y
Control & Selector Switches (IS : 6875)	Y	Y				Y	Y			Y				Y
CT's & PT's (IS 2705 / 3156)	Y	Y					Y							
MCCB (IS : 13947)	Y	Y					Y							
Indicating Meters (IS : 1248)	Y	Y				Y	Y			Y				Y
Indicating Lamps (IS : 13947)	Y	Y				Y	Y			Y				Y
Air Break Switches (IS : 13947)	Y	Y				Y	Y			Y				
Control Terminal Blocks	Y	Y				Y	Y							
Fuse (IS 13703)	Y	Y				Y	Y			Y				
Control Transformer (IS : 12021)	Y	Y				Y	Y			Y				Y

LT SWITCHGEAR
(MCC, PCC, ACDB, DCDB, FUSE BOARDS, LOCAL PUSH BUTTON STATION, LOCAL MOTOR STARTERS)

ATTRIBUTES/ CHARACTERISTICS / ITEMS/ COMPONENTS/ SUB SYSTEM ASSEMBLIY	Make, Model, Type, Rating & TC	Dimensions & Finish	Electrical properties	Mechanical Properties	Chemical properties	Functional & Operational Features as per relevant standard & Spec.	Item to conform to relevant Standards	Pre-treatment as per IS 6005	Paint Shade, Adhesion, Thickness & Finish	Functional Checks	Milli-volt drop Test	IR – HV – IR Test	Degree of Protection Routine test as per relevant standard.	All Routine tests as per spec. & IS
Push Buttons (IS : 4794)	Y	Y				Y	Y			Y				Y
Transducer (IEC : 60688)	Y	Y				Y	Y			Y				Y
MCB (IS : 8828)	Y	Y				Y	Y			Y				Y
Breaker Handling Trolley	Y	Y				Y			Y	Y				Y
Synthetic Rubber Gasket (IS : 11149)	Y	Y		Y	Y		Y							
LT SWITCHGEAR (IS : 8623)	Y	Y				Y	Y	Y	Y		Y	Y	Y	

Notes:This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.

3. Makes of all major Bought Out Items will be subject to Customer approval.

Y – Test Applicable.

LT BUSDUCT

ATTRIBUTES , CHARACTERISTICS / ITEM, COMPONENTS, SUB SYSTEM ASSEMBLY	Dimension & Surface Finish	Make, Type, Rating & TC	Electrical Properties	Mechanical Properties	Chemical Properties	Item to conform to relevant IS	WPS Approval, Welder Qualification	Weld Quality Check (DP test & x-ray Test)	Paint Shade, Thickness, Adhesion & Finish	Tightness by Torque measurement	Electrical Clearances	Galvanizing Test as per IS 2629/ 2633/	IR – HV – IR Test	Phase Sequence Check	Degree of Protection routine test as per relevant standard.
Aluminum Sheets / Plates / Strips / Flexibles / tubes (IS : 5082 / 737)	Y	Y		Y	Y	Y	Y	Y							
CRCA Flats / ISMC (IS 2062)	Y	Y		Y	Y	Y									
Neoprene / Synthetic Rubber Gaskets (IS 11149 / 3400)	Y	Y		Y	Y										
Rubber Bellows (IS : 3400)	Y	Y		Y	Y										
Support Insulator (BS : 2782, IEC : 660, IS : 10912)	Y	Y	Y	Y											
Galvanized Structure & GI Earthing Flat (IS : 2629 / 2633 / 4749)	Y	Y				Y						Y			
Space Heater & Thermostat		Y	Y										Y		
LT Busduct (IS : 8623 PART 2)	Y	Y				Y	Y	Y	Y	Y	Y		Y	Y	Y

Notes:

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. Makes of all major Bought Out Items will be subject to Customer approval.

2.5.2.11 MOTORS

INDUCTION MOTOR & SYNCHRONOUS MACHINE

TESTS/CHECKS / ITEMS/COMPONENTS	Visual	Dimensional	Make/Type/Rating/TC/General Physical Inspection	Mech/Chem. Properties	NDT /DP/MPI/UT	Metallography	Electrical Characteristics	Welding/Brazing(WPS/PQR)	Heat Treatment
Plates for stator frame, end shield, spider etc.	Y	Y	Y	Y					Y
Shaft	Y	Y	Y	Y	Y	Y			Y
Magnetic Material	Y	Y	Y	Y	Y		Y		
Rotor Copper/Aluminium	Y	Y	Y	Y		Y	Y		Y
Stator copper	Y	Y	Y	Y			Y		Y
SC Ring	Y	Y	Y	Y	Y	Y	Y	Y	Y
Insulating Material	Y		Y	Y			Y		
Tubes for Cooler	Y	Y	Y	Y	Y				Y
Sleeve Bearing	Y	Y	Y	Y	Y				Y
Stator/Rotor, Exciter Coils	Y	Y	Y				Y	Y	
Castings, stator frame, terminal box and bearing housing etc.	Y	Y	Y	Y	Y			Y	

Fabrication & machining of stator, rotor, terminal box	Y	Y			Y				Y
Wound stator	Y	Y					Y	Y	
Wound Exciter	Y	Y					Y	Y	
Rotor complete	Y	Y					Y		
Exciter, Stator, Rotor, Terminal Box assembly	Y	Y					Y		
Accessories, RTD, BTD,CT, Brushes, Diodes, Space heater, antifriction bearing, cable glands, lugs, gaskets etc.	Y	Y	Y						
Motor (IS 325 / 4722 / 9283)	Y	Y	Y						

TESTS/CHECKS / ITEMS/COMPONENTS	Magnetic Characteristics	Hydrualic/Leak/Pressure Test	Thermal Characteristics	Run out	Dynamic Balancing	All tests as per IS-325/IS-4722/IS 9283	Vibration	Over speed	Tan delta, shaft voltage & polarisation index test
Plates for stator frame, end shield, spider etc.									
Shaft									
Magnetic Material	Y		Y						
Rotor Copper/Aluminium									
Stator copper			Y						
SC Ring									
Insulating Material			Y						
Tubes for Cooler		Y							
Sleeve Bearing		Y							
Stator/Rotor, Exciter Coils									
Castings, stator frame, terminal box and bearing housing etc.									
Fabrication & machining of stator, rotor, terminal box									
Wound stator									
Wound Exciter									
Rotor complete				Y	Y				
Exciter, Stator, Rotor, Terminal Box assembly									

Accessories, RTD, BTD,CT, Brushes, Diodes, Space heater, antifriction bearing, cable glands, lugs, gaskets etc.									
Motor (IS 325 / 4722)						Y	Y	Y	Y1

Note :

1. This is an indicative list of tests/checks.The manufacture is to furnish a detailed Quality Plan indicating the practices & Procedure followed alongwith relevant supporting documents during QP finalisation. However QP approval is not envisaged for LT motors upto 50 KW.
2. Makes of all major bought out items shall be subject to Customers approval.

Y1 = for HT Motor / Machines only.

Y – Test Applicable

2.5.2.12 VARIABLE FREQUENCY DRIVE

Parameter Description / Component Description	Physical Inspection, Identification Labels & Physical Damages	Physical Inspection, Dimensions, Painting, Cutouts, Lifting Hooks	Locking Arrangements, Components, Drawing Pocket, Paying Accessories	Mounting Accessories, Plinth & AV pads, Cable	Hinges, Louvers & Filters	Physical Inspection	Type No., Rating, Dimensions & Accessories	No Phase, Ratio, Tappings & Rating	Type No., Rating, Dimensions & Accessories	Rating & Wattage	Rating & Wattage	Operation Of The Equipment	Mechanical Completion, Components Mounting	Terminal Block Mounting, Fixing Of Cable	Hardwares Checking, Labeling Of The Equipments,	Point to point Wiring Check	Wire Sizes Used, Wire Colours Used, Ferruling,	Termination Check, Continuity, Check	Power Up Tests & Power, Distribution Test,	VFD Parameterisation
VFD	Y																			
Panel		Y	Y	Y	Y															
Cables, wires						Y														
MCBs							Y													
Control Transformer								Y												
Contactor									Y											
Space Heater										Y										
Thermostat											Y	Y								
Assembled System													Y	Y	Y	Y	Y	Y	Y	Y

Notes :

1) This is an indicative list of tests / checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and procedure along with relevant supporting documents during QP Finalisation for all items.

2) All major Bought Out Items will be subject to Customer approval.

Y – Test Applicable

2.5.2.13 HT CABLES

Attributes / Characteristics / Item / Components / Sub System Assembly	Make, Type, Rating & T.C	Dimension/surface finish	Mechanical properties	Chemical Composition	Curing Properties	Electrical properties	Hot Set Test/ Eccentricity & Ovality	Lay length & Sequence	Armour coverage, cross over, looseness, gap between two wire	Sequential marking/surface finish/ cable length	T.S & elongation before & after ageing on sheath & insulation	Thermal stability on sheath	Anti Termite Test	Constructional requirements feature as per relevant standard & specification	Routine & Acceptance Test as per	FRLS Test
Aluminium (IS-8130)	Y	Y	Y	Y		Y										
Semiconducting Compound	Y		Y		Y	Y										
XLPE Compound (IS-7098 Part-II)	Y		Y		Y	Y					Y					
FRLS PVC Compound (IS-5831, ASTM-D2843, ASTM-2863,IEC-754 Part-1)	Y		Y								Y	Y	Y			Y
Triple Extrusion & curing /Manufacturing of Core							Y	Y								
Copper Tape	Y	Y	Y			Y										
Polyster tape	Y	Y														

Armour wire/strip	Y	Y	Y													
PVC compound(IS-5831)	Y		Y			Y										
Copper tapping																
Inner sheath																
Armouring									Y							
Outer Sheathing										Y	Y	Y	Y	Y		Y
Power Cable (Finished) (IS : 7098 Part II, IEEE : 383, IEC : 332, IS-5831, ASTM-D2843, ASTM-2863,IEC-754 Part-1)	Y							Y	Y	Y	Y	Y	Y	Y	Y	Y
Wooden drum(IS-10418)													Y			

tes:

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.

Make of all major Bought Out Items will be subject to Customer approval.

