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FUNCTIONAL SPECIFICATION FOR CONCRETE WEIGHT COATING OF SUBMARINE PIPELINES

OIL AND NATURAL GAS CORPORATION LTD.
INDIA

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1.0 SCOPE


This specification covers the minimum requirements for the materials and application of concrete coating to the external surface of line pipes to be used for submarine Pipelines and risers.

2.0 REFERENCE DOCUMENTS

Reference has been made in this specification to the latest editions of the following Codes and Standards

- a) ASTM A-82 : Cold-drawn Steel Wire for Concrete Reinforcement.
- b) ASTM A-185 : Welded Steel Wire Fabric for Concrete Reinforcement.
- c) ASTM A-641 : Zinc Coated (Galvanized) Carbon Steel Wire)
- d) ASTM C-33 : Concrete Aggregates
- e) ASTM C-39 : Compressive Strength of Cylindrical Concrete Specimens.
- f) ASTM C-40 : Organic Impurities in Sands for Concrete
- g) ASTM C-138 : Unit Weight Yield and Air Content (Gravimetric) of Concrete.
- h) ASTM C-150 : Portland Cement
- i) ASTM C-309 : Liquid Membrane Forming Components for Curing Concrete.
- j) ASTM C-642 : Specific Gravity, Absorptions and Voids in Hardened Concrete.
- k) BS-1881, Part-116 : Methods of Testing Concrete for Strength

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- i) DNV, 1981 : Rules for Submarine Pipeline Systems

In case of conflict between the requirements of this specification and the documents referred above, the requirements of this specification shall govern.

3.0 MATERIALS

3.1 Cement

Portland cement in accordance with ASTM C-150 Type-III shall be used. The Tricalcium Aluminate content shall be within the range of 5% to 8%. Cement which has hardened, partially set or lumpy shall not be used.

3.2 Fine Aggregate

Fine aggregate comprising of natural or manufactured sand used shall conform to the requirements of ASTM C-33 and shall be clean, free from injurious amounts of salt, alkali, deleterious substances or organic impurities. Maximum particle size shall be 4.75 mm and minimum particle size shall be 0.15 mm. Each source of sand shall be tested for organic impurities as per ASTM C-40 and approved by Company prior to its use.

3.3 Coarse Aggregate


Coarse aggregate consisting of gravel, broken stone, etc., in compliance with ASTM C-33 shall be used. It shall be free of clay and injurious amounts of alkali, deleterious substances and organic impurities that may affect the strength of the concrete. Maximum particle size shall be 9.5 mm and the minimum particle size shall be 0.15 mm.

Iron or barium ore aggregates of a type approved by Company may be mixed with coarse aggregate to obtain the required concrete density.

3.4 Water

Water used shall be clear, fresh and clean and shall not contain chloride and sulphates. Water from each source shall be tested prior to its use and shall be approved by Company. Sea water or contaminated water shall not be used.

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3.5 Reinforcement

Reinforcement steel shall consist of welded steel wire fabric manufactured in rolls (ribbon mesh) conforming to ASTM A – 185. Steel wires shall conform to ASTM A –82. Steel wires shall be galvanized at finished size as per ASTM A-641. Reinforcement mesh shall be 25 mm x 67.5 mm size and steel wire shall be of $\phi 1.8$ mm. A sample of reinforcement shall be furnished to the Company for approval.


4.0 COATING REQUIREMENT

Pipes shall be coated with concrete to a thickness and dry density as specified in the Contract document. The compressive strength of concrete shall not be less than 328 kg/cm² in 28 days and 246 kg/cm² in 7 days. Acceptable tolerance on concrete density shall be +5% and –2%. The concrete coating shall not absorb water more than 4% of its weight in water.

5.0 EQUIPMENTS

The mechanical equipment used for performing the concrete coating shall be capable of doing so with a required degree of uniformity with respect to thickness, density and strength. The proportioning equipment and procedure shall ensure consistently proportioned materials by weight and thorough mixing of all materials. Equipment shall have either the batching of materials by weight or continuous mixing, where all feeds are accurately controlled and percentages of mixer calibrated by weight. Batching scales/weighing devices shall be maintained in good conditions. Proportioning equipment shall be calibrated in the presence of Company representative. Any equipment that tends to separate the ingredients shall not be used.

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6.0 PROCEDURE QUALIFICATION

6.1 Before commencement of the work, Contractor shall perform all tests either in the laboratory or in the field and trials necessary to properly select type of mix and concrete application procedures.

