BIFPCL- MAITREE 2X660 MW
FLUE GAS DESULFURIZATION SYSTEM

TECHNICAL SPECIFICATION

FOR

RUBBER LINING FOR TANKS

CUSTOMER : **BIFPCL Bangladesh**

BIFPCL:MAI: RUBBER LINING TANKS:016: REV 00

Prepared	Checked	Approved
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R00 dated 22-02-19		

CONTENTS

1.0 PROJECT INFORMATION:

a.	Owner	BIFPCL (BANGLADESH-INDIA FRIENDSHIP POWER COMPANY (PVT.) LIMITED), Bangladesh
b.	Buyer	BHEL, Ranipet
c.	Process/Application	Flue Gas Desulphurization

A) SITE CONDITIONS

1.	**Ambient Temperature and Relative Humidity**		
a.	**Average Site Condition ASC**		
	Ambient Temperature	:	27.3 deg C
	Ambient Humidity	:	87%
	Ambient Pressure	:	1007.6 mbar
b.	**Summer Site condition SSC**		
	Ambient Temperature	:	36.9 deg C
	Ambient Humidity	:	60%
	Ambient Pressure	:	1007.9 mbar
c.	**Winter Site condition WSC**		
	Ambient Temperature	:	12.2 deg C
	Ambient Humidity	:	100 %
	Ambient Pressure	:	1017.2 mbar
d.	**Reference Site condition RSC**		
	Ambient Temperature	:	31 deg C
	Ambient Humidity	:	88%

	Ambient Pressure	:	1007 mbar
2.	**Design ambient conditions for Equipments**		
a.	Maximum Design temperature (outdoor)	:	45 deg C
b.	Maximum daily average ambient shade temperature	:	38 deg C
c.	Maximum monthly average temperature (in the shade)	:	34.6 deg C
d.	Maximum annual average temperature (in the shade)	:	27.3 deg C
e.	Maximum design temperature of the electrical equipment installed indoors in air conditioned rooms	:	40 deg C
f.	Maximum design temperature of the electrical equipment installed indoors in non-air conditioned rooms	:	45 deg C
g.	Minimum design temperature	:	0 deg C
3.	**Plant Elevation**	:	+5.0 m above sea level
4.	**Wind Load**	:	As per Bangladesh National Building code-2012, Part-6, Chapter 2.4
a.	Basic Wind speed, three-second gust at 10m above ground in exposure C, having a return period of 50 years	:	73 m/s, Exposure category-"C"
5.	**Seismic Load**	:	Seismic Zone 1 as determined by Bangladesh National Building code (BNBC-2012)

Note:

1) Equipment and Material must be suitable for the range of ambient site conditions. In particular the saline atmosphere has to be considered.

B) PROJECT LOCATION AND APPROACH

a.	State/Division	**Khulna**
b.	District	Bagerhat district
c.	Place	Moithara Village, Rampal Upazila
d.	Location	Latitude- 22 deg 37' 0" to 22 deg 34' 30"N Longitude- 89 deg 32'0"E to 89 deg 34'5"E

Technical Specification for Rubber Lining for Absorber

A) APPROACH TO SITE:

The nearest town Khulna is at a distance of 23 km from project site. The site is connected by road from Mangla- Khulna Highway. Nearest Domestic airport is Jessor, Bangladesh at a distance of about 107 KM and international airport is Dhaka at a distance of 263 KM, Bangladesh. The Bidder shall acquaint himself by a visit to the site, if felt necessary, with the conditions prevailing at site before submission of the bid. The information given above is for general guidance and shall not be contractually binding on the Owner. Bidders shall obtain clarifications/ information, if any, before submitting their offers, regarding scope of work, facilities available at sites, etc. No additional claim shall be entertained by BHEL in future, on account of non-acquaintance of above. All relevant site data/ information as may be necessary shall have to be obtained/ collected by the Bidder.

2.0 INTENT OF SPECIFICATION

1 This Specification and the attached Data sheets defines the minimum requirements of Rubber Lining for Absorber and internals for use in the process of Flue Gas Desulphurization (FGD)

2 The Gypsum Slurry will be sprayed in the absorber. The dimensions, thickness of rubber lining etc., for the absorber is furnished in Table-1 and Table-2.

3 This specification covers the general design, selection of rubber materials, construction features, manufacture, shop inspection, testing at manufacturer's works (As per latest applicable statutes, regulation and safety codes in the locality where the lining are to be carried out) and delivery at site, surface preparation of lining surfaces, lining the surfaces to the satisfaction of the customer.

