



BHARAT HEAVY ELECTRICALS LIMITED

TRANSMISSION BUSINESS ENGINEERING MANAGEMENT

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TITLE 1.1 kV Aux Power & Control Cables		SIGN	[Signature]	[Signature]	
		DATE	01/06/18	2/6/18	
		GROUP	TBEM	W.O. No	86001
CUSTOMER	Bangladesh-India Friendship Power Co. Pvt. Ltd. (BIFPCL)				
CONSULTANT	FICHTNER				
PROJECT	400/230kV Switchyard at 2X660 MW Maitree STPP, Bangladesh				

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Rev No.	Date	Altered	Checked	Approved	REVISION DETAILS				
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Project: 400/230kV Switchyard at 2X660 MW

Maitree STPP, Bangladesh

Customer: BIFPCL

Consultant: FICHTNER

Technical Specification: 1.1 kV Aux Power & Control Cables

Bharat Heavy Electricals Limited

Document No. TB-388-510-023

SECTION 1

SCOPE SPECIFIC TECHNICAL REQUIREMENTS AND QUANTITIES

1.0 SCOPE

This Specification covers the requirements of design, manufacture, testing at manufacturer's Works, packing, supply, and delivery at site of 1.1 kV Aux Power & Control Cables as listed under this specification. This section covers the specific technical requirements of 1.1 kV Aux Power & Control Cables. This constitutes minimum technical parameters for the above item as specified by the customer (BIFPCL/FICHTNER). The offered equipment shall also comply with the General Specification for the project as detailed under section-3 of this specification.

In case of any conflict between the technical details mentioned in this section and the remaining sections of this document, then Section-1 shall prevail and is to be considered as binding requirement.

The specification comprise of following sections:

- Section-1: Scope, Specific Technical Requirements and Quantities.
- Section-2: Equipment Specification.
- Section-3: Project Details and General Technical Requirements.
- Section-4: Guaranteed Technical Particulars.
- Section-5: Checklist.

Note: The term 'Owner' appearing in this specification shall refer to BIFPCL/FICHTNER, the term 'Purchaser' shall refer to BHEL and the term 'Contractor' shall refer to the successful Bidder.

1.1 THE EQUIPMENT IS REQUIRED FOR THE FOLLOWING PROJECT

Name of customer: Bangladesh-India Friendship Power Co. Pvt. Ltd. (BIFPCL)

Name of consultant: FICHTNER

Name of Projects: 400/230kV Switchyard at 2X660 MW Maitree STPP, Bangladesh

Refer Section - 3 for Project Details and General Specifications.

Project: 400/230kV Switchyard at 2X660 MW
Maitree STPP, Bangladesh
Customer: BIFPCL
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Technical Specification: 1.1 kV Aux Power & Control Cables

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1.2 SPECIFIC TECHNICAL REQUIREMENTS

As per Annexure-D, Annexure E, Annexure G, Annexure B-I to Section-1.

1.3 QUANTITIES

Sl. No.	Type of Control Cables	Quantity (kM)
1.1	2C x 2.5 sq mm PVC/Copper, Overall Screened	6.5
1.2	4C x 2.5 sq mm PVC/Copper, Overall Screened	22.0
1.3	7C x 2.5 sq mm PVC/Copper, Overall Screened	8.0
1.4	12C x 2.5 sqmm PVC/Copper, Overall Screened	17.0
1.5	19C x 2.5 sq mm PVC/Copper, Overall Screened	27.5
1.6	5C x 4 sq mm PVC/Copper, Overall Screened	32.0
	Type of Aux Power Cables	
2.1	2C x 16 sq mm XLPE/Copper	12.0
2.2	2C x 70 sq mm XLPE/Copper	2.0
2.3	4C x 16 sq mm XLPE/Copper	3.5
2.4	3.5C x 35 sq mm XLPE/Copper	3.5
2.5	3.5C x 70 sq mm XLPE/Copper	1.0
2.6	3.5C x 150 sq mm XLPE/Copper	2.0
2.7	1C x 300 sq mm XLPE/Copper	1.0
2.8	1C x 150 sq mm XLPE/Copper	1.5
	Type of Screened Control (Instrumentation) Cables	
3.1	4P x 0.5 sq mm PVC/Copper Individual & Overall Screened	2.0

Note:

- 1) The above quantities are tentative and the length of total cables procured may be subject to a change of $\pm 30\%$ at contract stage.
- 2) Some of the cable types mentioned above may not be ordered at all at contract stage.
- 3) Manufacturing Clearances may be given in two lots (Lot-I and Lot-II) as per actual site requirement.

All Control and Power Cables shall be supplied in drum length of 1000 m, unless otherwise specified. For power cable with conductor cross sectional area 150 sq mm and above may be supplied in 750m drums. Owner shall have the option of rejecting cable drums with shorter lengths. The cable length per drum is allowed a tolerance of $\pm 5\%$. However, the total quantity of cables after taking into consideration of all cable drums for each size shall be within the tolerance of $\pm 2\%$.

1.4 TESTS

Cables shall conform to type tests including additional type tests as per technical specification and shall be

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subject to routine & acceptance tests in accordance with requirements stipulated under respective sections.

The reports for all type tests and additional type tests as per technical specification shall be furnished by the bidder along with the tender documents.

The bidder will conduct the routine tests on each drum length. All the type and acceptance tests shall be conducted as per specification and relevant standards/ approved MQP. These tests will be witnessed by owner/purchaser/purchaser's representatives.

Price for conducting the type/ acceptance/ routine test as per TS and approved MQP is deemed to be included in the offered price.

1.5 QUALITY PLAN

The manufacturer shall carry out contract works in accordance with sound quality management principles which shall include items such as controls which are necessary to ensure full compliance to all requirements of the specification & applicable international standards. These quality management requirement shall apply to all activities during design, procurement, manufacturing, inspection, testing, packaging, shipping, inland transportation, storage, site erection & commissioning. Manufacturer shall submit detailed Quality Plan for BHEL / customer's approval.

1.6 TECHNICAL REQUIREMENT

1.6.1 Applicable for PVC Control Cable:

The bidder should have manufactured and supplied prior to date of techno-commercial bid opening the following:

- (a) At least 300 kM of PVC insulated, PVC sheathed stranded copper conductor 1kV grade control cables in one single contract.
- (b) At least 10 kM of Flame Retardant Low Smoke Control Cable.

1.6.2 Applicable for XLPE Auxiliary Power Cable:

The bidder should have manufactured and supplied prior to date of techno-commercial bid opening the following:

- (a) At least 100 kM of XLPE insulated, PVC sheathed power cables of 1kV or higher grade in one single contract.
- (b) At least 10 kM of Flame Retardant Low Smoke Aux Power Cable.
- (c) At least 10 kM of 1kV or higher grade power cable of minimum 630 sq mm conductor size.

1.7 WARRANTY

Refer relevant clauses mentioned elsewhere.

1.8 SEA-WORTHY PACKING, PACKING AND SHIPPING INSTRUCTION

Refer Annexure-E of Section-3.

	DESIGN CALCULATIONS FOR LV CABLES SELECTION & SIZING	Doc. No. MAITREE-00-BTW-EDB-105026-PEM
	2 X 660MW BIFPCL MAITREE KHULNA STPP (BANGLADESH)	Rev. 5
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ANNEXURE - D
CABLE DETAILS OF LV XLPE POWER CABLES

I. TECHNICAL DATA

1.0	Type of Cable	Flame Retardant Low Smoke (FRLS)
2.0	Standard applicable in general (Latest amendment to be referred if any)	IEC 60502-1, IEC 60228, IEC 60287, IEC 60949, ASTM D:2843, ASTM D:2863, IEC-754-1, IEC:60332 (Part-1); IEC:60332-3-23, IEEE-60383 & other relevant IEC
3.0	Voltage Grade	0.6 / 1.0 (1.2) kV
4.0	Number of cores, cross sectional area of conductors and quantities	As per Section-1, Clause 1.3
5.0	FAULT CHARACTERISTICS	
	Fault Level	50kA
	Fault Clearing Time	1 sec
6.0	CONDUCTOR	
(a)	Material	Copper
	Grade and Class	Stranded, annealed plain high conductivity, Class
(b)	Standard Applicable	IEC 60228
(c)	Shape	Circular / shaped as per IEC 60228
(d)	Min. number and diameter of strands for main and neutral conductor	As per Table-2 of IEC-60228
7.0	INSULATION	
(a)	Material	Cross-Linked Polyethylene (XLPE)
(b)	Standard Applicable	IEC-60502 (Part-1)
(c)	Continuous withstand temperature	90°C
(d)	Short-circuit withstand temperature	250°C
(e)	Method of application	By extrusion; sleeve extrusion not permitted.
(f)	Method of curing	Dry/ Steam/ Gas/ Sioplas
(g)	Nominal Thickness of insulation	As per IEC-60502 (Part-1)
8.0	CORE IDENTIFICATION	Colour coding as per relevant IEC
9.0	INNER SHEATH	
(a)	Material	PVC Type ST-2
(b)	Standard Applicable	IEC-60502 (Part-1)
(c)	Colour	Black
(d)	Whether FRLS	NO
(e)	Inner sheath applicable for single core cable	NO
(f)	Fillers	Acceptable
(g)	Material of fillers (if permitted)	Same as inner sheath (Material of filler to be compatible with that of inner sheath)
(h)	Method of application	
(1)	Multi-core cables:	
(i)	With fillers	Pressure/ Vacuum extruded

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(ii)	Without fillers	Pressure extruded
(2)	Single-core cables:	NA
10.0	ARMOUR	
(a)	Applicable	Not applicable
(b)	Material	
(i)	Single core cables	
(ii)	Multi-core cables	
(iii)	Standard Applicable	
(c)	Minimum Coverage	
(d)	Gap between armour wires	
(e)	Breaking load of joint	
11.0	OUTERSHEATH	
(a)	Material	PVC Type ST2 as per IEC-60502 (Part-1)
(b)	Colour	Black
(c)	Whether FRLS	Yes
(d)	Method of application	Extruded
(e)	Thickness of outer sheath	As per IEC-60502 (Part-1)
(f)	Marking	Cable size (cross section area and no. of cores) and voltage grade @ 5m (by embossing) Word "XLPE" "FRLS" @ 5m (by embossing) Manufacturer's name and/ or trade name, and year of manufacture @ 5m (by embossing) 'BHEL' and 'CUSTOMER' Name @5m (by embossing) Progressive sequential marking @ 1m (by embossing/ printing)
12.0	FRLS CHARACTERISTICS	
(a)	Oxygen index	Min 29 (As per Relevant IEC / ASTM D 2863)
(b)	Temperature index	Min. 250°C (As per Relevant IEC / ASTM D 2863)
(c)	Acid gas generation	Max. 20% by weight (As per IEC 60502-1/ IEC 60754-1)
(d)	Smoke density rating	Max. 60% (As per IEC 60502-1/ IEC 61034-2 / ASTM D 2843)
(e)	Flammability Test	
(i)	Flammability test for single cable	YES As per IEC-60332 Part-1
(ii)	Flammability test as per IEEE: 60383	YES—NO (IEEE 60383 IS APPLICABLE FOR NUCLEAR APPLICATIONS)
(iii)	Swedish Chimney test SEN-SS-424-1475-F3	YES
(iv)	Flammability test for bunched cable	YES As per IEC -60332 part-3 CAT-B
13.0	Anti rodent and Termite repulsion Test	YES (The cables will be resistant to insects and rodents)
14.0	Anti-Fungal Test	YES (The cables will be resistant to bacterial action)
15.0	TOLERANCE ON OUTER DIAMETER	Up to 30mm, $\pm 1.5\text{mm}$ Above 30mm; $\pm 5\%$ or $\pm 2\text{mm}$, whichever is less.
16.0	MINIMUM BENDING RADIUS	
(a)	Single core cables	15 x O.D.
(b)	Multi core cables	12 x O.D.

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17.0	SAFE PULLING FORCE	
(a)	Copper conductor cable	50 N/ sq. mm.
18.0	CABLE DRUMS	
(a)	Type of Drum	Steel
(b)	Standard drum length	750m (±) 5% - For sizes 150 sq. mm. & above 1000m (±) 5% - For all other sizes
(c)	Painting	Entire surface to be painted
(d)	Outermost Layer	To be covered with waterproof polyethylene
19.0	SEA WORTHY PACKING	YES
20.0	WATER TREE TEST (ACCELERATED) WATER TREE TEST IS APPLICABLE FOR HV AND MV CABLES. IT IS NOT APPLICABLE FOR LV CABLES SINCE IN CASE OF LV CABLES, THE STRESSES WHICH ARE DEVELOPED ARE NOT SUFFICIENT FOR TREE FORMATION ON INSULATION OF CABLES	Test Voltage = $3 \times U_0$ Test Frequency = 500 Hz Core Environment = 40°C water Duration of Test = 4 months Test after 4 months: Dielectric stress withstand > 14 kV/mm.

II. TESTING REQUIREMENTS

A. Type Test Conduction:

- Tests for which "T" is indicated in the 'Test Conduction Required As' column below shall be conducted as Type Test.
- Sampling:
 - Type test to be conducted on one size of cable for every lot and type of cable (CU conductor)
 - Flammability Test to be conducted only on one sample/ lot.

B. Sample Test Conduction:

- Tests for which "S" is indicated in the 'Test Conduction Required As' column below shall be conducted as Sample tests.
- Sampling:
Sampling for sample tests shall be as per IEC 60502-1.
- Flammability Test to be conducted only on one sample/ lot.

C. Routine Test Conduction:

- Tests for which "R" is indicated in the 'Test Conduction Required As' column below shall be conducted as Routine tests.

D. Tests listed in S.No-7.0, 8.0, 9.0 & 10.0 shall be conducted only on one sample / lot.

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S. No.	TEST	APPLICABLE FOR	TEST CONDUCTION REQUIRED AS	REFERENCE STANDARD	REMARKS
1.0	Tests for Conductor				
I.	Resistance test	For Cu	T, S, R	IEC 60502-1/ IEC- 60228	
2.0	Tests for Armour Wires/Strips				
I.	Measurement of dimensions	Not applicable			
II.	Tensile test				
III.	Elongation at break test				
IV.	Torsion test				
V.	Winding test				
VI.	Resistivity test				
VII.	Uniformity of Zinc coating test				
VIII.	Mass of Zinc coating test				
IX.	Wrapping Test				
3.0	Physical Tests for XLPE Insulation & PVC sheath				
I.	Test for thickness	Applicable for XLPE insulation, PVC inner sheath & PVC outer sheath	T, S	IEC 60502-1/ IEC- 60811-201/ IEC-60811-202	
II.	Tensile strength and elongation test at break	Applicable for XLPE insulation & PVC outer sheath			
(a)	Before ageing		T, S	IEC 60502-1/ IEC- 60811-401/ IEC-60811-501	
(b)	After ageing		T, S	IEC 60502-1/ IEC- 60811-401/ IEC-60811-501	
III.	Ageing in air oven	Applicable for XLPE insulation, PVC inner sheath & PVC outer sheath	T	IEC 60502-1/ IEC- 60811-401	
IV.	Loss of mass in air oven test	For PVC inner sheath & PVC outer sheath	T	IEC 60502-1/ IEC- 60811-409	
V.	Hot deformation test	For PVC inner sheath & PVC outer sheath	T	IEC 60502-1/ IEC- 60811-508	
VI.	Behaviour at low temperature	For PVC inner sheath & PVC outer sheath	T	IEC 60502-1/ IEC- 60811-504 IEC-60811-505 IEC-60811-506	
VII.	Heat shock test	For PVC inner sheath & PVC outer sheath	T	IEC 60502-1/ IEC- 60811-509	
VIII.	Shrinkage test	For XLPE insulation & PVC outer sheath only	T	IEC 60502-1/ IEC- 60811-502/ IEC-60811-503	
IX.	Thermal stability test	For PVC outer sheath only	T	Relevant IEC	

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S. No.	TEST	APPLICABLE FOR	TEST CONDUCTION REQUIRED AS	REFERENCE STANDARD	REMARKS
X.	Hot set test	For XLPE insulation only	T, S	IEC 60502-1	
XI.	Water absorption (gravimetric) test	For XLPE insulation only	T	IEC 60502-1/ IEC 60811-1-3	
4.0	Improved Fire performance (FRLS) Tests				
I.	Oxygen index test	For PVC outer sheath only	T, S	Relevant IEC / ASTM D 2863	
II.	Smoke density test	For PVC outer sheath only	T	IEC 60502-1/ IEC 61034-2 / ASTM D 2843	
III.	Acid gas generation test	For PVC outer sheath only	T, S	IEC 60502-1/ IEC 60754-1	
IV.	Temperature Index Test	For PVC outer sheath only	T	Relevant IEC / ASTM D 2863	
5.0	Flammability Tests				
I.	Flammability test for single cable	For complete cable	T, S	IEC:60332 Part-1	
II.	Swedish chimney test	For complete cable	S	SEN SS 424 1475 (Class F3)	
III.	Flammability test	For complete cable	S	IEEE: 60383 IEC -60332 part-3 CAT-B	
6.0	Electrical Tests				
I.	AC voltage Test for 5 min	For complete cable	T, S, R	IEC 60502-1	
II.	Insulation Resistance Test At ambient temperature	For complete cable	T, S	IEC 60502-1	
III.	Insulation Resistance Test At maximum conductor temperature in normal operation	For complete cable	T, S	IEC 60502-1	
IV.	High voltage test for 4 hour	For complete cable	T, S	IEC 60502-1	
7.0	Anti-rodent and Termite Repulsion test	For outer sheath only	S	Manufacturer's Testing Standard	Internal Test Report to be furnished
	The cables will be resistant to insects and rodents.				
8.0	Anti-Fungal Test	For PVC outer sheath only	A	Manufacturer's Testing Standard	
	The cables will be resistant bacterial action.				
9.0	Resistant to solar radiation	For PVC outer sheath only	S	Manufacturer's Testing Standard	Internal Test Report to be furnished
	The cables will be resistant to solar radiation.				

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S. No.	TEST	APPLICABLE FOR	TEST CONDUCTION REQUIRED AS	REFERENCE STANDARD	REMARKS
10.0	Resistance to the effect of oil, seawater The cables will be resistant to the effect of oil, seawater.	For PVC outer sheath only	S	Manufacturer's Testing Standard	
11.0	Water Tree Test (Accelerated) NOT APPLICABLE FOR LV CABLES. ONLY APPLICABLE FOR HV AND LV CABLES	XLPE Insulation	I	As per Technical Datasheet	Type Test Report to be furnished

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ANNEXURE - E
CABLE DETAILS OF LV PVC CONTROL CABLES

I. TECHNICAL DATA

1.0	Type of Cable	Flame Retardant Low Smoke (FRLS)
2.0	Standard applicable in general(Latest amendment to be referred if any)	IEC 60228, IEC 60502, ASTM D: 2843, ASTM D: 2863, ASTM D 3137:81, IEC-754-1, IEC: 60332 Part-1, IEC: 60332 Part-3-23, IEEE 60383 & other relevant IEC.
3.0	Voltage Grade	0.6 / 1 (1.2) kV
4.0	Number of cores, cross sectional area of conductors and quantities	As per Section-1, clause 1.3
5.0	Design Ambient Temperature	45° C
6.0	CONDUCTOR	
(a)	Material	Copper
	Grade and Class	Stranded, annealed plain high conductivity, Class B
(b)	Standard Applicable	IEC 60228
(c)	Shape	Circular as per IEC 60228
(d)	Min. number of Strands	As per Table-2 of IEC-60228
7.0	INSULATION	
(a)	Material	PVC
(b)	Standard Applicable	IEC-60502 (Part-1)
(c)	Continuous withstand temperature	70°C
(d)	Short-circuit withstand temperature	160°C
(e)	Method of application	By extrusion; sleeve extrusion not permitted.
(f)	Nominal Thickness of insulation	As per Table-5 of IEC-60502 (Part-1)
8.0	CORE IDENTIFICATION	As per relevant IEC
9.0	INNER SHEATH	
(a)	Material	PVC Type ST-1
(b)	Standard Applicable	IEC-60502 (Part-1)
(c)	Colour	Black
(d)	Whether FRLS	NO
(e)	Thickness of inner sheath	As per Table-8 of IEC-60502 (Part-1)
(f)	Fillers	Acceptable
(g)	Material of fillers (if permitted)	Same as inner sheath (Material to be compatible with inner sheath)
(h)	Method of application	
(1)	Multi-core cables:	
(i)	With fillers	Pressure/Vacuum extruded
(ii)	Without fillers	Pressure extruded

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10.0	ARMOUR	
(a)	Applicable	No
10A	Overall Screen - YES, Aluminium Mylar Tape, 100% coverage, 20% overlap, Drain wire ATC run longitudinally along screen	
11.0	OUTERSHEATH	
(a)	Material	PVC Type ST2-ST1 (ST2 OUTER SHEATH IS APPLICABLE FOR CABLES WITH XLPE INSULATION)
(b)	Standard Applicable	IEC-60502 (Part-1)
(c)	Colour	Black
(d)	Whether FRLS	Yes
(d)	Method of application	Extruded
(e)	Thickness of outer sheath	As per IEC-60502 (Part-1) (min. 1.8mm)
(f)	Marking	Cable size (cross section area and no. of cores) and voltage grade @ 5m (by embossing) Word "PVC" "FRLS" @ 5m (by embossing) Manufacturer's name and/ or trade name, and year of manufacture @ 5m (by embossing) 'BHEL' and 'CUSTOMER' Name @5m (by embossing) Progressive sequential marking @ 1m (by-embossing/ printing)
12.0	FRLS CHARACTERISTICS	
(a)	Oxygen index	Min 29 (As per Relevant IEC / ASTM D 2863)
(b)	Temperature index	Min. 250°C (As per Relevant IEC / ASTM D 2863)
(c)	Acid gas generation	Max. 20% by weight (As per IEC 60502-1/ IEC 60754-1)
(d)	Smoke density rating	Max. 60% (As per IEC 60502-1/ IEC 61034-2 / ASTM D 2843)
(e)	Flammability Test	
(i)	Flammability test for single cable	YES As per IEC-60332 Part-1
(ii)	Flammability test as per IEEE: 60383	YES (IEEE 60383 IS APPLICABLE FOR NUCLEAR APPLICATIONS)
(iii)	Swedish Chimney test SEN-SS-424-1475-F3	YES
(iv)	Flammability test for bunched cable	YES As per IEC -60332 part-3 CAT-B
13.0	Anti-rodent and Termite repulsion Test	YES (The cables will be resistant to insects and rodents)
14.0	Anti-Fungal Test	YES (The cables will be resistant to bacterial action)
15.0	TOLERANCE ON OUTER DIAMETER	Up to 30mm; $\pm 1.5\text{mm}$ Above 30mm; $\pm 5\%$ or $\pm 2\text{mm}$, whichever is less.
16.0	MINIMUM BENDING RADIUS	
(a)	Multi core cables	12 x O.D.
17.0	SAFE PULLING FORCE	
(a)	Copper conductor cable	50 N/ sq. mm.
18.0	CABLE DRUMS	
(a)	Type of Drum	Steel
(b)	Standard drum length	1000m ($\pm 5\%$)
(c)	Painting	Entire surface to be painted
(d)	Outermost Layer	To be covered with waterproof polyethylene

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19.0	SEA WORTHY PACKING	YES
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II. TESTING REQUIREMENTS

A. Type Test Conduction:

- Tests for which "T" is indicated in the 'Test Conduction Required As' column below shall be conducted as Type Test.
- Sampling:
 - Type test to be conducted on one size of cable for every lot and type of cable (CU/AL conductor)
 - Flammability Test to be conducted only on one sample/ lot.

