

	BHARAT HEAVY ELECTRICALS LIMITED (A GOVT OF INDIA UNDERTAKING)	Flue Gas Desulphurization Group-FGD, Boiler Auxiliary Plant (BAP), Ranipet
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TECHNICAL SPECIFICATION FOR RUBBER LINING OF SLURRY TANKS

SPECIFICATION NO : FGD:RL-TNKS
BUYER (EPC) : BHEL, BAP Ranipet
APPLICATION : WET LIMESTONE FGD

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REV	Date	Description	Prepared	Checked	Approved

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A) DOCUMENTS TO BE SUBMITTED ALONG WITH OFFER

Sl. No.	Description	Purpose
1	Performance certificate from end user for meeting the qualification requirement	Qualification requirement for considering the offer
2	Reference list / experience list as per Annexure-III	Qualification requirement for considering the offer
3	All pages of specification and all filled annexures duly signed & sealed	Technical evaluation
4	Write-up on technical features of rubber lining offered along with Catalogues, adhesive composition, drawings etc.	Technical evaluation
5	Data sheets of the Rubber lining material	Technical evaluation
6	Surface preparation & sequence of rubber lining Procedure zone wise. Detailed flow chart from start to finish of the lining to be furnished.	Technical evaluation
7	Vendor should clearly indicate the price (for both material and application) of Rubber lining per square meter	Commercial evaluation
8	Priced offer	Commercial evaluation

B) DOCUMENTS TO BE SUBMITTED AFTER AWARD OF CONTRACT

Sl. No.	Description	Purpose	Delivery Time
1	List of datasheets/documents to be submitted for review, approval and information with submission dates	CUSTOMER/BHEL approval to start manufacturing	1 week
2	Catalogue/Datasheets for the Rubber, Primer, Adhesive and any other chemical used for Rubber Lining.	CUSTOMER/BHEL approval to start manufacturing	2 week
3	Manufacturing Quality Assurance Plan for rubber sheet and adhesive to be submitted for approval.	CUSTOMER/BHEL approval to start manufacturing	2 week
4	Field quality plan for surface preparation and lining application procedure along with testing	CUSTOMER/BHEL approval to start manufacturing	2 week
5	Repair and rectification procedure for rubber lining	CUSTOMER/BHEL approval to start manufacturing	2 week

1.0 INTENT OF SPECIFICATION

- 1 This Specification and the attached Data sheets (table 3) defines the minimum requirements of Rubber Lining for Slurry Tanks to be used in the process of Flue Gas Desulphurization (FGD) .
- 2 Rubber lining area of Slurry Tanks, thickness of rubber lining required in various sections are Annexure- Tank Details for the Project as per the Enquiry/PO .
- 3 This specification covers the general design, selection of rubber materials, construction features, manufacture, shop inspection, testing at manufacturer's works and delivery at the destination as per purchase order, surface preparation, lining, inspection & testing of the lined surface at Project site.
- 4 It is the responsibility of the bidder to comply to the latest applicable statutes, regulation and safety codes in the locality where the lining are to be carried out.
- 5 The rubber lining shall conform to the latest applicable British/American/International Standards only.
- 6 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.
- 7 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 (Annexure-I) ". Deviations, not mentioned in the deviation list, but mentioned elsewhere in the offer will not be considered.

2.0 QUALIFYING REQUIREMENTS(QR)

- (1) Lining material selected should have been used in Wet Limestone based FGD application for *coal fired power plants* or similar corrosive environment for minimum 2500 sq.m for atleast one(1) project.
- (2) The lining material should have completed minimum **2 years of operation** reckoned as on/before the date of techno-commercial bid opening of the tender/enquiry.
- (3) The manufacturer should have designed, manufactured, supplied and supervised the installation of rubber lining of the referred plants.
- (4) Any Patch work/repair work will not be considered as experience/qualifying requirement unless it is done for the entire area.
- (5) Performance certificate from end user for meeting the above qualifying requirements altogether shall be provided by the bidder.

Lining material shall be supplied from such manufacturer who has got the proven material and meets the above Qualification requirements.

NOTE: Performance certificate from end user in their (end user's) letter pad, in their own country official language and a translated English copy by authorized English translator shall be submitted as mentioned. Performance certificate shall clearly state the name of the manufacturer who supplied material for the Project, material specification and the area of lining carried out.

