



Bharat Heavy Electricals Limited
Piping Centre, Chennai

Spec No: PC:TSP:3LPE:PATRATU

Rev No: 00

**TECHNICAL SPECIFICATION FOR
3 LAYER POLYETHYLENE COATING (3LPE)
FOR PATRATU 3X800 MW**



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1.00.00	SPECIFICATION FOR 3 LAYER POLYETHYLENE COATING																		
1.01.00	GENERAL																		
	This specification covers the minimum requirements for application of external anti-corrosion coating of pipes by using 3-layer side extruded polyethylene coating conforming to DIN-30670, 1991, 'Polyethylene Coating for Steel Pipes' and the requirements of this specification.																		
1.02.00	MATERIALS																		
1.02.01	The three-layer coating system shall comprise of a powder epoxy primer, polymeric adhesive and a polyethylene top coat. Coating materials shall be suitable for the service conditions and the pipe sizes involved. The coating materials i.e. epoxy powder, adhesive and polyethylene compound shall have proven compatibility. The coating system and materials shall be pre-qualified and approved by BHEL and NTPC in accordance with provisions of Clause 1.03.02 of this specification. Vendor shall obtain prior approval from BHEL and NTPC for the coating system and coating materials.																		
1.02.02	LIST OF ACCEPTABLE COMBINATIONS OF COATING MATERIALS The following combinations of coating materials are considered acceptable. In the event of award of contract, Vendor shall furnish the combination(s) proposed and re-confirmation of compatibility & properties of the proposed combination(s) from the raw materials manufacturers & system properties. <table><tr><th>Epoxy Powder (manufacturer)</th><th>Adhesive (manufacturer)</th><th>PE compound (manufacturer)</th></tr><tr><td>CORRO-COAT EP-F 2001 (JOTUN)</td><td>FUSBOND 158D (DUPONT)</td><td>SCLAIR 35 BP HDPE (NOVACOR)</td></tr><tr><td>PE 50-8190/8191 (BASF) OR CORRO-COAT EP-F 2001 (JOTUN)</td><td>LUCALEN G3510H (BASF)</td><td>LUPOLEN 3652 D SW 00413 (BASF)</td></tr><tr><td>PW 50-6109 (BASF) OR CORRO-COAT EP-F 2001 (JOTUN) OR SCOTCHKOTE 226N (3M)</td><td>ME 0420 (BOREALIS)</td><td>HE 3450 (BOREALIS)</td></tr><tr><td>CORRO-COAT EP-F 2001 (JOTUN)</td><td>LE - 149V (S K CORPORATION)</td><td>ET 509 B (S K CORPORATION)</td></tr><tr><td>SCOTCHKOTE 226N (3M)</td><td>ME 0420 (BOREALIS)</td><td>PB 48A004 (GAIL)</td></tr></table> The combination of coating material indicated above is indicative only. Vendor can offer other proven combinations of coating material also. In any case the final combination shall be subjected to BHEL and NTPC's approval.	Epoxy Powder (manufacturer)	Adhesive (manufacturer)	PE compound (manufacturer)	CORRO-COAT EP-F 2001 (JOTUN)	FUSBOND 158D (DUPONT)	SCLAIR 35 BP HDPE (NOVACOR)	PE 50-8190/8191 (BASF) OR CORRO-COAT EP-F 2001 (JOTUN)	LUCALEN G3510H (BASF)	LUPOLEN 3652 D SW 00413 (BASF)	PW 50-6109 (BASF) OR CORRO-COAT EP-F 2001 (JOTUN) OR SCOTCHKOTE 226N (3M)	ME 0420 (BOREALIS)	HE 3450 (BOREALIS)	CORRO-COAT EP-F 2001 (JOTUN)	LE - 149V (S K CORPORATION)	ET 509 B (S K CORPORATION)	SCOTCHKOTE 226N (3M)	ME 0420 (BOREALIS)	PB 48A004 (GAIL)
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1.02.03	All materials to be used shall be supplied in sealed, damage free containers and shall be suitably marked with the following minimum information: a) Name of the Manufacturer b) Type of Material c) Batch Number d) Place and Date of Manufacture e) Shelf Life/Expiry Date (if applicable) f) Quantity All materials noted to be without above identification shall be deemed suspect and shall be rejected by BHEL and NTPC. Such materials shall not be used for coating and shall be removed from plant site and replaced by Vendor at his expense.																
1.02.04	All coating materials shall be properly stored in accordance with the Manufacturer's recommendation at all times, to prevent damage and deterioration in quality prior to use.																
1.03.00	FUNCTIONAL REQUIREMENTS AND PROPERTIES OF COATING																
1.03.01	The coating shall be able to withstand a maximum in service operating temperature of (+)65°C and shall conform to 'S' type of coating as per DIN 30670. In addition, in open storage the coating must be able to withstand a temperature of at least (+)80°C, without impairing its serviceability and properties specified.																
1.03.02	The top coat polyethylene used shall be a black readymade compound, fully stabilized against influence of ultraviolet radiation (i.e. sunlight), oxygen in air and heat (due to environment temperature as specified above). No appreciable changes shall occur during exposure to such environments up to at least a period of 6000 hours. The Vendor shall submit certificate from Manufacturer in this regard.																
1.03.03	PROPERTIES																
1.03.03.01	<u>Properties of Epoxy Powder and Adhesive</u> Vendor shall choose such a brand of epoxy powder and adhesive that will achieve the functional requirements and properties of coating system as specified in Annexure 1. Epoxy powder properties shall be as per CSA Z245.20.98. the color of epoxy powder shall be either green or dark red or any other color approved by BHEL and NTPC except grey color. Copolymer grafted adhesive shall have the following properties: <table><tr><th>Sl. No</th><th>Properties</th><th>Unit</th><th>Requirement</th></tr><tr><td>a.</td><td>Melt flow rate (190°C/2.16 kg)</td><td>g/10 minutes</td><td>1.0 (min.)</td></tr><tr><td>b.</td><td>Vicat softening point</td><td>°C</td><td>100 (min.)</td></tr><tr><td>c.</td><td>Specific gravity</td><td>-</td><td>0.926 (min.)</td></tr></table>	Sl. No	Properties	Unit	Requirement	a.	Melt flow rate (190°C/2.16 kg)	g/10 minutes	1.0 (min.)	b.	Vicat softening point	°C	100 (min.)	c.	Specific gravity	-	0.926 (min.)
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1.03.03.02	<u>Properties of Polyethylene Compound</u>			
Sl.No.	Properties	Unit	Requirements	
1	Tensile strength @+25°C	N/mm ²	17(min.)	
2	Melt flow rate (190°C/2.16 kg)	g/10 minutes	0.25 (min.)	
3	Specific gravity @+25°C	-	0.926(min.) (MDPE) 0.941(min.) (HDPE)	
4	Hardness @+25°C	Shore D	50 (min.)	
5	Water absorption, 24 hours, @+25°C	%	0.05 (max.)	
6	Volume resistivity @+25°C	Ohm-cm	10 ¹⁵ (min.)	
7	Dielectric withstand, 1000 volt/sec rise @+25°C	Volts/mm	30,000 (min.)	
8	Vicat Softening Point	°C	110 (min.)	
9	Elongation	%	600 (min.)	
10	Oxidative Induction Time in Oxygen at 220°C, Aluminium pan, no screen	Minutes	10	
11	Environmental stress Crack (ESCR)(for F ₅₀) :- medium Density - (Condition "C") - High Density- (Condition "B")	Hours	300 300	
12	Carbon Black Content	%	2 (min.)	