B. Acceptance Test Conduction:

- Tests for which "S" is indicated in the 'Test Conduction Required As' column below shall be conducted as Sample tests.
- Sampling:
Sampling for sample tests shall be as per IEC 60502-1.
- Flammability Test to be conducted only on one sample/ lot.

C. Routine Test Conduction:

- Tests for which "R" is indicated in the 'Test Conduction Required As' column below shall be conducted as Routine tests.

D. Tests listed in S.No-6.0, 7.0, 8.0 & 9.0 shall be conducted only on one sample / lot.

S. No.	TEST	APPLICABLE FOR	TEST CONDUCTION REQUIRED AS	REFERENCE STANDARD	REMARKS
1.0	Tests for Conductor				
I.	Resistance test	For Al/Cu	T, S, R	IEC 60502-1	
2.0	Physical Tests for PVC Insulation & PVC sheath				
I.	Test for thickness	Applicable for PVC insulation, PVC inner sheath & PVC outer sheath	T,S	IEC 60502-1/ IEC 60811-1-1	
II.	Tensile strength and elongation test at break	Applicable for PVC insulation, PVC inner sheath & PVC outer sheath	T,S		
(a)	Before ageing		T,S	IEC 60502-1/ IEC 60811-1-1/ 60811-1-2	
(b)	Ageing in air oven		T,S	IEC 60502-1/ IEC 60811-1-1/ 60811-1-2	
(c)	After ageing of pieces of complete cable		T	IEC 60502-1/ IEC 60811-1-1/ 60811-1-2	

	DESIGN CALCULATIONS FOR LV CABLES SELECTION & SIZING	Doc. No. MAITREE-00-BTW-EDB-105026-PEM
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S. No.	TEST	APPLICABLE FOR	TEST CONDUCTION REQUIRED AS	REFERENCE STANDARD	REMARKS
III	Hot deformation pressure test	Applicable for PVC insulation, PVC inner sheath & PVC outer sheath	T	IEC 60502-1/ IEC 60811-3-1	
IV	Behaviour at low temperature	Applicable for PVC insulation, PVC inner sheath & PVC outer sheath	T	IEC 60502-1/ IEC 60811-1-4	
V	Loss of mass in air oven test	For PVC outer sheath only	T	IEC 60502-1/ IEC 60811-3-2	THIS TEST IS APPLICABLE FOR ST2 TYPE OUTER SHEATH ONLY
VI	Heat shock test	Applicable for PVC insulation, PVC inner sheath & PVC outer sheath	T	IEC 60502-1/ IEC 60811-3-1	
VII	Water absorption (gravimetric) test	For PVC insulation only	T	IEC 60502-1/ IEC 60811-1-3	
3.0 Improved Fire performance (FRLS) Tests					
I.	Oxygen index test	For PVC outer sheath only	T, A	Relevant IEC / ASTMD 2863	
II.	Smoke density test	For PVC outer sheath only	T	IEC 60502-1/ IEC 61034-2 / ASTMD 2843	
III.	Acid gas generation test	For PVC outer sheath only	T, A	IEC 60502-1/ IEC 60754-1	
IV.	Temperature Index Test	For PVC outer sheath only	T	Relevant IEC / ASTMD 2863	
4.0 Flammability Tests					
I.	Flammability test for single cable	For complete cable	T, A	IEC:60332 Part-1	
II.	Swedish chimney test	For complete cable	A	SEN SS 424 1475 (Class F3)	
III.	Flammability test for bunched cable	For complete cable	A	IEEE: 60383 As per IEC - 60332 part-3 CAT-B	
5.0 Electrical Tests					
I.	AC voltage Test for 5 min	For complete cable	T, A, R	IEC 60502-1	
II.	Insulation Resistance Test At ambient temperature	For complete cable	T, A	IEC 60502-1	
III.	Insulation Resistance Test At maximum conductor temperature in normal operation	For complete cable	T, A	IEC 60502-1	
IV.	High voltage test for 4 hour	For complete cable	T, A	IEC 60502-1	

	DESIGN CALCULATIONS FOR LV CABLES SELECTION & SIZING	Doc. No. MAITREE-00-BTW- EDB-105026-PEM
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S. No.	TEST	APPLICABLE FOR	TEST CONDUCTION REQUIRED AS	REFERENCE STANDARD	REMARKS
6.0	Anti-rodent and Termite Repulsion test The cables will be resistant to insects and rodents.	For outer sheath only	S	Manufacturer's Testing Standard	<i>Internal Test Report to be furnished</i>
7.0	<u>Anti-Fungal Test</u> The cables will be resistant bacterial action.	For PVC outer sheath only	A	Manufacturer's Testing Standard	
8.0	Resistant to solar radiation The cables will be resistant to solar radiation.	For PVC outer sheath only	S	Manufacturer's Testing Standard	<i>Internal Test Report to be furnished</i>
9.0	Resistance to the effect of oil, seawater The cables will be resistant to the effect of oil, seawater.	For PVC outer sheath only	S	Manufacturer's Testing Standard	
0	Tests for Al-Mylar Shield				
I	Continuity test	For Al-Mylar shield	T, A	Plant Standard	
II	Shield thickness	For Al-Mylar shield	A	ADS	
III	Overlap test	For Al-Mylar shield	A	ADS	
IV	Constructional details, dimensions	For Al-Mylar shield	A	ADS	
V	Visual surface finish	For Al-Mylar shield	A	Plant Standard	
VI	Overall coverage	For Al-Mylar shield	A	Plant Standard	
VII	Noise interference test	For Al-Mylar shield	A	ADS	
0	Tests for Drain Wire				
I.	Annealing test	For copper conductor only	T, A	IS 10810 Pt 1	<i>Internal in process Test Report to be furnished for acceptance test</i>
II	Tin coating test (for tinned copper)	For copper conductor only	T, A	IS 10810 Pt 4	
III	Resistance test	For AlCu	T, A, R	VDE 0815	
IV	Diameter test	For conductor	T, A	ADS	
V	Continuity test	For Al-Mylar shield	T, A	Plant Standard	

	TYPICAL DETAILS OF SCREENED CONTROL CABLES	Doc. No. Maitree-00-BTW-EDB-107001-PEM-0
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Annexure - G

I. TECHNICAL DATA

- 1.0 Voltage grade : 1.1kV
- 2.0 Type of cable : FRLS
- 3.0 Standards Applicable :

S. No.	STANDARD	APPLICATION
1	VDE 0815, VDE 0816, VDE 0472	General Construction & tests for cables.
2	VDE 0207	For insulation thickness.
3	SEN-SS-424-1475, IEC-60332 Part-1 IEC-60332 Part-3 Cat-B	Flammability Tests
4	ASTMD-2843, ASTMD-2863, IEC-754 Part-1	FRLS Tests

4.0 CONDUCTOR

- a) Material : High conductivity annealed Untinned copper
- b) Grade : Electrolytic
- c) Standard applicable : VDE 0815
- d) Min number of strands, Strand dia, and cross sectional area : 7, 0.3 mm (nom), 0.5 sq.mm

5.0 INSULATION

- a) Material : PVC as per VDE 0207 Part 4, compound Y I3
- b) Application : Extruded
- c) Insulation thickness Min/ Nom/ Max : As per voltage grade of 1.1kV
- d) Volume resistivity (Min) : 1×10^{14} ohm-cm at 20 deg .C & 1×10^{11} at 70 deg .C.

6.0 LAYING OF CORES

- a) Min. number of twist per Metre for paired cables : 20 (For 0.5 sq.mm.)
- b) Maximum lay of individual : 50 mm (For 0.5 sq.mm.)

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twisted pair

c) Diameter of core : In accordance with clause 5 (c)

7.0 IDENTIFICATION OF CORES : As per Annexure B-I

8.0 INDIVIDUALLY SCREENED

a) Material : Aluminium-Mylar tape

b) Coverage : 100%

c) Overlap : Minimum 20%

d) Min thickness (Micron) : 28

e) Binder : Polyester tape.

9.0 OVERALL SCREENED

a) Material : Aluminium-Mylar tape

b) Coverage : 100%

c) Over lap : Minimum 20%

d) Min. thickness (Micron) : 55 micron

e) Binder : Polyester tape.

10.0 DRAIN WIRE

To be provided separately for individual pair shield and overall shield.

a) Material : Annealed Tin coated copper conductor as per VDE: 0815

b) Min number of strands, : 7, 0.3 mm (nom), 0.5 sq.mm
Strand dia, and cross sectional area

11.0 ACCESSORIES (BEDDING, BINDER, TAPE REQ.)

a) Material : Mylar Tape

12.0 OUTER SHEATH

a) Material : Extruded PVC (compound YM1) as per VDE 0207 Part-5

b) Thickness : As per VDE 207 Part-5/ relevant VDE

Minimum Thickness at : 1.8 mm for unarmoured Cable

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any point

Nominal Thickness at any point : >1.8 mm for unarmoured Cable

- c) Application : Extruded
- d) Colour : Blue/ Black
- e) Whether FRLS : YES

13.0 FRLS/ FLAMMABILITY TESTS

- a) Oxygen Index : 29% Minimum as per ASTM D 2863
- b) Temperature Index : 250 °C Minimum as per ASTM D 2863
- c) Acid gas generation : less than 20% by weight (As per IEC-754-1)
- d) Smoke density rating : Not more than 60% (As per ASTM D 2843)
Derived as average area under curve when the results of smoke density plotted on a curve indicating light absorption v/s time as ASTM D 2843
- e) Flammability Test : ☒ SEN-SS-424-1475 Class F3
☒ IEC-60332 Part 1
☒ IEC-60332 Part 3 Cat-B

14.0 TOLERANCE ON OVERALL DIAMETER : ± 2mm max. Over the declared value in Technical Data Sheet

15.0 VARIATION IN DIA & OVALITY AT ANY CROSS-SECTION : Maximum 1 mm.

16.0 CABLE DRUM DETAILS

- a) Material Type & Construction : ☒ Steel as per relevant International/ Manufacturer standard.
- b) Standard drum length : 1000 metres.
- c) Tolerance on drum length : ±5%
- d) Painting : Entire surface to be painted
- e) Outermost Layer : To be covered with waterproof polythene
- f) Sea Worthy packing : Yes

	TYPICAL DETAILS OF SCREENED CONTROL CABLES	Doc. No. Maitree-00-BTW-EDB-107001-PEM-0
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17.0 RIP CORD : A non-hygroscopic and non-wicking non metallic cord

18.0 Markings on Outer Sheath

- a) Progressive sequential Length marking to be provided : [✓] @ 1M by Printing.
- b) Progressive marking @ 5M : Manufacturer's name, insulation, FRLS, cable size (cross- section & no. of pairs), voltage grade, year of manufacture, BHEL by [✓] Printing

19.0 TECHNICAL PARAMETERS (C & I) As per Table below

STANDARD CABLE PARAMETERS FOR INSTRUMENTATION CABLE

Parameter	0.5 mm ² (I & OS) type-F	0.5 mm ² (OS) type-G
Mutual Capacitance (max.) at 0.8 kHz, nF/Km	120	100
Conductor Loop Resistance (max.), Ohm/Km	73.4	73.4
Insulation Resistance (min), M Ohm/ Km	100	100
Cross Talk Figure (min) at 0.8kHz, dB	60	60
Characteristic impedance (max.) at 1 kHz	320	340
Attenuation(max.) at 1 kHz db/Km	1.2	1.2

Note:

1. Cable parameters indicated above are at 20 degC (+/- 3 degC)

20.0 TEST VOLTAGE

Core – Core Core- shield
As per voltage grade of 1.1kV

- a) High voltage test
- b) Resistance to direct current test:

ANNEXURE : B-I

The cable cores shall be colour coded as mentioned below:

PAIR	CORE	COLOUR
1 st	1 st	Blue
1 st	2 nd	Red
2 nd	1 st	Grey
2 nd	2 nd	Yellow
3 rd	1 st	Green
3 rd	2 nd	Brown
4 th	1 st	White
4 th	2 nd	Black

Each four pair is laid to form one unit and wound with Mylar tape. The cores of each unit shall then be identified by colour bands for cables of more than 4-pair. eg. All eight cores of the first unit shall have a single band of pink colour (preferably rose pink).

Unit No No.	COLOUR OF BANDS	BAND MARKS
1.	PINK	= === ==
2.		= ===== ==
3.		= === ==
4.		= === ==
5.	ORANGE	= === ==
6.		= ===== ==
7.		= === ==
8.		= === ==
9.	VIOLET	= === ==
10.		= ===== ==
11.		= === ==
12.		= === ==

The dimension L (distance between the marking) shall be limited to 60mm. The bands shall be neat and cover at least 2/3 of the periphery of the core.
eg: A grey wire having 3 orange bands is the first core of the second pair of the seventh unit.

	TYPICAL DETAILS OF SCREENED CONTROL CABLES	Doc. No. Maitree-00-BTW-EDB-107001-PEM-0
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II. TESTING REQUIREMENTS

A. Type Test Conduction:

- Tests for which "T" is indicated in the 'Test Conduction Required As' column below shall be conducted as Type Test.
- Sampling:
 - Type tests (except for Sl. no. b & c below) to be conducted on one size (2P,4P etc.) of each type/ lot.
 - Electrical tests to be conducted on each size (2P,4P etc.) of each type/ lot.
 - FRLS & Flammability Test to be conducted only on one sample/ lot, irrespective of size/type.

B. Acceptance Test Conduction:

- Tests for which "A" is indicated in the 'Test Conduction Required As' column below shall be conducted as Acceptance tests.
- Sampling:
Sampling for acceptance tests for every lot shall be as per Appendix-B (Clause 15.2.2) of IS: 1554 Part-I or relevant IEC/International standard.

C. Routine Test Conduction:

- Tests for which "R" is indicated in the 'Test Conduction Required As' column below shall be conducted as Routine tests
- Sampling:
Routine testing shall be conducted in line with the applicable standards and as per the Manufacturing Quality Plan approved for the project for every lot offered for inspection.

D. C&I Tests listed in S.No-9.0 shall be conducted only one size/ type / lot.

E. ADS: Approved datasheet.

S. No.	TEST	APPLICABLE FOR	TEST CONDUCTION REQUIRED AS	REFERENCE STANDARD	REMARKS
1.0	Tests for Conductor				
I.	Annealing test	For copper conductor only	T, A	IS 10810 Pt 1	<i>Internal in process Test Report to be furnished for acceptance test</i>
II.	Tin coating test (for tinned copper)	For copper conductor only	T, A	IS 10810 Pt 4	
III.	Resistance test	For Al/Cu	T, A, R	VDE 0815	
IV.	Diameter test	For conductor	T, A	ADS	
2.0	Physical Tests for PVC Insulation & PVC sheath				



TYPICAL DETAILS OF SCREENED CONTROL CABLES

Doc. No. Maitree-00-BTW-EDB-107001-PEM-0

2 X 660MW BIFPCL MAITREE
KHULNA STPP (BANGLADESH)

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S. No.	TEST	APPLICABLE FOR	TEST CONDUCTION REQUIRED AS	REFERENCE STANDARD	REMARKS
I.	Test for thickness & Eccentricity	Applicable for PVC insulation, PVC inner sheath & PVC outer sheath	T, A	VDE 0472/IS 1554-I	
II.	Tensile strength and elongation test at break	Applicable for PVC insulation & PVC outer sheath	T, A	VDE 0472	
(a)	Before ageing		T, A		
(b)	After ageing		T, A		
III.	Ageing in air oven	Applicable for PVC insulation & PVC outer sheath	T	VDE 0472	
IV.	Loss of mass in air oven test	For PVC Inner & outer sheath.	T	VDE 0472	
V.	Hot deformation test	For PVC Inner & outer sheath.	T	VDE 0472	
VI.	Heat shock test	For PVC Inner & outer sheath.	T	VDE 0472	
VII.	Shrinkage test	For PVC insulation, PVC inner & PVC outer sheath.	T	VDE 0472	
VIII.	Thermal stability test	For PVC outer sheath only	T	VDE 207	
3.0	Tests for Al-Mylar Shield				
I.	Continuity test	For Al-Mylar shield	T, A	Plant Standard	
II.	Shield thickness	For Al-Mylar shield	A	ADS	
III.	Overlap test	For Al-Mylar shield	A	ADS	
IV.	Constructional details, dimensions	For Al-Mylar shield	A	ADS	
V.	Visual, surface finish+	For Al-Mylar shield	A	Plant Standard	
VI.	Overall coverage	For Al-Mylar shield	A	Plant Standard	
VII.	Noise interference test.	For Al-Mylar shield	A	ADS	
4.0	Tests for Drain Wire				
I.	Annealing test	For copper conductor only	T, A	IS 10810 Pt 1	<i>Internal in process Test Report to be furnished for acceptance test</i>
II.	Tin coating test (for tinned copper)	For copper conductor only	T, A	IS 10810 Pt 4	
III.	Resistance test	For Al/Cu	T, A, R	VDE 0815	
IV.	Diameter test	For conductor	T, A	ADS	
V.	Continuity test	For Al-Mylar shield	T, A	Plant Standard	
5.0	FRLS Tests				
I.	Oxygen index test	For PVC outer sheath only	T, A	IS 10810 Pt 58 / ASTMD 2863	
II.	Smoke density test	For PVC outer sheath only	T, A	ASTMD 2843	
III.	Acid gas generation test	For PVC outer sheath only	T, A	IS 10810 Pt 59 / IEC-754-1	

Section-2
Equipment Specification
(As per BIFPCL/ FICHTNER contract specification)

 B0.6.18.12.2 General cable construction requirements

The medium and low voltage cables shall be of Fire Retardant Low Smoke (FRLS) with XLPE insulation. For cables that are exposed to ambient temperatures above 60°C, teflon or silicone cables are to be provided.

For safety related equipment fire survival cables shall be provided.

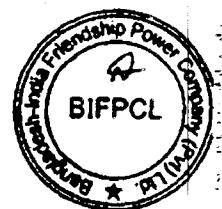
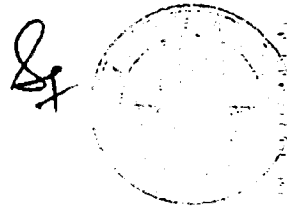


The cables must be suitable for laying indoors, in the open (direct or indirect sunlight), in ducts, on trays, in the ground and in water. The cables must be resistant to solar radiation, the effect of oil, seawater, bacterial action, insects and rodents. Outer sheaths are to be manufactured from non-combustible or flame retardant low smoke material.

Manufacturers testing standard related to resistance to solar radiation, effect of oil, seawater, bacterial infection, insects and rodents, will be accepted.

All cables must be provided at both ends, at every 20 m and every bend with identification in the form of numbered labels corresponding to the coding system. The individual cores will be numbered or identified by colour-coding.

The cables must be laid to ensure that they can be replaced or renewed in a simple manner.



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B0.6.18.12.4 Low voltage (LV) power cables

The low voltage power cables shall be standard single and multi-core cables of FRLS with copper conductor and XLPE insulation.

To ensure the elimination of excessive contact potentials on any object, effective earthing must be carried out as a safety measure and suitable 3-core, 4-core and 5-core low voltage power cables must be provided. The minimum conductor cross-section of the low voltage power cables is 2.5 mm². If 3 1/2-core cables are used, the reduced conductor for protective neutral must have a cross-section of at least 16 mm². In lighting systems (especially discharge lighting circuits) the use of a reduced conductor for the protective neutral is to be avoided.

Depending on the site conditions the DC cables must be single-core, 2-core or 4-core. Between batteries or rectifiers and the DC switchgear single-core power cables should in general be used.

The LV power cables must be designed for the dynamic and thermal characteristics of the electrical system and for continuous operation

B0.6.18.12.5 Current carrying capacity of power cables

The ratings for continuous loading of the cables shall be calculated according to the relevant IEC regulations. The Contractor must submit corresponding tabulations for all cables to be used.

The maximum voltage drop under normal conditions shall not exceed 2.5%.

Voltage drop during starting shall be considered as 15% & during running 3%.

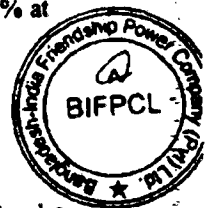
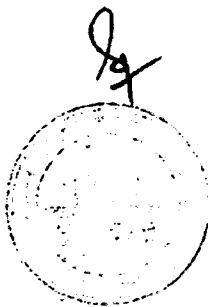
The voltage drop between the the MCC and the terminal of the load shall not exceed 2.5%. It is assumed that the switchgear and the MCC are connected by bus-bars/- ducts means the voltage drop is very low.

The voltage drop for MV Cable Shall be limited to 3% and for LV Cables:

- The voltage drop on the LV cables from Main Distribution to subdistribution shall not exceed 2.5%
- The voltage drop up to the LV motor terminals shall not exceed 5% at normal operation and 15% during starting.

B0.6.18.12.6 Measuring and control cables above 60 V/ instrument transformer cables

For voltages above 60 V the cables shall be of Fire Retardant Low Smoke (FRLS) with PVC insulation and a mini-mum conductor cross-section of



1.5 mm². If they lead to outlying buildings, cables with a common core screen and protection against induction must generally be used.

For instrument transformer cables inside buildings the minimum conductor cross-section must be 2.5 mm².

Instrument transformer cables leading to outlying buildings must have a minimum size of 4 mm² and must generally have a common core screen.