6.2 The type of mix i.e. the correct combination of the cement, aggregates and water shall be established by taking minimum 5 samples of concrete from each mix. Samples of hardened concrete, not less than 4 days old, shall be tested in accordance with ASTM C-642 to determine the dry specific gravity of the concrete and the saturated weight after immersion.

Test according to ASTM C-138 shall also be performed to determine the expected correlation between the fresh concrete density and dry density.

For each mix the following shall be accurately checked and recorded.


- Proportions & weights of respective materials used.
- Water / cement ratio
- Grading of the aggregates

6.3 When the results of the above tests do not meet the requirements, the mix shall be modified and concrete samples tested until a proper mix has been determined. The mix so determined shall be then used for sampling of concrete for compressive strength test. For this purpose minimum 4 cube samples, two each for 7 days strength and 28 days strength shall be tested in accordance with BS 1881 Part-116. Mix complying the specified dry density, compressive strength and presided as final mix.

6.4 Subsequent to selection of the mix, trials shall be performed by concrete coating application on lengths to test the placing procedures of the concrete and the following determined.

- Workability to the concrete and pouring or cement gun rates
- Number of passes required to meet the concrete coating thickness as specified.

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6.5 Contractor shall furnish the above procedure qualification details in the form of a report to Company for approval prior to application of regular concrete coating.

7.0 MEASUREMENT AND LOGGING

7.1 All measurement as mentioned below shall be taken during the works and logged in a log-book. A special log-book shall be used for recording tests and trial results. A log-book shall refer to pipe lengths having the same nominal diameter and wall thickness.

7.2 The following shall be subject to measurement and logging for each pipe length.


a. Line Pipe

- | | |
|--------------------------------|------|
| 1. Field identification number | (F) |
| *2. Mill serial number | (M) |
| *3. Length, m | (L) |
| *4. Weight, kg | (BW) |
| *5. Outside diameter, m | (OD) |

b. Corrosion Coating

- | | |
|---|-------------|
| **6. Type of coating | (C) |
| **7. Thickness of coating, mm | (CT) |
| 8. Weight of coated pipe,kg | (CW) |
| ** 9. Presence of anode | (Yes or No) |
| **10. Date of corrosion coating application | (DCC) |

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c. Concrete Coating

11. Batch identification number

(BN)

12. Date of concrete coating thickness, mm

(DC)

13. Average concrete coated thickness, mm

(CCT)

14. Wet weight of coated pipe, kg
(Weight and Date of weighting)

(WW)

15. Calculated Dry weight of coated pipe, kg
(Based on the correlation established between
wet weight and dry weight)

(CDW)

d. Additional Information
(On approved concrete mix at least twice per shift)

16. Dry density of concrete, kg/m³

(DDC)

17. Compressive strength of concrete, kg/cm²
(7 Days)

(CS1)

18. Compressive strength of concrete, kg/cm²
(28 days)
(On randomly selected coated pipes at the
rate of one out of every 50 pipes coated)

(CS2)

19. Saturated weight of coated pipe, kg

(SW)

20. Water absorption, %

(WA)


21. Dry weight of coated pipe, kg

(DW)

* Date can be obtained from Pipe Mill Tally Sheets

** Date can be obtained from Coating Plant Tally Sheets.

7.3 No concrete placing shall be permitted before items 1 thru 10 listed above have been logged. In addition each batch/shift shall be identified and logged against cube samples taken for compressive strength and dry density.

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8.0 APPLICATION OF CONCRETE COATING AND REINFORCEMENT

8.1 Application Method

Concrete coating shall be applied by impingement method. This method shall ensure the basic characteristics of concrete in compliance with the minimum requirements of this specification and the Contract Requirements.

8.2 Concrete Mixing

The components of the concrete mix shall be weigh batched before mixing by a proper weight-batcher or a continuous mixer with weigh devices. Weighing devices for each component shall have an accuracy of $\pm 1.0\%$ accuracy shall be used for adding water to the mix. The calibration of the weighing devices and the water meter shall be checked at the beginning of each shift.

The moisture content of the aggregates used shall be such as to maintain a satisfactory control on the water/cement ratio of the concrete mix.

8.3 Pipe length preparation


Prior to placement of reinforcement, the anti-corrosion coating of each pipe length shall be carefully inspected visually and by holiday detectors and if damages are found, they shall be repaired in accordance with the relevant specification issued for this purpose before start of the work. Foreign matters, if any, shall be removed from the surface of the anti-corrosion coating.