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1.03.03.03	Properties of Coating System			
	Sl.No.	Properties	Unit	Requirements
	1	Bond Strength (using type 2 Test Assembly i.e. Dynamometer) @20±5°C @65±5°C	Kg/cm	8.0 (min.) 5.0 (min.)
	2	Impact Strength (Min. of 30 impacts on body along the length. No breakdown allowed when tested at 25 KV)	Joules per mm of coating thickness	7 (min.)
	3	Indentation Hardness @23±2°C @70±2°C	mm	0.2 (max.) 0.3 (max.)
	4	Elongation at Failure	%	300 (min.)
	5	Coating resistivity	Ohm-m ²	10 ⁸ (min.)
	6	Heat Ageing (*)	-	Melt Flow Rate shall not deviate by more than 35% of original value
	7	Light Ageing (*)	-	Melt Flow Rate shall not deviate by more than 35% of original value
	8	Cathode Disbondment @+65°C after 30days @+65°C after 48hours	mm radius of disbondment (**)	15 max. 7 max.
9	Degree of Cure of Epoxy(***) Percentage Cure, ΔH ΔTg	% °C	95 +3/-2	
(*) Test for heat ageing and light ageing properties previously carried out in an independent laboratory of national/international recognition on PE top coat is also acceptable based on valid certificates in lieu of tests to be performed by the bidder. (**) Disbondment shall be equivalent circle radius of total unsealed area as per ASTM G 42. (***) Temperature to which the test specimens are to be heated during cyclic heating shall however be as per the recommendations of epoxy powder manufacturer.				
1.04.00	MEASUREMENT AND LOGGING			