2.5.2.14 LT POWER CABLES

Attributes / Characteristics / Item / Components / Sub System Assembly	Make, Rating, Type & TC	Dimension/surface finish	Mechanical Properties	Chemical Composition	Electrical Properties	Spark Test	Hot set test (XLPE)	Lay length / Sequence	Armour coverage, Cross over, looseness, Gap between two armour wire/strip	Sequential marking/surface finish /cable length	Tensile strength, elongation before & after ageing of insulation & sheath	Thermal Stability of insulation and sheath *	Anti ternite treatment test	Constructional / requirement as per relevant standards & Spec.	Routine and acceptance test as per Relevant Standard and specification	FRLS Test
Aluminium (IS-8130)	Y	Y	Y	Y	Y											
PVC Compound (IS-5831)	Y		Y		Y						Y					
XLPE Compound (IS-7098 Part-I)	Y		Y		Y		Y				Y					
FRLS PVC Compound (IS-5831)/ASTM-D-2843/ASTM-D-2863 IEC-754 Part-I	Y		Y								Y					Y
Armour wire/ Formed wire (IS-3975)	Y	Y	Y													
Insulated Core		Y				Y	Y	Y				Y				
Laid up core		Y														
PVC Inner sheath		Y														
Armouring		Y							Y							
Outer sheath		Y								Y	Y	Y	Y			Y

Finish cable (IS-1554 & 7098 Part-1)/ASTM-D-2843/ASTM-D-2863 IEC-754 Part-I Swedish Chimney SEN SS 4241475 for (F3 category)/ Flamability test IEEE-383	Y	Y							Y	Y	Y	Y	Y	Y	Y	Y
Wooden drum (IS-10418)		Y											Y			

- Not applicable for XLPE insulation

Notes:

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan Indicating the practice and procedure along with relevant supporting documents.
2. Make of all major Bought Out Items will be subject to Customer approval.

2.5.2.15 LT CONTROL CABLES

Attributes / Characteristics / Item / Components / Sub System Assembly	Make, Type, Rating, T.C	Dimension/surface finish	Mechanical Properties	Chemical Composition	Electrical Properties	Spark Test	Lay length/Sequence	Armour coverage, cross over, looseness, gap between two armour wire	Sequential marking/surface finish/cable length	Tensile strength, elongation before & after ageing of insulation & sheath	Thermal stability of insulation and sheath	Anti-termite treatment test	Constructional feature as per relevant standards & Spec.	Routine & Acceptance test as per relevant standard & specification	FRLS Test
Copper Conductor (IS-8130)	Y	Y	Y	Y	Y										
PVC Compound (IS-5831)	Y		Y		Y					Y					
FRLS PVC Compound IS-5831 ASTM-D-2843 ASTM-D-2863 IEC-754 Part-1	Y		Y							Y					Y
Armour wire/ Formed wire (IS-3975)	Y	Y	Y												
Insulated Core		Y				Y	Y								
Laid up core		Y													
PVC Inner sheath		Y													
Armouring		Y						Y							
Outer sheath		Y							Y	Y	Y	Y			Y
Finish cable (IS-1554) ASTM-D-2843 ASTM-D-2863 IEC-754 Part-1 Swedish Chimney: SEN SS 424-1475(F3 category)	Y	Y						Y	Y	Y	Y	Y	Y	Y	Y
Wooden drum(IS:10418)												Y			

Notes: 1.This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting Documents

2. Make of all major Bought Out Items will be subject to Customer approval.

Y – Test Applicable.

2.5.2.16 DC SYSTEM

BATTERY

LEAD ACID BATTERY											
ATTRIBUTES / CHARACTERISTICS / ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY	Dimensions & Finish	Conformance to relevant part drg. & Manufacturer's standards	Chemical composition	Lead Coating Thickness (min. 25 microns, IS: 6848 App.F) & Adhesion Check	Conformance to Spec. for Teak Wood	Paint Process checks, Paint Shade, Thickness, Adhesion & Finish	Constructional requirements as per relevant standard & spec.	Insulation Resistance	Marking (Routine & Acceptance Test)	Checking of Polarity & absence of short circuit (Routine & Acceptance Test)	Test for Capacities for 10 hrs. discharge rate along with the test for voltage during discharge (Acceptance Test)
Container & Lids (IS : 1146)	Y	Y									
Vent Plugs	Y	Y									
Sealing Compound (IS : 3116)		Y	Y								
Positive & Negative Plates		Y	Y								
Separators (IS : 6071)	Y	Y									
Electrolyte (Water / Sulphuric Acid) (IS : 1069 / 266)		Y	Y								
Inter-cell Connectors & Fasteners	Y	Y		Y							
Battery Stand	Y	Y			Y	Y					
Cell Insulators	Y	Y						Y			
Stack Assembly	Y	Y									

Lead Acid Battery (IS : 1652)	Y						Y		Y	Y	Y

Note: This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.

Y - Test applicable

Ni- Cd BATTERY													
ATTRIBUTES / CHARACTERISTICS / ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY	Dimensions & Finish	Impact Strength	Conformance to relevant part drg. & Manufacturer's standards	Resistance to Alkali	Chemical composition	Nickel Plating thickness	Paint Shade, Thickness, Adhesion & Finish	Air Pressure Test after heat sealing	Marking & Mass (Routine & Acceptance Test)	Air Pressure Test (Acceptance Test)	Retention of Charge Test (Acceptance Test)	AH Test (Acceptance Test)	Insulation Resistance (Acceptance Test)	Polarity & absence of short circuit (Routine & Acceptance Test)
Container & Lids	Y	Y	Y	Y										
Vent Plugs	Y		Y	Y										
Perforated Steel Strips	Y		Y	Y		Y								
Active Material for Positive & Negative Plates			Y		Y									
Separators	Y		Y	Y										
Electrolyte			Y		Y									
Inter-cell Connectors & Fasteners	Y		Y	Y		Y								
Battery Stand	Y			Y			Y							
Cell Insulators	Y		Y	Y										
Stack Assembly	Y		Y					Y	Y			Y		Y
Ni-Cd Battery (IS : 10918 / IEC : 623)	Y								Y	Y	Y	Y	Y	Y

Note:

4. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
5. Makes of all major Bought out Items will be subject to Customer approval.

Y - Test applicable

BATTERY CHARGER													
Attributes / Characteristics / Items / Components / Sub- assembly	Make, Model, Type, Rating & Finish	Chemical & Mechanical Tests	Sheet Steel Pre-treatment & Painting process checks	Conform to relevant Standards	Dimensional check and Paint shade, thickness, adhesion & Finish checks	Complete physical examination for constructional features of Battery Charger as per relevant standard & spec.	Temperature Rise Test	Dynamic Response Test	Ripple Content Test, Load Limiter & Annunciator & AVR Operation Test	Operational & Functional Checks	HV & IR Test	Burn-In Test at 50^C for 48 hrs	Degree of Protection Test as per relevant standard.
Rectifier Transformer (IS : 2026)	Y			Y			Y				Y		
Electronic Components including Potentiometer (Vernier Type)	Y			Y									
PCB & Electronic Cards	Y			Y									
19” standard racks for electronic cards	Y					Y							
Control & Selector Switches (IS : 6875)	Y			Y						Y			
Indicating Meters (IS : 1248)	Y			Y						Y			
Indicating Lamps (IS: 13947)	Y			Y						Y			
Air Break Switches / Fuses (IS : 13947 / 13703)	Y			Y						Y			
Control Terminal Blocks (IS : 13947)	Y			Y									
Control Transformer (IS : 12021)	Y			Y						Y			
Push Buttons (IS : 4794)	Y			Y						Y			
MCB (IS : 8828)	Y			Y						Y			

PVC insulated Copper control wires (IS : 694)	Y			Y									
Sheet Steel (IS : 513)	Y	Y	Y	Y									
Synthetic Rubber Gaskets	Y	Y		Y									
Annunciator	Y									Y		Y	
Battery Charger	Y				Y	Y	Y	Y	Y		Y	Y	Y

Notes:

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.

2. Makes of all major Bought Out Items will be subject to Customer approval.

Y - Test applicable

2.5.2.17 DIESEL GENERATORS

DIESEL ENGINE											
TESTS/CHECKS / ITEMS/COMPONENTS	Material Test	DP/MPI	UT(On forging and piston Bonding)	Balancing	Hydraulic/water fill test	Assy./fit up	Dimension	Functional/Operation test	Performance test as per BS-5514/or equivalent IS/ISO- Standard including Governing Test for 3 hors at full load and one hr at 10% overload	Fuel consumption, rated power measurement, rated speed	All other tests(if applicable) as per Spec./ relevant Std
Crank shaft	Y	Y	Y	Y							
Cylinder blocks/heads	Y				Y						
Liner/ Radiator	Y				Y						
Rotating/moving parts other than crank shaft	Y	Y									
Piston	Y	Y	Y								
Diesel Engine						Y	Y	Y	Y	Y	Y

Note: This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan Indicating the practice and procedure along with relevant supporting documents.

Y – Test Applicable

ALTERNATOR																		
TESTS/CHECKS ITEMS/ COMPONENTS	Visual	Dimensional	Make/Type/Rating/TC/General Physical Inspection	Mech./Chem. Properties	NDT /DP/MPI/UT	Metallography	Electrical Characteristics	Welding/Brazing(WPS/PQR)	Heat Treatment	Magnetic Characteristics	Hydraulic/Leak/Pressure Test	Thermal Characteristics	Run out	Dynamic Balancing	All tests as per IS-4722	Vibration	Over speed	Tan delta, shaft voltage & polarisation index test
Plates for stator frame, end shield, spider etc.	Y	Y	Y	Y					Y									
Shaft	Y	Y	Y	Y	Y	Y			Y									
Magnetic Material	Y	Y	Y	Y	Y		Y			Y		Y						
Rotor Copper/Aluminium	Y	Y	Y	Y		Y	Y		Y									
Stator copper	Y	Y	Y	Y			Y		Y			Y						
SC Ring	Y	Y	Y	Y	Y	Y	Y	Y	Y									
Insulating Material	Y		Y	Y			Y					Y						
Tubes for Cooler	Y	Y	Y	Y	Y				Y		Y							
Sleeve Bearing	Y	Y	Y	Y	Y				Y		Y							
Stator/Rotor, Exciter Coils	Y	Y	Y				Y	Y										
Castings, stator frame, terminal box and bearing housing etc.	Y	Y	Y	Y	Y			Y										
Fabrication & machining of stator, rotor, terminal box	Y	Y			Y				Y									

ALTERNATOR																		
TESTS/CHECKS / ITEMS/COMPONENTS	Visual	Dimensional	Make/Type/Rating/TC/General Physical Inspection	Mech/Chem. Properties	NDT /DP/MPI/UT	Metallography	Electrical Characteristics	Welding/Brazing(WPS/PQR)	Heat Treatment	Magnetic Characteristics	Hydrualic/Leak/Pressure Test	Thermal Characteristics	Run out	Dynamic Balancing	All tests as per IS-4722	Vibration	Over speed	Tan delta, shaft voltage & polarisation index test
Wound stator	Y	Y					Y	Y										
Wound Exciter	Y	Y					Y	Y										
Rotor complete	Y	Y					Y						Y	Y				
Exciter, Stator, Rotor, Terminal Box assembly	Y	Y					Y											
Accessories, RTD, BTD,CT,AVR. Brushes, Diodes,Space heater, antifriction bearing, cable glands, lugs, gaskets etc.	Y	Y	Y															
Alternator (IS 4722)	Y	Y	Y												Y	Y	Y	Y1

Note: 1.This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents during QP finalisation.