3.0 SCOPE OF SUPPLY

- 1 Design, manufacture, testing, supply of rubber lining material, delivery to site, surface preparation, application of rubber lining, inspection, testing & handing over of the slurry tanks as per BHEL Purchase Order for the duty condition as specified in Table-2,3.
- 2 Surface preparation for lining surfaces, lining the surface to the satisfaction of the customer shall be under bidder's scope. Cost for Erection and Commission (i.e. Lining application) shall be included in the offer.
- 3 Any Tools required for blasting (air hose, copper slag hose conduit and blasting gun) & rubber lining are vendor's scope.
- 4 Sufficient number of human safety devices required while working inside the Slurry Tank, during blasting & rubber lining are vendor's scope.
- 5 Scaffolding inside the Slurry Tank for rubber lining from top of the Slurry Tank to bottom shall be vendor's scope till completion of rubber lining process.
- 6 Rubber sheets, adhesives, solvents, primer and all other rubber lining material are to be brought by vendor from qualified source as per specification.
- 7 Tentative date of readiness of site will be informed by M/s BHEL based on the project progress.
- 8 Vendor has to make arrangements for delivery upto site including transportation & storage in AC /non-AC container depending on the vendor's product storage requirement to ensure shelf life of rubber products to the required temperature till the completion of rubber lining on the slurry tank surfaces at site. Vendors to quote on square meter basis, all-inclusive as above.
- 9 Delivery and Storage of material at Project site office is vendor's responsibility. Also, vendor is responsible for arranging suitable containers at site for storing the Rubber/Adhesive/Primer material. BHEL responsibility at Project site are unloading the container from the vehicle at site, providing space for the container and identifying the power supply location.
- 10 Any covering required during rubber lining shall be arranged by the vendor on their own.
- 11 Vendor has to arrange cables from the identified power source location to container location for air conditioning. (around 50 meters)
- 12 Vendor has to arrange cables from the identified power source location to Slurry Tank location for running the compressor. In case of electric driven compressor, BHEL will provide power

supply free of cost. In case of diesel compressor, the vendor at their cost shall arrange diesel. Reimbursement for diesel cost shall not be entertained by BHEL.

- 13 Lighting arrangements required inside the Slurry Tank and relevant wiring are in vendor's scope.
- 14 Exhaust and Man cooler fan required inside the Slurry Tank and relevant wiring are in vendor's scope.
- 15 Material shifting from container to lining location or vice-versa on day-to-day basis shall be vendor's scope.
- 16 Disposal of used copper slag and any other scrap to the identified location shall be in vendor's scope.
- 17 Boarding & lodging for vendor's crew including supervisor shall be bidder's scope.
- 18 Daily conveyance from lodging to work spot or vice-versa for vendor's crew including supervisor shall be bidder's scope.
- 19 Ten (10) hard copies and five (05) sets of electronic copies of all documents are to be submitted in the English language as paper copies and in electronic format by the vendor.

4.0 SURFACE PREPARATION

- 1 The Slurry Tank and internals to be lined are made of Carbon Steel HR plate IS2062 E250 A/BR,
- 2 The walls are painted with minimum 60μ DFT of Red oxide phosphate (rust proof primer), which is to be removed by vendor during blasting.
- 3 Bidder is requested to go through all sections of the Typical GA drawing of various slurry Tanks. Vendor may raise their observations in the **pre-bid query**. Any other new requirements brought forward during technical evaluation stage shall not be considered by BHEL.
- 4 External sharp corners shall be rounded off into convex to radius R3. All fillet welds have to be converted into concave with radius R7min (BHEL's scope).
- 5 Before handing over of tanks to the vendor, BHEL and vendor have to jointly inspect the surface to be lined. Any sharp corners, weld spatters, crack, surface slag inclusions, blister, undercuts noticed during inspection shall be rectified by BHEL. In this regard, vendor may require to visit Project site 2-3 times, TA/DA has to be considered suitably in the offer.
- 6 The Slurry Tank surface to be lined should be blasted by vendor 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 slag) under dry air pressure of 7 Kg/cm² by Compressor.
- 7 After blasting, blasted surface shall be jointly inspected by vendor & BHEL. In case any defect is observed, the same shall be rectified by grinding, welding & grinding by the BHEL and re-blasting shall be vendor's scope. The rubber manufacturer's trained supervisor (qualified as per

specification) shall visit the site along with BHEL. If any minor surface imperfection noticed, which is not possible to re-weld & ground, shall be filled with suitable rubber liquid primer by vendor (if their standard practice permits). Cost estimate in this regard shall be suitably taken care in the offer. Filler material such as resin, putties, fillers and low melting point solders and brazes shall not be used.