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	Vendor shall maintain records in computer using suitable database Software containing all the relevant data of individual pipe and pipe coating including pipe number, heat number, diameter, length, wall thickness, defects, coating number, batches of materials, sampling, testing, damages, repairs, rejects and any other information that NTPC considers to be relevant and required for all incoming bare pipes and NTPC approved outgoing coated pipes as applicable. Vendor's documentation shall be designed to ensure full traceability of pipe and coating materials through all stages of coating and testing. VENDOR shall submit this information in the form of a report at the agreed intervals. VENDOR shall provide one Computer terminal NTPC Representative for monitoring/tracking of the above. The VENDOR shall also submit the material balance details to NTPC for information at the end of each shift.
1.05.00	COATING PROCEDURE AND QUALIFICATION
1.05.01	At least four (4) weeks prior to the commencement of coating, a detailed procedure of the VENDOR's methods, material proposed, etc., shall be formulated by the VENDOR and submitted for BHEL and NTPC approval. The procedure shall include, but not limited to, the following information and proposals: a. Steel surface preparation, including preheating, removal of steel defects, method of pipe cleaning, dust removal, abrasive blast cleaning and surface profile; methods of measurements and consumables. b. Complete details of chemical pre-treatment viz phosphoric acid wash, de-ionized water wash, and chromate wash including product data sheets, health and safety sheets and manufacturer's recommended application procedure. c. Pipe heating, temperatures and control prior to epoxy application. d. Complete details of raw materials including current data sheets showing values for all the properties specified together with quality control and application procedure recommendations from manufacturer(s). e. Application of FBE powder, adhesive and polyethylene, including characteristic, temperature line speed, application window, curing time, etc. f. Quenching and cooling, including time and temperature. g. Detailed method of repair of coating defects duly classified depending upon nature and magnitude of defects and repair thereof including coating stripping technique. h. Details of instrument and equipment calibration methods including relevant standards and examples of calibration certificates. i. Complete details and inventory of laboratory and equipment for procedure qualification and regular production j. Pipe handling and stock piling procedures k. Sample of recording and reporting formats, including laboratory reports, certificates and requirement as per relevant clause of this specification. l. Complete details of test certificates for raw materials including test methods and standards used. m. Health, safety and environment plans n. Storage details of coating materials and chemicals.



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	o. Continuous temperature monitoring at various stages of coating.
1.05.02	Procedure Qualification Tests (PQT) shall be carried out only after obtaining written approval of the above procedure from BHEL and NTPC. No change in the procedure shall be made after approval has been given by the BHEL and NTPC. However, unavoidable changes shall be executed only after obtaining written approval from BHEL and NTPC. Prior to start of production, the Vendor shall, at his expense, carry out a coating PQT for each pipe diameter on max, wall thickness, for each type of pipe, for each coating material combination, and for each plant, to prove that his plant, materials, and coating procedures result in a quality of end product conforming to the properties stated in relevant clause of the specification, relevant standards, specifications and material manufacturer's recommendations. During PQT, the Vendor shall qualify various procedures forming a part of coating operations as detailed subsequently
1.05.03	QUALIFICATIONS OF PROCEDURES
1.05.03.01	<u>Epoxy Powder Application & Recycling</u> During pre-qualification, air pressure in the epoxy spray guns, satisfactory functioning of monitoring system, line speed vs. coating thickness, etc. shall be established. Dew point of air used to supply the fluidized bed, epoxy spray system and epoxy recycling system shall be recorded during the PQT. Also, the VENDOR shall remove samples of reclaimed powder from the reclamation system. These samples of reclaimed powder shall be subject to a detailed visual examination, thermal analysis and moisture content tests. The properties of the reclaimed powder shall be within the range specified by the manufacturer of epoxy powder. In case the properties of the reclaimed powder are out of the range specified by the manufacturer, VENDOR shall not use the reclaimed powder during the regular production.
1.05.03.02	<u>Pipe Pre-heating</u> The VENDOR shall establish the temperature variation due to in-coming pipe temperature, line speed variation, wall thickness variation, emissivity, interruptions, etc. and document the same during the PQT stage. During PQT, proper functioning of pipe temperature monitoring and recording system including alarm/hooter shall be demonstrated to the NTPC representative.
1.05.03.03	<u>Surface Preparation</u> The procedure to clean and prepare the pipe surface shall be in accordance with the requirements of this specification. The ratio of shots to grits shall be established during procedure qualification testing, such that the resultant surface profile is not dished and rounded. The qualification shall be performed through a visual inspection, measurement of roughness and check of the presence of dust in the abrasive blast cleaned pipe surface.