2. Make of all major bought out items will be subject to Customer approval.

Y1= for HT Machines only.

Y – Test Applicable

FINAL ASSEMBLY										
TESTS/CHECKS / ITEMS/COMPONENTS	Material Test	Dimension	WPS/PQR/Welding	NDT/DP/MPI/UT	Check completeness	Hydraulic/Leak/Pressure test	Functional Tests	All routine test as per Spec/ IS	No load test for one hour of the DG set assembly	Clearances & Alignment
Base frame	Y	Y	Y	Y	Y					
Fuel Tank	Y	Y	Y	Y	Y	Y				
Battery (IS – 1691)								Y		
Battery Charger								Y		
Control Panel								Y		
Assembled DG Set		Y			Y		Y		Y	Y

NOTES:

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.

2. Make of all major Bought Out Items will be subject to Customer approval.

2.5.2.18 CABLING, EARTHING & LIGHTNING PROTECTION

ATTRIBUTES / CHARACTERISTICS / ITEMS/COMPONENTS / SUB SYSTEMS	Make, Type, Rating/ TC	Dimension	Pre-treatment of sheet	Paint shade, paint thickness, adhesion	IP protection	Bought out items/Bill of material	HV & IR	Galvanise Test (If Applicable)	Functional Test as per spec.	Proof Load	Deflection test	Constructional feature as per relevant standard & Specification.	Routine & acceptance test as per Relevant standard and specification	Item confirm to relevant standard
Switch box/junction box/ Receptacles (IS-513, IS:5, IS:2629, 2633, 6745)	Y	Y	Y	Y	Y	Y	Y	Y	Y			Y	Y	
Cable glands(BS-6121)	Y	Y												Y
Cable lug(IS-8309)	Y	Y												Y
Lighting wire(IS-694)	Y	Y										Y		Y
Flexible conduits	Y	Y										Y		Y
Conduits(Galvanise & Epoxy) IS-9537 & IS-2629,2633,6745	Y	Y	Y					Y					Y	
RCC Hume Pipe (IS-458)	Y	Y												Y
Cable termination & straight through joint (VDE-0278)	Y	Y			Y	Y						Y	Y	
Cable Trays, Flexible supports system & accessories IS-513, 2629,2633,6745	Y	Y	Y			Y		Y		Y	Y	Y	Y	
Trefoil clamp	Y	Y												Y
GI flats for earthing & lightning protection (IS 2062, 2629, 6745,2633)	Y	Y	Y					Y						Y
GI wire (IS-280)	Y	Y	Y					Y						Y
Wall Mounted – Lighting Panel (IS-513, IS-5, IS-2629, IS-2633, IS-6745)	Y	Y		Y	Y			Y				Y	Y	
Fire Sealing System (BS-476)	Y	Y			Y							Y		Y

Notes:

1. 1This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. Make of all major Bought Out Items will be subject to Customer approval.

Y – Test Applicable

2.5.2.19 ILLUMINATION

Attributes/Characteristics / Item/Components / Sub System/Assembly	Make, Type , Rating/ TC	Dimension	Pre-Treatment of sheet	Paint Shade Thickness Adhesion & Finish	Galvanise Test	IP Test	Bought Out Items/ Bill of Material	HV & IR	Functional Check as per spec.	Constructional Feature as per relevant standard & spec.	Routine & Acceptance Test as per relevant std and spec	Item to conform to relevant standard
Luminaries (IS-10322 Part-5 Sec.1)	Y					Y		Y			Y	
Electronic Ballast	Y											Y
Lighting Wire (IS-694)	Y											Y
Fans (IS-374)	Y											Y
Pole (IS-2713)	Y			Y						Y	Y	
Lamps (IS-9800, IS-9974)	Y											
Lighting Mast (IS-2629, 2633, 4759, 2062, 6745)	Y	Y			Y					Y	Y	
Wall Mounted Lighting Panel (IS-513, IS-5)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
Switch Box/ Junction Box/Receptacles/ Local Push Button Station, Lighting Panel (IS-513, 2629, 2633, 4759, 6745)	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	
Cable Gland (BS-6121)	Y	Y										Y
Cable Lug (IS-8309)	Y	Y										Y
Flexible Conduit	Y											Y
Lighting Transformer (IS-1117)	Y									Y	Y	
Flood Light Mast										Y	Y	

Attributes/Characteristics Item/Components / Sub System/Assembly	Make, Type , Rating/ TC	Dimension	Pre-Treatment of sheet	Paint Shade Thickness Adhesion & Finish	Galvanise Test	IP Test	Bought Out Items/ Bill of Material	HV & IR	Functional Check as per spec.	Constructional Feature as per relevant standard & spec.	Routine & Acceptance Test as per relevant std and spec	Item to conform to relevant standard
Epoxy & Galvanised Conduit (IS-9537, 2629, 2633, 4759, 6745)	Y	Y									Y	

Notes:

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.

2. Make of all major Bought Out Items will be subject to Customer approval.

Y – Test Applicable

Quality Assurance Plan

Part 2.5.3 Control & Instrumentation Works

VOLUME II-SECTION 2

PART 2.5- QUALITY ASSURANCE PLAN

CONTENTS

QUALITY ASSURANCE AND TESTING AND GUARANTEES

2.5 Quality Assurance Plan

2.5.3 General Requirement

All equipment furnished under this specification shall be subject to test by authorized quality assurance personnel of the Bidder, representatives of the Owner during manufacture, erection and on completion. Bidder'' quality assurance personnel for these shop and site tests shall be identified in advance and shall be acceptable to the Owner. The approval of the Owner or passing of such inspection of tests will not, however, prejudice the right of the owner to reject the equipment if it does not comply with the specifications when erected or fails to give complete satisfaction in service.

The Bidder shall furnish details of shop and site tests proposed to be conducted by him at various stages to meet the specification requirements for each type of instrument/system along with his proposal. Bidder shall also furnish details of his proposed shop and site quality assurance organization for this contract. Bidder shall prepare a detailed shop and site 'Quality Assurance Programme' to meet the requirements of these specifications for Owner's approval. This document shall also contain the formats for reports and maintenance of test records specification of test equipment to be used for site tests.

All equipment and systems furnished under this specification shall be subjected to shop & site tests in accordance with the Quality Assurance Program approved by the Owner and shall be adequate to ensure full compliance with these specification, all applicable codes & standards and detailed engineering drawings and documents approved by the Owner.

The Bidder shall provide all required test equipment and simulation devices for performing all shop and site tests. All tests equipment shall be of reputed make, required accuracy class and shall be recently calibrated. The record of calibration of test equipment shall be made available to the Owner on demand.

The cost of all tests as per the requirements of this specification and approved quality assurance programme shall be included in Bidder's lump sum price for this package and no extra price shall be payable by the Owner for conducting any test as per the intent and requirements of this specification.

All approval/Inspection are to be carried out by the Owner only.

2.5.3.1 Testing Method

i) Shop Test

Shop tests shall include all tests to be carried out at Bidder's works at of this sub-bidder and at works where raw materials used for manufacture of equipment is produced.

Individual components, instruments and devices furnished in accordance with specification sheets, and I&C device list enclosed with these specifications shall be shop tested by manufacturer prior to shipment. The manufacturer shall conduct these tests for certifying compliance with published specifications for the equipment and provide test results to the Owner in writing. These tests and test certificates shall be in accordance with the agreed 'QA' programme for major systems/equipments. However, manufacturer's standard methods shall be followed if details of tests for any equipment are not covered under this agreed 'QA Programme'. Whenever tested quality material is specified and wherever called upon by Indian Boilers Regulations or by the design code, the test pieces are to be prepared and tested to Owner's satisfaction.

In the event of Owner being furnished with certified particulars of tests, which have been carried out by the suppliers of material, the Owner may, at his discretion, dispense with these tests.

ii) Material Tests

Whenever tested quality material specified and whenever called upon by Indian Boilers Regulations or by design code, the test pieces, are to be prepared and tested to Owner's satisfaction.

In the event of Owner being furnished with certified particulars of tests, which have been carried out by the suppliers of material, the Owner may, at his discretion, dispense with these tests.

iii) Test at Manufacturer's Works

Works tests are to include electrical, mechanical performance and hydraulic tests in accordance with relevant IS, IBR or any other approved standard or any other tests called for by the Owner under these specifications to ensure that the equipment being supplied fulfils the requirements of these specifications. For equipments not covered by any IS or other approved standards, the tests to be carried out shall be in accordance with Bidders' quality assurance programme approved by the Owner.

Control systems, monitoring systems, control panels instrument enclosures, and power supply systems shall be shop tested according to unique requirements specified in the applicable section of these specifications for each item and quality assurance program approved by the owner.