- 8 Primer and further rubber lining process shall be started after satisfactory concurrence from the qualified supervisor as specified in the QR.
- 9 After blasting of the Slurry Tank, the surface has to be cleaned by appropriate solvent, so as to ensure that all the small dust particles are removed. The blasted surface shall be applied with surface protecting primer to prevent the corrosion.
- 10 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.
- 11 Compressor, hose, gun and any other facilities required for grit \shot blasting shall be arranged by vendor. Any hoses provided in the compressed air line shall be tested with air before commencement of shot blasting job.
- 12 The grit\shot blasting machine should be provided with safety valve (safe trip) as a protection against over pressure.
- 13 Scaffolding shall be arranged by vendor. Any scaffolding shall be of steel only.

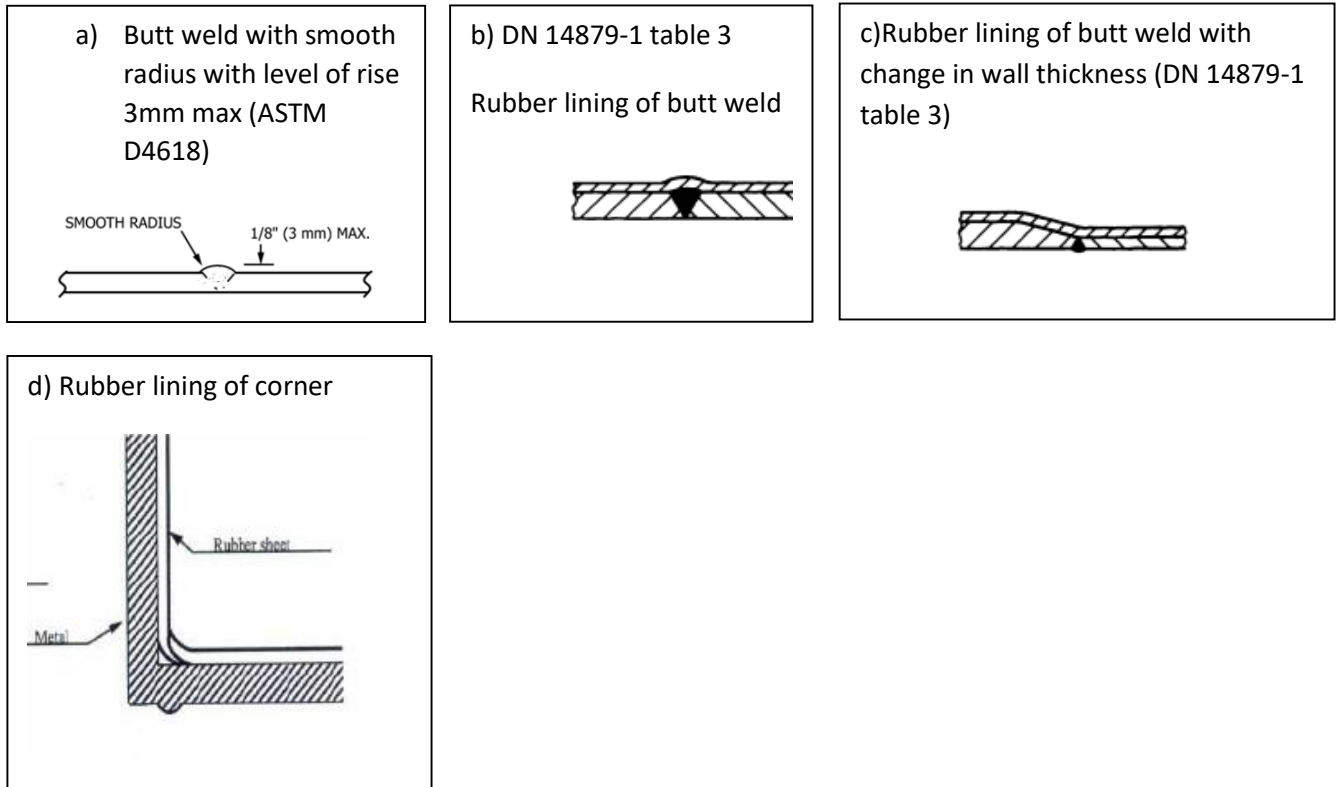
5.0 RUBBER LINING

- 1 The lining shall completely cover the roof, bottom, sides and internals of Slurry Tank, internal supports , insert plates, openings, Man Hole / Inspection / Flange & nozzle openings, baffle walls etc. as per drawing enclosed.
- 2 The rubber used for the lining shall be of high grade pre-vulcanised **Chloro or Bromo Butyl Rubber as per Enquiry/PO** and shall be proven material meeting the qualification requirements as per specification.
- 3 After Rubber sheet is 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 to be properly overlapped (vendor to specify the overlapping width). All the joints shall be covered with suitable size of rubber strip (vendor to specify the size of strip and their practice).