8.4 Reinforcement Application

8.4.1 Reinforcement shall be placed around the pipe in such a manner to cover the whole pipe length or sections to be concrete coated. The reinforcement shall not protrude beyond the concrete coating at ends.

8.4.2 Splicing shall be done either by binding with soft steel wire having a dia. of 1.5 mm and an overlap of three meshes or pre-bend the end of the wires on the new roll into hooks and then engage it in the end of the preceding roll and pressed short. Wire fabric in rolls (ribbon mesh) shall be provided with a spiral lap of one mesh.

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8.4.3 One layer of reinforcement steel for concrete thickness upto and including 60 mm, two layers of reinforcement for concrete thickness between 61 mm and 120 mm and three layers of reinforcement for thickness beyond 121 mm shall be provided. In case of one layer of reinforcement, it shall be located approximately in the middle of the concrete thickness. In case of two layers of reinforcement, layers shall be located at $1/3^{\text{rd}}$ and $2/3^{\text{rd}}$ of the concrete thickness. In case of three layers of reinforcement, layers shall be located at $1/4^{\text{th}}$, $1/2^{\text{th}}$ and $3/4^{\text{th}}$ of concrete thickness. Contractor shall demonstrate that the procedure used ensured no physical contact between steel reinforcement and the pipe and the reinforcement is placed in position as mentioned above.

8.4.4 For the first pipe every shift a water jet shall be used to clear away the freshly placed concrete in the center of pipe, down to the corrosion coating for an area of approximately 75 mm wide and 200 mm long in the longitudinal direction. Inspection of the exposed area shall be used to confirm that the reinforcement mesh is positioned and overlapped within the concrete as specified. If the reinforcement is not positioned correctly, the pipe shall be rejected and re-coated. Proper adjustment as required shall be inspected in this manner until the position of the mesh is accepted.

Repair of inspection slot shall be carried out as per the provisions of para 13.0 of this specification.


8.5 Concrete Placing

8.5.1 Concrete shall be placed within 30 minutes from the time of mixing (i.e. after adding water to mix) and shall be handled in such a way to prevent aggregate segregation and excessive moisture loss. Concrete containers shall always be kept clean and free from hardened or partially hardened concrete.

8.5.2 Placement of concrete shall be upto the specified thickness in one continuous pass, allowance being made for splices of reinforcement and providing reinforcement in the right location. Concrete shall be projected at high velocity against the external surface of pipe to procedure a hard, tight-adhering coating of the specified thickness.

8.5.3 No pass shall be stopped for more than 30 minutes. In case of any interruption beyond 30 minutes, coating shall be removed and entire joint shall be re-coated at no extra cost to Company.

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8.5.4 Concrete placing shall be completed as quickly as possible. In case excessive evaporation of water from the concrete is expected, exposed surfaces shall be immediately covered. Concreting shall not be done at temperatures below 5°C.

8.5.5 Coating at each end of the pipe shall be beveled to a slope of approximately two-to-one (2:1). Coating shall terminate about 75 mm short of the surface and the fresh concrete shall be washed of at the ends accordingly.


8.5.6 Inside and outside surfaces of the uncoated sections of all pipes shall be kept clean and free from cement concrete and grout. Cement concrete and grout. Cement concrete and grout present on said surface after coating completion shall be fully removed before their setting.

8.5.7 Bevel protectors shall be reinstalled subsequent to the concreting coating application.

8.6 Curing

Curing shall be performed by water, steam, sealing compounds or by any other suitable method duly approved by Company. Sealing compounds shall meet the requirements of ASTM C-309 or shall be of white pigment type manufactured by Hunt Process Company. The material shall be prepared and applied to provide complete surface coverage as per the Manufacturer's instructions. The ingredients of any such compound shall be non-toxic and non-inflammable and shall not react with any ingredient of the concrete, the reinforcement the protective coating or pipe. The application of the curing compound shall take place immediately after the coating is completed and preferably before the pipe is removed from the concrete coating apparatus. The surface of the concrete shall be lightly sprayed, with water before applying the curing compound. Curing period shall be 7 days. During which period the freshly coated pipes surface shall be kept wet for seven days after application of the concrete coating. Pipes shall not be handled, stacked or loaded out from the yard until so cured. Transportation and handling of concrete coated pipe shall be done only after 28 days of coating. Concrete shall be protected from freezing during the curing period.