4 The rubber lining shall conform to the latest applicable International/American/Japanese Standards. Indian & GB standards are not acceptable. Nothing in this specification shall construed to relieve the contractor of the required statutory responsibility. Vendor shall offer only proven material meeting the Qualifying requirements.

5 Compliance to this specification shall not relieve the vendor of the responsibility of furnishing Rubber lining materials of proper design, materials and workmanship to meet the specified requirements.

6 In case of deviation, it shall be listed in the vendor's proposal under separate section titled as "list of deviations/exceptions to the enquiry documents.

3.0 QUALIFYING REQUIREMENTS

Lining material selected should have been used in Wet Limestone based FGD absorbers for minimum two(2) separate coal fired power plants of 250 MW or higher capacity for minimum 25000 hrs operation and should be installed at site under the complete supervision of the rubber lining manufacturer. The site supervisor should have previous experience of installing similar lining in minimum two (02) Wet Limestone based FGD absorbers in at least two (02) separate coal fired power plants for minimum 25000 hrs operation. Proof of such experience shall be provided by the bidder.

Any relining or patch work experience will not be considered as qualifying requirement.

4.0 SCOPE OF SUPPLY

1 Design, manufacture, testing and supply of rubber lining material for the duty condition as specified in Table -2,3,4.

2 Delivery of material at site, scaffolding material supply and erection inside the tank ,surface preparation for lining surfaces ,deputing of personnel to site for lining the surface to the satisfaction of the end customer boarding and lodging, travel arrangement to and fro from site shall be under bidder's scope, cost for Erection and Commission shall be included in the offer.

3 Ten (10) hard copies and five (05) sets of electronic copies of all documents are to be submitted in the English language. In addition, One (1) copy of operation and maintenance manuals shall be translated into "Bangla" and provided as paper copies and in electronic format.

5.0 SURFACE PREPARATION

1. The Absorber tank & wall surface to be lined shall be blasted to a bright grey metal finish (Sa 2½ requirement), free from rust, weld marks, oil and any other foreign matter. The blasting is carried out with the help of dry grit (copper sludge)/Sand under dry air pressure of 7 kg/cm2 by Compressor. Surface roughness shall be 50-60 Microns.

2. After blast cleaning, blasted surface will be applied by surface protecting primer to prevent the corrosion. After 100% blasting is completed, the surface is cleaned by appropriate solvent, so as to see that all the small dust particles are removed. Sharp corner will be suitably rounded off. Surface should not have any sharp notch.

3. After this procedure suitable bonding agent and 3 to 4 coating of the specially formulated rubber adhesive should be applied for proper bonding of the Rubber Sheets to be lined.

4. Compressor and any other facilities required for grit \shot blasting will be arranged by rubber lining vendor. Any hoses provided in the compressed air line will be tested with air before commencement of grit blasting job.

5. The grit\shot blasting machine will be provided with safety valve (safe trip) as a protection against over pressure.

6. All scaffolding will be of steel and will be arranged by rubber lining vendor.(customer wants scaffolding metal also.)

7. Applicable Standard: BS6374 Part V or any equivalent International Standard.

6.0 RUBBER LINING

1. The lining shall completely cover the base, sides and internals of Absorber, baffle plates, supports, Man Hole / Inspection / Flange openings etc. Rubber Lining shall be applied by vendor at site.

2. The rubber used for the lining shall be of high grade **Bromine Butyl Rubber**.

3. After Rubber sheet applied on the surface, rubber sheets should be systematically pressed to the metal surface by the help of mechanical tools like Rubber Rollers and metal thin rollers to remove the air between metal and rubber sheet. All rubber joints are properly overlapped by 25 to 35 mm wide tapered cut rubber sheet. All the joints will be covered by 75 mm X 1.5 - 1.7 mm thick rubber strip.

4. Maximum Service temperature of Rubber –100 Deg C (Continuous) including Adhesives & Primer.

5. Vendor shall specify the shelf life of the rubber material being supplied and shall furnish the storage methods to be followed at site to ensure that the rubber material shall not be spoilt during storage.

6. Vendor shall submit the surface preparation and lining procedure to the purchaser for approval. The lining work shall start only after obtaining approval from Purchaser.

7. Applicable Standard: BS6374 Part V or any equivalent International Standard.

6.1 INSPECTION AND TESTING OF RUBBER LINING

The rubber sheet specified shall meet the following specifications. After the completion of lining, tests shall be conducted by the vendor to assess the quality of rubber lined surfaces.