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1.05.03.04	<u>Coating Application</u> The NTPC representative will check the correctness of each coating application operation, values of the main parameters of each operation, pre-heating pipe surface temperature prior to epoxy powder application temperature, line speed, fusion bonded epoxy curing time, temperature and flow rate of co-polymer adhesive and polyethylene, etc. and the same shall be recorded. These values shall be complied with during regular production.
1.06.00	PIPE SURFACE PREPARATION
1.06.01	Prior to cleaning operation, Vendor shall visually examine the pipes and shall ensure that all defects, flats and other damages have been repaired or removed. The Vendor shall also remove marking stickers, if any, present within the pipe. Record shall be kept of such marking on the stickers to ensure traceability of pipe after coating.
1.06.02	Any oil, grease, salt or other contaminants detrimental to the formation of a good coating bond or coating quality shall be removed prior to coating application. Contaminants may be removed by the use of non-oily solvents. Gasoline or kerosene shall not be used for this purpose. Visible oil and grease spots shall be removed by solvent wiping. Solvent cleaning shall be in accordance with SSPC-SP1. Steel surface shall be allowed to dry before abrasive cleaning.
1.06.03	All pipes shall be preheated to a temperature of 65°C to 85°C prior to abrasive blast cleaning. The external surface of the pipe shall be cleaned using 2 no. dry abrasive blast cleaning units to achieve the specified surface cleanliness and profile.
1.06.04	The abrasive blast cleaning units shall have an effective dust collection system to ensure total removal of dust generated during blast cleaning from the pipe surface. During abrasive blast cleaning, the metallic abrasive shall be continuously sieved to remove "fines" and "contaminants" and the quality checked at every four hours. Abrasives used for blast cleaning shall comply ISO-11124.
1.06.05	Suitable plugs shall be provided at both pipe ends to prevent entry of any shot/grit into pipe during blast cleaning operations. These plugs shall be removed after blast cleaning. Alternatively, the vendor may link the pipes suitably together to prevent the entry of any short/grit into the pipe.



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1.06.06	Abrasive cleaning carried out shall be such that the resultant surface profile is not dished and rounded when viewed with 30x magnification. The standard of finish for cleaned pipe shall conform to near white metal finish to Sa 2½ of Swedish standard SIS 055900 latest edition. Surface of pipe after abrasive blast cleaning shall have an anchor pattern of 50 to 70 microns (RZ). This shall be measured for each pipe by a suitable instrument such as surface profile depth gauge. In addition the pipe surface after blast cleaning shall be checked for the degree of cleanliness (Sa 2½), degree of dust and shape of profile. Degree of dust shall comply the requirements of ISO 8502-3. Acceptance limit shall be either quality rating 2 or class 2. Tape used for assessment of degree of dust shall comply IEC 454-2. Pressure shall be exerted on the applied tape using a 4kg roller, prior to peeling-off to assess the degree of dust.								
1.06.07	At no time shall the blast cleaning be performed when the relative humidity exceeds 85%. The vendor shall measure the ambient conditions at regular intervals during blast cleaning and coating operations and keep records of prevailing temperature, humidity and dew point.								
1.06.08	The total allowable elapsed time between completion of the blasting operations and commencement of the pre-coating and heating operations shall be such that no detectable oxidation of the surface occurs. Relative humidity readings shall be recorded every 30mins. During the blasting operations in the immediate vicinity of the operations. The maximum elapsed time shall not exceed the duration given below: <table><tr><th>Relative Humidity %</th><th>Maximum Elapsed time</th></tr><tr><td>>80</td><td>2 hours</td></tr><tr><td>70 to 80</td><td>3 hours</td></tr><tr><td><70</td><td>4 hours</td></tr></table> Any pipe not processes within the above time-humidity requirement shall be completely re-blasted. Any pipe showing flash rusting shall be re-blasted even if the above conditions have not been exceeded. Pipe handling between abrasive blasting and pipe coating shall not damage the surface profile achieved during blasting. Any pipe affected by the damage to the surface exceeding 200mm² in area and/or having contamination of steel surface shall be rejected and sent for re-blasting.	Relative Humidity %	Maximum Elapsed time	>80	2 hours	70 to 80	3 hours	<70	4 hours
Relative Humidity %	Maximum Elapsed time								
>80	2 hours								
70 to 80	3 hours								
<70	4 hours								
1.07.00	COATING APPLICATION								
	The external surface of the cleaned pipe conforming to this specification shall be immediately coated with 3-layer extruded polyethylene coating in accordance with the procedures approved by BHEL and NTPC, relevant standards and this specification. In general, the procedure shall be as follows.								
1.07.01	<u>Pipe Heating</u>								