- 4 Vendor shall specify the shelf life of the rubber material/adhesive/primer being supplied.
- 5 Vendor shall submit the sequence of operation & time requirement for surface preparation

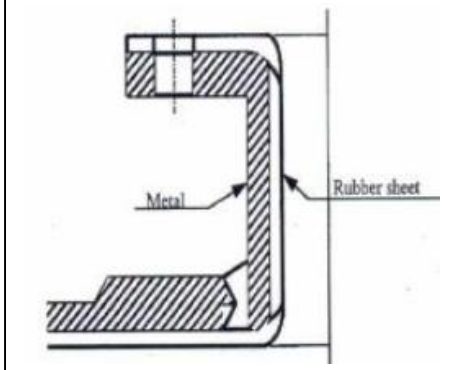
and rubber linings for top, bottom, side walls, baffle plates, nozzles , manholes , internal supports, etc.

- 6 Lining material shall be brought to site by vendor in batches as per lining schedule considering the shelf life.
- 7 Lining procedure shall be submitted for Purchaser Approval.
- 8 Vendor has to furnish curing period of rubber along with the precautions to be taken during curing.
- 9 In case of any mechanical damage of rubber lining due to BHEL's erection work/internals fixing, repair procedure shall be submitted by the vendor for review & approval and cost of re-lining shall be paid by BHEL on actual square meter basis and it should not exceed the rate per square meter as per the PO.
- 10 Rubber lining procedure for nozzle, flanges and manhole door shall be provided by the vendor.

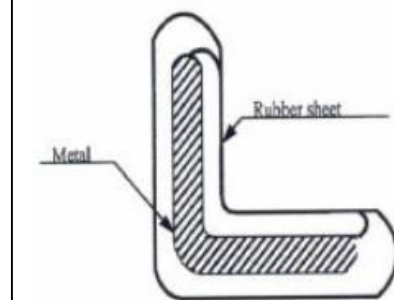
5.1 RUBBER LINING METHOD RECOMMENDED



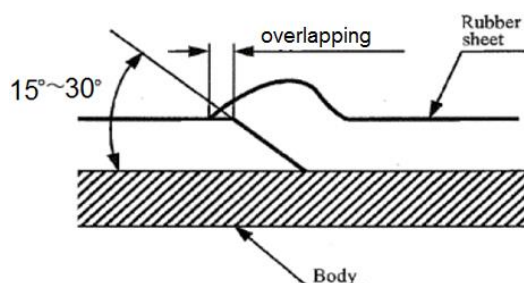
e) Rubber lining of Nozzle and Flanges



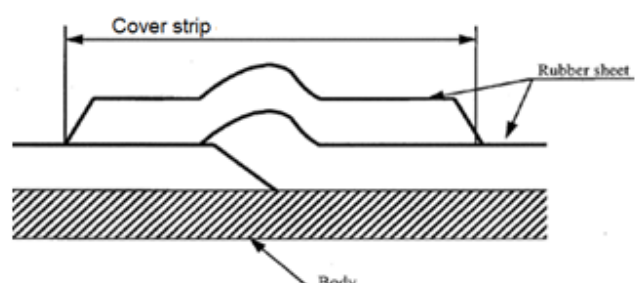
f) Rubber lining of Angles



g) Rubber lining joint with overlap (vendor to specify minimum overlap)



h) Rubber lining joint with overlap and additional cover strip (vendor to specify their practice and size)