1	Ageing Test	:	70°C for 24 hrs. Change in Tensile Strength: ± 5% Elongation at break: ± 10%
2	Abrasion Test	:	Wt. loss – Max. 25%
3	Tensile Strength	:	≥ 2 MPa for 4 mm thk Rubber specimen. .
4	Elongation at break	:	≥ 400% minimum for 4mm thk rubber specimen
5	Peeling strength	:	≥ 3 N/mm
6	Hardness	:	55 ±5 ° Shore A
7	Spark Test	:	3-4 KV/ mm

8 Lining shall be visually inspected to ensure free from poorly weed out fibers, entrapped air and exposed fires. Defects are to be repaired by slandering a generous area around the defected portion and applying a layer of rubber material.

9 Spark test shall be carried out at appropriate areas in the presence of Purchaser. Vendor should conduct test as per relevant standards.

10 After installation, the Rubber lining shall be subjected to testing at site as per relevant standards. If the performance is found not to meet the requirements as specified, the Rubber lining shall be rectified or replaced by the Vendor without any extra cost to the Purchaser.
Inspection and testing will be as per the Quality plan approved by BHEL /BIFPCL.

6.2 FINISHING & INTERNAL TESTING

1 Rubber surface of all flanges, supports, baffle plates and manhole of Equipment will be finished by the mechanical tools to get leakage free surface during commissioning.

2 After above finishing, 100% testing will be carried out for continuity by high frequency high voltage spark tester. If there is any puncture, they are checked and rectified as per the standard procedure of repair (Clause 6.1) as mentioned in procedure.

6.3 REPAIRING PROCEDURE

1 Faulty spots on the rubber lining are cut off down to be substrate and the seams of the remaining rubber are beveled.
2 Rubber sheet with a broad bevel cut is glued on the substrate laid bare.
3 On spots to be repaired of a diameter < 300 mm a second layer of Rubber sheet is glued covering the seams of the first layer.
4 Several spots to be repaired in a small area are jointly covered with a second layer of Rubber sheet.
5 Any chemicals required for repairing is in vendor scope only.

7.0 PERFORMANCE GUARANTEE

1 **The lining shall be guaranteed for uninterrupted minimum life of 25,000 hrs**. Performance parameters to be guaranteed by the vendor and tolerances permitted shall be as indicated in the data sheet. Rubber lining or any portion thereof is liable for rejection, if it fails to give any of the guaranteed performance parameters. The lining should be guaranteed for faultless material and workmanship and also for a period as mentioned above from the date of handing over. During Guarantee period any defects noticed due to faulty material and workmanship, shall be rectified by vendor free of cost.

8.0 PACKING

1. The part items of the Rubber lining should be identified by Tag numbers and should be packed as to minimize the possibility of damage during storage or transit. The packing should be suitable for tropical conditions. Vendor should specify the storage requirements for the Rubber lining materials.
2. The list of items identified as dispatch able units shall be furnished along with unit weight and the quantity for preparation of packing slip at BHEL end for dispatch to site and for easy identification, storage and erection at site. Sea worthy packing has to be done before dispatch. Packing has to be done separately for each absorber unit.

9.0 DOCUMENTATION

9.1 DOCUMENTS TO BE ENCLOSED ALONG WITH THE OFFER

1 Confirmation to this technical specification and filled annexure – I, II,III
2 Write-up on technical features of rubber lining offered along with Catalogues, Resin composition, drawings etc.
3 Data sheets for the Rubber lining material.
4 The erection sequence/Procedure of the Rubber lining. Detailed flow chart from start to finish of the lining to be furnished. Application procedure.
5 Man days required to complete the Rubber lining for each area is to be spelt from start to finish.
6 Vendor should clearly indicate the following:
- Utility/Utilities from customer/purchaser required for Rubber lining at site.
- Storage Instructions/ facility requirement for Rubber lining materials

7 Vendor should clearly indicate the price for Rubber lining of carbon steel construction per Square meters to enable to meet any additional lining areas.

9.2 DATA TO BE FURNISHED BY THE VENDOR AFTER RECEIPT OF PURCHASE ORDER

1 List of Drawing and documents to be submitted for review, approval and information with submission dates

2 Quality Assurance Plan to be submitted for approval.

3 Detailed dimensional General Arrangement drawing of the lining surfaces.

4 This drawing shall indicate all the design data and information about the material, scope of work and weight of the material supply, Packing procedure etc.