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1.07.01.01	Immediately prior to heating of pipe, all dust and grit shall be removed from inside of the pipe by a combination off air blast, brushing and vacuum cleaning. Suitable arrangement shall be made to protect the bevel ends form getting damaged during the coating operation.
1.07.01.02	Induction heater or gas fired heating shall be used for heating the pipe. The method shall be capable of maintaining uniform temperature along the total length of the pipe, and shall be such that it shall not contaminate the surface to be coated. In case of induction heating, appropriate frequency shall be used to ensure 'deep heating' and intense skin heating is avoided. Gas fired heating system shall be well adjusted so that no combustion products are deposited on the steel surface. This shall be demonstrated on bare pipes prior to start of PQT. Oxidation of the cleaned pipe surfaces prior to coating (in the form of bluing or other apparent oxide formation) is not acceptable.
1.07.01.03	External surface of the pipe shall be heated to about 190°C or within a temperature range (min. to max.) as recommended by the powder manufacturer. Required pipe temperature shall be maintained as it enters the coating chamber.
1.07.01.04	Temperature of the pipe surface shall be continuously monitored & recorded by using suitable instruments such as infrared sensors, contact thermometers, thermocouples etc. the recording method shall allow to correlate each line pipe. The monitoring instrument shall be able to raise an alarm/ activate audio system (hooter) in the event of pipe temperature being outside the range recommended by the manufacturer. Any deviation from the application temperature range recommended by the manufacturer shall be rectified. If immediate rectification is not feasible, the production shall be stopped until cause of deviation has been removed. Any pipe coated during the duration of temperature deviation shall be identified by marking and rejected. Such rejected pipes shall be stripped, re-cleaned and recoated.
1.07.01.05	Temperature measuring & monitoring equipment shall be calibrated twice every shift and/or as per NTPC representative's instruction.
1.07.01.06	Vendor shall ensure that pipe surface emissivity variations are minimized during pipe heating. To avoid significant variance, more than once blasted joints should be coated at the same time and not mixed with joints blasted only once.
1.07.02	<u>Pipe Coating</u>
1.07.02.01	Subsequent to pipe heating, coating consisting of following layers shall be applied onto the pipe. i. Electrostatic application of epoxy powder of minimum dry film thickness 0.150mm, unless otherwise specified. The maximum thickness shall not exceed the epoxy thickness specified by epoxy powder manufacturer. ii. Grafted co-polymer adhesive application by extrusion, minimum thickness 0.200mm. iii. Polyethylene application by extrusion. Minimum total thickness of finished coating shall be 3.0 mm.