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8.7 Coating of Pipe Joint with Anode Bracelet

Corrosion protection coating on pipe sections where anode bracelets have been installed shall be repaired as per the relevant specification issued for the purpose. After proper curing of repairs to the corrosion coating, the concrete weight coating shall be applied. The anode shall be protected to ensure that no concrete contacts the external surface of the anode bracelet. Wire reinforcement shall terminate a minimum of 50 mm from the anode bracelet. The anode assembly shall not protrude above the concrete coating. If due to any reason concrete thickness is more than anode thickness, concrete shall be tapered to 1:4 to make anode concrete transition smooth


9.0 TOLERANCES


- 9.1 Contractor shall maintain a tolerance of ± 6 mm on outside diameter of the coated pipes measured by diameter tape. The diameter of each coated pipe shall be obtained at five points, spaced at equal intervals between the end points.
- 9.2 The acceptable weight tolerance of any single pipe shall be limited to + 5% or – 2% of the calculated weight. Calculated weight shall consider the total weight of pipe with corrosion and concrete coating based on approved concrete density and thickness.
- 9.3 Acceptable weight tolerance from the approved mix. during production shall be as follows :
- $\pm 3\%$ for each type of aggregate
 - $\pm 2\%$ for aggregate as a whole
 - $\pm 3\%$ for the total quantity of water
 - $\pm 3\%$ for the cement


10.0 WEIGHING

- 10.1 All weighing of concrete coated pipe lengths shall be performed using suitable weighing device having an accuracy of $\pm 0.5\%$. Calibration of the weighing device shall be carried out daily to the satisfaction of the Company Representative. Weighing devices used shall have valid certificate regarding

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<p>the range and accuracy. Company have the option to request calibration at any time during the works.</p> <p>10.2 Each concrete coated pipe shall be weighed as soon as it is feasible to move it after concrete placing and Contractor shall mark the weight on the inside surface of the pipe with paint followed with letters “WW” meaning Wet Weight.</p> <p>10.3 Contractor shall weigh one out of every fifty pipes coated when dry prior to shipment (i.e. 28 days after placement of concrete) and mark the weight with paint of the inside of the pipe. The weight mark shall be followed with letter “DW” meaning “Dry Weight”.</p> <p>11.0 INSPECTION AND TESTS</p> <p>11.1 General</p> <p>11.1.1 Contractor shall perform all inspection and testing of coated pipes as per the requirements of this specification and relevant codes by qualified inspectors. All equipment, tools, tackles, manpower etc., required for inspection and testing shall be provided by the Contractor. Personnel who in the opinion of Company Representative lack the necessary skill or do not exercise a reasonable degree of care shall not be deployed on the job.</p> <p>11.1.2 Company reserves the right to perform stage wise inspection and witness tests on all activities concerning the pipe coating operations starting from preparation of mix to finished coated pipe ready for dispatch.</p> <p>11.1.3 Contractor shall give reasonable notice of time and shall provide access to every part of the coating yard during all phases of the work and facilities required for inspection to the Company Representative. Inspection and tests witnessed by Company Representative shall in no way relieve the Contractor’s obligation to perform the required inspection and tests. In case of rate of defective or rejected pipes and/or sample tests are 10% or more for a single shift, Contractor shall be required to stop production and carry out a full and detailed investigation with Company Representative. Any expense caused by the stopping of work shall be borne by the Contractor. Pipe coating not meeting the requirements of this specification shall be rejected and re-coated by Contractor without any extra charges.</p>				
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<p>11.2 Inspection of Concrete Coating Materials and Mix</p> <p>11.2.1 Cement</p> <p>Test certificates from the Cement Manufacturer shall be supplied to Company Representative for each batch of cement, prior to its use.</p> <p>11.2.2 Sand, Aggregate and Water</p> <p>The grading and purity of sand and aggregate shall be checked at least on alternative days. Purity of water shall be checked atleast every week. Report of the above check shall be submitted for Company Representative's approval.</p> <p>11.2.3 Proportion of Concrete Material</p> <p>Tolerance permitted for the mixing proportions shall be checked at least twice per shift. The accuracy of measurement shall be checked at least once per week, taking into account the tolerances allowed for the scales and for the proportion of the materials.</p> <p>11.3 Testing of Concrete</p> <p>11.3.1 Daily samples of the concrete mix, as being applied during the coating operation shall be taken to determine the compressive strength and density of the concrete coating.</p> <p>11.3.2 Compressive Strength Test</p> <p>Compressive strength test of concrete used at least twice per shift shall be carried out as per BS 1881 Part-116 on four cubes, two each for 7 days and 28 days strength. Copies of all test reports shall be submitted to Company for approval. If any cube test results do not meet the requirements of this specification, all pipes coated with such concrete batch shall be rejected. Coating on such rejected pipes shall be removed and the pipe recycled for concrete coating.</p>				
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11.3.3 Density