The maximum voltage drop shall not exceed 2%.

All instrumentation cables including both prefabricated and non-prefabricated type shall be with Fire Retardant Low Smoke (FRLS) type Poly Vinyl Chloride (PVC) overall sheath. For cables that are exposed to ambient temperatures above 60°C, teflon or silicone cables are to be provided. For safety related equipment fire survival cables shall be provided. The cables must be suitable for laying indoors, in the open (direct or indirect sunlight), in ducts, on trays, in the ground and in water. The cables must be resistant to solar radiation, the effect of oil, seawater, bacterial action, insects and rodents. Shields for individual pair and overall shield shall be provided for cables for analogue signals. Cables for binary signals shall have an overall shield. Multipair cables of 0.5 sq. mm, shall be used extensively for I&C cables, wherever required, prefabricated cables may also be used.

For thermocouple measurements compensation cable NiCr-Ni 2x0.5sq. mm or 4x0.5 sq. mm with silicone insulation and pair screen will be used. Fiber optic cables shall be provided for Remote I/O bus, CCTV, Station LAN etc.

B10.4.23 Power and control cables

B10.4.23.1 General

The requirements specified under the section "General Specification Part B0" apply and, where applicable, further regulations from the sections of this Technical Requirements.

Cables having a cross section greater than 16 mm² are to be of XLPE cable type, LV cables of smaller size of PVC insulated type. All cables have to be suitable for an ambient temperature given under General Specification (B0).

For cables, which are subjected to ambient temperature above 60°C, teflon- or silicone-insulated cables must be provided.

All power cables shall be XLPE insulated. However, this is applicable only for the insulation.

All cables laid on the surface of walls, steel frames etc., must be protected against mechanical damage by galvanized steel tubes or robust PVC pipes. In all areas where the cable conduits can be damaged, e.g. walk-ways, only steel tubes shall be installed.

For running out power cables, heavy screw jacks and spindles shall be used. The cable has to be continuously pulled from the upper side of the drum in the same direction and runs over rollers. The rollers shall be placed into the trench at intervals of 1 m max. At corners or when pulling cables into ducts, special rollers have to be used. Sharp edges in the trenches or at the ends of the cable ducts have to be covered in such a manner that no damage of the cable occurs.

During the approval procedure, the Contractor shall provide a cable schedule listing all cables and their destination including details with regard to number of cores, core size, cores in use and spare cores, cable length etc. for each substation.

All control cables which have to be laid between the outdoor switchyard and the existing control building have to pass the new control building via marshalling kiosks to be installed in the new control building including associated terminals for future connection of new control and protection equipment.

B10.4.23.2 MV power cables

MV voltage connection from power plant to substation auxiliary transformers, please refer to Chapter B7.

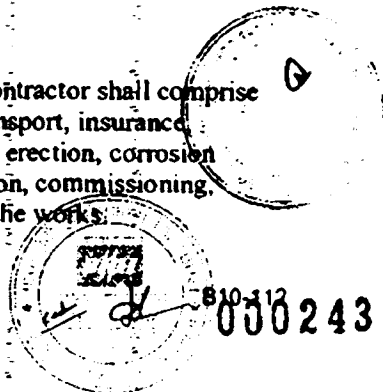
B10.4.23.3 LV Cables

B10.4.23.3.1 General

The LV Cable system installed in the substation shall be designed to support auxiliary power, monitoring and control functions of the substation. The selection of materials, design and installation shall ensure a high level of availability, minimize damage or disruption to other systems in the event of a fault and minimize the risk to personnel.

B10.4.23.3.2 Scope of works

The supply and services to be performed by the Contractor shall comprise the design, manufacture, shop testing, packing, transport, insurance, unloading, storage on Site, construction works and erection, corrosion protection, site testing, submission of documentation, commissioning, training of Employer's personnel and warranty of the works.



The Contractor is bound to provide complete works, even if the equipment or services to be provided are not specifically mentioned in the specification.

B10.4.23.3.3 LV power and multicore cables

The scope of supply shall include the following:

- Power cables used for the connection between auxiliary supply system and consumers such as motors, chargers, sub-distribution boards, local control cubicles, protection panels, substation control systems, marshalling cubicles, equipment cabinets and all other users directly fed from the switchgear shall be sized according to the continuous site rating calculation. ~~These calculations shall be submitted for approval.~~
- Power cables used for the connection between 630 kVA, 11.0/415 kV auxiliary transformers and L.V.A.C. switchboard; between batteries, chargers and DC Boards
- Multicore control cables for 220 V D.C. and 48 V DC system
- Multicore (control, protection, measuring, alarm and indication) cables used for the connection of various individual control boards or equipment cabinets to the remote control panels, protection panels, substation control system, marshalling cubicles, equipment and consumers, connection between the elements of control cubicles, connection between telemetry marshalling cubicles and control cubicles and all other connections
- Cable racks trays and fixing devices for all LV cables.
- Cable terminating material for all LV cables
- Corrosion protection
- Special equipment, tools and spare parts shall be included as required for proper maintenance.

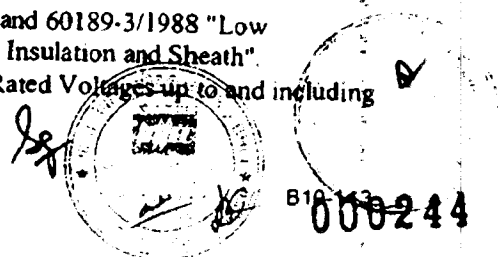
B10.4.23.3.4 Technical data

The main technical data for all LV power, control and signaling cables are listed in the Technical Data Sheets. All parts of the cable installation shall comply with this Specification and the latest revisions of the relevant IEC standards except where otherwise stated.

B10.4.23.3.5 General design requirements

The low voltage power and multicore cables shall comply with these specifications and the requirements of the latest revision of the following IEC Standards, except where otherwise stated:

- IEC 60189-1/1986, IEC 60189-2/1981 and 60189-3/1988 "Low Frequency Cables and Wires with PVC Insulation and Sheath"
- IEC 60227 "PVC Insulated Cables on Rated Voltages up to and including 450/750 V."



- IEC 60228 "Conductors of Insulated Cables".
- IEC 60287 "Calculation of the continuous current rating of cables (100% load factor)".
- IEC 60724 "Guide to the Short-Circuit Temperature Limits of Electric Cables with a Rated Voltage Not Exceeding 0.6/1 kV".
- IEC 60811 "Common Test Methods for Insulating and Sheathing Materials of Electric Cables and Optical Cables".
- IEC 60885 "Electric Test Methods for Electric Cables".

All cables shall be suitable for continuous operation under climatic conditions prevailing on site. All transient and abnormal conditions, such as overload and short circuits shall be withstood without detrimental effects. The cables shall have copper conductor with PVC insulation and PVC over. The cables shall be identified at both terminations with plastic ferrules showing the cable number and the designation of the opposite end.

At those points of interconnection between the wiring carried out by separate contractors where a change of number cannot be avoided double ferrules shall be provided on each wire. The change of numbering shall be shown on the appropriate diagram of the equipment.

The Contractor shall provide a complete set of cable schedules listing all cables required for connecting the equipment supplied under this Contract. Cable schedules listing all cables and their points of termination including details of cable, number of cores, core reference, core size, number of cores in use and cable length etc. shall be provided.

The Contractor shall ensure that the core identification at their terminals corresponds to the above mentioned schedule.

The cables shall be laid on trays in single layers in such a manner that they can be replaced or added to without difficulty.

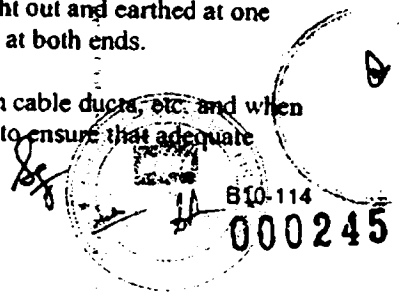
In general, the cables for double in-feeds from the switchgear, transformers, distribution boards and cubicles shall be laid separately so that in the event of short-circuit in one in-feed, the other is not affected.

All AC and DC control and power circuits shall be segregated from one another and the circuits to main protective gear shall be segregated from those for back up protection.

The cable sheaths must be resistant to solar radiation, the effect of oil, bacterial action, insects and rodents. They must be suitable for being laid indoors, outdoors, underground and in water.

The screen of the shielded cables shall be brought out and earthed at one end. The armoring of the cables shall be earthed at both ends.

When laying the cables on trays, vertical runs, in cable ducts, etc. and when choosing the sizes of cables, care must be taken to ensure that adequate



ventilation is guaranteed and that there is no risk of thermal overloading, undue pressure or distortions of the cables.

B10.4.23.3.6 Low voltage power cables

The conductors for power supply cables at voltages up to 600/1000 V AC shall be plain annealed copper wire complying with IEC 60228 as applicable, with circular or shaped conductors. All cores shall be identified by phase colors.

During motor starting or re-acceleration in groups, the voltage at the motor terminals shall not fall below 80% of the rated voltage. Cables and systems shall be sized to meet these criteria. The basis of voltage drop calculations shall be for worst case, i.e. minimum fault level and outage of supply feeders or transformers.

The maximum permissible volt drop in cables shall be:

- feeders and sub-feeders 1%
- motors branch circuits 2.5% (from power centre to load terminals)
- lighting sub-circuits 2.5% (from lighting switchboard to furthest fitting)
- A derating factor shall be applied to cable vendors stated current capacities, taking into account grouping factor, ambient temperature and environmental conditions.

Cable shall be sized by consideration of:

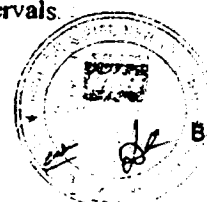
- nameplate full load current of equipment,
- current carrying capacity after de-rating,
- voltage drop,
- short circuit rating.

The minimum cross-section of standard conductors shall be 2.5 mm². The low voltage power cables shall consist of single, two, three and four core-cables. On the low-voltage side, the cable connection between the station service transformers and the 0.4 kV infeed cubicles shall consist of single conductor power cables. The connections between batteries or rectifiers respectively and the DC distribution board shall generally consist of single core power cables.

B10.4.23.3.7 Low voltage multicore cables

The conductors for power supply cables at voltages up to 600/1000 V AC and for all 220 V DC protection, control, alarm and indication as well as 48 V Telecommunication equipment shall be plain annealed copper wire complying with IEC 60228 as applicable or equivalent and all cores shall be clearly identified by printed numbers at regular intervals.

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The minimum conductor size of stranded conductors shall be not less than seven strands of 0.52 mm diameter wire and the minimum cross-sectional area shall be not less than 1.5 mm².

All multicore cables except where used for instrument transformer circuits shall have stranded copper conductors.

Multicore cables of 7 cores and above shall have a minimum of ten percent (10%) spare cores over the original design requirements.

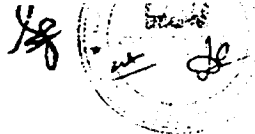
The number of cores in multicore cables shall be selected from the following numbers: 2, 3, 4, 7, 12, 19, 24, 27, 37 and 47.

The multicore cable tails shall be so bound that each wire may be traced to its cable without difficulty.

The screens of screened pairs of multipair cables shall be earthed at one end of the cable only. The position of the earthing connections shall be shown clearly on the diagram.

All spare cores shall be earthed at both ends of the multicore cable. The Contractor shall submit full details of all cable loads and in the case of interposing current transformer connections, the loop resistance of each circuit.

An instrument transformer cable may transmit the current or voltage from only one transformer. If the same voltage is required for different purposes (e.g. protection, measurement, metering) each voltage transformer circuit must be wired via a separate MCB to the switchgear control cabinets.



B10.4.24 Inspection and tests

B10.4.24.1 General

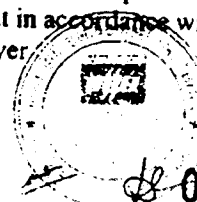
Tests shall be carried out in order to determine whether the material and equipment comply with the required properties.

Testing shall comply with Section B0 -General Technical Requirements. All tests on material and equipment shall be carried out in accordance with IEC Standards if not otherwise approved by the Employer.

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B10.4.24.2 Workshop tests

Routine test shall be performed at each item of equipment to be supplied for the purpose of revealing faults in material or construction. They shall not impair the properties and reliability of a test object or reduce its lifetime. The following routine tests shall be performed on all lengths of cables and all accessories to be supplied:

- general inspection
- examination of sheath, armor and protective coverings, as well as examination of insulation, to be performed after bending test
- measurement of conductor resistance
- high voltage test
- high voltage test on outer sheath.

SECTION-3

3.0 GENERAL

This section stipulates the General Technical Requirements under the Contract and will form an integral part of the Technical Specification. This shall include but shall not be limited to: engineering, manufacturing, shop testing, supply, supervision of erection, testing at site, commissioning, performance testing, training Employer's personnel.

The requirements stated in this Section of General Technical Requirements are valid for all sections of the specification, except only where additional and/or special requirements are specified.

In case of a contradiction between different Sections of this specification or mentioned standards, the more stringent requirements shall be applicable to Bidder/ Supplier.

The Equipment shall be new and clean, and designed, manufactured and arranged so that it will have a functional design and a pleasant appearance. All parts of the Equipment shall be arranged in such a manner as to facilitate surveillance by the operator and to ease maintenance, operation and control.

The parts of the Equipment shall be designed and arranged so that they can be easily inspected, leaned, erected and dismantled without necessitating large scale dismantling of other parts of the Equipment. They shall be designed, manufactured and put into operation in accordance with the latest recognized rules of workmanship, modern engineering practice and with good standards of prudence applicable to the international electricity generation industry which would have been expected to accomplish the desired result at the lowest reasonable cost consistent with reliability, safety and expedition.

The regulations, standards and guidelines listed in the Specification as well as all applicable laws and governmental decrees, regulations, orders, etc. shall be observed in the design, calculation, manufacture, erection, installation, testing, commissioning and start-up of all parts of the Equipment. The following shall be considered in the design and engineering of the Equipment facilities:

- All parts of the Equipment shall be suitable in every respect for continuous operation at maximum output as well as part loads and expected transient operating conditions peculiar to the site and shall be able to safely withstand the stresses arising from the operating conditions without any reduction in its planned life.
- The Supplier shall familiarize himself with the conditions on site.
- Suitable and automatically acting protection and safety measures shall be provided for automatic load reduction or shut down of equipment in case of abnormal operating conditions.
- Switchover to stand-by units shall be automatically, as far as required for continuous Plant operation without interruption of Plant operation.

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- In case of equipment and/or system shut down process conditioned drainage of components (such as pipelines, tanks, etc.) shall be performed automatically from the control room
- Minor equipment which, in case of failure would cause a failure of a power generation unit and/or the Plant is to be provided with a stand-by facility in order to ensure further operation of the power generation unit or the Plant.
- All live, moving and rotating parts shall be provided with appropriate effective protection in order to avoid danger to the operating staff. All metal parts shall be electrically grounded.
- All equipment shall be designed to ensure start-up from any condition, i.e. from long term shut-down, cold, warm or hot condition without necessitating special or preparatory measures.
- The project language shall be English.
- Material and personnel costs for tests and inspections which are mandated in legislation
- Material and personnel costs for site inspections
- Declaration of conformity with requirements from Bangladesh and markings for all machines
- Engineering design of complete supplied equipment including interface coordination
- All as-built documents (on data carriers; data formats as requested by the Employer)
- Quality control plan and safety plan
- Complete documentation as set out in the tender specification
- Operating manual (5 hardcopies and 3 electronic copies)
- Detailed operating and maintenance instructions/manual (5 hardcopies and 3 electronic copies)
- A maintenance program for all equipment of the Plant instructions (5 hardcopies and 3 electronic copies)
- For all documents softcopy format shall be searchable pdf, however in addition all drawings, diagrams like P&IDs shall be supplied in ACAD or other editable format, and all lists in Excel format.

Terminology:

Owner/ Employer: BIFPCL/ BHEL

Contractor: Supplier/ Bidder

3.1 PROJECT INFORMATION AND SYSTEM PARAMETERS

Site conditions

The following information on local conditions is investigated or compiled by the Owner. The Contractor is hereby in no way relieved from his duties of carrying out all investigations required for satisfactory performance of his equipment/ works. The Contractor shall perform his own Site visits and investigations, prior to Contract award in order to familiarize him with the existing conditions of the Site and the surrounding area.

Location, accessibility and present condition of the Site

The site for the Maitree-STPP Project is geographically located between 22° 37'0" N to 22° 34' 30" N and 89° 32' 0" E to 89° 34' 5" E, approximately 14 km northeast of the Mongla Port

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and 14 km northwest of the Sundarbans, is infringed by the Passur and Moidara Rivers to the west and south east respectively.

The topographical survey indicates a natural ground level of +1.15 to + 1.35 meters above sea level. A severe cyclone in 2009 raised the level to 4.47 meters and it was decided to raise the Plant level to +5.00 meters.

Politically, the site is located in Rampal Upazila of the Bagherat District in the Rajnagar Union.

Currently, the Site is accessible by boat only.

The nearest inland port is Mongla port at around 14km direct distance.

The proposed Khan Jahan Ali Airport is located at a distance of approximately 12 km from the project site.

Soil conditions

In general the subsoil conditions can be described as follows:

- top layer filled sand (with unknown silt content) in Plant area
- underlying layers of clay
- underlaying fine sand.

Seismic zone

Related to soil type as identified to Soil Investigation Report, the effect of local soils on earthquake ground motion shall be determined.

For site class “S1” and “S”, as expected for the Project, site specific studies shall be carried out to determine the design acceleration response spectrum. During field study minimum the following tests shall be executed:

- Seismic cross hole test; and
- Seismic refraction test.

Based on these results (Attached as Annexure-A) a site specific Response Spectra shall be established. Peak spectral acceleration shall be determined, but shall be not less than 0.12g, as mentioned in BNBC 2012, Table 2.5.2.

Bidder to design equipment based on parameters of Seismic report (attached as Annexure-A), other relevant electrical requirements, standard codes etc. Foundation loading shall be provided as per parameters of Seismic report.

Site climatic conditions

Site climatic conditions

The Plant site is from the climatic point of view under maritime tropical conditions. The assumed meteorological conditions for the Site are as follows:

The project site is located in the country’s South Central Zone consisting of three dominant seasons:

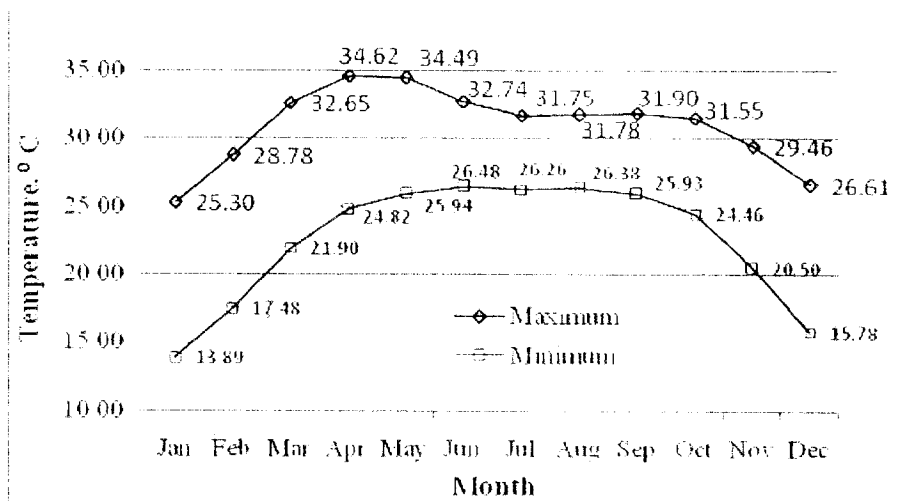
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- summer season-March to May
- monsoon season-June to October
- winter season-November to February.

During the Monsoon Season occasional cyclonic storms can occur.

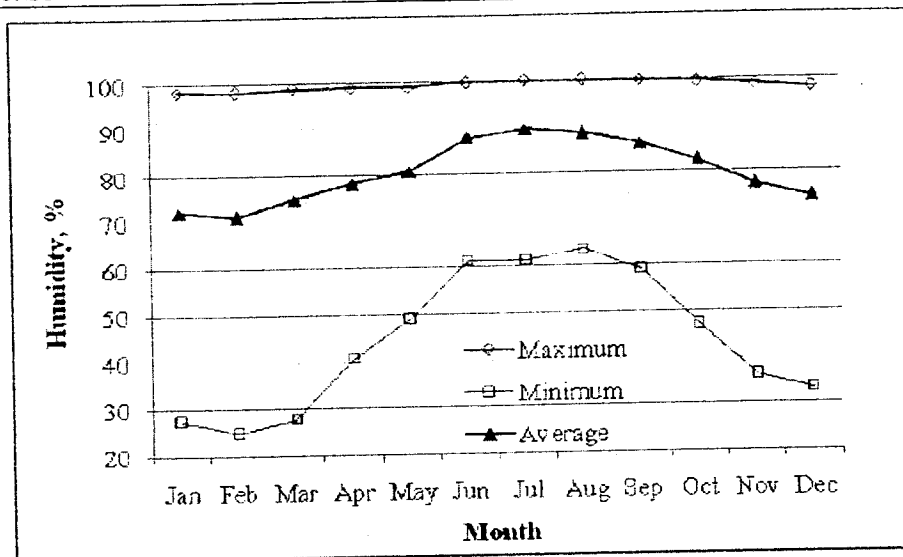
The climatic conditions in the area are continuously monitored by the Bangladesh Meteorological Department (BMD) at the Mongla Meteorological Station.

The temperature varies only slightly throughout the year with the highest temperature of 36.9°C and the lowest temperature of 12.2°C recorded in the period from 1989 to 2008. This distribution is depicted in figure below.