All shop tests shall be performed prior to shipment and the Owner shall be given the opportunity to witness these tests. The Bidder shall notify the Owner regarding readiness for shop test at least 10 days before the scheduled date if the tests to be conducted within Indian and at least 60 days before the schedule date if the test is to be conducted abroad.

iv) Factory Tests

Automatic Control and Monitoring system (DDCMIS, DCS & any other microprocessor based control system) including alarm annunciation system furnished as per this specification shall be subject to shop and site tests as per the requirements of this specification, applicable codes and Owner approved Quantity Assurance Program so as to demonstrate to the Owner that the equipment furnished by the Bidder meets the intent and requirement of this specification. These tests shall include but shall not be limited to the tests indicated in the subsequent clauses.

v) Surge Protection Test for Solid State Equipment

All solid state equipment shall be able to withstand the noise and surge inherent in a Power House, and shall strictly comply with SWC tests ANSI C 37.90A, 1974 for IEEE-472 (1974). Complete details of the features incorporated in electronic system to meet this requirement, the relevant test carried out, and the test certificates shall be submitted along with the proposal.

vi) Burn-in and Elevated Temperature Test

All solid state electronic equipment shall be tested as a complete system/equipment with all devices connected for a minimum of 168 hours continuously under energized conditions prior to shipment from manufacturer's works, as per the following cycle :-

1. During the first 48 hours of testing the ambient temperature shall be maintained at 50 deg.C and relative humidity at 95%. The equipment shall be interconnected with all devices, which will cause it to repeatedly perform all operations; it is supposed to perform in actual service, with load on various components being equal to those, which will be experienced in actual service.

2. The 48 hours tests period shall be continuous but shall be divided into four 12 hours segments. The input voltage during each 12-hour segment shall be nominal voltage for 11 hours, followed by 110% of normal voltage for 30 minutes followed by 90 percent of nominal voltage for 30 minutes. The 48 hours elevated temp test shall be followed by 120 hours of burn in test as specified in the above paragraphs except that the temperature is reduced to ambient temperature prevalent at that time. Alternatively copy of type test certificate for burn-in test shall be submitted.

The Bidder shall furnish full details regarding shop tests and site tests, as per good engineering practices. The Owner shall approve all such tests and the supplier shall conduct all such tests without calling for additional price. The tests shall cover factory tests, burn-in and elevated temperature tests, simulation and functional tests, insulation tests as applicable, the rating of the contact devices and components, surge withstand capability test, conformity of interconnection cables, testing and checking of other conditions deemed to be necessary with the system/equipment items.

All instruments and control equipment supplied against this contract shall be factory calibrated at least at five (5) points throughout the range and checked for their

functional/performance requirements. The instruments shall also be calibrated at site prior to commissioning.

All panels, instruments enclosures, junction boxes, etc. shall be type tested for degree of protection and applicable in accordance with IS: 2147. 8.02.04

Type, routine and acceptance testing of all equipments, supplied under this contract, shall be in accordance with relevant NEEA/IS/IEC/ANSI/BS/ISA standards, in addition to the requirements of Owner approved Quality Plans. Six (6) copies of test reports shall be submitted to the Owner for approval prior to dispatch of respective equipment

The representative of Owner shall be given opportunity to witness the factory tests which shall be mutually finalized during the progress of the contract.

All control systems to be furnished for this project, shall be factory tested for circuit continuity and direction of response. The Components to be tested shall include all controllers, HAND/AUTO station, other system modules, alarm contactors and multi-conductor interconnecting cables. The tests shall be performed with all of the system components supplied by the Bidder connected to form a complete system with the sole exception of transmitters. The tests shall include a means of confirming the mathematical design response of the control system by simulating changes in system input. The tests shall be a qualitative functional test of each component of control system, which simulates dynamic inputs and monitors system outputs.

Certain control loops shall be factory tested using closed loop mathematical simulation techniques. Control loops to be tested by closed loop methods are broadly as under. However, owner has discretion to test and all control loops during simulation testing.

1. Firing rate control (fuel and air flow control)
2. Furnace draft control
3. Boiler separator level control

2.5.3.2 Response time for Turbine Control System.

The input simulation equipment shall be designed to produce effects from control system outputs based on mathematical model of the predicted performance and process dynamics of the main unit equipment. The control constants of various control loop components shall be adjusted to produce a stable and optimum control adjusted to produce a stable and optimum control when connected to the simulation equipment.

Simulation data including factory adjustment of control system constants, and simulation equations shall be tabulated and shall be made available by the Bidder for owner's use during field check out and the Startup of the control system.

Availability of a simulated type test for automatic control loops specified with a detailed description of testing methods utilized, shall be indicated.

The availability of facilities for carrying out the model test for the control systems shall be indicated by the bidder. Also details of test procedures and copies of test results conducted for a similar fossil fuel fired unit shall be furnished. The data required from Boiler and Turbo generator supplies shall also be furnished by the Bidder.

Brief description of all tests proposed to be conducted on each control system components during various stages of manufacture, installation and commissioning shall be furnished. Copies of test data accumulated during the tests shall be submitted to the mutually agreed formats. The owner shall witness the factory tests which shall be performed at a time mutually agreeable to the Bidder and the owner.

2.5.3.3 Factory Acceptance Tests for DDCMIS, DCS & Simulator

Type of Document	S.No	Name of the document	Test required or not
General	**1**	Factory acceptance test (fat): ref note-1	**Yes**
Test requirements	**1**	Test shall be performed with the completely assembled system and also with complete package	**Yes**
	2	I&C software and performing all functions expected out while in actual service and with system configuration as finalised	**Yes**
	3	Process input/output conditions and other load on the system to be stimulated either by hardware /software	**Yes**
	4	All system software and application software to be loaded and operational on the system prior to fat	**Yes**
	5	Fat to be conducted at elevated temperature of 45 deg. C for minimum 48 hours	**Yes**
	6	Fat under four cycles of voltage fluctuations via normal at 110% of rated voltage	**Yes**
	7	Performance test	**Yes**
Test drawing and documents	**1**	Total system configuration drawings	**Yes**
	2	Fat procedure consisting of	**Yes**
	i.	Test equipment	**Yes**
	Ii.	Test environment	**Yes**
	iii.	Test configuration	**Yes**
	iv.	Test procedure	**Yes**
	v.	Test schedule	**Yes**
	vi.	Test venue	**Yes**
	vii.	Test reports – specimen copies	**Yes**
	3	Function design specification for each equipment / system	**Yes**
Preliminary checks	**1**	General appearance check and bill of material check	**Yes**
	2	Construction check as per overall general arrangement drawings	**Yes**
	3	Dimensional check	**Yes**
	4	Labelling, terminal arrangement and equipment identification check	**Yes**
	5	Power supply, voltage level check and power led's on check	**Yes**

Type of Document	S.No	Name of the document	Test required or not
	6	Cooling fan operation check	Yes
	7	Grounding network check	Yes
Redundancy check	1	Power supply under voltage and over voltage check (+/- 10%)	Yes
	2	Processor and main data bus network redundancy check, if applicable	Yes
	3	Communication coupler if applicable redundancy check	Yes
	4	Communication module of the controller to network redundancy check, if applicable	Yes
	5	Power supply redundancy check	Yes
	6	Hardware on line maintainability check	Yes
Controllers engineering	1	Closed loop control simulation check	Yes
	2	Open loop control simulation check	Yes
	3	Control loop response check	Yes
	4	Bumpless auto manual transfer check	Yes
	5	Operating station – graphic overview check	Yes
	6	Operating station- trend check	Yes
	7	Operating station- real time trend check	Yes
	8	Operating station- mimics check	Yes
	9	Operating station- check for operating control directly from mimics	Yes
	10	Operating station- function keys check	Yes
	11	Operating station- touch screen function check	Yes
	12	Operating station- analog control display check	Yes
	13	Operating station- sequence control display check	Yes
	14	Operating station- operator guidance message check	Yes
	15	Operating station- alarm management function check	Yes
	16	Operating station logging function check	Yes
	17	Operating station / response / updating check	Yes
	18	Keyboard lock function check	Yes
	19	Operating station interchangeability and assignability check	Yes
	20	Printer assignability and back-up function check	Yes
	21	Floppy disk / std. / optical disk unit storage and retrieval check	Yes
	22	Operating station assignability check for hard copier function	Yes
	23	Plant performance calculation check	Yes
	24	Communication interface to other's system simulation check	Yes
	25	Data bus distance building check (refer note- 3)	Yes
	26	Graphic display building function check	Yes
Maintenance	1	Closed loop control system modification check	Yes
	2	Open loop control system modification check	Yes
	3	Alarm display prioritisation check	Yes
	4	System security check	Yes
	5	System alarm check	Yes
	6	System diagnostic function check	Yes
	7	Point detail configuration check	Yes
	8	Control loop tuning check	Yes
	9	System self documentation check	Yes
Notes	1.	The intent of the fat is to demonstrate and ensure that the I&C system meets all the functional requirements as intended in the specification / contract. A completed integrated test of the system shall be carried out at vendor's works in the presence	

Type of Document	S.No	Name of the document	Test required or not
		of owner, on completion of integration / manufacturing of the system. The shipment of I&C equipment to site will be effected only after the fat has been accepted by the owner.	
	2	Fat procedure shall be prepared by vendor and to be submitted for owners / approval well in advance prior to the commencement of fat	
	3.	Fat shall be conducted with the distance between the processor and other supporting peripherals as per the final layout in the control room.	
	4.	All the relevant approved documents required for fat shall be submitted by the bidder in advance prior to commencement of fat.	

2.5.3.4 Factory Acceptance Test for Simulator

Factory Acceptance Test (FAT) shall include all required tests to fully demonstrate to Owner's satisfaction that each equipment/sub-system/system software modules etc. furnished as per this specification, as well as Simulator as a whole, fully meets the functional, parametric and other requirements of this specification and Owner's approved drawings/documents under all operating regimes.

Bidder to note that FAT procedure given below in subsequent clauses are only indicative in order to help the Bidder in understanding the requirements and help him in submitting a detailed procedure based on these guidelines meeting all the specification requirements.

The Bidder shall also carry out the tests included in subsequent clause as pre FAT and submit its results before inviting Owner for FAT.

The Factory Acceptance Test (FAT) shall include all reasonable exercises, which the combination of equipment and software can be expected to perform. These tests shall be divided into, as a minimum, but not limited to the following categories:

1. Pre power on checks
2. Power on check
3. Hardware tests
4. Functional tests
5. Parametric tests
6. Specific tests on Electronic hardware

The major Functional Tests shall include but not limited to the following:

a. Verification of individual modules in line with approved documents.

b. Verification of adherence to parameters for various plant configurations at different initial conditions.

c. Functional test for C&I Model

Verification of proper realization of Control and Logic functions as per input documents and approved functional design specification (FDS).

d. Functional tests for HMIPIS

1. Verification of all types of displays, logs including their formats, bar graphs, X-Y plots etc. Verification of all function keys on keyboards and availability of all operator functions.