6.0 INSPECTION AND TESTING OF RUBBER LINING

A) Stages of inspection prior to lining

1. Joint inspection by vendor and BHEL as fabricated condition (vendor to visit site along with qualified supervisor)
2. Joint inspection after blasting (by vendor along with qualified supervisor & BHEL). Reference photographs or plate shall be used to establish the level of surface cleanliness.
3. Before application, all material to be used in the lining process are visually examined and where appropriate, physically and practically tested to confirm that they are in an acceptable condition.

B) 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: $\pm 5\%$
Elongation at break : $\pm 10\%$ |
| 2 | Abrasion Test | : | Wt. loss – Max. 25%ss |
| 3 | Sound Testing for blister or less adhesion: | | Vendor to specify. |
| 4 | Tensile Strength | : | $\geq 35 \text{ kg/cm}^2$ (min) for Bromo Butyl Rubber and
$\geq 40 \text{ kg/cm}^2$ (min) for Chloro Butyl Rubber and . |

- 5 Elongation at break : $\geq 400\%$ minimum for 4mm thk rubber specimen
- 6 Peeling strength as per EN14879-4 : ≥ 3 N/mm upto service temperature 60°C
- 7 Hardness : $55 \pm 5^{\circ}$ Shore A
- 8 Spark Test : 3-4 KV/ mm (Vendor to specify voltage & sweeping speed)
- 9 Lining shall be visually inspected to ensure free from any visible imperfection, i.e., blistering inclusions, discontinuity, cracks, or mechanical damage, weed out fibers, entrapped air and exposed fires. More attention shall be paid to edges, corners, flange facings and joints. Imperfections in the lining of joints shall be suitably marked and it shall be subjected to additional testing. Defects are to be repaired by the vendor to the satisfaction of BHEL/Customer as per approved repair procedure.
- 10 Measurement of lining thickness after lining application: Vendor to specify the measurement method. Lining thickness less than 10% of the nominal thickness is not be permitted.
- 11 Final inspection and testing of the rubber lining & finishing shall be as per customer approved field quality plan.
- 12 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.
- 13 Spark test shall be carried out in the presence of customer/BHEL for continuity by high frequency high voltage spark tester. If there is any puncture, they are to be checked and rectified as per approved field quality plan.

7.0 REPAIRING PROCEDURE

Repair and rework procedure to be submitted by the vendor along with technical bid and also after ordering also. Repairing procedure submitted after ordering shall be duly endorsed and stamped by qualified manufacturer as per specification clause #3.

8.0 PERFORMANCE GUARANTEE

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. During Guarantee period any defects noticed due to faulty material and workmanship, shall be rectified by vendor free of cost.

9.0 STAGE PAYMENT

In case of Stage payment:

- (1) Before starting rubber lining, blasted surface inspection certificates issued by qualified supervisor along with BHEL/Customer shall be enclosed.
- (2) After Rubber lining application all necessary certificates for inspection and all necessary tests, conducted on the lining as per specification clause #6 witnessed by qualified supervisor & BHEL/Customer, also to be enclosed.

Note:

- 1 Lining area indicated in the enquiry/PO may vary +/-5% . Bidder should clearly indicate the price for Rubber lining per Square meters to meet any additional lining areas Payment will be as per the actual lining carried out by vendor with proper justification.**
- 2 All these tanks and sumps are fitted with an agitator. Tank base and agitator zone are subject to abrasion. Rubber lining shall be selected considering the anti-abrasion effect.**

Table -1 Process Parameters

The tanks will be handling slurry whose details are given below:

Sl. No.	Parameter	Slurry
1	Slurry to be handled	Limestone/Gypsum Slurry
2	Maximum solid particle size	From 75 micron to 7 mm
3	Normal solid particle size,d50	325 mesh (43 micron)
6	Chloride concentration	30,000 ppm (max)
7	Hardness of particle	5-7 (Mho scale)
8	Slurry concentration	30 wt%
10	Sp. Gravity of Slurry	1.22
11	Sp. Gravity of Limestone or Gypsum	2.32
12	Viscosity	3 cP to 30 cP
13	Temperature(design)	70 deg C

Note: Lining material chosen shall withstand a maximum service temperature of 85 deg C.