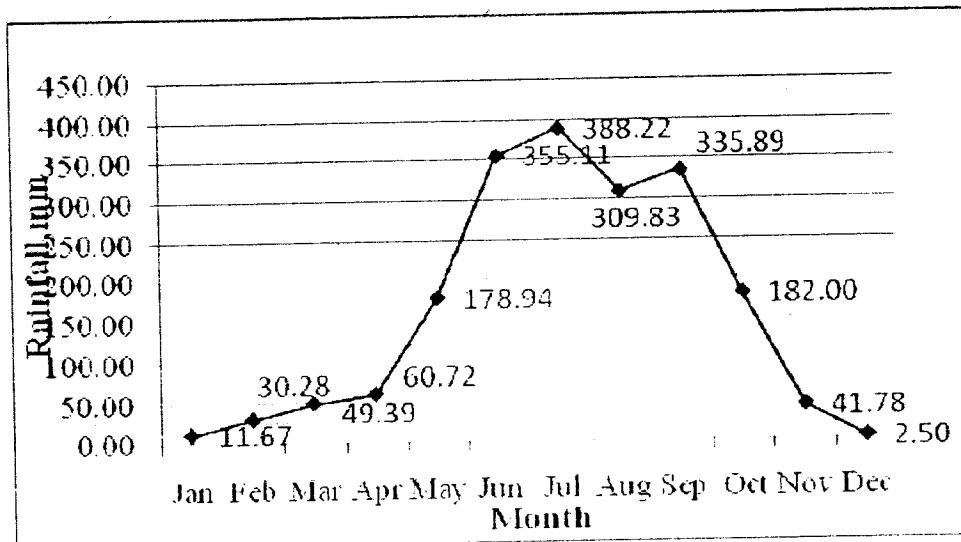
The relative humidity varies drastically during the Monsoon Season with 80% to 90% and the lowest levels of 20% to 30% during the Summer Season. The humidity profile recorded in the same period as the temperature is visualized in below figure.

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The maximum rainfall occurs during the Monsoon Season by varying between 300 mm and 350 mm with almost no rainfall during the Winter Season.

The average evaporation in the project area varies between 3 - 5 mm/day with its peak of 16 mm/day during July. The average rainfall for the period between 1991 and 2008 is depicted in below figure.



Below definitions are to be used as typical data for the different climatically seasons at the site.

Average Site Condition ASC

Ambient Temperature: 27.3 °C

Ambient Humidity 87 %

Ambient Pressure 1007.6 mbar

River Water Temperature: 29.8 °C

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Summer Site Condition SSC

Ambient Temperature 36.9 °C
Ambient Humidity 60 %
Ambient Pressure 1007.9 mbar
River Water Temperature: 33 °C

Winter Site Conditions WSC

Ambient Temperature 12.2 °C
Ambient Humidity 100 %
Ambient Pressure 1017.2 mbar
River Water Temperature: 20°C

Reference Site Conditions RSC

Ambient Temperature 31 °C
Ambient Humidity 88 %
Ambient Pressure 1007 mbar
River Water Temperature: 32°C
Wind speed 1 m/s

Design ambient conditions for Electrical Systems

- Maximum design temperature (outdoor) 45°C
- Maximum daily average ambient shade temperature 38°C
- Maximum monthly average temperature (in the shade) 34.6°C
- Maximum annual average temperature (in the shade) 27.3°C
- Maximum design temperature of the electrical equipment installed indoors in air conditioned rooms 40°C
- Maximum design temperature of the electrical equipment installed indoors non in air conditioned rooms 45°C
- Minimum design temperature 0°C

Marine conditions

Two tides (e.g. flood and ebb) are regularly observed in the Passur River, which enters into the project site through numerous connected creeks.

The tidal range varies between 1.2 and 3.1 meters. The mean water level (CD) is about 0.87 meters (PWD=CD -1.17 meters). The mean high water level varies due to spring-neap tide conditions between +1.60 m and +2.6m PWD. The Highest High Water Level (HHW) is about +3.1m PWD and the Lowest Low Water Level (LLW) is about -1.4m PWD.

The salinity of the Passur River system varies with the amount of fresh water entering the system which is highly seasonal dependent. The surface water temperature ranges between 22.9°C and 33.0°C.

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The marine conditions as recorded at Mongla Port Gauge Station (approx. 14 km south-east to the site) are as follows:

- Highest High Water Level (HHW) + 2.642 MSL
- Lowest Low Water Level (LWL) - 1.858 MSL

The Power Plant shall be designed for 100 years flood condition based on data provided by relevant Organization in Bangladesh and taking into account the Highest Astronomical Tide (HAT), the maximum wave conditions (including storm surges) and the potential event of Cyclone. The Contractor is responsible to verify the worst conditions.

These reference data are with respect to LAT, which corresponds to the Chart Datum (CD). The site land data is however with respect to the Bangladesh Land Survey Datum (BLSD), which corresponds to approx. +1.55 m CD (hence the MLSD corresponds to MSL).

Design Wave Height 2.0 m

Design Wave Period 6.0 sec

Sedimentation and Siltation: Soft to stiff clay and alternations of very sandy and stiff clay.

A water analysis from the area adjacent to the site giving salinity and water quality is shown below:

Sl. No.	Date	Temp. °C	pH	EC µS/cm	Cl mg/l	T. Alkalinity mg/l	Turbidity NTU	TS mg/l	TDS mg/l	SS mg/l	DO %	BOD mg/l	COD mg/l	Salinity mg/l
1	7-Jan	27.4	7.74	3010	279	30	68	1545	1510	55	5.1	0.3	55	10
2	7-Jan	27.1	7.72	3000	278.3	34	68	1470	1450	40	5.1	0.3	44	14
3	7-Jan	27.8	7.71	3050	279	30	68.4	1545	1510	55	5.1	0.3	55	10
4	11-Feb	26.8	7.66	4580	1180	30	182	2300	2180	230	4.7	1	75	23
5	11-Feb	29.2	7.63	4580	1168	30	175	2300	2190	200	4.7	1	75	23
6	11-Feb	29.1	7.61	4580	1163	30	175	2320	2180	200	4.7	1	75	23
7	9-Mar	32.0	7.50	11790	2944.4	34	170	6080	5296	190	4.7	1.2	75	67
8	9-Mar	32.6	7.57	11790	2945.2	33	172	6080	5306	190	4.7	1.2	75	67
9	9-Mar	32.1	7.55	11790	2944.4	34	170	6069	5296	200	4.7	1.2	75	67
10	17-Apr	32.6	7.55	10500	2773	28	183.6	15000	12700	250	4.5	0.7	135	15.5
11	17-Apr	32.6	7.59	10500	2773	30	180.1	12900	12700	250	4.5	0.7	135	15.5
12	17-Apr	32.6	7.59	10500	2773	30	184.3	12900	12700	250	4.5	0.7	135	15.5
13	17-Apr	32.6	7.59	10500	2773	30	183.6	12900	12700	250	4.5	0.7	135	15.5
14	17-Apr	32.6	7.59	10500	2773	30	183.6	12900	12700	250	4.5	0.7	135	15.5
15	17-Apr	32.6	7.59	10500	2773	30	183.6	12900	12700	250	4.5	0.7	135	15.5

Figure 1 Water quality of the Passur River at Mongla point
 (Source: EIA-Report)

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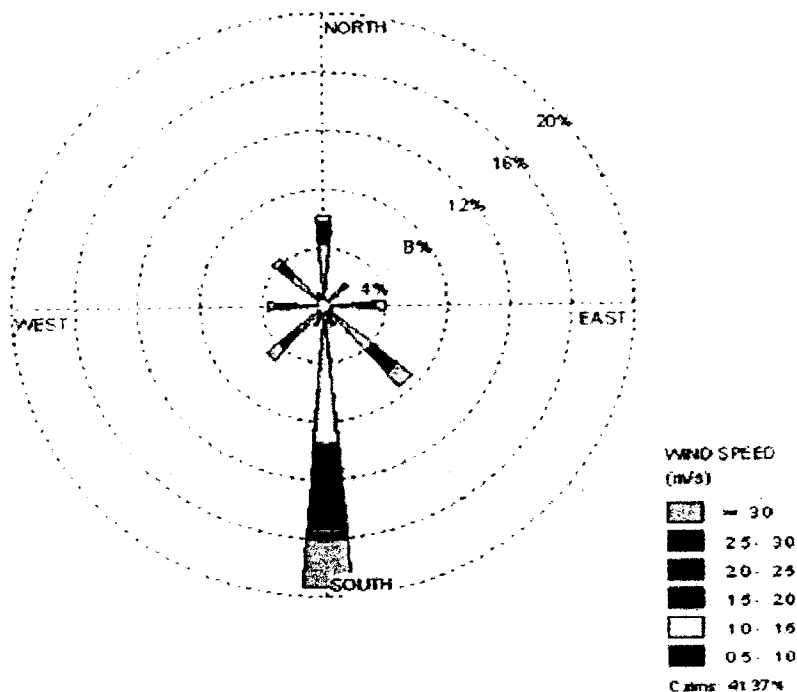
Loc. no.	Date	Temp.	pH	EC	Cl ⁻	T. Alkalinity	Turbidity	TS	TDS	SS	DO	BOD	COD	Salt
		°C		µS/cm	mg/l	mg/l	NTU	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
3	5-Mar	33.2	7.57	29200	94.0	36	129.6	14900	14600	300	4.3	1.2	177	17.6
1	13-Jun	31.5	7.49	18000	33.0	36	112.6	9200	9000	200	4.7	1.1	97	10.5
2	13-Jun	31.5	7.49	18000	33.0	36	113.2	9200	9000	200	4.7	1.1	97	10.5
3	13-Jun	31.5	7.49	18000	33.0	36	112.4	9200	9000	200	4.7	1.1	97	10.5
1	1-Jul	31.5	7.49	440	32.6	36	76.6	237	220	63	5.2	0.5	26	-
2	1-Jul	31.5	7.49	440	32.6	36	76.6	237	220	63	5.2	0.5	26	-
3	1-Jul	31.5	7.49	440	32.6	36	76.6	237	220	63	5.2	0.5	26	-
1	5-Aug	31.5	7.49	275	16.6	36	65.6	192	137	53	5.3	0.7	22	-
2	5-Aug	31.5	7.49	275	16.6	36	65.6	192	137	53	5.3	0.7	22	-
3	5-Aug	31.5	7.49	275	16.6	36	65.6	192	137	53	5.3	0.7	22	-
1	8-Sep	31.5	7.74	270	15.6	36	65.6	190	137	45	5.3	0.7	22	-
2	8-Sep	31.5	7.74	270	15.6	36	65.6	190	137	45	5.3	0.7	22	-
3	8-Sep	31.5	7.74	270	15.6	36	65.6	190	137	45	5.3	0.7	22	-
1	12-Oct	30.5	7.79	290	16.6	36	62.6	192	143	47	5.6	0.7	22	-
2	12-Oct	30.5	7.79	290	16.6	36	62.6	192	143	47	5.6	0.7	22	-
3	12-Oct	30.5	7.79	290	16.6	36	62.6	192	143	47	5.6	0.7	22	-
1	5-Nov	24.5	7.79	340	33.6	36	56.6	210	170	40	5.6	0.7	22	-
2	5-Nov	24.5	7.79	340	33.6	36	56.6	210	170	40	5.6	0.7	22	-
3	5-Nov	24.5	7.79	340	33.6	36	56.6	210	170	40	5.6	0.7	22	-
1	12-Dec	21.5	7.72	520	62.6	36	72.6	320	260	60	5.1	0.9	25	0.4
2	12-Dec	20.9	7.71	520	62.6	36	73.6	320	260	60	5.1	0.9	25	0.4
3	12-Dec	21.1	7.72	520	62.6	36	71.6	320	260	60	5.1	0.9	25	0.4

Figure 2 Water quality of the Passur River at Mongla point
 (Source: EIA-Report)

Wind data

The project region is characterized by southerly winds from the Bay of Bengal during the Monsoon Season and north-westerly winds from the Himalayas during the Winter Season. During the Summer Season, the wind blows from south-southwest to north-northeast. The annual average wind speed amounts to 1.7 meter/second and the wind rose for the entire year is shown in Figure 5.5.

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The wind load calculation for the buildings and structures shall be as per Bangladesh National Building Code -2012. Part 6. Chapter 2.4.

Basic wind speed, V , shall be taken as 73m/s. Three second gust at 10m above ground in exposure C, having a return period of 50 years.

3.2 Design requirements

The main design features (basic design reports, drawings, PFD, P&IDs, design data etc.) and the main vendors and subcontractors shall be subject to the approval by the Owner/ BHEL.

The Owner/ BHEL has the right to refuse design features and vendors or subcontractors, if the supplier cannot verify the reliability of the suggested design, vendor or subcontractor.

The Plant is expected to operate in base-load mode with high plant load factor. The design lifetime of the Plant shall be of not less than 30 years of operation or 200,000 full load operating hours, whichever is longer. The Plant and all its auxiliaries shall be designed to operate for the complete lifetime under the site conditions as described in this section and dedicated other part of this FTS.

All Plant equipment and material must be suitable for the range of ambient site conditions. In particular the saline atmosphere has to be considered.

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Redundancy concept

All equipment shall be implemented with (n+1) redundancy -- unless otherwise stated --, where n is the number of equipment required to maintain the maximum capacity of a unit. N+1 means that even in case of outage of the biggest component sufficient capacity is available to maintain the maximum capacity of the Power Plant unit.

For all components which are not redundant, the supplier shall provide a maintenance and spare part concept to ensure that outage times are minimized and to ensure that the required availability is met.

Each equipment whose unavailability due to a failure could result in damages to another equipment shall be backed up by a stand-by equipment, one of them being fed by an emergency source in case of external black out.

Failure of any single item of auxiliary equipment including the Power Plant's DCS and electrical systems shall not result in a reduction in power evacuated from the Power Plant.

Replacement and repair of redundant components shall be possible without interrupting Plant operation.

Note: The Power Plant shall be designed for 100 years flood condition based on data provided by relevant Organization in Bangladesh and taking into account the Highest Astronomical Tide (HAT), the maximum wave conditions (including storm surges) and the potential event of Cyclone. The Contractor is responsible to verify the worst conditions.

3.3 SYSTEM PARAMETERS

NOMINAL VOLTAGE (kV)	400 kV	230 kV	132kV
HIGHEST SYSTEM VOLTAGE (kV)	420 kV	245kV	145kV
RATED FREQUENCY (Hz)	50	50	50
RATED SHORT CIRCUIT CURRENT (1 SEC)	50	50	50
RATED PEAK WITHSTAND CURRENT /(kAp)	125	125	125
CREEPAGE DISTANCE (mm/Phase Voltage in kV)	53.7		53.7
CREEPAGE DISTANCE (mm/Line Voltage in kV)	31		31

3.4 Latent Defects:

Notwithstanding the issue of the Take Over Certificate, the Contractor shall be responsible for making good with all possible speed any Latent Defect in any Works /equipment of the plant which appears at any time before the expiry of defect liability period. And shall remedy such defect at its own cost and expense. The latent defect liability period shall be a minimum of 5 years from the end of defect liability period. The defects to which this applies are defects in design, materials or workmanship or defects arising from any act or omission of the Contractor done or omitted prior to Take-over of the portion of the Plant affected by the defects or during the Warranty Period which a reasonable examination at the end of the Warranty Period would not have disclosed.

3.5 PACKING FOR SHIPMENT

The equipment complete with its accessories, spares, special tools and tackles shall be suitably protected by respective packing for shipment considering handling during transit, distance and weather conditions involved. The Contractor shall submit the packaging method for shipment to be adopted by him, if so desired by the Owner / Purchaser.

Each consignment shall be marked with Equipment name, Owner /Purchaser's name & address, Project details, handling instruction etc. It shall be complete with part list and identification details. The copies of the part list of each consignment shall also be furnished to the Owner / Purchaser after dispatch.

Equipment shall be packaged for transportation so as to meet the space and weight limitation of transport facilities. The contractor shall obtain approval from concerned authorities for transportation of over dimensioned consignment/package, if any, before starting manufacture of such equipment.

3.6 TROPICAL PROTECTION

All electrical equipment, accessories and wiring shall have fungus protection involving special treatment of insulation and metal against fungus, insects and corrosion.

Fine mesh screen of corrosion resistant material shall be furnished on all ventilating openings to prevent entry of insects.

3.7 HANDLING, STORING AND INSTALLATION

Contractor may engage manufacturer's Engineers to supervise if required for unloading, transportation to site, storing, testing and commissioning of the various equipment being procured by them separately. In case of any doubt/misunderstanding as to the correct interpretation of manufacturer's drawings or instructions, necessary clarifications shall be obtained from the purchaser. Contractor shall be held responsible for any damage to the equipment consequent to not following manufacturer's drawings/instructions correctly.

Where assemblies are supplied in more than one section, contractor shall make all necessary mechanical and electrical connections between sections including the connection between buses. Contractor shall also do necessary adjustments/alignments necessary for proper operation of circuit breakers, isolators and their operating mechanisms. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning.

Contractor shall be responsible for examining all the shipment immediately of any damage, shortage, discrepancy etc. for the purpose of Purchaser's information only. Any demurrage, pilferage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. The Contractor shall be fully responsible, for the equipment/material until the same is handed over to the purchaser in an operating condition after commissioning.

The minimum phase to earth, phase to phase and section clearance along-with other technical parameters for the various switchyard voltage levels to be maintained shall be strictly as per the approved drawings.

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The design and workmanship shall be in accordance with the best engineering practices to ensure satisfactory performance throughout the service life. If at any stage during the execution of the Contract, it is observed that the erected equipment(s) do not meet the above minimum clearances, the Contractor shall immediately proceed to correct the discrepancy at his risks and costs.

Common equipment and services

The following supplies and services are to be included in the corresponding Section prices:

3.8 DOCUMENTS TO BE SUBMITTED ALONGWITH OFFER

- 1) Drawings
- 2) Guaranteed Technical Particulars
- 3) Type Test Reports
- 4) Manufacturing Quality Plan

3.8.1 DOCUMENTATION SCHEDULE

S. No.	DESCRIPTION	TENDER STAGE	CONTRACT STAGE FOR APPROVAL	FINAL DOCUMENTATION	
				Prints	CDs
1	Drawings and Data Sheets	1	6	6	3
2	Drawings "As Built "	-	-	6	3
3	Type Test Reports	1	6	6	3
4	Erection Manuals	-	6	6	3
5	Operating manuals, maintenance and service manuals, component documentation, assembly documentation, drawing and listing etc.	-	-	6	3
6	Operation and Maintenance Manuals (shall be translated into Bangla and provided as paper copies in electronic format).	-	6	6	3
7	Manufacturing Quality Plan	1	6	6	3
8	Field Quality Plan	1	6	6	3
9	Inspection Test Reports	-	-	6	3

Electronic copies shall be submitted in primary original data format (e.g. DOC, XLS, DWG) as well

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as in printable non-proprietary document format (e.g. PDF).

Final Documentation shall be submitted in bound volumes with Customer & Project etc. written on top.

3.8.2 AS-BUILT DRAWINGS

The Contractor shall furnish drawings and document in as-built condition as stipulated in the specification.

On completion of the project, contractor should submit Three Sets of As commissioned drawings, Three Sets of as Installed Bill of Materials and Three Sets of As Commissioned Data/ Specification /Parameter Sheets Duly Signed by the Competent Authority.

3.8.3 DRAWINGS, DATA, INFORMATION AND MANUALS

Drawings, data, information & manuals shall be submitted as indicated below:

To be submitted after award of the Contract.

- a) Single line diagram giving rating of each equipment.
- b) Design calculations in support of selection of equipment rating and system design.
- c) Technical Data sheets, characteristic curves.
- d) Equipment layouts, layout of switchyard with sections.
- e) Grounding & lightning protection drawings and details.
- f) Cabling, cable trench and tray layouts with section and details with cable sizing calculation.
- g) Dimensional general arrangement drawing along with cross- sections for equipment.
- h) Foundation plan and loading data : design calculation and detail drawing of foundation.
- i) Design calculation and detail drawing for civil work related to this specification.
- j) Design calculation, GA drawing for GI structure and equipment supporting structure, and subsequently detailed drawings.
- k) Mounting details of equipment and structure.
- l) Fire fighting and sump arrangement.
- m) Control & operation write up/Block logic diagrams.
- n) Control schematic and wiring diagram.
- o) Cable schedule and interconnection and cable routing.
- p) Relay co-ordination.
- q) Civil & structural analysis, design calculations and working drawings including bar bending schedule and fabrication.
- r) Erection and maintenance manual.
- s) Any other drawings & data as required for satisfactory installation, operation & maintenance.

3.8.4 OPERATING MANUALS AND MAINTENANCE INSTRUCTIONS

- (i) The Contractor shall provide at least six (6) months before the time of commissioning and before taking over of the plant and equipment, all necessary maintenance manuals and operating instructions. The instruction manual shall be submitted in the form of one (1) soft copy in CD and 15 hardcopies.

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(ii) The information provided, which shall be contained in loose leaf stiff backed covers, shall include :

- a) A complete inventory of all main items of plant, with identification details.
- b) Service manuals for all plant and equipment giving full descriptions of the main items and auxiliary items such as power packs, hydraulic equipment, actuators, lubricating pumps, etc.
- c) A separate electrical manual covering items such as switchgear, cabling, instrumentation, controls, cabling layouts and wiring diagrams.
- d) A schedule of recommendations for routine maintenance of all electrical and mechanical equipment, recommended inspection point, information on detection, cause and rectifications of troubles & faults.
- e) A lubrication schedule with all necessary drawings diagrams to identify the lubrication points.
- f) Manufacturer's literature.

(iii) The instruction manual shall be subject to the approval of Owner.

3.9 Electrical network connection conditions

The electrical equipment shall be designed according to the IEC standards (if not specified otherwise) and

The Plant shall comply with:

- a) the Essential Electrical Requirements of the Power Purchase Agreement (PPA);
- b) the latest edition of the Electricity Grid Code of the Bangladesh Energy Regulatory Commission; and
- c) The Great Britain Grid Code.

The Contractor shall familiarize himself with such requirements. In case of contradictions or discrepancies the order of precedence shall be as follows:

- a) Essential Electrical Requirements of the PPA
- b) Electricity Grid Code of the Bangladesh Energy Regulatory Commission
- c) Great Britain Grid Code.

Any other requirements of the Bangladesh Power Development Board (BPDB) or Power Grid Company of Bangladesh (PGCB) shall also be considered. The bidder shall list all those grid connection requirements which cannot be met by the proposed Plant.

3.10 Standards and codes

The work must be performed according to the most recent relevant codes, standards, accident prevention regulations and local rules and legal regulations.