2. Verification of event generation and handling capabilities of HMIPIS processors by simulating various types of events / data and observing associated event sequence display and alarm signalling boxes.

3. Calculations:

   All calculations shall be tested to demonstrate that these are in accordance with the specification and I/O schedule. The Bidder shall prepare all tests cases for calculations (3 for each calculation at low, mid and upper ranges of inputs) and submit them for the owner's approval. Test cases shall include performance calculations, flow and level calculations, pressure and temperature compensations, etc.

4. Checking historical storage and retrieval functions including long-term storage.

5. Checking healthiness of processor, main memory. Testing of initialization and loading of configuration data, etc.

6. Verification of all programmers' stations functions for HMIPIS and Control System, as well as for documentation facility as specified.

7. Various display response time / System accuracy etc.

8. Display update time on OWS

e. Functional test for networking & communication devices

1. Verification of various features as per approved documents.
2. Verification of throughput after creating high communication traffic.

f. Instructor's workstation Functions

Verification of all features of instructor functions like malfunction, initial conditions, snap shots, trainee exercises etc. in line with specification & approved documentation.

g. Programming and Documentation functions

1. Verification of all programming function like, modification of application software, database, administrators function etc. in line with specification and approved documents.
2. Verification of all documentation functions in line with specification and approved documents.

2.5.3.5 FAT Procedure

The Bidder shall submit a detailed FAT procedure for owner's approval during detailed engineering stage based on the above guidelines. The FAT procedure to be submitted by the Bidder shall be detailed and exhaustive enough such that owner is satisfied that all the Simulator System specification requirements and features are being tested and the system meets these requirements.

i) Tests to be performed during FAT of Peripherals & other control system

1. Colour Graphic Video Display Unit (OWS)

a. Functional tests (As per FAT procedure. Note-1)
b. Test for capabilities of OWS including error detection for the complete system (Both hardware & software) simulating worst conditions
c. Noise test
d. Surge withstanding capacity as per IEEE or equivalent
e. Quality assurance as governed by BS 5750 or equivalent
f. Design, construction, components, finishes and testing of electronic equipment as per EES-1980 (General specification of electronic equipment) or equivalent Note-1: Test to be witnessed by Owner.

2. Keyboard

a. Test for satisfactory operation of keyboard controls, push buttons and all associated functions (As per FAT procedure. Note-1)
b. Quality assurance as governed by BS 5750 or equivalent for functional test for the complete system simulating worst conditions
c. Design, construction, components, finishes and testing of electronic equipment as per EES-1980 (General specification of electronic equipment) or equivalent Note-1: Test to be witnessed by Owner.

3. Printers

a. Noise level test for the printer
b. Test of interlock performance and error detection feature.
c. Quality assurance as governed by BS 5750 or equivalent
d. Design, construction, components, finishes and testing of electronic equipment as per EES-1980 (General specification of electronic equipment) or equivalent

4. Floppy / Tape Drive Unit / Bulk Memory Unit / DVD, CD drive Unit / DAT Drive

a. Noise test
b. Surge withstanding capacity as per IEEE or equivalent
c. Quality assurance as governed by BS 5750 or equivalent
d. Design, construction, components, finishes and testing of electronic equipment as per EES-1980 (General specification of electronic equipment) or equivalent
e. Test of Control unit and drive for all features, date checking features.

5. Vibration Monitoring & Analysis System

a. Simulated functional test (Note-1)
b. Tests for server, LED monitor, Printer, Keyboard (Note-1: Test to be witnessed by Owner)

6. PADO (Performance & Optimization System)

a. Simulated functional test (Note-1)
b. Tests for server, LED monitor, Printer, Keyboard (Note-1: Test to be witnessed by Owner.)

7. ERP System

a. Simulated functional test (Note-1)
b. Tests for server, LED monitor, Printer, Keyboard (Note-1: Test to be witnessed by Owner.)

8. MIS System

a. Simulated functional test (Note-1)
b. Tests for server, LED monitor, Printer, Keyboard (Note-1: Test to be witnessed by Owner.)

9. HMS System

a. Simulated functional test (Note-1)
b. Tests for server, LED monitor, Printer, Keyboard (Note-1: Test to be witnessed by Owner.)

Notes:

1. The intent of the FAT is to demonstrate and ensure that the I&C system meets all the functional requirements as intended in the specification / contract. A completed integrated test of the system shall be carried out at vendor's works in the presence of Owner or Owner's representative, on equipment to site will be effected only after the FAT has been accepted by Owner.

2. FAT procedure shall be prepared by vendor and to be submitted for Owners approval well in advance prior to the commencement of FAT.

2.5.3.6 Calibration of Instruments

The Bidder shall carry out the calibration of instruments as indicated below by submitting the test procedure and quality assurance plan for the Owner's approval. Bidder shall also prepare detailed checklist/calibration sheets for each of the systems/equipment clearly indicating the step-by-step procedures to be carried out for calibration pre commissioning, loop checking, powering and commissioning.

The calibration of all instruments shall be checked and calibration records prepared for the Owner's use. If the instruments require recalibration, Bidder shall recalibrate the instruments and revise the calibration records and submit to the Owner.

2.5.3.7 Tests to be performed for Field Instruments

S.No	Tests to be performed
1.	**Pressure Gauges**
	Calibration Hydro test (1.5 times max. pr.)
2.	**Pressure switches**
	Calibration test / Hydro test / Contact rating test / Accuracy test / Repeatability
3.	**Differential Pressure Gauges**
	Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.
4.	**Differential Pressure Switches**
	Calibration test / Hydro test / Contact rating test / Leak test / Accuracy test / Repeatability test.
5.	**Thermometers**
	Calibration / Material test / Accuracy test / Bore concentricity : $\pm$ 5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.)
6.	**Temperature switch**
	Calibration / Material test / Accuracy test / Bore concentricity: 1.5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.) / Contact rating test.
7.	**Resistance temperature detector assembly.**
	Calibration / Material test / Bore concentricity test / Insulation test ($\leq$ 500 MΩ at 500V DC) As per ISA, Hydro test for TW. Bore concentricity: $\pm$ 5% of wall thickness, Accuracy test.
8.	**Thermocouple assembly**
	Calibration / Material test, Insulation test ($\geq$ 500 Ω at 500 V, DC) as per ISA, Hydro static test (1.5 times max. pr.), Bore concentricity: $\pm$ 5% of wall thickness.
9.	**Thermo wells**
	Material test / Bore concentricity: $\pm$ 5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.)
10.	**Level Gauges**

S.No	Tests to be performed
	Hydrostatic test / Material test / Seat leakage test / Ball check test.
11.	**Level switches (Magnetic)**
	Material test / Contact rating test / Hydro test / Calibration test.
12.	**Flow Switch**
	Material test / Hydro static test (1.5 times max. pr.) / function test.
13.	**Flow glasses**
	Material test / Hydrostatic test (1.5 times max. pr.) / function test.
14.	**Variable area flow meters**
	Calibration test / Material test / Hydrostatic test (1.5 times max. pr.)
15.	**Flow element**
	100% Radiography test / Hydro test / Calibration test, IBR Certificate.
	Calibration test for flow element shall be witnessed by Owner.
16.	**Control valves / Pneumatic block valve / Pressure regulating valve – Refer chapter 10.**
17.	**Position transmitters**
	Calibration / hysteresis and Accuracy test
18.	**Electro Pneumatic Convertors**
	Calibration test / Accuracy test
19.	**Solenoid valves**
	Hydro test / Seat leakage test / CV test / Coil insulation test
20.	**Air filter regulators**
	Calibration test / Accuracy test
21.	**Junction Boxes**
	Test for degree of protection / Material test
22.	**Tests for terminal blocks**
	Test for moulding for flame resistant, Non-hygroscopic and Decarbonised / Insulation test between terminals / Insulation between terminal block and frame.
23.	**Thermocouple extension cable**
	Thermo-e.m.f characteristic / Continuity test / Measurement on capacitance, inductance and loop resistance / Insulation resistance / High voltage test as per latest IS / Tensile and elongation test / Oxygen index test / Any other test applicable.
24.	**Mass flow meter**
	Performance test / Calibration test / Hydrostatic test.
25.	**Boiler Level Gauge**
	Hydrostatic test / Material test / Seat leakage test / IBR Certificate
26.	**pH / Conductivity measurement / Silica / Dissolved oxygen analysers**:
	Calibration test, Accuracy test
27.	**Sample cooler :**

S.No	Tests to be performed
	Hydro test, IBR Certificate
28.	**Sampling racks :**
	Hydro test, IBR Certificate for tubes and fittings.
29.	**SO2 / NOx analyser / SPM analyser:**
	Calibration test, accuracy test
30.	**Interposing relay**
	Functional test, temperature rise test, H.V test, Insulation test
31.	**Transmitter Racks** :
	Hydro test, air leak test for piping / tubing and fittings. IBR certification as required for tubing / piping and fittings.
32.	**Pressure Transmitter**
	Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.
33.	**Differential pressure transmitter**
	Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.
34.	**Temperature Transmitter**
	Calibration test / Accuracy test / Ambient temperature error test
35	**Pneumatic Block Valves**
	a) IBR certificate form III C b) Hydrostatic test : ANSI B 16.34 c) Seat leakage test : As per ANSI B 16-104 d) CV test: As per ISA procedure e) Magnetic particle test ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 Deg.C) f) Liquid penetration test: ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 Deg.C) g) Radiography test: ANSI B 16.34 special class h) Calibration and Hysteresis test i) Actuator leakage test
36.	**Pressure Regulating Valve**
	a) IBR certificate form III C b) Hydrostatic test : ANSI B 16.34 c) Seat leakage test : As per ANSI B 16-104 d) CV test: As per ISA procedure e) Magnetic particle test ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 Deg.C) f) Liquid penetration test: ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 Deg.C) g) Radiography test: ANSI B 16.34 special class h) Calibration and Hysteresis test i) Actuator leakage test
37.	**Local Panels :**
	Visual inspection, wiring & continuity check, H.V. and I.R. tests on panels, checking of bill of materials, functional tests.
38	**Wiring Termination & Accessories**

S.No	Tests to be performed
	Routine test: Conductor resistance test / High voltage test / Impulse dielectric test / insulation test / Humidity test / Temperature rise test on power circuits / short time current test on power circuits.
	Type test: Annealing test / Test for insulation and sheath / Flame retardency test - a) Oxygen index, b) Flammability / Test for acid gas generation / test for water absorption / wet dielectric test
39	**Marshalling / System cabinets**
	Verification of degree of protection / Electrical tests as detailed under wiring Termination & accessories / Type test and routine test as per relevant Indian standards.
	Notes:
	1. Test Certificates in addition to inspection at manufacturers works shall be furnished for all the instruments for Owner's review. 2. Above Test to be witnessed shall be finalized by Owner. 3. In addition to above test, test as per approved QAP shall also be witnessed by owner

i) Testing Types

The BIDDER shall furnish the Type test reports of all type tests as per relevant standards and codes. As well as other specifics test indicated in the specification. A list of such test are given for various equipment in table titled, Type Test Requirement for C&I System and under the item special requirement for solid state requirements/systems. For the balance equipments/instruments type test may be conducted as per manufacturer standards or if required by relevant standards.