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1.07.02.02	The coated pipe shall be subsequently quenched and cooled in water for a period that shall sufficiently lower the temperature of pipe coating to permit handling and inspection.
1.07.02.03	Prior to starting the application of fusion bonded epoxy powder, the recovery system shall be thoroughly cleaned to remove any unused powder remaining from a previous line pipe coating application. The use of recycled powder shall be permitted subject to: a) Satisfactory qualification of the reclaimed system during PQT stage b) The proportion of the reclaimed powder in the working mix does not exceed 20% at any one time. c) The quantity of the recycled powder being routinely checked during production, at a minimum frequency of once per shift and consistently meets the requirements stated in <u>Annexure 1</u>.
1.07.02.04	Dry air, free of oil and moisture shall be used in the coating chamber and spraying system. Filters, dehumidifier/dryer as required along with control & monitoring system shall be provided for this purpose. Dew point of air used to supply the fluidized bed, epoxy spray system and epoxy recycling system shall be at least (-)40°C and this shall be monitored during the regular production.
1.07.02.05	Air pressure in the epoxy spray guns shall be controlled, continuously monitored and recorded by using suitable instruments. The air pressure shall be controlled within the limits established during coating procedure qualification. The monitoring system shall be capable of raising an alarm / activate audio system (hooter) in the event of change in air pressure beyond the set limits. Any deviation from the pre-set limits shall be rectified. If immediate rectification is not feasible, the production shall be stopped until cause of deviation has been removed. Any pipe coated during the duration of air pressure deviation shall be identified by suitable marking and rejected. Such rejected pipes shall be stripped and recoated.
1.07.02.06	Extruded adhesive layer shall be applied before gel time of the epoxy coating has elapsed and within the window recommended by the manufacturer. The VENDOR shall establish, to the satisfaction of the NTPC Representative, that the adhesive is applied within the gel time window of epoxy and at the temperature recommended by the adhesive manufacturer. The VENDOR shall state the minimum and maximum time interval between epoxy and adhesive application at the proposed pre-heat temperature and line speed.
1.07.02.07	Extruded polyethylene layer shall be applied over the adhesive layer within the time limit established during PQT stage and within the time/temperature range recommended by the manufacturer. The extrusion temperatures of the adhesive and polyethylene shall be continuously recorded. The monitoring instruments shall be independent of the temperature control equipment. The instruments shall be calibrated prior to start of each shift.



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1.07.02.08	Vendor shall ensure that there is no entrapment of air or void formation along the seam weld (where applicable) during application of coating. Air entrapment below the coating and also along the coating overlap shall be prevented by forcing the coating on the pipe using high pressure roller of suitable design during coating application. In case it is not adequately achieved, Vendor shall supplement by other methods to avoid air entrapment. The metals used shall be witnessed and approved by BHEL and NTPC.
1.07.02.09	Resultant coating shall have a uniform gloss and appearance and shall be free from air bubbles, wrinkles, holidays, irregularities, discontinuities, separation between layers of polyethylene & adhesive, etc.
1.07.02.10	Coating and/or adhesive shall terminate mm (+) 20 / (-) 0 mm from pipe ends. The adhesive shall seal the end of applied coating. Vendor shall adopt mechanical brushing for termination of the coating at pipe ends. Edge of the coating shall be shaped to form a bevel angel of 30° to 45°.
1.07.02.11	Failure to comply with any of the above applicable requirement and of the approved procedure shall cause for the rejection of the coating and such coating shall be removed in a manner approved by BHEL and NTPC at Supplier's expense.
1.08.00	INSPECTION AND TESTING :
	All Inspection and Testing requirements shall be as per NTPC approved Quality Plan, this specification and DIN 30670.
1.09.00	HANDLING, TRANSPORTATION AND STORAGE
1.09.01	The Vendor shall load, unload, transport and stockpile the coated pipes within the coating plant using approved suitable means and in a manner to avoid damage to the pipe and coating. Handling, Transportation & Storage procedure shall be submitted for BHEL and NTPC approval prior to commencement of work.
1.09.02	Coated pipes may be handled by means of slings and belts of proper width (minimum 60mm) made of non-abrasive/non-metallic materials. In this case pipes to be stacked shall be separated row by row to avoid damages by rubbing the coated surface in the process of taking off the slings. Use of round sectional slings is prohibited. Fork lifts may be used provided that the arms of the forklift are covered with suitable pads, preferably rubber.
1.09.02	Bare / coated pipes at all times shall be stacked completely clear from the ground, at least 300mm, so that the bottom row of pipes remain free from any surface water. The pipes shall be stacked at a slope so that driving rain does not collect inside the pipe. Bare/coated pipes may be stacked by placing them on ridges of sand free from stones and covered with a plastic film or on wooden supports provided with suitable cover. This cover can be of dry, germ free straw covered with plastic film, otherwise foam rubber may be used. The supports shall be spaced in such a manner as to avoid permanent bending of the pipes.
1.09.03	Stacks shall consist of limited number of layers such that the pressure exercised by the pipe's own weight does not cause any damages to the coating. Each pipe section shall be separated by means of spacers suitably spaced for this purpose. Stacks shall