Table 2 : Datasheet - 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, SO₂ absorbers etc.

1) Physical Properties		
Properties	Values	Bidder to specify/confirm
Hardness	55±5 (Shore A Hardness)	
Tensile Strength	35 kg/cm ² (Min)	
Elongation at break	400% (Min)	
Specific Gravity	1.12±0.03 g/cc	
Adhesion to metal	≥3 N/mm	
Available Gauges	2mm – 6mm	
Max Service temperature	85 Deg C (Continuous)	
Available form	Pre-vulcanized sheets for site lining	
2) Brief formulation info:		
Polymer content	~60%	
Filler content	~35%	
3) Cure methods and time		
Autoclave	NA	
Internal Pressure	NA	
Atmospheric	72 Hours	
4) Ideal Storage Life		
Pre-Vulcanized rubber sheet @ < 20°C	~2 Years	
Pre-Vulcanized rubber sheet @ 20°C to 30°C	1 to 2 Years	
Pre-Vulcanized rubber sheet @ 30°C to 40°C	~1 year	
Adhesive @ 15°C to 23°C	1 year	
Self-life (no's of Month) of Rubber liner, Adhesive, primer etc with non AC container		_____ no's of Month
Self-life (no's of Month) of Rubber liner, Adhesive, primer etc with AC container		_____ no's of Month

The above data is basic data and BHEL may consider the rubber recommended by vendor based on proven supply/experience.

Chloro Butyl Rubber is a chlorinated 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, SO₂ absorbers etc.

1) Physical Properties		
Properties	Values	Bidder to specify/confirm
Hardness	55±5 (Shore A Hardness)	
Tensile Strength	40 kg/cm ² (Min)	
Elongation at break	400% (Min)	
Specific Gravity	1.21±0.03 g/cc	
Adhesion to metal	≥3 N/mm	
Available Gauges	2mm – 6mm	
Max Service temperature	85 Deg C (Continuous)	
Available form	Pre-vulcanized sheets for site lining	
2) Brief formulation info:		
Polymer content	~45%	
Filler content	~45%	
3) Cure methods and time		
Autoclave	NA	
Internal Pressure	NA	
Atmospheric	72 Hours	
4) Ideal Storage Life		
Pre-Vulcanized rubber sheet @ < 20°C	~2 Years	
Pre-Vulcanized rubber sheet @ 20°C to 30°C	1 to 2 Years	
Pre-Vulcanized rubber sheet @ 30°C to 40°C	~1 year	
Adhesive @ 15°C to 23°C	1 year	
Self-life (no's of Month) of Rubber liner, Adhesive, primer etc with non AC container		_____ no's of Month
Self-life (no's of Month) of Rubber liner, Adhesive, primer etc with AC container		_____ no's of Month

The above data is basic data and BHEL may consider the rubber recommended by vendor based on proven supply/experience.

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

Sl. No	Sec / Clause no.	Specification	Statement of deviations/ variations	Reason for deviation	Cause of withdrawal
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

Note: Enlarge the table to incorporate items

SIGNATURE OF BIDDER -----

NAME -----

DESIGNATION -----

ANNEXURE – II- SCHEDULE OF GUARANTEES

We, _____,
guarantee that the Rubber Lining proposed for this project will have an uninterrupted minimum life of **25,000 hrs.**

The lining is guaranteed for faultless material and workmanship and also for a period as mentioned above from the date of handing over. During the Guarantee period any defects noticed due to faulty material and workmanship, the same shall be rectified by us free of cost.

SIGNATURE OF BIDDER (Rubber Manufacturer) -----

NAME -----

DESIGNATION -----

ANNEXURE – III

REFERENCE LIST as per format shown below.

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

SIGNATURE OF BIDDER -----

NAME -----

DESIGNATION -----