1) Out of these test listed, the bidder / sub vendor / manufacturer is required to conduct certain type test specifically for this contract (and witnessed by employer or his authorized representative). Even if the same have been conducted earlier as clearly indicated subsequently such tests.

2) For the rest, submission of type test, results, and certificates shall be acceptable provided following points

   a) The same have been carried out by the bidder/ sub vendor on exactly the same model/rating of equipment. (For control valves this shall be same size, type & design).
   b) There has been no change in the components from the offered equipments and tested equipments.
   c) The test has been carried out as per the latest standards along with amendments as on the date of bid opening.

3) In case the approved equipment is different from the one on which the type test had been conducted earlier or any of the above grounds, then the tests have to be repeated and the cost of such tests shall be borne by the bidder/sub-vendor within the quoted price and no extra cost will be payable by the owner on this account.

As mentioned against certain items, the test certificates for some of the items shall be reviewed and approved by the main bidder or his authorized representative and balanced have to be approved by the employer. The schedule of conduction of type test/submission of reports shall be submitted and finalized during preaward discussion.

For the type test to be conducted, bidder shall submit detailed test procedure for approval by owner. This shall clearly specify test setup, instruments to be used, procedure, and acceptance norms (wherever applicable). , recording of different parameters, intervals of recording precaution to be taken etc. for the test to be carried out.

ii) Special Requirements for Solid State Equipments /Systems

The minimum type test report, over and above the requirements of above clause which are to be submitted for each of the major C&I systems like DDCMIS, DCS etc. shall be as indicated below:

Surge Withstand Capability (SWC) for solid state equipments/equipments

1. All solid state systems/equipments shall be able to withstand the electrical noise and the surges as encountered in actual service conditions and inherent in the power plant. All the solid states systems /equipments shall be provided with all required protection that needs the surge withstand capability as defined in ANSI 37.90.1/IEEE 472. Hence, all front end cards which receive external signals like analog input and output modules, Binary input and output modules etc. including power supply, data highway, data links shall be provided with protection that meets the surge withstand capability as defined in ANSI 37.90.1/IEEE 472. Complete details of the features incorporated in the electronic system to meet this requirement the relevant test carried out, the test certificates, etc. shall be submitted along with the proposal. As an alternative to the above, suitable class of EN 61000-4-12 which is equivalent to ANSI 37.90.1/IEEE 472 may also be adapted for SWC test.
2. The dry heat test as per IEC-68-2-2 or equivalent
3. Damp heat test as per IEC 68-2-3 or equivalent
4. Vibration test as per IEC 68-2-6 or equivalent
5. Electrostatic Discharge test as per EN 61000-4-2 or equivalent
6. Radio frequency immunity test as per EN 61000-4-6 or equivalent
7. Electromagnetic Field Immunity test as per EN 61000-4-3 or equivalent

Test listed at Item no 5, 6, 7 above are applicable for electronic cards only as defined under item no. 1 Above

iii) Type Test Requirements for C&I Systems

S.No	Item	Test Requirement	Standard	Test to be specifically conducted	Owners approval required on test certificate

S.No	Item	Test Requirement	Standard	Test to be specifically conducted	Owners approval required on test certificate
1	Electrical metering instruments	As per standards	IS 1248	No	Yes
2	Thermocouple	Degree of Protection Test	IS - 13947	No	No.
3	Junction Box	Degree of Protection Test	IS - 13947	Yes	Yes
4	RTD	As per standards	IEC-60751	No	No
5	Electronic Transmitter	As per standards	BS 6447 / IEC 60770	No	Yes
6	E / P convertor	As per standards	Manufacturing standard	No	Yes
7	Instrumentation cable (Twisted and shielded) (Refer Vol. II, Chapter 8)				
8	Battery	As per standard	IS 10918	Yes	YES
9.	Voltage stabiliser	Over load test	Approved procedure	No	YES
		Temp. rise test without redundant fans	Approved procedure	No	YES
		Input voltage variation test	Approved procedure	No	YES
10	**DDCMIS**				
	CLCS system	Model Test	Approved procedure	No	No
	BMS & MFT	Safety requirement	VDE0116, SEC 8.7	No	YES
11	Conductivity type level switch	Degree of protection test	IS 13947	No	No
12	Local gauges	Degree of protection test	IS 13947	No	No
13	Process actuated switches	Degree of protection test	IS 13947	No	No
14	Control valves	CV test	ISA 75.02	No	YES
15	LIE / LIR	Degree of	IS 13947	YES	YES
16	Flue gas O2 analyser, other Flue	Degree of protection test	IS 13947	No	YES
17	Flow nozzles & Orifice plates	calibration	ASMEPTC BS 1042	YES	YES

Note:

Type test are to be conducted only for the items, which are being supplied as part of this package.

For batteries with electric power supply system of main plant C&I, the bidder shall submit for owner's approval the reports of all the type tests as per IS-10918 carried out within last 5 years from the date of bid opening and the test should have been either conducted at an independent laboratory or should have been witnessed by an owner/client. The complete type test report shall be for any rating of battery in a particular group, based on plate dimensions being manufactured by supplier.

For batteries with electric power system of auxiliary plants, type test reports for batteries shall be as per standard –practice of manufacturer.

iv) Testing at Site [Prior to commercial operation]

a) All equipment shall be checked thoroughly in respect of the following:

1. Visual and mechanical testing
2. Complete system configuration loading functions; system diagnostics; system proper operation specified power supply specifications.
3. Checking of loop configuration & OS displays; correct functioning of all keyboards; correct change-over of redundant devices; proper functioning of printer, sample printing of all types of log reports, shutdown reports and MIS reports; shutdown system.
4. Loading of user's programme and checking out of results.
5. Repeating any or all such tests (as necessary) as performed at works.

b) Modulating Control Loop Test

Loop test performed after calibration of all instruments and leak test of signal lines to check the functional performance of all elements of loop. Control loop testing shall be generally by simulation of process conditions and shall fix points namely 0%, 25%, 50%, 75% and 100% of full scale inputs. The field/receiver pressure switches shall be simulated for abnormality by disconnecting the wires of terminals and checking the function of all associated systems. Performance of individual loops may be accepted for an overall accuracy of +0.5%. After the loop test is complete, the bidder shall connect back any terminations and connections removed for loop check.

c) Protection, Interlocking Sequence Control Loop Checking

1. Loop check shall be carried out for checking the interconnection, configuration and overall system functioning. It includes termination of field cables in control room, checking of interconnection between equipment, ferruling, tagging of interconnecting cables & ferruling of field cables in control room and performing overall loop performance check from field instruments/equipment to DDCMIS and back; and all associated loop interconnections.

2. Loop checking ensures proper configuration, functioning and interconnection.

3. All readings shall be recorded on an approved format covering the following:

   i) All loop components shall be checked for proper functioning.
   ii) For field switches and other initiating devices, abnormalities shall be simulated by disconnecting the wires at the field instruments end.
   iii) Alarm cards shall be checked for different settings on both increasing and decreasing signals. Shutdown schemes shall be checked for proper functioning, configuration and actuation.
   iv) Signal from shutdown scheme to shutdown values shall be checked at the respective values. The stroke checking as well as time of operation checking of shutdown values with its logging also forms a part of loop checking.

d) Commissioning Tests

The Bidder shall perform commissioning tests for all their offered instrumentation and control devices, loops, sub-systems and systems. Commissioning tests for instrumentation and controls shall include but not be limited to

i) Test on devices and loops
ii) Functional tests on subsystems and systems
iii) Performance tests on systems to demonstrate that it meets all guarantees as proposed by the bidder
iv) Fine tuning of control systems

e) Authorization to Ship Test

Authorization to ship test procedures shall be prepared by the Bidder and shall be submitted to the Owner for approval of at least 7 days prior to commencement of these tests. The Authorisation to ship test shall test all functions of the system. These tests shall include all of the features of the operational tests. Every input point will be tested. The following tests shall also be included: -

1. Simulation of Inputs

To verify conversion accuracies, scans rates, operator's panel functions, and correctness of calculations.

2. Operational Test

To verify that the system performs all required functions and meets the specification requirement.

3. Diagnostic Test

To test working and bulk memory locations, instruction complements, functioning of outputs and peripheral devices, functioning of system check modules, etc.

4. Power Consumption Test

To verify KW consumption.

5. Power Failure Test

To observe the consequences of a total power failure.

6. Accuracy and Repeatability Test

Accuracy and repeatability for analog inputs shall be demonstrated by statistical analysis using the point values read every scan cycle for a consecutive 8 hour period for a total of 10 per cent of all analog inputs. The specified noise rejection capabilities shall be demonstrated using the same test and analysis, by the application of at least 135 V RMS common mode and 25 RMS differential mode to the inputs. The noise rejection test shall be a second 8-hour test. Inputs to be used will be randomly selected by the Owner prior to the test. The test shall be carried out during the Authorisation-to-Ship Tests

7. Functions

All computer functions shall be tested to demonstrate they are in accordance with the specification.