Dry concrete density of concrete used shall be determined at least twice per shift from hardened and cured concrete not less than 4 days old, taken from sample of coating materials and being applied during normal coating operations in compliance with ASTM C-40 with a known specific gravity of water. For this purpose two samples shall be taken an every batch of concrete used.

11.4 Coated Pipe Inspection and Testing

11.4.1 All pipes shall be visually inspected to detect whether any damages and/or defects are present. Possible and/or defects with these allowable limits are mentioned in para 12.0.

11.4.2 Diameter and weight shall be checked for each concrete coated pipe. Based on the correlation established between fresh concrete density and dry density during the procedure qualification prior to start of the work, the acceptance of the concrete coated pipes will be made based on the equivalent wet weight of each concrete coated joint immediately after coating.

Pipes exceeding the tolerance limits specified shall be repaired or stripped and re-coated at the discretion of the Company Representative.


11.4.3 All concrete coated pipes shall be checked to verify insulation between steel reinforcement and pipe by means of a MEGGER or equivalent device.

11.4.4 At least one out of every 50 concrete coated joints shall be tested for water absorption as follows :

- The concrete coated pipe length shall be weighed in air when dry and the weight recorded as “Dry Weight” (DW)
- The pipe length shall be completely submerged in water of known specific gravity, and so kept for a period as indicated below -

Submerged pipe length shall be weighed at 6 hours interval of continuous submergence till water saturation is reached and the time and weight data recorded. The last weight shall be recorded as “Saturated Weight” (SW). Reaching “Water Saturation” shall mean that the difference between the two

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last consecutive weighings at 6 hours intervals are not differing, more than accuracy of weighting device, as defined at para 10.0.

Percentage of water absorption shall be calculated as using following formula and value reported to Company. Water absorption (WA), % =

$$\frac{SW - DW}{DW} \times 100$$

Company retains the option of the required additional submerged weight tests in case of any variation from the value established during the procedure qualification.


12.0 REPAIRS

12.1 The following are repairs that are permitted to coating due to unavoidable damage in handling and storage (This is applicable only to concrete that has hardened).

12.2 Spalling due to compression or shearing caused by impact against other objects. Spalling is defined as damage which causes a loss in concrete of more than 25% of the total thickness of the coating at the point of damage.

12.3 Damage due to spalling of an area of less than 0.1 m² where the remaining concrete is sound and reinforcement steel not exposed, will be accepted with out repairs. Damage due to spalling of an area of less than 0.1 m² with reinforcement exposed; and area more than 0.1 m² and less than 0.3 m² shall have the concrete removed as necessary to expose the reinforcing steel throughout the damaged area. Edges of the spalled area shall be under-cut so as to provide a key lock for the repair material. A stiff mixture of cement, water and aggregated shall be troweled into and through the reinforcement and built up until the surface is level with the coating around the repaired area at the top and shall be moist cured for a minimum of 36 hours before further handling.

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12.4 Should the damaged area be more than 0.3 m² coating shall be removed around the entire damaged area. A repair shall be made by satisfactorily restoring the reinforcement either by forming the area with a metal form pouring complete replacement materials similar to that from which the coating was made or by gunniting with similar concrete. The resulting coating, shall be equal in weight, density, uniformity, thickness, strength and characteristics to the originally applied coating. The pipe shall then be carefully laid in a position where it shall be allowed to remain a minimum of 36 hours before further handling.

13.0 MARKING

13.1 Every concrete coated pipe length shall be clearly marked by a suitable type of paint red or white in color. Making of concrete coated piping shall be made inside of pipe close to bevel end. The minimum marking requirements shall be as below:


13.2 For each concrete coated pipe length, at one end, the field identification number and the date of concrete placing shall be marked, while the weight alongwith number of days after coating shall be marked at the other end. In addition, Contractor shall develop a color coding (band) system to be marked on the outside surface for easy identification of the coated pipe for each concrete coating thickness, concrete density, pipe diameter, pipe thickness and pipe material variation.