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All materials and equipment supplied and all work carried out as well as calculation sheets, drawings, quality and class of goods, methods of inspection, specific design features of equipment and parts and acceptances of partial plants shall comply in every respect with the applicable standards, codes and regulations to be chosen from the following:

• American Association of State Highway and transportation Officials	AASHTO
• American Concrete Institute	ACI
• American Gear Manufacturers Association	AGMA
• American Institute of Steel Construction	AISC
• American Iron & Steel Institute	AISI
• American Moving and Conditioning Association	AMCA
• American National Standards Institute	ANSI
• American Petroleum Institute	API
• American Public Health Association	APHA
• American Society for Testing and Materials	ASTM
• American Society of Civil Engineers	ASCE
• American Society of Heating, Refrigeration & Air Conditioning Engineers	ASHRAE
• American Society of Mechanical Engineers	ASME
• American Water Works Association	AWWA
• American Welding Society	AWS
• American Wire Gauge	AWG
• Anti-Friction Bearing Manufactures Association	AFBMA
• Architectural Institute of Japan	AIJ
• Association Francaise de Normalisation	AFNOR
• British Standards Institute	BS
• Chlorine Institute	CI
• Crane Manufacturers Association of America	CMAA
• Deutsches Institut für Normung	DIN
• Diesel Engine Manufacturers Association	DEMA
• European Norm	EN
• Expansion Joint Manufacturer Association	EJMA
• Fédération Européene de Manutention	FEM
• Heat Exchanger Institute	HEI
• Hydraulic Institute	HI
• Illuminated Engineers Society	IES
• Institute of Electrical and Electronics Engineers	IEEE
• Instrument Society of America	ISA
• Insulated Power Cable Engineers Association	IPCEA
• International Electrotechnical Commission	IEC
• International Standards Organization	ISO
• Japanese Architectural Standard Specification	JASS
• Japanese Electrical Manufacturers Association	JEMA

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• Japanese Electrotechnical Institute	JEC
• Japanese Industrial Standards	JIS
• Manufacturers Standardization Society	MSS
• National Association of Corrosion Engineers	NACE
• National Electrical Code (USA)	NEC
• National Electrical Manufacturer's Association (USA)	NEMA
• National Electrical Safety Code	NESC
• National Fire Protection Association	NFPA
• National Structural Code for Building	NSCB
• Occupation Safety and Health Administration	OSHA
• Portland Cement Association	PCA
• Properties of Water and Steam	IFC
• Scientific Apparatus Manufacturers Association	SAMA
• Society of Automotive Engineers	ASE
• Standards of Japanese Electrotechnical Committee	JEC
• Steel Structures Painting Council	SSPC
• Technische Vereinigung der Grosskraftwerksbetreiber	VGB
• Tubular Exchanger Manufacturers Association	TEMA
• Underwriters Laboratory	UL
• Uniform Building Code	UBC
• Verband Deutscher Elektrotechniker	VDE
• Verein Deutscher Ingenieure	VDI
• Vereinigung Deutscher Elektrizitätswerke (Association of German Power Plants)	VDEW
• Water Pollution Control Federation	WPCF

Generally, all internationally and nationally recognized standards as above will be applied, except if specific standards called for by:

- a) Occupational Safety Board of Bangladesh
- b) Department of Inspection for Factories and Establishments, Bangladesh
- c) Department of Environment, Bangladesh
- d) Bangladesh Power Development Board
- e) Bangladesh Energy Regulatory Commission
- f) Ministry of Power, Energy and Mineral Resources
- g) Bangladesh Fire Service and Civil Defence Ministry
- h) All relevant Bangladesh National Statutory Regulations
- i) Bangladesh National Building Code
- j) Bangladesh Standards
- k) Local Authorities.

All steam boilers and unfired pressure vessels together with associated pipework and fittings shall comply with the Bangladesh Boiler Act, 1923 with amendments.

All pressure parts shall be designed in accordance with applicable ASME codes.

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All services, supplies and works shall comply with the requirements of the relevant laws of Bangladesh and the IFC/World Bank Group Standards and Guidelines in their latest edition, including but not limited to:

- Environmental Conservation Rules
- Bangladesh Energy Regulatory Commission Act;
- BERC Licensing Regulation
- BERC Technical Quality Standards;
- Bangladesh National Building Code;
- other applicable laws in Bangladesh;
- IFC Performance Standards on Environmental and Social Sustainability;
- IFC / World Bank Group Environmental, Health and Safety (EHS) General Guidelines;
- IFC / World Bank Group EHS Guidelines for Thermal Power Plants;
- IFC / World Bank Group EHS Guidelines for Electric Power Transmission and Distribution.

It is the Contractor's responsibility to provide sufficient evidence that any national or other standard the Contractor proposes (other than those mentioned above) will ensure an equivalent or higher standard.

Immediately after effective date of the Contract the Contractor shall supply an indexed list of all standards, codes and associated standards referred to, to which the work is to be performed. A copy of all applied standards shall be forwarded to the Employer. The Contractor shall supply preferably two (2) searchable softcopies, else two (2) hardcopies each.

3.11 Plant and equipment identification

All design submissions shall include a detailed labelling list indicating the label text, size of the lettering and fixing details for the approval of the Employer or its representative.

The identification and numbering of equipment, systems, items, etc. of supply, as well as of all documents and drawings shall be in accordance with the VGB guideline RDS-PP (Reference Designation System for Power Plants - KKS system).

There is to be only one approved description for any one item of Plant and this must be used consistently for Plant, electrical and instrumentation designations throughout.

The supplier shall supply all labels (Equipment Identification Plates), nameplates, manufacturer's equipment nameplate, instruction and warning plates necessary for the identification and safe operation of the Plant, and all inscriptions shall be in the English language and Bangla language.

All labels, nameplates, instruction and warning plates shall be securely fixed to items of Plant and equipment with stainless steel rivets, plated self-tapping screws or other approved means. The use of adhesives will not be permitted.

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Nameplates for Plant and equipment identification and record purposes shall be manufactured from stainless steel or aluminium with a mat or satin finish, and engraved with black lettering of a size which is legible from the working position.

Warning plates shall be manufactured from stainless steel or aluminium engraved red lettering on a white background and sited in the position where they afford maximum safety of personnel.

All equipment within panels and desks shall be individually identified by satin or mat finish stainless steel or aluminium labels.

Each circuit breaker panel, electrical control panel, relay panel, etc. shall have a circuit designation label on the front as well as on the rear panels engraved with black lettering in accordance with the circuit designation system. Circuit designations must be precise and convey complete information. There should be no doubt whatsoever for the operation as to which area of the Plant a particular feeder is supplying with power. Labels such as interconnector 1 or feeder 2 are not acceptable. Corridor type panels shall in addition have circuit designation labels within the panels.

Pipework systems shall be identified with a colour identification systems in conformity with the colours according to the Employer's specification, with colours at the nameplates and, if necessary by colour bands and with KKS numbering and plain language. The direction of flow shall be shown.

Each valve/instrument shall be fitted with a stainless steel or aluminium nameplate indicating the valve/instrument service and reference number in accordance with the approved equipment coding system.

Where possible valve nameplates shall be circular and shall be fitted under the hand-wheel captive nut. They have to be of such a diameter that there is no danger for persons operating the valve or that they do not prevent lock-off of this valve; on check valves and small valves the Contractor may provide rectangular nameplates fitted to brackets on the valve or attached to a wall or steelwork in a convenient position adjacent to the valve.

Marking and labelling

Each crate or package is to contain a packing list in a waterproof envelope. All items of material are to be clearly marked for easy identification against the packing list.

All cases, packages, etc. are to be clearly marked on the outside to indicate the total weight, where the weight is bearing and the correct position of the slings and are to bear an identification mark relating them to the appropriate shipping documents.

All stencil marks on the outside of cases are either to be made in waterproof material or protected by shellac or varnish to prevent obliteration in transit.

3.12 Corrosion protection, coating and galvanizing

This specification shall be used for the corrosion protection of steel structures, components, piping and equipment in general which are installed in confined areas (indoors) or outdoors.

Surface preparation, as well as protective coatings and coating systems are based on this specification in order to assure that structural parts of different suppliers will get a corrosion protection of similar and high quality.

Coating material shall only be supplied by manufacturers with international experience and their products can be obtained internationally.

Regarding maintenance work (storage), application and supervision of coating work, choice of coating suppliers should be minimized. At any rate, similar parts of structures/components (such as structural steel, containers, piping, etc.) shall only be coated with products of one individual Manufacturer.

The materials and equipment used, the methods of application and the quality of work shall at all times be subject to the inspection and approval of the Employer or his Representative.

To mitigate crevice corrosion, the designs and construction of structures and equipment shall ensure that no collection of water occurs in crevices which could lead to crevice corrosion. It is the responsibility of the Contractor/Supplier to ensure that, for all supplied equipment (including that from sub suppliers):

- The protection system is perfectly suitable for the Site conditions and for the specific purpose.
- The shop paints provide a sufficient protection during transport, storage and erection.
- The shop paints are suitable for handling and erection conditions (slinging, Site welding works etc.) and are compatible with the Site finishing coats
- All necessary precautions are taken in order to prevent damage to paints during storage, handling, welding.
- The necessary repairs are carefully executed as soon as possible.
- The colour RAL number of the finishing coat has been approved by the Employer, including identification code for piping.
- Standardised equipment will be painted according to the manufacturer's standard.
- All corrosion protection and coating on site shall be done in a workshop specifically for the purpose of the application of corrosion protection and coating.

Codes and standards

Applicable standards are:

- Product data of coating manufacturer
- DIN 2403 Indication of pipe-lines according to flowing material
- DIN 4762 Surface roughness

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- ISO 8503 Surface roughness
- DIN 8201 Part 1-9 tight blasting agents
- DIN 50976 Corrosion protection, hot dip batch galvanizing of single parts, requirements and testing
- DIN 55928 Part 1-9 corrosion protection of structural steel work through protective coatings and topcoats
- ISO 8501 Preparation of steel substrates before application of paints and associated products
- ISO 12944 Paints and varnishes -- corrosion protection of steel structures by protective paint systems
- RAL Colour card
- ISO 8501-1 Preparation of steel substrates before application of paints and related products
- SSPC Vol. 1 and 2 Steel structure painting council

SURFACE PREPARATION AND CLEANING OF SURFACES IN THE SHOP

Prior to blasting, areas have to be cleaned from oil, grease, paint residues, splatters, welding splashes and welding slag using a suitable aqueous degreaser, or solvent for more severe grease contamination. The cleaning should be to provide a "water break free surface".

Sharp edges have to be rounded off.

Contaminations caused by salts, acids and alkali solutions shall be eliminated by rinsing with water up to a pH value of 6-8. Soluble salt contamination is to be tested using the Weber Reilly test method (or similar approved) and pH is to be tested using universal indicator paper strips prior to continuation with the blasting.

The preparation of substrates shall be carried out on the basis of the specifications of ISO 12944 part 4 and ISO 8501. The preparation of steel before application of paint and related products shall be in line with ISO 11124 for metallic blast cleaning abrasives and ISO 11126 for non-metallic blast cleaning abrasives. No recycled blast grit may be utilised.

After blasting, an anchor profile of 25 - 50 µm shall be achieved. Blasted surfaces have to be provided with a prime coat of the approved coating system immediately within 4 hours of blasting. All blasting and priming must take place outside of the high humidity periods of the day (i.e. maximum relative humidity of 80%).

Cleaning of prime and intermediate coats (if required)

To prevent contamination by mineral oil products, areas with prime and intermediate coat have to be treated with suitable cleaning agent. Cleaning has to be done free of residues, e.g. with alkaline detergents and thorough washing done with fresh water. Rusty spots have to be removed according to required purity. Metallic areas which are provided with temporary corrosion protection have to be cleaned. No oxidation products shall remain on the surface. Further care shall be taken that on hot components, no destructive or reaction products will be released when heating which could injure insulation.

Application procedure

When using the provided coating material, strict adherence to all application instructions given in product data of coating manufacturer is necessary. To obtain the maximum performance, technical data as well as application instructions for the individual coating material have to be strictly followed. For a multi-layer coating system each layer has to have a different colour shade in order to clearly identify number of coats applied.

The last finish coat has to be applied in the specified colour shade.

All paintings shall be performed according to ISO 12944. The durability of all paintings shall be "high" which corresponds to 15 years.

The interval between applying the different coats has to follow according to supplier's precautions. Each layer has to be cleaned and released from spray dust before the next layer will be applied. Prior to applying a further layer, the last one has to be repaired. All coatings have to be applied without retarding.

Following application procedures are allowed:

- prime coats by airless spray
areas like disconnections, angles, corners, etc. which are difficult to be reached can be applied by brush or roller
- repair of prime coat by brush
- finish coats
 - at works by airless spray, roller or brush
 - at site by roller or brush or airless spray.

When applying coating systems by roller, rollers have to be of kind and quality which make an appropriate application possible.

Control areas in accordance with the coating supplier's instructions have to be applied. For this procedure, a schedule for control areas has to be prepared by the Contractor and coating supplier which corresponds with the requirements of the warranty agreement.

Number and performance of the control areas have to be done in accordance with ISO 12944 part 7 and have to be documented in writing.

No application shall take place either in the condition of the relative humidity not within the given limit or in case of poor weather conditions such as fog, dust, rain, snow, hail or when it can be assumed that such conditions of poor weather will arise within 2 hours after application.

Temperature of the coated parts has always to be above 5 °C and 3 K above dew point.

All specified dry film thicknesses (DFT) are minimum thicknesses.

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Welding seams executed at site have to be taped with an adhesive tape of about 30-50 mm after surface preparation (blasting or manual derusting) and prior to application in the manufacturing plant and to be coated with stripping coat.

Chequered plates, nap plates, etc. have not to be covered with adhesive tape, but have to be coated with stripping coat in a dry film thickness of at least 150 μm .

Edging lines on steel structure have to be taped prior to application and after blasting in sufficient width or have to be protected with varnish before application. Thickness of prime coat may be 50 μm maximum.

During repairing works at site on shop-primed structures, it is important that different coats will have different colour shades. Numbers of layers have to be the same as the original coating system to be used.

Application of temporary primer on structures which have to be insulated has to be in accordance with a sufficient corrosion protection for the period of storage respectively erection time.

Galvanizing

Galvanizing work shall conform in all respects to ISO 1461 or equivalent standards and shall be performed by the hot dip process unless otherwise specified.

It is essential that details of steel members and assemblies which are to be hot-dip galvanized should be designed to suit the requirements of the process. They should be in accordance with ISO 12944.

Vent holes and drain holes shall be provided to avoid high internal pressures and air locks during immersion and to ensure that molten zinc is not retained in pockets during withdrawal.

Careful cleaning of welds is necessary before welded assemblies are dipped. All defects of the steel surface including cracks, surface laminations, laps and folds shall be removed in accordance with BS 4360. All drilling, cutting, welding, forming and final fabrication of unit members and Assemblies shall be completed, where feasible, before the structures are galvanized.

The minimum coating thickness shall be as specified in Table 1 of BS 729. Structural steel items shall be first grit-blasted to BS 4232, second quality, (Sa 2 1/2) or pickled in a bath, and the **minimum average coating weight on steel Sections 5 mm thick and over shall be 900 g/m², on steel Sections 2 – 5 mm thick 600 g/m².**

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

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

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Small areas of the galvanized coating damaged in any way shall be restored by:

- cleaning the area of any weld slag and thorough wire brushing to give a clean surface
- The application of two coats of zinc-rich paint, or the application of a low melting point zinc alloy repair rod or powder to the damaged area, which is heated to 300 °C or the treatment with suitable cold galvanizing paint, such as ORAPI n.z.a.b 706. All zinc rich paint used for such repairs must contain a minimum of 81% by mass of zinc in the dry film.

Connections between galvanized surfaces and copper, copper alloy or aluminium surfaces shall be protected by suitable tape wrapping.

Coating Systems								
Syst em- No.	Surface location	Temp. °C	Surface preparation	Coating systems	No. of coats	Generic type	Dry film thickness (DFT) per coat µm	Total DFT µm
1	Structural steel works, piping, vessels, tanks INDOOR	up to 120	SA 2.5	Primer Finish	1 1	Zinc-Epoxy Epoxy High Solid	80 80	80 80 160
2	Structural steel works, piping, vessels, tanks OUTDOOR	up to 120	SA 2.5	Primer Intermediate Finish	1 1 – 2 1	Zinc-Epoxy Epoxy High Solid 2-Comp.Polyurethane	80 160 50	80 160 50 290
3	Piping, tanks, etc. INDOOR and OUTDOOR, Insulated	up to 120	SA 2.5	Primer	1	Zinc-Epoxy	50	50
4	Pumps, motors, other equipment OUTDOOR	up to 120	SA 2.5	Primer Intermediate Finish	1 1 1	Zinc-Epoxy Epoxy High Solid 2-Comp.Polyurethane	80 110 50	80 110 50 240
5	Pumps, motors, other equipment INDOOR	up to 120	SA 2.5	Primer Finish	1 2	Zinc-Epoxy Epoxy High Solid	80 50	80 100 180
6	Piping, reactors OUTDOOR Insulated	> 120	SA 2.5	Primer	1	Zinc Ethysilicate	75	75
7	Stacks OUTDOOR	< 120 < 200	SA 2.5	Primer Finish	1 2	Zinc Ethysilicate Silicone Acrylic	75 50	75 100 175
8	Steel surfaces Uninsulated	200 - 450	SA 2.5	Primer Finish	1 2	Zinc Ethysilicate Silicone Aluminium	75 25	75 50 125
9	Galvanized surfaces	up to 120	Mechanical cleaning from contaminant s and zinc salts by means of washing or steam jetting or	When Finish Coat is required, such as sea climate with chloride exposure	1	Epoxy High Solid*	125	125

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			sweep-blasting with fine sand					
10	Steel surfaces permanently in contact with water, also river water splash zone	Medium temp. °C up to 60	SA 2.5	Prime and Finish Coat in One	1	Glassflake reinforced High Solid Epoxy	500	500
11	Plant / Cooling water pipes	GRP, or steel lined concrete pipes with cathodic protection and coating according to AWWA C 203						

* Additional 1 x Finish Coat 2-Comp. Polyurethane, 50 µm, when exposed to UV or weathering conditions and colour retention is required

3.13 Documentation after Award of Contract

The documents required for design, construction, installation, operation and maintenance of the equipment shall be submitted by the bidder in good time so as to permit the Plant as a whole to be erected in compliance with the specified time table.

All documents, including the installation and operation and maintenance manuals as well as the related software shall be in fluent, legible English. In addition, operation and maintenance manuals shall be translated into Bangla and provided as paper copies and in electronic format.

The bidder shall list all the drawings and submission schedule for the Employer's approval. These documents shall be submitted sufficiently in advance, so that corrections and amendments desired by the Employer as well as resubmission of the documents will not result in any delays with respect to the guaranteed time schedule. The Employer reserves the right to request from the Contractor additional drawings, documents, etc. as may be required for proper understanding and definition of the design and engineering of the Plant.

The overall responsibility with regard to completeness, correctness and suitability for the permit application process remains with the Contractor. In no case any comment, correction, amendment and approval (if any) by the Employer shall relieve the Contractor from this responsibility.

The drawings and documents to be submitted during this stage shall be listed. They shall be submitted within the specified time scale calculated in weeks after Award of Contract.

Details shall be agreed according to the approval procedure for drawings and documents above.

The Contractor may propose modifications to the list, in order to ensure timely completion of permit application documents and performance of the works according to the project's requirements and in accordance with the specified project time schedule. Any modification to this list shall be submitted for Employer's review and approval.

The Employer reserves the right to require detailed information on the progress of drawing and document preparation from the Contractor at any time during this stage.

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Approval procedure for drawings and documents

The Employer reserves the right to ask the Contractor to submit drawings and other documents for approval to the Employer or to its representative.

Before submittal of any such drawing or other document, the Contractor shall submit a detailed list comprising all drawings or other documents the Contractor will produce. Based on this list the Employer will decide which drawings or other documents will have to be submitted for approval, information or other purpose.

When submitting drawings or other documents for approval, including any prepared by subcontractors, the Contractor shall certify in each case that he has examined such drawings or documents and that they comply with the requirements of the Contract.

The Contractor is requested to provide Third Party Verification of structural documents, e.g. structural analysis, drawings and connecting details prior to submission for approval. These documents must contain all information necessary for the execution of the works.

Approval of a drawing or other document will imply that:

- They have been examined and appear to be in accordance with the basic design concept of the project and meet the requirements of the specification.
- They have been examined in relation to compatibility of the items and equipment with the specification and respect of interconnections with other items, equipment or systems.
- The Contractor is not relieved of his responsibility under the Contract. The Contractor is to arrange for the revision history of drawings and other documents as follows. The first revision shall be indexed by the letter "A" followed up by the respective letter in alphabetical order.

Once the drawing or document is approved for construction by the Employer or its representative the document shall be indexed with the number "0" followed up by the respective number in chronological order. Hence, the sequence of the revision index of a design document shall be as follows: A -

B - C - [...] - 0 - 1 - 2 - [...]. Each revision is to be listed in the revision history with the respective date and a short description of the modification(s). In addition, all modification(s) shall be highlighted and/or marked up as specific and detailed as possible.

Furthermore, each drawing/document shall be indicated with a unique document number according to the following standard:

Maitree – Unit – KKS – DCC - 12345 – XYZ – REV

Where:

Maitree Project-Denomination

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Unit - 00 (for common), 01 (for unit 1), 02 (for unit 2)

KKS - Function Key as per KKS system (1 to 3 letters)

DCC - DCC code according to EN/IEC 61355

12345 - Document number

XYZ - Sub-/Contractor number

REV - Revision index

For each comment, the Employer will allocate a priority in the TCS (Technical Comment Sheet).

The priorities range from 1 to 3 as follows:

1 - High Priority

2 - Medium Priority

3 - Low Priority

The TCSs are to be named with the above described identification key and the supplementary ending "... - RI" ("Revision Income") for TCSs being sent from the Contractor to the Employer and "... - RO" ("Revision Outcome") vice versa.

The Contractor shall be responsible for any discrepancies, errors or omissions in the drawings and other documents supplied by him, whether such drawings or other documents have been approved or not.

3.14 Quality control procedure

A comprehensive **quality control procedure / quality assurance programme** for all aspects of the products/works shall be prepared by the Supplier/Contractor and shall be submitted to the Employer for approval.

The Supplier/Contractor shall adopt suitable quality assurance programme (QAP) to ensure that the equipment and services under the scope of Contract whether manufactured or performed within Contractor's works or at his subcontractor's premises or at the site or at any other place of work are in accordance with the specifications. Such QAP shall be outlined by the Supplier/Contractor and shall be finally accepted by the Employer or his authorized representative after discussions before the start of work. The QAP shall be generally in line with ISO Systems.