8. Format

All computer print outs & OWS display formats shall be checked to demonstrate that they are in accordance to the specification.

9. Calculations

All computer calculations shall be tested to demonstrate they are in accordance with the specification and computer I/O schedule. The Bidder shall prepare all test cases for calculations (three for each calculation at low, mid and upper ranges of inputs) and submit them for the Owner's review in accordance with contract schedule. Test cases shall include performance calculations, flow and level calculations.

10. Demonstration of the manual and auto switchover from master to standby controller.

11. Demonstration of automatic switchover from the main to redundant data highway.

12. System and sub-system response time tests.

13. The Bidder shall provide a complete factory test of the system hardware and software. All diagnostic and software debug tests shall be performed at the factory in presence of the Owner. Test shall be performed with the computer system assembled and all parts interconnected together with simulated analog and digital inputs.

14. Solid-state logic system shall be tested as complete assemblies. Testing of individual components or modules will not be acceptable.

The authorization-to-ship tests shall include all reasonable exercises, which the combination of equipment and software can be expected to perform. The test shall include, but not be limited to the following:-

1. Thorough exercising of each device.
2. Demonstration of required spare system capacity point by point exercising of each input and output.
3. Demonstration of all man/machine functions.
4. Demonstration of the proper functioning of all software.

One month to the start of the factory test, the Bidder shall submit his testing procedures for approval. The Owner will witness factory tests. The Bidder shall notify the Owner at least 2 weeks prior to factory testing. Following the test if, in the opinion of the Owner, the system has not been adequately manufactured, programmed, tested, or debugged, the test shall be re-run. The system shall not be shipped without the approval of the Owner. The results of all the factory tests shall be documented and submitted to the Owner.

Upon successful completion of the authorisation-to-ship tests the Owner/ Engineer will provide the Bidder with a written authorisation for shipment of the system equipment to the site.

f) On site tests

All the site activities including unloading, storage cum insurance of equipment and materials on arrival to site, installation, commissioning and carrying out all the tests at site shall be performed by the Bidder at no cost to the Owner in presence of Owner and with the permission of owner as and when required.

The Bidder shall furnish the necessary manpower and the services of technical representative(s), who shall provide technical guidance and advice for the installation of the equipment and placing the system in operation. The services of the technical representative(s) shall be available for the period from arrival of the equipment on site until the equipment is finally accepted by the owner. The on-site tests shall include the following tests in the sequence given:-

g) Inspection of Equipment on Arrival

The Bidder's field representative(s) shall inspect all supplied equipment upon arrival on-site. All observed damage to equipment shall be reported to the Owner.

h) Preliminary onsite checks and tests

After field installation and before equipment energisation and connection of field inputs, the Bidder shall carefully inspect all equipment and shall check all Bidder supplied wiring and cable to assure correctness of corrections and proper equipment installation. After these checks, the Bidder's representative shall power the system and perform a standard diagnostic test to assure that the system is working. The field inputs and outputs will then be connected by Bidder.

i) Startup / Initial Operation

On completion of erection of the equipment and before start-up, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the owner and the Bidder for correctness and completeness of installation and acceptability for start-up, leading to initial precommissioning tests at site. The list of pre-commissioning tests to be performed shall be as mutually agreed and included in the Bidder's quality assurance program.

The Bidder's commissioning/start-up engineers, specifically identified as far as possible, shall be responsible for carrying out all the precommissioning tests. On completion of inspection, checking and after precommissioning tests are satisfactorily over, the complete equipment shall be placed on initial operation during which period the complete equipment shall be operated integrally with sub-systems and supporting equipment as a complete plant.

The Bidder shall intimate his clearance for taking unit in service after completion of routine / performance tests.

j) Trial Operation

After taking the unit in service and taking full loading of the same, the plant shall then be taken on trial operation during which period all necessary adjustments shall be made while operating, over the full load range enabling the plant to be made ready for performance and guarantee tests.

The duration of Trial operation of the complete equipment shall be 7 days out of which at least 72 hours shall be continuous operation on full load or any other duration as may be agreed to between the owner and the Bidder. The Trial Operation shall be

considered successful, provided that each item of the equipment can operate continuously at the specified operating characteristics, for the period of Trial Operation.

For the period of Trial Operation, the time of operation with any load shall be counted. Minor interruptions not exceeding 30 minutes at a time caused during the continuous operation shall not affect the total duration of Trial Operation. However, if in the opinion of the Owner, the interruption is longer, the Trial Operation shall be prolonged for the period of interruption.

A trial operation report comprising observations and recordings of various parameters to be measured in respect to the above described Trial Operation shall be prepared by the Bidder. This report, besides recording the details of the various observations during trial run, shall also include the dates of start and finish of the trial operation and shall be signed by the representatives of both the parties. The report shall record all the details of interruptions, adjustments made and any minor repairs done during the Trial Operation. Based on the observations, necessary modifications/repairs to the system shall be carried out by the Bidder to the full satisfaction of the Owner to enable the latter to accord permission to carry out performance and Guarantee tests on the plant. However, minor defects which do not endanger the safe operation of the equipment shall not be considered as reasons for withholding the aforesaid permission.

The system shall be completely tested in the field by the Bidder's service representatives in the presence of the Owner. All diagnostic and software debug tests performed at the factory shall also be performed in the field. These tests shall include a full demonstration of all operating software programs operating in the real time environment. The results of all field tests shall be documented and submitted to the owner.

k) System Documentation Check

Upon successful completion of the preliminary On-site checks and tests the owner's and the Bidder's representative shall check that all required system documentation, in its final form was delivered to the Owner. All error and insufficiencies in the system documentation (manuals, drawings, software) shall be corrected by the Bidder before the Owner accepts the system. Duly corrected system documentation shall be furnished to the Owner.

l) Performance and Guarantee Test and Acceptance of the System by Owner

After successful trial operation the final test as to the performance and guarantees shall be conducted at site, by the Owner. The Bidder's commissioning and start-up engineers shall make the unit ready for such tests, assist the owner in conducting such tests free of cost. Such tests will be commenced within a period of one month or less after the successful completion of Trial Operations. Any extension of time beyond the above-specified period shall be mutually agreed upon. Such test shall be for operation of 7 days out of which at least 72 hours shall be continuous operation on full load.

These tests shall be binding on both the parties of the Bidder to determine compliance of the equipment and the performance guarantees.

Any special equipment, tools and tackle required for the successful completion of the performance and Guarantee Tests shall be provided by the Bidder, free of cost.

The guaranteed performance figures of the equipment/systems shall be provided by the Bidder as per this specification. Should the results of these tests show any decrease from the guaranteed values, the Bidder shall modify the equipment as required to enable it to meet the guarantees. In such case, Performance and Guarantee Tests shall be repeated within one month from the date of equipment is ready for retest, and all cost for modifications including labour, materials and the cost of additional testing to prove that the equipment meets the guarantees shall be borne by the Bidder. If the Vendor is unable to meet the guarantees, even after the adjustments/calibration, the Owner retains the option to reject the Equipment, and in the case of such option of rejection being exercised, the Vendor shall replace the entire equipment with the one, which shall meet the guaranteed values.

The above guarantees will be inclusive of the final control element responses. The bidder has the responsibility to commission the control loop inclusive of the final control element, some of which are supplied by others/Owner.

These tests shall be sufficiently detailed so as to fully satisfy the Owner that the equipment/systems furnished by the Bidder meet all requirements of this specification as well as the published specifications of the respective manufacturers.

2.5.3.8 Measurement System

The Bidder shall guarantee the proper functioning of all the measurement system equipment as specified in enclosed data sheets.

The test of long-term stability of analog inputs calibration shall be demonstrated by the comparison of the results of the 8-hour stability test run at the field, using precision test voltage, with no calibration allowed during the test (no manual recalibration allowed for the time of the eight-hour field stability test. The bidder will have access to the records at all times and the test will be conducted in a manner as to satisfy the bidder that the specified operating conditions have been maintained. A complete copy of the test data will be furnished to the Bidder. In case of failure to pass the test, the bidder shall change or replace the equipment furnished so that the test can be performed successfully.

2.5.3.9 Control System

The distributed control system shall provide a unit operating turndown ratio of not less than six to one. The requirement is based upon the unit maximum load resulting in readings for steam flow, feed water flow, air flow, fuel flow and stem pressure that are at a maximum of 90 per cent of the range span. If the readings are less than 90 per cent, the turn down requirement will be adjusted for each affected system.

The control system shall permit the performance of the following dynamic load tests while maintaining safe furnace conditions, major process parameters and without endangering other equipment. All tests will be performed with the system in automatic mode:

a. Drop 50 per cent of maximum load capability from approximately full load at a rate of 10% per minute
b. Drop load from full rated output to the lowest load runback limit, at a rate corresponding to the fastest runback rate.
c. Pick up 50 per cent of the maximum load capability from approximately 50 per cent load at a rate of 10 % per minute.

During transient conditions causing deviation of process variables, the control system furnished under this specification shall not permit deviations which exceed those permitted by the manufactures of the controlled process equipment, for load demand changes as indicated above. The exact parameters to be monitored for this test are given in the table no. 4.1, chapter 4. The control loops shall perform to return the controlled variable to the set point in a stable manner without cycling in the shortest possible time and without any loop interactions or cycling of generation when generation matches unit load demand.

The bidder shall also guarantee that the control system provided by him will be responsive and stable and will maintain the deviation of controlled variables from set point within the limits, so that the equipment being controlled will operate below over the range required. The controls shall operate automatically, with no assistance from the operator. The bidder shall successfully demonstrate the performance of automatic control systems as per Table No.4.1 at Chapter 4 before acceptance and taking over of this system by the Owner.

The following parametric tests shall also be conducted under worst case loading conditions

a. For control system CPU loading, cycle time/controller reaction time and memory spare capacity.
b. For Controllers CPU loading, spare duty cycle spare memory capacity
c. Spare duty cycle for system bus
d. Various display response time
e. System accuracy
f. OWS update time

For the parametric test, the following requirements shall be met Processor spare duty cycle (free time) Under worst case loading of MMIPIS and system bus each MMIPIS processor shall have 40% free time when measured over any two second period and 50% free time when measured over any one minute period. Under worst case loading conditions of control system processor shall have 20% free time when measured over any one minute period.