5 Installation, operation and maintenance manual.

6 Surface preparation and Lining procedures.

7 Catalogues, data sheets and drawings for Rubber lining.

Note:

The lining area indicated in Table 1 is only approximate. This area includes wall area and area of supports. During actual lining work at site, the area may be varying from the indicated area. In such case, BHEL clarifies that payment shall be made for lining work of the actual area based on justification and proof given by the vendor.

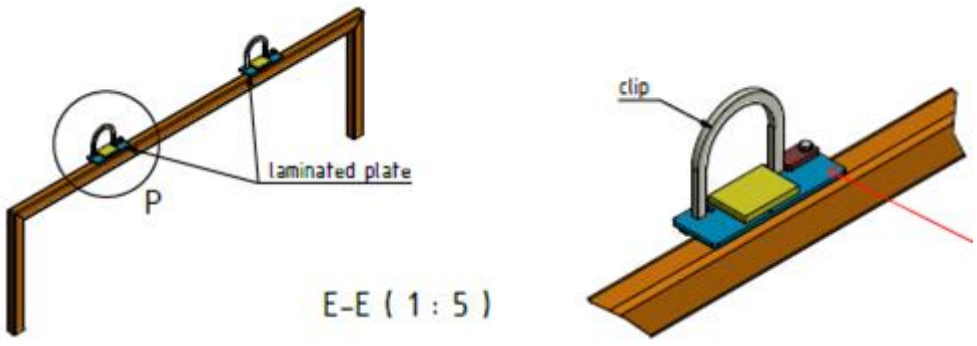
Table -1 Dimension of Absorber

S. No.	Description	Best quality Bromine Butyl Rubber lining of thickness (mm)	Tank Dimensions (m)	Surface area of different sections (m2)	Number of Absorbers	Total area (m2) with tolerance
1	Absorber top section	8	**Width: 9.9** **Length: 21.1** **Height:9.28**	575.36	Two(2)	1150
2	Clean gas and mist zone	8	**Width: 9.9** **Length: 21.1** **Height:**7.02	435.24	Two(2)	870
3	Gas and Liquid mixing zone	8	**Width: 9.9** **Length: 21.1** **Height:**17.2	1066.4	Two(2)	2132
4	Liquid tank zone and absorber bottom	8	**Width: 9.9** **Length: 21.1** **Height:**4.5	487.89	Two(2)	976
Total area for two absorbers(with 8 mm lining)						5128
Total area for one absorber (with 8 mm lining)						2564

b) Mist Eliminator Wash Pipe Supports					
S.No	Description	Best Quality Bromine Butyl Rubber lining of thickness (mm)	Dimensions	Quantity for both the absorbers	Surface area (m2)
1	Support (name:TSBD 1.1)	4	Box 40 x 60 x 3 (mm) (As per Dwg)	196 Sets	150
2	Support (TSBD 1.1S)	4		56 Sets	40
3	Support (TSAC 1.1)	4		56 Sets	30
4	Support (TSAC 1.1S)	4		196 Sets	110
5	Gluing of Laminated Plates on rubber surface	-	Laminated plates 80 mm x 216 mm (BY BHEL)	1008 Sets	--
c) Absorber Internals					
S.No	Description	Best Quality Bromine Butyl Rubber lining of thickness (mm)	Dimensions	Quantity for both the absorbers	Surface area (m2)
1	Nozzles, Flanges, any beams & supports inside absorber	4	Will be given during contract stage	During contract stage	1026

Wash pipe supports, absorber internals area which has to be rubber lined = 678 sq.m (per absorber)
Wash pipe supports, absorber internals area which has to be rubber lined = 1356 sq.m (for both the absorbers)

Gluing of Laminated plates on Rubber surface (typical Mist Eliminator wash pipe support):



The blue plate is made of Polypropylene. Blue plate, yellow plate and clip are in BHEL scope of supply. The yellow plate needs to be welded on the blue plate which is BHEL scope of work. And those plates are need to be glued on the rubber lined pipe supports. This is included in the scope of rubber lining supplier.

Note: Bidder should clearly indicate the price for Rubber lining of carbon steel construction per Square meters to enable to meet any additional lining areas. Payment will be as per the actual area for which rubber lining is carried out.