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	be suitably secured against falling down and shall consist of pipe sections having the same diameter and wall thickness. The weld seam of pipes shall be positioned always in a manner so as not to touch the adjacent pipes.
1.09.04	The ends of the pipes during handling and stacking shall always be protected with bevel protectors.
1.09.05	The lorries used for transportation shall be equipped with adequate pipe supports having as many round hollow beds as there are pipes to be placed on the bottom of the lorry bed. Total width of the supports shall be at least 5% of the pipe length and min. 3 no. support shall be provided. These supports shall be lined with a rubber protection and shall be spaced in a manner as to support equal load from the pipes. The rubber protection must be free from all nails and staples where pipes are in contact. The second layer and all following layers shall be separated from the other with adequate number of separating layers of protective material such as straw in plastic covers or mineral wool strips or equivalent, to avoid direct touch between the coated pipes.
1.09.06	All stanchions of lorries used for transportation shall be covered by non-abrasive material like rubber belts or equivalent. Care shall be exercised to properly cover the top of the stanchions and other positions such as reinforcement of the truck body, rivets, etc. to prevent damage to the coated surface. Slings or non-metallic straps shall be used for securing loads during transportation. They shall be suitably padded at the contact points with the pipe.
1.09.07	Materials other than pipes and which are susceptible of deteriorating or suffering from damages especially due to humidity, exposure to high thermal excursions or other adverse weather conditions, shall be suitably stored and protected. Deteriorated materials shall not be used and shall be replaced at Vendor's expenses. These materials shall always be handled during loading, unloading and storage in a manner so as to prevent any damage, alteration and dispersion. When supplied in containers and envelopes, they shall not be dropped or thrown, or removed by means of hook, both during the handling operations till their complete use. During unloading, transport and utilization, any contact with water, earth, crushed stone and any other foreign material shall be carefully avoided.
1.09.08	Vendor shall strictly follow manufacturer's instructions regarding storage temperature and methods for volatile materials that are susceptible to change in properties and characteristics due to unsuitable storage. If necessary, the Vendor shall provide for a proper conditioning.
1.10.00	REPAIR OF COATING



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Vendor shall submit to BHEL and NTPC, its methods and materials proposed to be used for executing a coating repair of the defects noticed after receipt at site and shall receive approval from BHEL and NTPC prior to use. In open storage the repair coating materials must be able to withstand a temperature of at least (+) 80°C without impairing its serviceability and properties. Vendor shall furnish manufacturer's test certificates for the repair materials clearly establishing the compliance of the repair materials with the applicable coating requirements indicated in this specifications.

All pipe leaving coating plant, shall have sound external coating with no holiday or porosity on 100% of the surface.

Defects, repairs and acceptability criteria shall be as follows:

- Pipes showing porosities or very small damage not picked up during holiday test and having a surface less than 0.5 cm² or linear damage (cut) of less than 3cm shall be repaired by stick using material of same quality.
- Damages caused to coating by handling such as scratches, cuts, dents, gouges, not picked up during holiday test, having a total reduced thickness on damaged portion not less than 2mm and an area not exceeding 20cm² shall be rebuild by heat shrink patch only and without exposing to bare metal.
- Defects of size exceeding above mentioned area or holidays of width less than 300mm shall be repaired with heat shrink repair patch by exposing the bare metal surface.
- Defects exceeding the above and in number not exceeding 2 per pipe and linear length not exceeding 500mm shall be repaired using heat shrinkable sleeves of HTLP 80 or equivalent.
- Pipes with bigger damage shall be stripped and recoated
- In case of coating defect close to coating cut back, Vendor shall remove the coating throughout the entire circumference of the pipe down to the steel surface and increase the coating cut back length. Now if the coating cut back exceeds 140mm of linear length of pipe then the coating cut back length of 120mm.

Notwithstanding the above, under no circumstances, if the defect exceeds 70mm from the original coating cut back length, the entire coating shall be removed and the pipe shall be recycled through the entire coating procedure.

Irrespective of type of repair, the maximum numbers of repair of coating shall be as follows:

- Holiday repair $\leq 100\text{cm}^2$ attributable to process of coating application shall be maximum one number per pipe.
- In addition to the above, defects to be required by heat shrink patch/sleeve shall be maximum 2 (two) per pipe.