The quality assurance program shall consist at least of the following:

- testing during manufacturing
- workshop inspections and testing
- factory acceptance tests (FAT)
- testing at site
- construction inspections and testing
- erection / mechanical completion
- pre-commissioning and commissioning tests (cold and hot commissioning)
- optimization of overall Plant
- final inspection and testing
- Bench mark testing
- completion test
- performance tests
- reliability test run.

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An outline of the proposed comprehensive quality assurance programme is to be provided with the Tender and is subject to review by the Employer.

The Supplier/ Contractor shall provide complete laboratory facilities and staff to perform the required tests. The facilities could be fully or partially on site. Arrangements could be made with an experienced testing laboratory to support the site laboratory, all subject to the approval of the Employer.

Only approved fully qualified and experienced staff shall carry out the quality control all in accordance with the approved quality control procedure.

The Supplier/Contractor shall appoint a dedicated, experienced and competent QA&QC in-charge at site, preferably directly reporting to the project manager, supported as necessary by experienced personnel, to ensure the effective implementation of the approved QAP. An indicative structure of Contractors QA&QC manpower required to be deployed at site shall be submitted with the Tender.

The results of the tests shall be made available to the Employer within 24 hours of obtaining the relevant test results. Acceptance of the relevant part of the work shall be subject to the performed tests showing satisfactory results. Individual construction completion certificates shall be issued by the Contractor to certify the readiness for equipment erection.

The Employer may instruct tests at no cost provided either the overall frequency governed by the specification is not exceeded and the notification given to the Contractor is equal to that currently being provided by the Contractor for his normal testing in formality and warning, or the Employer has due cause to suspect a change in the quality, such concern having been advised to the Contractor. The Employer may instruct sampling, testing or both which satisfy only some or none of the above criteria.

The Employer shall have the right to carry out independent inspections and testing either using his own resources or those of a third party. Should the Employer require the results to determine the conformance with the specification then he shall notify and inform the Contractor.

As far as is practicable the Employer shall have free access to the site, fabrication areas and suppliers work at all times without notice. Should he discover unsatisfactory work then he will invite a formal joint inspection. Either after such an inspection or if the Contractor declines the invitation the Employer shall issue instructions with regard to the faults and their reparation.

Should any materials, items or complete parts of the equipment/works fail to comply with the requirements of this specification when tested in accordance with this Section the Employer may reject such materials or items, or condemn complete parts of the equipment/works, and demand of the Supplier/Contractor such replacement or modification as may be necessary to ensure their compliance.

Should modification or adjustment be deemed a satisfactory alternative to demolition and /or removal, the Contractor shall submit full details in writing such modifications to the Employer for approval, and should such approval be forthcoming carry them out without undue delay.

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If however, the Supplier/ Contractor is required to demolish and /or remove any such items or materials this shall be carried out quickly and with as little disruption to the works as possible.

No claims of any sort whatsoever will be entertained arising from the rejection of any part of the products/works through failure to meet this specification, and repairs, demolitions, removals, additional testing etc. Such modifications, removal, demolitions etc, shall be entirely at the expense of the Supplier/Contractor. No extension of the Contract period shall be granted for such a reason.

If for any reason materials or other items are received or made on site before approval of them has been granted, these shall be transported, handled and stored separately or labelled in such a way in order to, wherever possible, prevent them being incorporated into the works or, should such prevention not be possible, to accurately define the part(s) of the works in which such materials or items were used.

Approvals previously granted for any materials etc. shall be withdrawn if they are not properly transported, handled which may adversely affect their properties and subsequent performance. The Supplier/Contractor has the option of removing such materials or having them retested for approval.

The Contractor shall submit to Employer, the quality plans and field welding schedules (for field weld of pressure parts only), along with test procedures and WPS endorsed by designer wherever applicable, for checks to be done during manufacturing and erection, for review and approval by Employer.

Interfaces

The Supplier/Contractor shall actively clarify all interfaces with the Employer, the Operator, PGCB and all companies, authorities and any other entity participating in the project.

All mentioned equipment, connections, connection materials, counter flanges, shut-off valves, safety valves, seal up material and works are included in the scope of supply.

3.15 Units of measurement

The Contract shall be conducted in the Systems International d'Units (SI) system of units in accordance with the provisions of ISO 31 and ISO 1000. In all correspondence, technical schedules, drawings and instrument scales, the following units shall be used:

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Quantity	Name of Unit	Symbol
Length	Millimeter	mm
Mass	Kilogram	kg
Time	Second	s
Temperature	Degree Celsius	°C
Temperature Difference	Kelvin	K
Electric Current	Ampere	A
Luminous Intensity	Candela	cd
Area	Square meter	m ²
Volume	Cubic meter Liter	m ³ l
Force	Newton	N
Pressure	Bar	bar
Pressure below 1 bar	Millibar	mbar
Stress	Newton per square millimeter	N/mm ²
Velocity	Meter per second	m/s
Rotational speed	Revolutions per minute	rpm
Flow	Cubic meter per day Cubic meter per hour Kilogram per hour Liter per second metric ton per hour For gaseous substance: standard cubic meter per hour	m ³ /d m ³ /h kg/h l/s t/h Nm ³ /h
Density	Kilogram per cubic meter Kilogram per standard cubic meter	kg/m ³ kg/Nm ³
Torque, moment of force	Newton meter	Nm
Moment of inertia (mr ²)	Kilogram square meter	kgm ²
Work, energy or heat	Joule	J
Heat capacity, entropy	Joule per Kelvin	J/K
Specific heat capacity, specific entropy	Joule per kilogram Kelvin	J/kgK
Calorific value	Joule per cubic meter Joule per gram	J/m ³ J/g

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Quantity	Name of Unit	Symbol
Power, radiant flux	Watt	W
Heat release rate	Watt per square meter	W/m ²
Thermal conductivity	Watt per meter Kelvin	W/mK
Dynamic viscosity	Newton second per square meter	Ns/m ²
Kinematic viscosity	Meter squared per second	m ² /s
Surface tension	Newton per meter	N/m
Concentration	Parts per million	ppm
Electrical conductivity	Microsiemens per meter at 25 °C	μS/m
Frequency	Hertz	Hz
Electric charge	Coulomb	C
Electric potential	Volt	V
Electric field strength	Volt per meter	V/m
Electric capacitance	Farad	F
Electric resistance	Ohm	Ω
Conductance	Siemens	S
Magnetic flux	Weber	Wb
Magnetic flux density	Tesla	T
Magnetic field strength	Ampere per meter	A/m
Luminous flux	Lumen	lm
Illuminance	Lux	lx
Thermal resistivity	Kelvin meter per Watt	Km/W
Energy	Kilowatt hour	kWh

3.16 Materials

General material requirements

All materials shall be new and of the best quality for use in the conditions and the variations in river water quality, the temperature and pressure that will be encountered in service without undue distortion or deterioration or the setting up of undue strains in any part that might affect the efficiency and reliability of the Plant.

All materials shall correspond either to the approved standards and the respective code number or to exact analysis data, and full information concerning properties and applied heat, chemical and mechanical treatment shall be submitted.

Special attention must be paid to eliminating the possibility of corrosion resulting from galvanic effects. Design, selection of materials and all methods of erection shall be such as to keep these

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effects to a minimum. Materials complying with codes and standards listed below shall be used for the design and construction work.

Unless the materials meet these codes and standards the equivalent ASME/ASTM standard shall be used.

Materials and standards

Materials and standards

(A)	a.	Structural Steel Built-up Members	DIN EN 10 027-1 Formerly DIN 17100 and EN 10 025	all steel brands S235 and S355 Formerly St. USt & RS37-2, S37-3, St52-3 or Fe360B, BFU, BFN, C & D1, and Fe 510
	b.	Structural Steel Hot Rolled Members	DIN 1024 Series DIN 1025 Series DIN 1026 Series DIN 1027 Series DIN 1028 Series DIN 1029 Series	all steel brands S235 and S355, Formerly St. USt & RS37-2, S37-3 and St52-3, or Fe360B, BFU, BFN, C & D1, and Fe 510
	c.	Structural Steel Tubes	DIN EN 10 210-1,2	S235 and S355
	d.	Crane rail	DIN 4132	
(B)	a.	Bolts and Anchor Bolts	DIN ISO 898, DIN 18 800-1	4.6 ($f_y \geq 240 \text{ N/mm}^2$) 5.6 ($f_y \geq 300 \text{ N/mm}^2$)
	b.	High Strength Bolts	DIN ISO 898, DIN 18 800-1	8.8 ($f_y \geq 640 \text{ N/mm}^2$) 10.9 ($f_y \geq 900 \text{ N/mm}^2$)
	c.	Stud Bolts	DIN 32 500, Part 1 & DIN 18 800-1 DIN 32 500, Part 3 & DIN 18 800-1	4.8 ($f_y \geq 320 \text{ N/mm}^2$) St 37-3 per DIN 17 100, ($f_y \geq 350 \text{ N/mm}^2$)
(C)		Electrodes for Arc Welding	DIN 1913/ DIN EN 499	
(D)		Ordinary Portland Cement	DIN 1164-1 / 1164-2 EN 197-1	
(E)		Reinforcing Bars	DIN 488-2 / 488-4	

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Structural steel

DIN 18800 / DIN 18801 / DIN 18807 shall be followed.

For all above mentioned material standards, the equivalent standards as per BS, ASME/ASTM are also accepted.

Structural steel works

Materials

All ferrous materials, their dimensions, forms, weights, tolerances, chemical and mechanical properties, shall be the best of their kind, complying with relevant international Standards.

All structural steel material shall be minimum S235 for rolled steel shapes, angles, tees, plates, etc. having a minimum yield stress of 235 N/mm².

In the case of structural steel work, care shall be taken that all parts in the assembly fit accurately together and corresponding parts shall preferably be interchangeable.

The supplier shall submit to the Employer for approval the country of origin and manufacturer of the steel he proposes to supply.

The structural steelwork and testing shall comply with the relevant clauses of BS 4, BS EN 10162, BS 4360 and BS 6323 or equivalent standards.

Each steel part shall be marked with the manufacturer's name or trademark.

The steelwork shall be manufactured by a specialist firm approved beforehand by the Employer. As much of the work of manufacturing of the steelwork as is reasonably and technically practicable shall be executed in the manufacturer's works, and facilities for inspection by the Employer shall be provided.

All steelwork before and after manufacturing shall be smooth, un-deformed, straight and free of cracks, twist and burrs. All steelwork shall be cut and fabricated to a tolerance of ± 1.5 mm in its length. All plates shall be truly at right angles to the longitudinal axis of the section. No work shall be painted, packed or dispatched from the manufacturer's works until it has been inspected and complies with or has been certified to comply with all the tests and requirements of the standard applicable to the material specified and until it has been inspected and approved.

Tests

The manufacturer's test certificate for all steelwork shall be supplied to the Employer. The certificates shall state the manufacturing process and shall include a test sheet giving the results of the mechanical tests and the chemical composition. The supplier shall provide free of charge any supplementary tests reasonably required by the Employer. Steel which do not conform to the

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specified standards shall be rejected at the expense of the supplier. No steelwork shall be delivered from the manufacturer's works until it has been tested and the results comply with the requirements of the relevant standards.

Workmanship

Tolerances

Care shall be taken to ensure that the tolerances specified on the drawings or the relevant standards are worked to. The erection tolerance for cleated ends of members connecting steel shall be not greater than 2 mm at each end. No work shall be painted, packed or dispatched from the manufacturer's works until it has been tested and complies with all requirements of the standards.

Cutting

Cutting may be by shearing, cropping, sawing or machine flame cutting. Hand flame cutting shall be avoided. If rolled products for steel structures under predominantly static loading are cut by flame-cutting or shearing there will generally be no need for a finishing operation if the cut surface is free of defects.

Bolting

The threaded portion of each bolt shall project through the nut by at least one thread. Approved high strength friction grip bolts, preferably the type with indicated load, shall be used where specified and shall be tightened strictly in accordance with the manufacturer's instructions and the relevant regulations. The surfaces in contact shall not be painted and shall be free of oil, dirt, loose rust, burrs and other defects, which would prevent proper seating of the parts or interfere with the development of friction between them.

When connections are made using high strength friction grip bolts the relevant standards shall be observed.

Welding

The execution and testing of welding shall be in accordance with BS EN 1011-1, BS EN 1011-2 or equivalent standards.

All welds, unless otherwise stated shall be continuous minimum 6 mm fillet weld and shall be dressed smooth, free of porosity, cracks, holes and finished to match adjacent surfaces. When welding operations are completed, all welding flux shall be removed without delay. Cooling of welds shall not be accelerated by any special measures.

Site welding shall be restricted to the absolute minimum. Site welding is subject to approval by Employer. The examination of welded work and the inspection of welds during and after

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manufacture shall be carried out by responsible specialist welding engineers. Welding shall be carried out by expert trades men and in strict accordance with the current code of practice.

Painting

Surface treatment and painting before and after delivery to site shall be done.

Parts to be encased in concrete shall not be painted or oiled. Surfaces inaccessible after shop assembly shall receive the full-specified protective treatment before assembly.

Rejection

Any steelwork, which in the opinion of the Employer is not in accordance with the requirements of the standards or with the specifications, shall be mandatory rejected and removed from the site at the Contractor's expense.

Small non-structural steel parts

General

This Clause refers to the specifications covering the provision of all materials and labor in relation to supply and manufacture on site of articles made of steel or cast iron.

All steel structures and parts specified under this clause shall be hot dip galvanized and painted.

The list of small items to be furnished shall contain but not be limited to the following:

- steel sections, bent plate sections and square bars for construction of:
 - metallic stairs, platforms and walkways
 - railing for stairs, platforms, walkways and protective around floor openings
 - corner and edge protection for concrete steps and concrete
 - Structural parts such as columns, beams, removable cover slabs, etc.
 - support of any equipment foundation
 - joint covers
 - Anchors, ties, hangers, inserts, slots, embedded steel parts, etc.
- steel pipes and plain round bars for making guardrails and ladders
- steel plates, chequered and/or flat, for fabrication of removable covers
- Open steel grating for metal steps, platforms, and walkways.

Materials

The requirements for materials of structural steel specified herein are applicable to all steel sections, bars, plates, pipes and any sections as far as their quality, source, dimensions, mechanical characteristics and their delivery, handling, storage and tests on site are concerned.

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Specific requirements for high temp./high pressure part materials

The purpose of this part is to provide the additional requirements for the purchase, manufacturing and fabrication of:

- austenitic stainless steels used for high temperature superheater and reheater tubing,
- ferritic/ martensitic steels used for high temperature pressure parts.

All manufacturers and suppliers of the base metals, from raw materials until finished products, shall be ISO 9001:2000 certified for the duration of the contract or being renewed during the duration of the contract as appropriate. Only seamless tubes and pipes are acceptable for power piping. For low pressure systems (< 6 bar (g)) welded pipes will be accepted. The welded pipes provided shall be of certified source.

All materials and manufacturing procedures shall be certified by an independent 3rd party. The approval shall be part of the quality documentation.

The use of SA213-T24 material for membrane walls is not accepted.

The material SA213-T23 is known for cracking sensitivity. It shall be demonstrated and documented in the final data package that all such materials are free from any cracks and that all hardness values are within the required limits.

For SA213-T23 the Contractor must provide a detailed procedure for the calculation, design, purchase, manufacturing, erection, cleaning and pressure testing of this material. The relevant ASME code cases must be respected. For SA213 T91 and SA335 P91 the latest stress values and the latest information according to ASME code cases must be used. Also the EPRI „Guidelines and Specifications for High-Reliability Fossil Power Plants Best Practice Guideline for Manufacturing and Construction of Grade 91 Steel Components“ shall be respected.

For SA335 P92 the Contractor shall provide a detailed procedure for the calculation, design, purchase, manufacturing, erection, cleaning and pressure testing of this material. The relevant ASME code cases must be respected. SA213-T92 may be used for header nipples outside of the flue gas pass, while meeting the above mentioned requirements for quality control. The details on preheating for welding and PWHT shall be stated in detail. Special consideration shall be given to record the metal temperatures during manufacturing, erection and operation.

In case of any repair of any of such materials at site the 3rd party engineer must be involved concerning the proposed repair method.

Pre-service cleaning and protection of plant equipment

This clause covers mechanical and pre-service cleaning and protection of the plant items and equipment at the Manufacturer's workshop and at site that are not subsequently to be painted.

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

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

Mechanical cleaning as opposed to alternative chemical cleaning is the preferred method for workshop cleaning except where this is precluded by design or access considerations.

Machined surfaces shall be protected during the cleaning operations. For recleaning small areas, hand cleaning by wire brushing may be permitted. Wire brushes used on austenitic materials shall have austenitic steel bristles. Austenitic stainless steels, copper and aluminium alloys, cast iron, bimetallic and metallic/plastic items, and components fabricated by spot welding or riveting shall not be chemically cleaned. All weld areas shall be suitably stress-relieved before chemical cleaning.

At an appropriate time, the Contractor shall submit drawings of temporary pipework necessary to carry out the pre-service cleaning simultaneously with a list of works to be carried out on the pipelines, heaters, feedwater tanks, vessels etc. to connect the temporary pipework with the parts of equipment to be cleaned.

Further, the Contractor shall submit at the same time the basic draft of the cleaning procedure and of the treatment of wastes.

Not less than six months prior to the commencement of any site cleaning, the Contractor has to submit programs covering all procedures, lists of chemicals, calculations which quote the velocities, temperatures handpipework forces and movements imposed during site cleaning.

All necessary equipment, provisions, chemicals etc. are to be provided by the Contractor.

All tests, analyses, etc. as required are to be performed by the Contractor.

Besides this, the Contractor shall take over all responsibility for the treatment and disposal of wastes according to the local law and to the satisfaction of the Employer.

The date at which cleaning of plant equipment will be carried out at site shall be notified to the Employer at least 20 days in advance.

The Contractor shall take all necessary precautions to ensure that the internal surfaces of all plant are kept clean and free from injurious matter during erection.

When all plant has been erected and lagged or at such other time as may be agreed with the Employer for sub-assemblies, the installation shall undergo a procedure for site cleaning proposed by the Contractor and subject to the approval of the Employer.

Welding

All pressure part welding must follow the requirements of ASME and connected standards.

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Welding work and related heat treatment as well as inspections and test shall be performed in accordance with the specific and approved welding procedure specifications (WPS) and the respective material specifications.

WPS shall be prepared in accordance with relevant ASME standards, endorsed by 3rd party / inspector and submitted to the Employer.

Welding plans have to be prepared by every manufacturer for his scope of work.

No welding shall be undertaken until the applicable WPS and Procedure Qualification Record (PQR) are approved by the Employer.

The PQR shall be qualified in accordance with relevant ASME standard. Welding procedures must be qualified by a qualified independent testing authority engaged by the manufacturer.

Welding procedures shall be qualified in accordance with the requirements of the construction code/specification for the Item of plant concerned and in the case of critical plant items the tests shall be witnessed by an internationally recognized inspection authority.

Welders shall be qualified in accordance with the requirements of the construction code/specification for the Item of plant concerned for all types/positions of welding he may perform.

Welder tests shall be carried out in accordance with the approved standards within Contractor's scope. Test results are available for review in the workshops.

If at any time in the opinion of the Employer the work of any welder appears questionable, such welder is required to pass additional qualification tests to determine his ability to perform the type of work on which he is engaged. Any welder failing the retest may, at the discretion of the Employer be disqualified from further welding on items under this Contract.

The 2 first production welds of every welder shall be 100% examined by volumetric NDE and only when the results are acceptable, shall the welder be released for production welding.

A system of positively identifying the work of each welder shall be maintained and any welder whose work is the subject of multiple rejections shall be required to undergo a requalification test. Any welder failing the retest may, at the discretion of the Employer's Representative be disqualified from further welding on items under this contract.

Welded fabrications shall be stress relieved when specified by the applicable standard or for dimensional stabilization prior to machining.

Copies of temperature charts referenced with load items shall be included in the test certification supplied for the relevant items.

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All welds shall be visually examined and shall be of smooth contour, free from cracks, undercut and other significant defects. Wherever possible the interior of tubes etc. shall be examined using a suitable optical device where necessary. The manufacturer shall make every effort to avoid any contamination of the tube interior during the manufacturing process. To ensure the tubes are free from obstruction and debris the tubes shall be cleared with a sponge being blown through.

Fillet welds shall be checked for size using suitable gauges which shall be available for use on request by the Employer's Representative during an inspection visit.

For single side butt welds, all root passes shall be welded using a TIG welding process.

Preheating shall be in accordance with the applicable WPS and the respective material specification. The preheat temperature shall be in function of welding process, wall thickness, type of welding consumables, ambient temperature and climatic conditions.

Welding performed outside a workshop is authorised if an approved wind and rain protection (welding bay) is installed around the working place. Anyway, when ambient temperatures falls below 5°C, preheat is required for all ferritic materials and thicknesses. Gas burners or oxy-fuel torches can be used for pre-heating. Preheat shall be maintained over a distance of not less than 4 times the nominal thickness with a minimum of 75mm on either side of the weld. If the material required pre-heating, the same pre-heating shall be done for oxy-fuel or plasma cutting.

Welding consumables such as TIG-rods, electrodes, wires shall be clearly marked in order to avoid any mix-up of material grades. Positive Material Identification to be carried out on where a doubt for mix-up exists.

Any post welding heat treatment (PWHT) shall be performed in accordance with an approved procedure. The procedure shall describe the method, the heat treatment parameters (e.g. holding temperature and time, heating/ cooling rates, heated/insulated band...), the number and location of thermocouples, records and calibration. The procedure shall be available on Site and or in the workshops.

Before welding and/or heat treating valves, valve-manufacturer instructions shall be taken into consideration.

In the case of sensitive materials, grinding of the welds or other grinding work may only be carried out with special grinding wheels so as to avoid overheating or an increase in the hardness of the material.

Welding defects of all kinds must be documented and be available to the Employer on Site or in the workshop.

The Contractor maintains and makes available to the Employer or his representative, both at works and Site, adequately indexed records of all welds, weld inspections, weld controls and repair.

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3.17 Electrical equipment and works

Standards

The design and manufacture of all electrical equipment shall comply with the latest editions of the IEC Recommendations if not specified otherwise elsewhere in the specification. Compliance with ANSI/IEEE/NEMA, BS, EN or VDE standards will only be accepted in case no applicable IEC standards are available and subject to approval by the Employer/Engineer.

The Plant shall comply with:

- a. the Essential Electrical Requirements of the PPA
- b. the latest edition of the Electricity Grid Code of the Bangladesh Energy Regulatory Commission; and
- c. the Great Britain Grid Code.