Table -2 Process Parameters

Sl. No.	Parameter	Slurry
1	Slurry to be handled	Gypsum Slurry
2	Maximum solid particle size	150 mesh (140 micron)
3	Normal solid particle size,d50	325 mesh
		(43 micron)
6	Chloride concentration	27,000 ppm (max)
7	Hardness of particle	5-7 (Mho scale)
8	Slurry concentration	30 wt%
10	Sp. Gravity of Slurry	1.22
11	Viscosity	0.03 Pa.S
12	Slurry temperature	70 deg C

Table 3 General technical specification of Bromine Butyl Rubber:

Bromine Butyl Rubber is a brominated isobutylene isoprene based rubber. It is a pre-vulcanized rubber employed as a cold bond lining system having chemical resistance for acids and alkalis like phosphoric acid, hydrochloric acid, sulfuric acid, etc. It is suitable for lining static storage tanks with mild agitation, vessels, SO_2 absorbers etc.

Material	Bromine Butyl Rubber
1) Physical Properties	
Hardness	55± 5(Shore A Hardness)
Tensile Strength	≥ 70 kg/cm^2
Elongation at break	400% (Min)
Specific Gravity	1.12±0.03 g/cc
Adhesion to metal	≥3 N/mm
Available Gauges	2mm – 6mm
Service temperature	100°C (Continuous) 120 Deg C for 5 minutes. (Short term temperature).
Available form	Pre-vulcanized sheets for site lining
2) Brief formulation info:	
Rubber content	~60%
Filler content	~35%
3) Cure methods and time	
Atmospheric	<72 Hours
4) Ideal Storage Life	
Pre-Vulcanized rubber sheet @ 30°C to 40°C	1 year
Adhesive @ 30°C to 40°C	1 year

The above parameters may vary as per the recommendations given by vendor for a proven material.

Table: 4 Flue Gas Parameters at inlet and outlet

a) Normal Operation:

DESCRIPTION / LOAD	Unit	FGD Design Point-FGD Inlet	FGD Design Point-FGD Outlet
FGD Outlet Flue Gas Flow	t/h	2780	3085.69
FGD Outlet Flue Gas Volume	m^3/s	910.3	824.17
Flue Gas Temperature	°C	150	60
Flue Gas Density	kg/m^3	1.04	1.04
Humidity	(H_2O/Dry)	0.058	0.13
H_2O	Wt% (Wet)	9.00	11.30
SO_2	Wt% (Wet)	0.014	0.014
SO_3 (Gas)	ppm(Dry) @ actual O_2	<1	<1

H_2SO_4 mist	mg/Nm^3(Dry)	-	73
CO_2	Wt% (Wet)	19.72	16.98
O_2	Wt% (Wet)	5.19	5.03
N_2	Wt% (Wet)	69.4	66.7
HCl	ppm (Dry)	72	7.2
HF	ppm (Dry)	13	1.3
Dust	mg/Nm^3(Dry)	<50	<50

b) Emergency Condition: Since Maitree FGD is without bypass system, rubber lining shall be designed to the severe service conditions. Emergency quench system is provided to quench the flue gas before it enters the absorber. Maximum temperature shall be 100 Deg C (Continuous). Heat resistant time of rubber lining shall be 120 Deg C for 5 minutes. (Short term temperature).

c) Absorber base, bottom tank, spray area, agitator installed areas, and Oxidation Zone are subject to abrasion. Rubber lining inside absorber shall be selected considering anti-abrasion also.

ANNEXURE – I- LIST OF DEVIATIONS/EXCEPTIONS TO THE ENQUIRY DOCUMENT

S.no	Clause	Page	Description of Deviation

Note: Enlarge the table to incorporate items

SIGNATURE OF BIDDER ----------

NAME ----------

DESIGNATION ----------

Technical Specification for Rubber Lining for Absorber

ANNEXURE – II- SCHEDULE OF GUARANTEES

S.no	Description	Bidder to confirm
1	Lining material shall be guaranteed for a uninterrupted minimum life of 25000 hrs	

SIGNATURE OF BIDDER ----------

NAME ----------

DESIGNATION ----------

ANNEXURE – III

a) REFERENCE LIST as per format shown below. (at least One (1) reference plant details)

S. No.	Project Name , Customer & Plant capacity	Coal fired Yes/No	Wet Limestone Based FGD Absorber (Yes/No)	Year of Commg	Rubber Lining Area

NOTE: Performance certificate (End user feedback) or for 2 No Reference plant.

SIGNATURE OF BIDDER ----------

NAME ----------

DESIGNATION ----------

ANNEXURE – IV

Sea Worthy packing as per specification REF : PE-TS-888-100-A001

SIGNATURE OF BIDDER ----------

NAME ----------

DESIGNATION ----------

ANNEXURE – V

Refer to Health & Safety Management Manual.

SIGNATURE OF BIDDER ----------

NAME ----------

DESIGNATION ----------