1. System bus spare duty cycle (free time)

The Bidder shall furnish all necessary data to fully satisfy the owner that the processor spare duty cycle figures quoted by the Bidder are realistic and based on configuration and

computation capability of the offered system and these shall be achieved in the fully implemented system as commissioned at project site.

The system bus shall have min. 50% free time during the worst case loading conditions of control system, MMIPIS and the system bus, measured over any 2 seconds interval.

2. Display response time

The system shall acknowledge all operator requests in one of the following manners within one second of pressing of the last button:

a. Commencement of the request display OR
b. Acknowledgement of operator request in a suitable manner.
c. The display response time as defined above, under the worst case loading conditions shall not be worse than the following:

1	All control related displays	1sec.
2	Point details display (Single point)	1-2sec.
3	Bar chart display (20point, current data)	1-2sec.
4	Operator guide / plant start-up Guide message display (full Screen of alphanumeric Information and a maximum of ten numbers of dynamic Data items)	1-2sec
5	Plant mimic display of fair Complexity with a minimum of 120 numbers of dynamic data Items e.g., values, macros, Line segment, etc.	2-3sec.
6	Group review display (current Values of twenty points)	2-3sec.
7	X-Y plot display (2 X-Y-plots And a single display requiring Both historical as well as Current data)	3-4sec.
8	X-T plot display (trend of 6 Analog points and a single Display requiring both historical As well as current data)	3-4sec.
9	Plant summary display (e.g., Bad point summary, limit check Removed point summary. Assume The whole data base search is Required and the summary display Contains ten points only).	3-4sec.

The response time for screen update after the execution of the control command from the command is issued (for example command to start a motor to the time the screen is updated) shall be two seconds (excluding the drive actuation time).

3. System accuracy requirements

The overall system accuracy from signal input terminals to output presentation on LED display and printers for the least accurate input range and maximum scan rate shall be not worse than +/-0.2% of full scale of the process range.

4. OWS update rates

1. All OWS display shall be updated at least every one second.

2. The system shall be accepted by the owner after satisfactory completion of precommissioning test, trial operation and performance guarantee test, contingent upon satisfactory computation of 365 days availability guarantee tests.

3. All expenses connected with performance guarantee test for acceptance of the system and all operating & test personnel shall be borne by the bidder.

4. The system acceptance will consist of a written statement by the owner that all system documentation are received in the proper form and quantity, and that all on site operational and acceptance tests are successfully completed.

2.5.3.10 Availability Guarantee Test

The Bidder shall guarantee 99.7 per cent system availability for a continuous period of 365 days. An availability guarantee test shall be conducted to assure this level of availability. If the accrued downtime exceeds 0.3 per cent of 365 days, during a loss of availability, a new 365 days run shall start at the time when the system becomes available again. Loss of availability (unavailable system) shall be defined as the loss of the system's guaranteed accuracy and repeatability or of any system function; except, however, that the loss of a function for not more than five per cent of the points shall not be considered loss of availability. Loss of a function for not more than five per cent of the points shall be treated as partial unavailability and the corresponding outage time shall be weighed with respect to function and percentage of the points for which the function and percentage of the points for which the function is unavailable. Loss of each function shall have one weighing factor and unavailability of each equipment, peripheral device or process I/O card etc. shall have another weighing factor. The system shall be considered unavailable upon loss of functions or equipment such as loss of two control OWSs, all control room printers, all control room displays, control room operator keyboard, all alarming capability more than 5 percent of inputs or accuracy of more than 5 per cent of inputs, etc. The guaranteed accuracy and repeatability shall be maintained for the entire 365 days run without manual recalibration.

Downtime shall start upon loss of a system function and shall end upon restoration of all system functions. A minimum of one hour's down time shall be charged for each loss of availability in determining system availability. If availability is lost due to owners error exclusive of any possible errors through misuse of the operator's console or engineer's/programmer's console while locked but inclusive of any possible errors through misuse of operator's or engineer's / programmer's console while unlocked, downtime will not be charged to the Bidder.

2.5.3.11 Test Dates

The availability test shall commence after the performance guarantee and acceptance tests.

2.5.3.12 Test Duration and Definition

The availability test duration shall be 365 days of accumulated test duration time. Such duration time shall be continuous from the start of test except as declined hereinafter. The availability shall be expressed by a percentage, which shall be calculated as:

100 (Test duration time – Accumulated system outage time)

2.5.3.13 Test Duration Time

The accumulated system outage time shall be a total of time in which all Bidders supplied systems and system functions are not available. A weighing factor shall be used to determine the amount of outage/time assesses due to partial failures. System outage time shall be calculated as:

(Outage time) x (Weighing Factors)

System outage time shall be accumulated over the test duration and shall be the accumulated system outage time.

i) Outage Time and Weighing Factors

Outage time will be assessed for the length of time in which all or any part of each of the following functions are not either continuously available or available when requested by operator action. The outage time shall be weighed by each function's associated weighing factor as listed in below:

ii) System Element Weighting Factor

a)	Data acquisition and Validation	-	1.00
b)	Control Function	-	1.00
c)	Historical Storage Function	-	0.30
d)	Operator guides (OWS)	-	0.50

iii) System Element Weighting Factor

a)	System summaries	-	0.30
b)	Alarming, displays and logs	-	0.90
c)	Other displays	-	0.30
d)	Logs (except SOE)	-	0.30
e)	Report	-	0.30
f)	Sequence of events log	-	0.30
g)	OWS Graphic	-	0.30
h)	Each Bulk Memory	-	0.50
i)	Each utility OWS and alarm OWS	-	0.33

iv) Display / KBD

a)	Each Control OWS	-	0.50

b)	Each Keyboard	-	0.50
c)	Each printer	-	0.30
d)	Cartridge Tape	-	0.40
e)	Data Highway	-	0.75
f)	Each Programmer's OWS/KBD	-	0.30
g)	Engineer's Workstation	-	0.30
h)	5% I/O Points	-	1.00
i)	5% Controllers	-	1.00

Weighting factors for other system elements shall be defined and agreed upon after contract award. The loss of functions based on the weighting factors above shall be limited to 1.00 maximum.

2.5.3.14 Conditions

Upon loss of any function as listed previously the Owner shall notify the Bidder. Downtime shall start at the time of notification exclusive of actual travel time required by the Bidder but not in excess of 8 hours.

The Bidder shall include in his proposal the price and quantity of any spare parts necessary for his performance of the availability test. Any degradation of functions shall accrue outage time regardless of processor configuration. During a period of system outage, the Owner shall use operable functions of the system provided that such use does not interfere with maintenance of the inoperable functions or hardware as determined by the Bidder.

Should the Bidder determine that partial use of the system by the Owner will interfere with the Bidder's maintenance procedures, system outage time shall accumulate with a weighing factor of 1.0 since no functions are available to the Owner? This shall include off-line servicing. Outage time for each function shall stop at the time the Bidder returns each of the functions as listed in clause on "outage time and weighing factors" to full service and relinquishes full use of the system to the Owner.

Outage of system functions due to the failure of equipment not supplied by the Bidder shall not be used to calculate system availability. The time required to initialize the Bidder's system following such outages shall not be used to calculate system availability provided that initialization time does not exceed 10 minutes. Time required for initialization of the Bidder's system for any reason, in excess of 10 minutes shall accumulate as system outage time.

All costs associated with maintaining 99.7 percent availability for a continuous period of 365 days shall be borne by the Bidder. This includes hardware, software, spares and services. The 99.7 per cent availability shall exclude downtime required for scheduled maintenance and service. The Bidder's proposal shall list maintenance and service requirement for all applicable equipment. If these requirements are not listed, it shall be understood that no downtime is required.

2.5.3.15 Training

Bidder will be responsible for providing training to Owner's personnel on offered control systems at Bidder's Works/Bidder's Associate's Works. It shall include training operators in the use of system, in

the programming and hardware maintenance of the equipment to the extent that the Owner's personnel can make corrections and changes to the systems programs and maintain the system's hardware.

2.5.3.16 Warranty

The Bidder shall provide an unlimited warranty on all equipment and software for three years after the start of the warranty period, i.e. after satisfactory completion of initial operations. This warranty shall include repair, replacement or correction of identified software or hardware discrepancies at no cost to OWNER. No repairs/replacement shall normally be carried out by the Owner when the plant is under the supervision of Bidder's supervisory engineers. If in the event of any emergency, in the judgment of the Owner, delay would cause serious loss or damage, repairs may be made by the Owner or a third party chosen by the Owner without advance notice to the Bidder and the cost of such work shall be paid by the Bidder.

The Bidder shall provide warranty spares and an exhaustive list of warranty spares including components for system hardware and instrumentation and peripherals based on (and keeping adequate margin over) normally experienced failure rate shall be submitted by the Bidder for Owner's review regarding adequacy of the same. The Bidder must furnish the list before inviting OWNER personnel for ATS test. The warranty spares as per the list mentioned above will be dispatched by the Bidder along with the main equipment consignment. The Bidder shall also provide expandable items for the warranty period. This shall include printer ribbon, ink/toner cartridge print head etc.

In case of any hardware failure which hamper normal operation, the Bidder during the warranty period must provide on-site technical expertise to repair/rectify the problem within a week and if any component is not available at site, the Bidder must arrange to supply these components at site within additional 48 hours. If a software problem is identified, this problem shall be corrected within two weeks.

After six months of DDCMIS operation the Bidder shall provide the list of parts and expendables utilized for the period. The same information will be provided at the conclusion of the warranty. In order to discharge the warranty responsibility, the bidder shall include in his proposal lump sum price for the provisions of a team of service personnel at Site who will be fully qualified to perform the required duties throughout the warranty period of one year. The Bidder shall deploy at least one engineer, two supervisors and four technicians in the team. The Owner shall approve the exact nos. & composition of team members. In case, the team is unable to rectify hardware or software problems, the Bidder shall depute and/or station additional specialist to rectify the problem to ensure 99.7% availability of system.

2.5.3.17 Remote Service Centre for DDCMIS & DCS

Bidder shall provide the necessary hardware & software required for connecting the DDCMIS, DCS to Bidder's remote service centre, through which the diagnostics & fault analysis of the DDCMIS, DCS system can be carried out. The method of connection shall be as per Bidder's standard practice. However, it is preferred to have the connection through a single point in the plant's DDCMIS, DCS system.