In case of contradictions the order of precedence shall be as follows:

- a. Essential Electrical Requirements of the PPA;
- b. Electricity Grid Code of the Bangladesh Energy Regulatory Commission;
- c. Great Britain Grid Code.

Any other requirements of BPDB/PGCB shall also be considered (if available).

Voltage levels

The following voltage levels shall apply:

- 240/415 V + 10%, 50 Hz standard voltage for power supplies to small electric power consumers and motors below 160 kW
lighting and domestic power outlets
- 240/415 V + 10%, 50 Hz voltage for power supply of essential electric power consumers - the system shall be operated with un-grounded neutral
- 220 V DC + 10%/-15% voltage for emergency users of electricity, like turbine emergency oil pumps, circuit breaker control, inverters
- 240/415 V $\pm$ 10%, 50 Hz uninterrupted voltage supplies to consumers, which require uninterrupted infeed like DDCMIS components, control actuators, burner control panels, VDUs.
- 24 V DC $\pm$ 15% for power supplies to the DDCMIS system components

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- 24 V $\pm$ 10%, 50 Hz for erection work in enclosed plant items of metal

Insulation levels

- The 400 kV system shall be designed to limit the switching surge overvoltage to 2.3 p.u. and the power frequency over-voltage for the 400 kV system and the 230 kV system to 1.5 p.u. The lightning arrestors associated with the 400 kV reactors shall be of 336 kV.

- Following insulation levels shall be considered:

Description	400 kV	230 kV	Generator*	11 kV	3.3 kV
1. Highest voltage for equipment	420	245	24 or 36	12	3.6
2. Power frequency withstand voltage	650	460	50 or 70	28	10
3. Lightning impulse withstand voltage	1425	1050	145 or 170	75	40
4. Switching impulse withstand voltage (phase to earth)	1050	-	-	-	-

* According to manufacturer standard

- The creepage distance of the outdoor insulators shall be minimum 31 mm/kV.

Protective measures, earthing and lightning protection

In view of the potential dangers of electrical power, the following measures are required for the protection of life, equipment and materials. Basically, all 'live' parts, i.e. all parts of electrical, operational equipment at an electrical potential above or below earth potential when in operation, and with a rated voltage over 24 V, must be insulated or covered so that they cannot be touched accidentally.

In addition, measures must be taken by the Contractor to prevent the occurrence or persistence of excessively high contact potentials on conductive parts of electrical operational equipment (frames etc.) brought about by faults in insulation.

For installations up to 1000 V, voltages over 50 V are considered to be excessive contact voltages. Within enclosed electrical installations, with voltages over 1000 V, the contact potential shall be according to the values given in EN 50522 (VDE 0101-2) Earthing of power installations exceeding 1 kV: enclosure B

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The following rules and regulations are to be observed in carrying out protective measures and in earthing procedure:

- IEC 60079 and 60364 for installations up to 1000 V,
- EN 50522 (VDE 0101-2) Earthing of power installations exceeding 1 kV.

In areas exposed to the hazard of explosion, the protective measures outlined in IEC 60079 and IEC 61241 are to be adhered to in the erection and installation of electrical plant and equipment.

Protective measures for installations up to 1000 V

Protection against direct contact

All 'live' parts of electrical operational equipment that can be reached by hand must be protected against direct contact either by means of insulation or through constructional design, position or arrangement, or by means of special devices. If, in the case of enclosed switchgear or control cabinets, access is required in the course of normal operation (e.g. for replacing fuses), protection against direct contact must still be ensured when the switchgear or control cabinet has been opened up.

Protective insulation

Protective insulation is to be provided by means of additional insulation over and above the insulation provided for operational purposes. This measure must prevent the occurrence of a dangerous contact potential.

Use of low voltages as a safety measure

This safeguard applies to all equipment, which is required to operate in metal enclosures, boilers, tanks etc. The operational voltage of tools and lighting equipment must not exceed 24 V AC. Isolating transformers shall be provided by the Contractor for the purpose of producing the protective low voltage. A separate 24 V system will not be provided.

Protective measures for installations over 1000 V

Protection against contact

At least the following measures are to be taken for all parts that are 'live' when in operation:

- Protection outside of closed electrical operating areas:
 - complete protection from all sides against contact, the degree of protection shall be at least IP23D according IEC 62271-202 and IEC 60529
 - protective devices may only be removed by means of tools.
- Protection inside closed electrical operating areas:
 - protection against contact with 'live' parts within reach of personnel,

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- protection against accidental contact outside the reach of personnel.

The above-mentioned measures for protection against contact are also to be applied to 'dead' parts of the Plant where, in the case of a fault, a dangerous contact potential might arise, however, where the parts must not be connected to the protective earthing system for operational reasons.

Protection against contact voltages

Protective earthing is to be used as a safeguard against excessively high contact potentials for conductive parts of the installation, which do not form part of the operational circuit. Here, all normally 'dead' parts equipment and apparatus shall be earthed if it is possible for them to come into contact with 'live' parts as a result of faults due to the occurrence of surface leakage paths, arcs or direct connections to a 'live' part of the equipment.

In considering the dimensioning of the protective earthing system, the thermal loading and voltages on the earthing equipment are decisive factors and these should be based on the maximum possible earthing current, which can arise.

3.18 Inspection and Testing

General

This Section contains general requirements for inspection of material, parts, equipment and workmanship of the Plant during manufacture, assembling and erection and upon completion to demonstrate compliance with specification, codes and standards and to ensure overall reliability of Equipment operation and performance.

Development and implementation of test procedures for the construction inspection, start-up and performance testing and capacity demonstration of the Plant shall be the responsibility of the Contractor.

The Contractor shall be responsible for providing all supplies required for carrying out such tests.

The overall testing program for the Project shall consist of the following:

- workshop inspections and testing
- construction inspections, and testing

The Employer shall have the right to have their representatives present during inspections and tests of Plant equipment and systems in the workshops and during construction. The presence of the Employer's representatives during any inspection or test shall in no way relieve the Contractor of its responsibility for supplying the equipment or systems in accordance with the milestone dates.

The Employer will be notified by the Contractor in writing at least ten (10) days prior to such testing and inspection at workshop and two (2) days for test at site.

The Contractor shall submit to the Employer all relevant test documents, which shall include:

- inspection and test program

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- test standards
- type of inspection and tests
- tests which are to be witnessed by third parties.

The results of all tests shall be certified by the manufacturer, Contractor or independent agency as appropriate.

Document files containing material certificates, welding procedures, test report etc. shall be compiled for each item of plant and shall be suitably identified (including equipment classification reference) and bound.

Welding tests

Non-destructive examination of pressure and vacuum containment welds

Welds shall be non-destructively tested in accordance with the construction standard applicable to the item of plant. In addition the requirements of the following Table 1 shall be observed. Table 1 shall also apply in cases where the standards used for design and construction of an item of plant does not specify the quality requirements for welds. Fault limitations to be subject of agreement with the Employer's Representative prior to fabrication.

Hardness testing shall determine the hardness for welds and heat affected zone according to Vickers (HV10).

The test procedure ISO 6507-1 or equivalent shall be used. Minimum 3 hardness locations shall be tested for the weld. On circumferential welds the test locations shall be located at 120° distance. Hardness tests shall be conducted after PWHT.

Following percentages of welds shall be hardness tested.

Carbon steels or low alloy steels (<2%Cr)	10%
2.5% Cr steels	50%
9 - 12% Cr steels	100%
Austenitic steels	-

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TABLE I

Type of Steel	Design factor (shell)	Wall thickness (mm)	Inside diam (mm)	Type and Extent of non destructive testing			Remarks
				Butt	Nozzle	Fillet	
C and C-Mn steels with C content not exceeding 0.25%	≤ 0.85	≤ 10	all				Only applicable to Atmospheric systems (excluded systems, which handle chemicals, toxics or inflammable media).
		40≤	all	20% R			
		> 40	all	100% R	10% M	10% M	
	> 0.85	≤ 40	≤ 100	20% R			
		> 40	all	100% R	10% M	10% M	
C-Mn steels with C content 0.25 to 0.35%, CrMoV steels, C 1/2 Mo steels, low alloy steels, and CrMo steels except 12% Cr steels	all	≤ 30	all	20% R	10% M	10% M	Test after stress relief
		> 30	all	100% R	100% M	100% M	
	all	all	all	100% R	100% U**	100% M	
		all	all	100% R	100% M	100% M	
	all	all	≤ 100	100% R	100% M	100% M	
12% Cr ferritic/martensitic steels	all	all	> 100	100% R	100% M	100% M	Test after stress relief
			> 100	100% U	100% U	100% U	Test after stress relief

* Radiographic examination may be omitted if done on as-welded joint

** If feasible, otherwise 100% M.

Type of Steel	Design factor (shell)	Wall thickness (mm)	Inside diam (mm)	Type and Extent of non destructive testing			Remarks
				Butt	Nozzle	Fillet	
Austenitic Stainless Steels	≤ 0.85	≤ 15	all				Not applicable to: Butt welds made from one side only Operating temperatures exceeding 200 °C
		≤ 30	all	20% R			
		> 30	all	20% R	10% D	10% D	
	> 0.85	≤ 30	≤ 100	20% R			
		> 30	all	100% R	10% D	10% D	
		> 30	all	100% R	100% D	100% D	

Legend: R = Radiographic examination

U = Ultrasonic examination

M = Magnetic particle examination

D = Dye penetrant examination

Note:

1. Where 10% examinations are shown for pipework under 100 mm diam bore this shall be the circumference of 10% of the welds by each welder selected at random with a minimum of one per welder.
2. Where 10% examinations are shown for vessels or large diameter pipework this shall be 10% of each weld length and must include all intersections of longitudinal and circumferential welds.
3. Where partial examinations reveal rejectable defects, adjacent welds or areas of weld shall be examined. In the event of rejectable defects being found welds shall be subject to 100% examination.
4. Welds in clad materials shall be tested in accordance with the requirements of the base material and the surface of the overlaid welds shall be dye penetrant tested throughout their length.

Non-destructive examination of structural welds

Welds shall be non-destructively tested in accordance with the construction standard applicable to the item of plant. Where appropriate, the following requirements shall also be observed:

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- magnetic particle testing of the tension side welds in major fabricated girders and Sections,
- ultrasonic examination of heavily restrained welds (e. g. cruciform joints) where there is a risk of lamellar tearing in the parent material.

Weld Repairs

Unacceptable defects observed by visual examination or indicated by non-destructive testing shall be completely removed by chipping or thermal gouging and grinding. The resulting excavation shall be crack detected prior to rewelding.

Details of the original defects and repair shall be recorded.

Repaired welds shall be subjected as a minimum requirement to the same inspection requirements as the original welds and test records should indicate that a repaired weld is referred to.

3.19 Electrical equipment

Electrical equipment and material which is not covered by the tests specified elsewhere in this document shall be inspected and tested in accordance with the latest edition of standards listed hereafter. Alternatively, equivalent standards approved by the Employer's Representative may be used.

Type tests shall be carried out if type test certificates certified by an independent test authority are not available.

Installation Material

IEC 60130	Connectors for frequencies below 3 MHz
IEC 60364	Low voltage electrical installations/ Electrical installations of buildings
IEC 60423	Conduits for electrical purposes

Materials for earthing and lightning protection

IEEE 80	Guide for safety in AC Substation Grounding
IEEE 81	Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface potentials for Ground system
NFPA 780	Installation of lightning protection systems

Insulators and Bushings

IEC 60383	Insulators for overhead lines with a nominal voltage above 1000 V
IEC 60507	Artificial pollution tests on high voltage insulators to be used on AC systems
IEC 60137	Insulating bushings for AC voltages above 1000 V

Surge Protection Equipment

The surge protection equipment shall be tested in accordance with IEC 60099.

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AC Switchgear for voltages above 1 kV

IEC 62271 High-voltage switchgear and control gear
IEEEC37.013 IEEE standard for AC-High-Voltage generator circuit breakers on a symmetrical current.

At least the following tests shall be performed in the manufacturer's workshop on the individual apparatus and on the complete installation, respectively, all in accordance with IEC Standards:

- Visual inspection
- Power frequency HV tests
- Dielectric tests of the auxiliary circuits
- Measurement of the main contacts resistance with dc
- Temperature rise test on circuit breakers (type test certificate)
- Test of mechanical endurance (type test certificate)
- Measurement of the contact opening period (type test certificate)
- Functional tests of the control circuits
- Check of the operational sequence
- Measurement of the instrument transformer's angle and ratio errors (according to IEC-standards 60044)
- Check of the denominations.

Note 1: All MV switchgear shall be type tested according IEC 62271-1, IEC62271-100 and IEC 62271-200 including internal arc classification IAC = AFLR. Related type test certificates shall be provided with the Tender. If the test has already been carried out on similar type switchgear, type test certificates may also be accepted.

Note 2: All GIS above 52 kV shall be tested according IEC 62271-1, IEC 62271-203.

Note 3: Generator circuit breakers shall be tested according IEEE Std C37.013.

High voltage fuses

IEC 60282 High voltage fuses
IEC 60644 Specification for high voltage fuse links for motor circuit applications

Dry type transformers

The following routine tests in accordance with IEC 60076 shall be carried out on all transformers:

- Measurement of winding resistance
- Measurement of voltage ratio and phase displacement
- Measurement of short circuit impedance and load loss
- Measurement of no-load loss and current
- Separate source AC withstand test
- Induced AC voltage test
- Lightning Impulse test
- Partial discharge measurement.

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The following tests in accordance with IEC 60076 to be carried out as type tests (type tests shall not be repeated if type tests certificates of an identical transformer issued by a recognized test laboratory are available):

- Temperature rise test
- Measurement of sound level
- Short circuit test
- Environmental Test according Class E2
- Climatic test according Class C1
- Fire behaviour test according to Class F1.

Fault withstand (fault versus time) curve for all transformers shall be submitted by the Contractor. Separate type and routine tests shall be carried out for all accessories like bushings, bushings CTs, tap changers, etc.

3.20 Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
AC	Alternating Current
AGC	Automatic Grid Control
ASC	Average Site Conditions
AVQR	Automatic Voltage and Reactive Power Control
BOP	Balance of Plant
BOQ	Balance of Quantities
BPDB	Bangladesh Power Development Board
CCR	Central Control Room
CCTV	Closed Circuit Television
COD	Commercial Operation Date
CT	Current Transformer
DC	Direct Current
DCDB	DC Distribution Board
DCS	Distributed Control System
DDCMIS	Distributed Digital Control Monitoring & Information System
DOE	Department of the Environment, Bangladesh
DOSH	Department of Safety and Health, Bangladesh
EHSR - TTP	IFC Environmental Health and Safety Guidelines Thermal Power Plants
EHV	Extra High Voltage (500 kV)
EIA	Environmental Impact Assessment
EMC	Electro-Magnetic Compatibility
EPC	Engineering, Procurement, Construction
FTU	Field Mounted Termination Unit
G-EHSR	IFC General Environmental Health and Safety Guideline
GJ	Gigajoule
GPS	Global Positioning System
GWh	Gigawatt hour
GSO	Grid System Operator
HART	Highway Addressable Remote Transducer
HAZOP	Hazard and Operability Study

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HDPE	High Density Polyurethane
HMI	Human Machine Interface
HRC	High Ruption Capacity Fuse
HV	High Voltage
HVAC	Heating, Ventilation, Air Conditioning
Hz	Hertz
I&C	Instrumentation and Control
IOD	Initial Operation Date
IPL	Independent Protection Layer
IR	Infrared
kV	Kilovolt
kW	Kilowatt
LAN	Local Area Network
LCC	Local Control Center
LIE	Local Instrument Enclosure
LIR	Local Instrument Rack
LV	Low Voltage
LVS	Large Video Screen
MCC	Motor Control Center
MCL	Maximum Continuous Load
MCR	Maximum Continuous Rating
MLSD	Land Survey Datum
MNCL	Minimum Continuous Load
MNCR	Minimum Continuous Rating
MOV	Motor Operated Valve
MV	Medium Voltage
MVA	Megavolt Ampere
MVAR	Megavolt Ampere Reactive
MWh	Megawatt hour
NCC	Network Control Center
NDE	Non Destructive Examination
NFPA	National Fire Protection Association
NLDC	National Load Dispatch Centre
NOR	Notice of Readiness
NRV	Non Return Valve
O&M	Operation and Maintenance
OEM	Original Equipment Manufacturer
OHL	Over head line
PA	Public Address
PABX	Private Automatic Branch Telephone Exchange
PLC	Programmable Logic Controller
PPA	Power Purchase Agreement
PQR	Procedure Qualification Record
PSS	Power System Stabiliser
PVC	Polyvinyl Chloride

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PWD	Public Works Department
PWHT	Post welding heat treatment
QA	Quality Assurance
RC	Reinforced Concrete
RSC	Reference Site Conditions
SCADA	Supervisory Control and Data Acquisition
SCS	Substation Control System
SER	Sequence of Events Recording
SI	Soil Investigation
SIL	Safety Integrity Level
SOE	Sequence of Events
SSC	Summer Site Conditions
TCS	Technical Comment Sheet
UHF	Ultra High Frequency
UV	Ultraviolet
VDU	Video Display Unit
VT	Voltage Transformer
WSC	Winter Site Conditions
WPS	Welding procedure specification

3.40 Enclosures:

- Packing & Shipping Instructions (Annexure-E) – 2 Pages
- Seaworthy Packing – 5 Pages

ANNEXURE – E
TO
INTERNAL ORDER NO. INTORD0489

PACKING & SHIPPING INSTRUCTIONS

1. All units/ sub vendors/ contractors are strictly advised to comply with packing instructions mentioned in contract documents (GCC clause 65: Packaging & Section V, FTS, Clause B0.3.5 Packaging and transportation).

2. Special Packing Instructions & Inspection Prior to Dispatch

- Packing (tare) shall be part of the Equipment cost and shall not be subject to return. The packing should ensure integrity and cohesiveness of each delivery batch of Equipment during transportation. In case of Equipment assemblies and unit's delivery in the packing of glass, plastics or paper the specification of packing with the material and weight characteristics are to be indicated.
- All packages to be wrapped in transparent polythene inside the crates for effective weather proofing
- Each package should have the following inscriptions and signs stenciled with an indelible ink legibly and clearly:

Destination:

Package number: BHEL/MTR/BD/XXX/YYYYY where XXX stands for Unit abbreviation e.g. RPT

YYYYY stands for package no.

Gross and Net weight

Dimensions

Lifting places

Handling marks and the following delivery marking:

"BANGLADESH-INDIA FRIENDSHIP POWER COMPANY (Pvt.) LIMITED
2X660 MW MAITREE SUPER THERMAL POWER PROJECT
BANGLADESH"

EPC CONTRACTOR: BHARAT HEAVY ELECTROCALS LIMITED, INDIA

- Completeness of Contents of each packing case: Concerned CQA/Unit QC/Third Party Inspection Agency shall verify the completeness of contents of each package w.r.t packing list both in terms of quality and quantity before authorising dispatch of the consignment.
- Packing commensurate with international standards and accepted norms will be ensured by CQA/ Unit QC/Third Party Inspection Agency. Packing has to be **SEA WORTHY** and secure.
- As far as possible, the packing has to be rectangular in shape for optimum space utilization in the ship and economize on shipping costs. Projections on packages are prohibited.
- The packing list has to be checked and certified by the Inspection agency (ies) with due signatures.
- All packages shall be enclosed in suitable GI sheets on all sides
- No loose items / Gunny bag packing are allowed for shipment.
- Proper pallets and crates are to be used for packing of Oil drums and Structures.
- Routing of Packing Lists: Packing list is an extremely important document, which forms a part of export documentation in connection with the processing of customs formalities. Packing List has to be generated by units/Unit vendors and sent to IO and ROD (both at

the same time), two weeks in advance, for processing and obtaining shipping bills' clearances and avoiding octroi payment through 'N' form at Mumbai.

- Advance intimation to ROD & IO: All supplying units/vendors will give at least 15 days advance intimation to ROD & IO along with package details before actual dispatches to arrange for storage/shipping arrangements by ROD and customs invoicing by IO. Information must be sent to consolidate the details and arrange for shipments in time.
- Excise Attestation at Works: To avoid opening of big cases for examination by customs at port of shipment, the supplying unit may arrange to get the packing cases sealed by local excise authorities/ self-certification and the relevant invoices and packing lists to be endorsed from Superintendent, Central Excise. For this purpose, Units should send the packing lists to IO at least 2 weeks in advance to enable prepare Shipping Invoices for furnishing to the units for requisite attestation and sending to ROD through fastest means for a smoother and faster customs clearance. Also Units to provide "specification of packing with the indication of the number of cargo packages, type of packing and weight of packing in English" along with the packing list.
- Provision of Inspection Windows on Packages: Unit/Vendors should provide inspection window of size 8" x 4" (glass perplex) for customs examination for all packages (above 1.5 x 1.5 x 1.5 cu m) involving panels of any kind. Care would be taken to ensure that all packages are properly sealed to avoid ingress of moisture, rodents etc. Packing slip folders to be attached in each box.
- Drawings for Heavy Weight/ODC consignment: Any package/item weighing above 20000 kgs and/or size greater than 2.5 X 2.5 X 4 m. detailed engineering documents (at least 4 sets) for all items of the above category will be furnished by respective units to issue shipment enquiries in a proper manner. The drawing has to include centre of gravity of the item clearly (Units to identify such items and notify io as soon as the engineering documents are released).
- Lifting Beams: All heavy lifts for which safe handling is essential at the port of dispatch shall be accompanied by lifting beam on non-returnable basis.
- "Marking for Safe Handling: To ensure safe handling, packing case shall be marked to show the following:
 - ✓ Upright position.
 - ✓ Sling position and Centre of Gravity position
 - ✓ Storage category.
 - ✓ Fragile components (to be marked properly with a clear warning for safe handling).



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SEAWORTHY PACKING

(PACKING INSTRUCTIONS FOR GENERAL COMPONENTS / ASSEMBLIES / EQUIPMENTS)

1.0 GENERAL

This standard lays down packing instructions for packing of Components /Assemblies/Equipments to be dispatched against Customer's contracts, for which there are no special instructions issued by the Engineering Departments.

The Components/Assemblies need to be packed suitably to avoid physical damage & corrosion during transit for storage. For specific applications the concerned engineering department shall issue a product standard. Reference of this standard, must appear in the Shipping list/Packing List.