Defects exceeding the above limits shall cause pipe coating rejection, stripping and recoating. The above is exclusive of the repairs warranted due to testing as per this specification.



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	All repairs carried out to coating for whatever reason shall be to the account of Vendor. Cosmetic damages occurring in the polyethylene layer only need not be repaired by exposing up to steel surface, as deemed fit by the Customer. In any case the Vendor shall establish his material, methods and procedure of repair that result in an acceptable quality of product by testing and shall receive approval from BHEL and NTPC prior to use. All repairs shall result in a coating thickness no less than the parent coating thickness.
1.11.00	MARKING Vendor shall place marking on the outside surface of the coating at one end of the coated pipe, and marking shall indicate, but not limited to the following information: a. Pipe number, heat number b. Diameter & wall thickness c. Coated pipe number d. Colour band e. Pipe manufacturer name f. Inspection mark/punch g. Any other information as per Approved Marking Procedure. Vendor shall obtain prior approval on marking procedure to be adopted from BHEL and NTPC.

**ANNEXURE 1 TO TECHNICAL SPECIFICATION FOR
3LPE COATING (PC:TSP:3LPE:PATRATU REV 00)**

4.03.0

MATERIALS AND EQUIPMENT

4.03.01

Field joint anti-corrosion coating material shall be heat shrinkable wraparound sleeve suitable for a maximum operating temperature of (+) 60°C (T_{max}) and shall conform to designation EN 12068-C-HT-60 UV. In addition, the field joint anti-corrosion coating shall comply the requirements specified in para 3.2 of this specification.

4.03.01.01

Heat shrinkable wraparound sleeves:

Heat shrinkable wraparound sleeve shall consist of radiation cross-linked, thermally stabilized, ultraviolet resistant semi-rigid polyolefin backing with a uniform thickness of high shear strength thermoplastic/co-polymer hot melt adhesive. The joint coating system shall consist of a solvent free epoxy primer applied to the pipe surface prior to sleeve application. The backing shall be provided with suitable means (thermo-chrome paint, dimple, or other means) to indicate the desired heat during shrinking in field is attained. The sleeve shall be supplied in pre-cut sizes to suit the pipe diameter and the requirements of overlap.

The total thickness of heat shrinkable wraparound sleeve in the "As Applied" condition shall be as follows:

Pipe Size (Specified Outside Diameter)	Thickness (mm)		
	On Pipe Body		On Weld Bead
	Average	Min.	(Min.)
<30" (762.0mm)	2.0	1.8	1.6
>32" (813.0mm)	2.4	2.2	2.0

The heat shrink wraparound sleeve shall have the required adhesive properties when applied on various commercial pipe-coating materials. The pre-heat and application temperatures required for the application of the shrink sleeve shall not cause loss of functional properties of the pipe coating.

4.03.02

Functional Requirements of Field Joint Coating

4.03.02.01

Properties of the PE backing shall be as follows:

S.No.	Properties	Unit	Requirement
a.	Tensile Strength @ +25° C	N/mm ²	>12
b.	Ultimate Elongation @ +25° C	%	>250
c.	Dielectric withstand with 1000	KV	>30

	Volts/sec		
d.	Water absorption @ +25° C For 24 hours	%	<0.05
e.	Volume Resistivity @ +25° C	Ohm-cm	>10 ¹⁵

4.03.02.02

Functional Properties of Joint Coating System (As supplied)

As applied field joint coating system shall comply the requirements of DIN EN 12068, Table 1 & 2 corresponding to designation EN 12068 – C HT 60 UV, except as modified below:

a) Cathodic Disbondment Resistance at T_{max} i.e. 60°C shall be 20mm when tested as per Annexure K of EN 12068. Test shall be carried out at (+) 60°C.

b) Peel Strength shall be as follows:

Peel Strength		Unit	Requirement for Mech. Resistance Class-C (minimum)
Inner to Inner (+)	@ 23°C	N/mm	1.5
Outer to Inner	@ T_{max}	N/mm	0.3
Outer to Outer	@ 23°C	N/mm	1.5
	@ T_{max}	N/mm	0.3
To Pipe Surface	@ 23°C	N/mm	3.5
	@ T_{max}	N/mm	0.5
To Factory Coating	@ 23°C	N/mm	3.5
	@ T_{max}	N/mm	0.5