14.0 UNLOADING, TRANSPORT, STORING AND HAULING

14.1 Contractor shall unload, load, stockpile and transport the corrosion coated pipes and concrete coated pipes using suitable means and in a manner to avoid damage to coating, pipe wall and beveled ends, from the site of receipt to the coating yard and after concrete coating completion and acceptance to delivery site. The procedure shall be approved by Company prior to commencement.

14.2 Damage to pipes which occur after the Contractor has taken delivery such as dents, flats or damage to weld ends shall be cut off or removed and pipes rebevelled and repaired again as necessary. The cost of this work, as well as


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that of the pipe lost in cutting and repair shall be to the Contractor's account. All such works shall be carried after written approval of the Company Representative.

- 14.3 Adequate strapping and padding shall be provided during handling. All pipe handling shall be with equipment approved by Company. All lifting equipment shall be of such a design so as to prevent damage to the bump against any other pipe or other objects. Rolling, skidding or dragging shall not be permitted.
- 14.4 Coated line pipes shall be handled at all times with best quality wide nonabrasive slings and belts or end hooks. End hooks shall have sufficient width and depth to fit the inside of the pipe and padded with soft material like rubber, Teflon or equivalent, so as not to cause damages to bevel or pipe ends.
- 14.5 Stacking of coated pipes shall be carried out on surface previously leveled and coated with a layer of soft earth or sand berms to prevent coating from being damaged and water and mud entering inside the pipe. Berms shall generally consist of two rows of roughly trapezoidal shaped mounts. Stacks shall consist of a limited number of layers such that the pressure exercised by the pipes own weight does not cause damages to coating. Contractor shall calculate based on the characteristics of the concrete used, the number of layers for stacking and submit the same of Company for approval.
- 14.6 Stacks shall be suitably secured against falling down and shall consist of pipe section having the same diameter, grade, thickness and concrete coating.
- 14.7 If the Company Representative observes coating or pipe damage due to handling, Contractor shall review the handling procedure adopted and take corrective actions as required to the satisfaction of the Company Representative. Damaged pipes shall not be loaded until the repairs in compliance with the requirements of para 12.0 are done.
- 14.8 Acceptance of pipes shall be delayed, when pipe lengths having an acceptable concrete coating shows cement concrete, grout, sand, mud, etc. on the inside and on the uncoated surfaces of the pipe or defects on steel pipe especially at bevelled ends till the cleaning and repairing completion.

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<p>14.9 Materials other than pipes and which are susceptible of deteriorating or suffering from damages especially due to humidity or other adverse weather conditions, shall be suitably stored and protected.</p> <p>15.0 DOCUMENTATION</p> <p>15.1 At the time of Bidding, Contractor shall submit the following documents:</p> <ol style="list-style-type: none"> Details of the coating yard, layout, capacity and production rate. Facilities in the yard for unloading, handling, transport, production, storage, stockpiling, loading of coated pipes alongwith the laboratory and equipment details. Reference list of previous coating projects carried out giving complete details of diameter, length, concrete coating thickness, concrete density, name of the project, name of client and year. Proposed source/list of various materials proposed to be procured for carrying out the coating works. A clause wise list of technical deviations, if any, from the requirements of this specifications. Deviations indicated anywhere else in the offer shall not be considered valid. <p>15.2 Within three weeks of placement of order, the Contractor shall submit four copies of, but not limited to, the following for Company approval.</p> <ol style="list-style-type: none"> Proposed procedure for application of concrete coating in compliance with the characteristics and tolerances mentioned in the specification. Complete details of raw materials together with Manufacturer's data and test certificates. Inspection & testing methods and reporting formats including instruments and equipment types, makes and use etc. Dimensional tolerances and control procedures including details of instrument and equipment and calibration methods including relevant standards and examples of calibration certificates. 				
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- e. Complete details and inventory of laboratory and equipment.
- f. Sample of recording and reporting formats, including reports and certificates.

Once the approval has been given by Company, no change shall be made. However unavailing changes shall be executed only after obtaining written approval from Company.

15.3 Prior to shipment, Contractor shall submit six copies of the following:

- a. Final approved procedure document as established at 15.2 above.
- b. Log sheets as established at 7.2 above.
- c. Histogram of dimensional parameters indicating minimum, maximum, average and standard deviation.
- d. All test results carried out on each batch of concrete and on pipes.
- e. Information on tests failures, rejected batches, etc.

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