2.0 SCOPE:

This procedure gives minimum guidelines to be complied with for packing of Components /Assemblies / Equipments. This packing shall be suitable for different handling operations and for the adverse conditions during transportation and during indoor / outdoor storage for periods more than one year.

3.0 CROSS REFERED SPECIFICATION:

Expanded Polyethylene Foam Sheet	: AA51420
Packing Wood	: AA51401
Silica gel	: AA55619
Thermocole	: AA51416
Packing slip holders	: AA7240901
Corrugated Fibre Board	: AA51414
Rubber sheet	: AA59001
VCI paper	: AA51406

4.0 WOOD SPECIFICATION FOR PACKING:

The wood shall conform to specification AA51401.

5.0 TYPE OF PACKING:

The following 5 types of packings have been standardized for packing of General Components /Assemblies.

'OP' - Open Type

'PP' - Partially Packed

'CP' - Crate Packing - Components/Equipments requiring physical protection

'CQ' - Case Packing - Small medium Components/ Assemblies/ Equipments which require corrosion & physical protection

'CR' - Case Packing - Electrical Components/Assemblies which require special packing viz. Water Proof, Shock Proof, etc.

Revisions: Refer 25 th MOM of MRC-M&CD			APPROVED: INTERPLANT MATERIAL RATIONALISATION COMMITTEE - MRC(M&CD)		
Rev No.00	Amd No.	Reaffirmed	Prepared	Issued	Dt. of 1 st Issue
Dt:17-08-2013	Dt:	Year:	HPBP, Trichy	Corp.R&D	17 Aug 2013

**6.0 DESCRIPTION OF TYPES OF PACKING:**

The various types of packing, as standardized above, are described below.

6.1 'OP' - Open Type:

In case, of components which are not affected by water & dust & do not require special protection &, are generally not machined, shall be sent as open packages. However these components may be sent in crates, wherever necessary.

6.2 'PP' - Partially Packed:

Components which need special protection, at selected portions only, shall be dispatched partially packed. Machined surfaces should not be allowed to come directly in contact with the wood. Such surfaces after application of TRP should be protected with Polyethylene Coated Bitumen Hessain Kraft Paper to AA51409 or Polyethylene sheet to AA51408 of at least 100 micron thickness.

6.3 'CP' - Crate Packing - General:

Assemblies/Components which need only physical protection from the point of view of handling shall be dispatched duly packed in crates.

6.4 'CQ' - Case Packing - Machined Components/Assemblies/Equipments:

- a) Small & Medium sized components/assemblies/equipments due to size/weight & to avoid handling, and pilferage, problems shall be packed in Case/Containers.
- b) Wherever required adequate quantity of silica gel to AA55619 or VCI Powder/ Tablets, packed in thin muslin cloth cotton bags shall be suitably placed.
- c) Small machines/components of less weight shall be provided with suitable cushioning. Wood Wool/Expanded Polyethylene Foam Sheet, if used, shall be sandwiched between polyethylene sheets and sealed.
- d) The components inside the case shall be entirely covered with a polyethylene sheet of at least 100 micron thickness to AA 51408, where-ever required.

6.5 'CR' - Case Packing - Electrical & Electronic Components/Assemblies:

Delicate components likely to be damaged e.g. Gauges, Instruments etc. are to be wrapped in waxed paper or polyethylene air bubble film and packed in cartons.

- a) Adequate quantity of Silica gel to AA55619 packed in cotton bags, of 100 grams each are to be suitably placed in the cartons. The cartons shall be entirely covered with a polyethylene sheet to AA51408 of at least 100 micron thickness, before being packed in the cases.
- b) VCI Powder/Tablets can be used as an alternative to Silica Gel to AA55619.
- c) Empty space in the cartons shall be filled with small chips of Expanded Polystyrene (Thermocole), Wood Wool etc. Polyethylene air bubble film shall conform to IS:12787/AA51420 Expanded polystyrene (Thermocole) shall conform to AA51416.
- d) The cartons shall be manufactured from corrugated Fibre Board, meeting requirements of AA 51414.

6.6 Volatile Corrosion Inhibitor (VCI) Paper:

- a) Un-protected surfaces of steel and cast iron components, tools bearing, shaft seals etc. are covered with VCI paper. VCI paper has been impregnated with



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corrosion inhibitors which by evaporation and chemical conversion protect metals in an enclosed area against corrosion.

- b) 7 m³ VCI paper is necessary for 1 m³ of packed item approximately as per AA51406.

Application Limitation:

VCI paper shall not be used for components made of aluminium, aluminium alloys as well as Zinc, copper, brass, cadmium and silver.

VCI powder is sprinkled inside the piping components ends shall be protected with end cover as specified in plant standards, drawings.

6.7 Moisture Absorber:

Silica gel is used for this purpose to protect the contents over sufficiently long time from corrosion. At the time of use, silica gel should be so dried that its colour becomes dark blue. These shall be filled in small cotton bags. Before sealing the equipment, the silica gel bags should be kept inside the polyethylene film cover at different locations. The quantity of silica gel should not be less than 1.0 kg per cubic metre volume of the packing box

7.0 TYPE OF CASES:

For specific requirement of packing the cases are to be provided with Tongue and Groove joints.

8.0 PREPARATION OF PACKING CASE:

- 8.1. The base of the case shall be made of wooden batons for planks giving necessary reinforcement, such that the bottom of the equipment is at a height of 100 to 200 mm from the ground level depending upon size, ft weight of equipment. However for packing cases of smaller size equipment can be at a height of -40 mm from the ground level.

- 8.2. In case of 'CR1 - Packing Viz. Electrical ft Electronic components for instruments /assemblies, a rubber sheet, Self-expanded polyethene foam sheet, preferably 10 mm thick, shall be fixed on to the base to act as cushioning to the equipment.

- 8.3. The four sides, shall be lined, from inside with packing paper water proof bitumen laminated to AA51410 Type - I or polyethylene sheet to AA51408 of at least 100 micron thickness and tacked at suitable places.

Whenever specified in addition to the bitumen laminated paper/polyethylene sheet the top cover will have a layer of bitumen felt over the cover. This should project about 100 - 250 mm on all sides.

It is preferable to have a single piece of the above Kraft paper fixed on the four sides. In case jointing is unavoidable, it should be done by overlapping of approximately 100 mm.

- 8.4. Place the Components/cartons with corrosion inhibitors duly applied wherever necessary for place suitably, thin muslin cloths bags containing 100 grams (approx.) of activated Blue Silica Gel to AA55619, wherever necessary. Alternatively VCI Powder or Tablet may be used.

- 8.5. In case, depression is formed, at the top, after the equipment is lowered, provide ply board/wooden batons.

- 8.6. Cover the whole equipment with polyethylene sheet of at least 100 micron thickness, on all sides preferably by a single piece.

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8.7. For indoor panels/equipments, provide suitable packing batons with covering of Thermocole/expanded soft polyethylene foam/polyethylene air bubble film wrapped with suitable cords, to avoid cutting of the polyethylene sheet so that finished surface is not damaged.

8.8. Empty space in the box shall be filled with adequate cushioning material e.g. Thermocole Chips, Wood Wool etc. to avoid movement for shocks. Alternatively put wooden blocks/batons wherever necessary.

8.9. The inner side of the top cover shall be lined with polyethylene sheet, of at least 100 micron thickness, which shall project approximately 25 to 150 mm depending upon the size of the case on all sides of the top cover shall be provided below the top cover. This projection, after nailing the top cover, shall be folded over, on the sides of the crates fit tacked, to, prevent ingress of water from the top.

9.0 STEEL CONTAINERS:

Steel containers for packing can be used in case of repeated supplies of the same equipment. Empty steel containers are to be returned back from customer's end and to be reused for the next supplies.

The containers are to be made of structural steel as per AA 10108 with proper reinforcement with I, C and T Sections.

Following precautions are to be taken during packing:-

Put the Components/Assemblies/Equipments in the steel container properly.

Cover the Components/Assemblies/Equipments with polythene.

To arrest the movement in the steel container necessary wooden Blocks/Batons may be put.

Put cover on steel, container and Bolt Properly.

10.0 SEALED PACKING:

Components sub-assemblies and assemblies sensitive to climatic conditions shall be packed seal tight. All the openings of the sensitive components, sub-assemblies and assemblies shall be blanketed to prevent the ingress of dust and moisture.

The components sub-assemblies and assemblies are completely covered with 2 layers of polyethylene sheet. All sharp corners and edges are to be protected by rubber mats to prevent the polyethylene sheet from damage. Top surface of the case shall be free from dents to prevent rain water pockets.

11.0 SLING PLATE:

Sling plate shall be provided to prevent damage to the packing box during lifting. Size of the sling plate shall be selected depending upon the net weight of the consignment.

12.0 PACKING SLIP HOLDERS:

Two nos. steel packing slip holders, specification no. AA7240901 containing the packing list, sealed in thick polyethylene film, shall be fixed one inside and the other outside the packing box.

13.0 GENERAL PRECAUTIONS:

- a) While fixing nails during packing, necessary care shall be taken to ensure that materials used for protection inside the case e.g. paper, polyethylene sheet, coir etc. do not get damaged.



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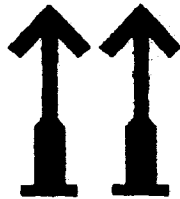
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- b) Sling protection brackets to be provided on cases wherever required.
- c) It shall be ensured that all stencil marks external, front & rear sides of the casing shall be of water proof Material to prevent obliteration in transit.
- d) The various caution signs shall be marked with stencil on both sides of the packing box.
- e) Do not pack any other Mechanical items with this case.

THE FOLLOWING DETAILS ARE TO BE MARKED ON THE PACKING CASES.

- a) Address of consignee.
- b) Purchase Order No.
- c) Description of item or title of packing list.
- d) Case identification Number.
- e) Net Weight.
- f) Gross Weight.
- g) Dimensions of box
- h) Marking showing upright position.
- i) Marking showing sling position.
- j) Marking showing umbrella (i.e. for machines/components to be stored under covered storage).

MARKING ON PACKING BOXES



A



B



C



D



E

- A UPRIGHT
- B FRAGILE
- C PROTECTION FROM FALLING OR CONDENSING MOISTURE
- D SLING POSITION
- E PROTECTION FROM DIRECT RADIATION

GENERAL GUIDELINE FOR FILLING QA PLAN IN CUSTOMER FORMAT

[1] Suppliers are required to fill the necessary relevant details under each column for **QA activities** planned during realization of final product covering the following stages :

A) Raw material stage –Covers all significant raw materials which are **procured from various approved sources by supplier** and **processed in supplier works** before assembly & final inspection of finished product. Example: Structural material, Pipes , tubes , strips, Sheets, Casting, Rods, Wires, packing material etc.

B) BOI stage – covers all instruments , devices, equipments ,assemblies & sub-assemblies which are **procured from approved sources by supplier** and are **used as sub assemblies / components** in finished product without any processing at supplier works. Example: Motors, transformers, switchgear [Circuit breakers, SFU ,fuses etc.] ,MCC, Resistors, All meters, Relays , Contactors, Displays, CT/PT ,Gears, Fans ,cables etc.

C) In process stage – covers all processes [including outsourced processes] which are required for conversion of raw material & BOI into finished product. Example: Wiring, Fabrication, Soldering, Brazing, Welding , Surface preparation, Painting , Galvanizing , Electroplating, Assembly, Finishing etc.

D) Final inspection stage - covers applicable Routine tests[FRT] for 100% of lot size & Acceptance test[FAT] on samples drawn from population of Offered Finished product

Routine tests are conducted on 100 % lot size for confirmation of proper manufacturing by checking for manufacturing defects.

Acceptance tests [include most routine test & any other test / check stated in standard/ specification] are conducted on specified sample size [usually mentioned in QA plan / IS /BS/ IEC Standards] for the purpose of acceptance [rejection] of offered lot of finished product.

Type test approval wherever necessary must be obtained prior to Final inspection.

E) Packing stage – covers all process including finishing , preservation & packaging of product prior to dispatch.

[2] For each of above stages, there will be components [in case of Raw material/BOI stage] and operations [in case of In-process stage, Final inspection & packing stages] involved. Under the 'COMPONENTS / OPERATION' column the name of respective item/component/operation will be mentioned.

[3] For each component / operation there will be a list of test /checks involved which will ensure that the desired characteristics [specified in Technical specification, IS/BS/IEC & Plant standards] are confirmed in the lot under test. It could include Chemical composition, Metallurgical examination for grain size , Mechanical properties like UTS/ % Elongation, hardness, Impact test etc, Electrical characteristics like resistivity , capacitance / inductance/ PD/ Tan delta etc. , Functional checks, Operation check, pressure test etc. Sample sizes should be adequate & in conformity with relevant specification & standards [IS/BS/IEC/ Plant standard]. Under the column 'CHARACTERISTICS' the list of relevant characteristics for all component/operation must be mentioned

[4] The various Characteristics checked for any component /operation are further classified into Critical, Major & Minor categories. Under Critical category, the characteristics which are essential for the finished product to meet the specified performance criteria & the non-conformance of which will harm or impair the product , user/operator and to associated equipment. Under Major category , those characteristics whose non-conformance will impair the ability of final product to deliver the specified performance criteria is included . All other characteristics are under Minor category Under Column 'CLASS' the relevant category [Critical/Major/Minor] shall be mentioned.

[5] The type of various check[s] for different characteristics for all components /operation shall be detailed as Chemical / Electrical / Mechanical / Measurement/ Metallurgical/ NDT/ Pressure test / Functional/ Visual/Physical etc. in the column 'TYPE OF CHECK' as applicable

[6] The sample size must be mentioned clearly as % of lot / nos. / nos per lot/ nos. per shift etc. under column 'QUANTUM OF CHECK'. The sample size must be adequate & in line with relevant standards / Plant norms. Two columns are mentioned in Quantum check, first one "M" is for the manufacturer/sub supplier quantum of check, whereas the next column as "C/B" represents the Quantum of check to be verified or witnessed by B and/or C

[7] Reference documents includes all approved Engg. documents [GA & part Drawings/ Schematics/ isometrics/ GTP/ datasheet /catalogue/TT approvals] alongwith relevant plant standards / International standards mentioned in specification for the product. The applicable reference document no. / name for each characteristics of all components/processes shall be listed by supplier under the column 'REFERENCE DOCUMENT'.

[8] Under the column 'ACCEPTANCE NORMS', supplier shall include the relevant document name in which the acceptance criteria are listed / stated or referred. In cases where no such document exists, supplier shall detail the acceptance criteria itself.

[9] The results of various checks for characteristics of all components /operation are recorded in the form of Inspection reports[IR], Test reports[TR]/ Joint inspection reports[JIR]/ Test certificate[TC]/ Log sheet/ QC register / Job card/ Third party lab report/ Certificate of Conformance [COC] etc. . Under the column 'FORMAT OF RECORD', relevant test record type will be mentioned. Wherever applicable the format no. of record format should be mentioned. Also the documents which are to be included as part of Final inspection report [QA documentation] will be identified by "Y" or tick mark under "D" sub column.

[10] Column 'AGENCY' mentions the agency for each of the activity [namely Perform ,Witness , Verification.] Legend details are as below :

P- Performing the relevant characteristic test/check , W- for Witnessing the relevant characteristic test/check & V- verification of records pertaining to relevant characteristic checked.

Under each of the sub columns "M", "C" & "B", supplier shall propose the agency as per below legend.

M- Supplier /Manufacturer / Sub supplier . C- BHEL/ BHEL nominated agency. B- BIFPCL/ BIFPCL nominated agency.

"P" [i.e. perform] shall be mentioned under sub column M always [meaning supplier/sub supplier/ manufacturer shall be responsible for performing the test/check.]

Under activity sub-column "C and /or B", "V" shall be mentioned wherever applicable [i.e BHEL and/or Customer shall verify the necessary records for relevant Characteristics checked.] CHP stages will be identified by "W" in "C and/or B" sub-column

[11] Any special information like name & place of Sub supplier for the component / operation [if outsourced] shall be mentioned by Supplier under 'REMARKS' column.

[12] The Customer format of QA plan has 11 columns [suitable to fit paper of A4 size in Landscape orientation]. The header & footer should be as mentioned in blank format. QA plan must include the supplier name & address and the item name in left hand side of Header. Supplier must fill in the necessary relevant details against Project name, Package detail [like 400 KV Switchyard], QP no., Rev., date must be correctly. The QA plan must be signed & stamped by authorized QA representative of supplier in the left hand side of footer before submission to BHEL.

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Customer: BIFPCL
Consultant: FICHTNER
Technical Specification: 1.1 kV Aux Power & Control Cables

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SECTION-4

GUARANTEED TECHNICAL PARTICULARS

Bidder shall submit the GTP as per TS requirement stipulated in Annexure D, Annexure E and Annexure G of Section-1.

The GTP shall be submitted at CONTRACT stage only.

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SECTION-5

CHECK LIST FOR INFORMATION TO BE FURNISHED WITH OFFER RETURN THIS CHECKLIST AS PART OF THE OFFER DULY SIGNED

The offer may not be considered if the following information and this Checklist are not enclosed with the Offer.

BHEL ENQUIRY. NO:

BIDDER OFFER REFERENCE:

A)

(1) S.No.	(2) Parameters	(3) Data	(4) Yes / No	(5) Remarks in case reply in Col (4) is NO
1.0	Applicable Standard	Latest IEC 60228, IEC 60502, IEC 60287, ASTM-D2843, ASTM-D2863, ASTM-D3137:81, IEC 60754-1, IEC 60332-1, IEC 60332-3-23, VDE 815, VDE 816, VDE 472, VDE 207, SEN-SS-424-1475 and other relevant standards.		
2.0	Type	FRLS		
3.0	Construction feature for PVC Control cable			
3.1	Material of Conductor for Control cables	Plain Annealed, High Conductivity, Stranded Copper (with minimum 7 strands), Grade EC		
3.2	Conductor Insulation for Control cables	Extruded PVC, Type-A		
3.3	Inner sheath	Extruded PVC, Type ST-1		
3.4	Overall Screening for Control Cables	Aluminium-Mylar Tape of Minimum Thickness 55 micron and 100% coverage with 20% overlap. The drain wire of 0.5 sq mm (7/0.3 mm) ATC shall run longitudinally along the cable screen.		

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(1) S.No.	(2) Parameters	(3) Data	(4) Yes / No	(5) Remarks in case reply in Col (4) is <i>NO</i>
3.5	Outer sheath for Control cables	PVC extruded, FRLS, Type ST-1, Category C2		
4.0	Construction feature for XLPE Aux Power cable			
4.1	Material of Conductor for Power cables	Plain Annealed, High Conductivity, Stranded, Copper (with minimum 7 strands), Grade EC		
4.2	Conductor Insulation	XLPE		
4.3	Inner sheath	Extruded PVC, Type-ST2		
4.4	Outer sheath	PVC extruded, FRLS, Type ST-2, Category C2		
5.0	FRLS properties of Outer sheath			
5.1	Minimum Oxygen index	29		
5.2	Minimum Temperature index	250°C		
5.3	Acid gas emission	Max 20% by weight		
5.4	Smoke density rating	Max 60%		

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(1)	(2)	(3)	(4)	(5)
S.No.	Parameters	Data	Yes / No	Remarks in case reply in Col (4) is NO
6.0	Tolerance on overall diameter	As per Annexure of Sec-1		
7.0a	Cable shall be resistant to insects rodents, bacterial action, solar radiation, effect of oil and seawater.	Yes		
8.0	Drum lengths shall be 1000m for cables with conductor cross section area less than 150 sq mm	Yes		
9.0	Tolerance on total quantity	$\pm 2\%$		
10.0	Minimum bending radius for multicore cables	12 x D		
11.0	Core Identification	As per relevant IEC		
12.0	The fillers and inner sheaths shall be of non-hygroscopic, fire retardant material, shall be softer than insulation and outer sheath shall be suitable for the operating temperature of the cable	Yes		
13.0	Instrumentation Cables	Fully conforming to technical specification mentioned in Annexure-G and Annexure B I of Sec-1		

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B) TYPE TESTS

- i) Type Tests shall be conducted by the bidder as per Annexure D, E, G & B I of Section-1.
(YES)

C)

(1) S.No.	(2) Description	(3) Confirmation of Supplier
1.	Bidder to confirm that at all drawings / data sheets/QP/ valid type tests reports/ all relevant information shall be submitted to BHEL for organising approval of ultimate customer.	

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SECTION-5

CHECK LIST FOR INFORMATION TO BE FURNISHED WITH OFFER RETURN THIS CHECKLIST AS PART OF THE OFFER DULY SIGNED

The offer may not be considered if the following information and this Checklist are not enclosed with the Offer.

BHEL ENQUIRY NO:

BIDDER OFFER REFERENCE:

TECHNICAL REQUIREMENT

Sl. No.	Cl. No. 1.6.1 of Section-1 of TS (Applicable for PVC Cable)	ITEMS SUPPLIED TO	ORDER REFERENCE No. & DATE	ITEMS	QUANTITY	ORDER FULLY EXECUTED YES/NO	STATUS, IF ORDER UNDER EXECUTION	Dispatch Instructions/ Material Receipt at site certificate/ Lorry Receipt details
1	The bidder should have manufactured and supplied prior to date of techno-commercial bid opening At least 300 km of PVC insulated, PVC sheathed stranded copper conductor 1kV grade control cables in one single contract.							
2	The bidder should have manufactured and supplied prior to date of techno-commercial bid opening At least 10 km of Flame Retardant Low Smoke Control Cable							

Project: 400/230kV Switchyard at 2X660 MW

Maitree STPP, Bangladesh

Consultant: FICHTNER

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Cl. No. 1.6.2 of Section-1 of TS (Applicable for XLPE Cable)	ITEMS SUPPLIED TO	ORDER REFERENCE No. & DATE	ITEMS	QUANTITY	ORDER FULLY EXECUTED YES/NO	STATUS, IF ORDER UNDER EXECUTION	Dispatch Instructions/ Material Receipt at site certificate/ Lorry Receipt details
The bidder should have manufactured and supplied prior to date of techno-commercial bid opening At least 100 km of XLPE insulated, PVC sheathed power cables of 1kV or higher grade in one single contract							
The bidder should have manufactured and supplied prior to date of techno-commercial bid opening At least 10 km of Flame Retardant Low Smoke Aux Power Cable.							
The bidder should have manufactured and supplied prior to date of techno-commercial bid opening At least 10 km of 1kV or higher grade power cable of minimum 630 sq mm conductor size.							

Date:

Signature of the authorized representative of Bidder

Company Seal