# SECTION IV : SCOPE OF WORK

## 1.0 INTRODUCTION

2 M/s. HARIDWAR NATURAL GAS PVT. LTD. (HNGPL), a joint venture (JV) of Bharat Petroleum Corporation Limited (BPCL), A Govt. of India Enterprise and GAIL Gas Limited, a fully owned subsidiary company of GAIL (India) Limited has been set up to provide CNG (Compressed Natural Gas) as fuel to commercial & private vehicles through filling stations and PNG (piped Natural Gas) to Industrial, household and commercial sector in Haridwar GA.

This tender deals with the Laying, testing and commissioning of underground Steel pipeline along with MDPE pipe in the above-mentioned location and associated works.

M/s Haridwar Natural Gas Pvt. Ltd. intends to lay underground steel pipeline network of various sizes along with associated facilities from HNGPL existing pipeline / SV to make natural gas available for CNG & PNG facilities in the specified areas of Haridwar.

## 2.0 PIPELINE FACILITY DESCRIPTION

| | | |
|---|---|---|
| Line Size | : | 4" NB |
| Length | : | As per SOR/Scope of work |
| Line Pipe Specification | : | API 5L Gr. X42 / X52 PSL2 or Higher etc. |
| Line Pipe Wall Thickness | : | 6.4 mm or Higher etc. |
| Line Pipe External Coating | : | 3 Layer Polyethylene |
| Stations | : | Tap-off/ Station / Customer End, etc. as applicable. |

### 2.1 SCOPE OF WORK:

The brief scope of work covered in this bidding document broadly consists of the following:

- Laying, Testing and Commissioning of underground 4"dia x 100 m. approx steel pipeline including associated works like Cathodic protection (TCP), above ground piping & consumer connectivity's along with civil,structural works at Haridwar area.

- Laying, testing and commissioning of Underground Polyethylene (PE) pipelines of sizes 180 mm PE 100 pipe various end point consumers of Piped Natural Gas (PNG) in Haridwar GA. All materials shall be procured by the contractor as indicated in SOR and scope of work.

The brief scope of work includes supply of bulk materials (other than free issue), pipe laying work including but not limited to Construction Management, HSE & Quality Management, Survey, clearing of ROU, grading. Stringing, bending, welding, trenching, lowering, crossings. Tie-ins, NDT and destructive testing, backfilling, site restoration, hydrotesting, dewatering, drying, pre-commissioning, commissioning and Gas-in of pipeline of size 4" Dia. steel and 180 PE 100 along with HDPE duct including construction / installation of related facilities at consumer ends, SV Stations, tap-off station at various locations including associated Mechanical, Civil, Structural, Cathodic Protection, Instrumentation works at stations etc.

| Sr No | Stretch Details | Dia | Length(m) approx |
|---|---|---|---|
| 1 | Existing Steel line connectivity from Main line to Compressor & DRS at A.R. Filling Station, SIDCUL, Haridwar of M/s. BPCL RO along with MDPE Line. | 4" & 180mm | 100 |

Note: Laying shall be done as per the instructions of EIC , accordingly quantity may vary.

The brief scope of work includes the following:

- Supply of bulk materials (other than free issue), pipe laying work including but not limited to Construction Management, HSE & Quality Management.
- Supply of L.R. bends, IJs, assorted piping, fittings, elbows, valves etc. to complete the entirework as per SOR.
- Laying, testing and commissioning of underground Steel pipeline of 4" NB size inthe above-

mentioned locations.

- Laying of 180 mm MDPE pipe along with Steel Pipeline in same pipeline trench.
- Survey, grading, stringing, bending, welding, trenching, lowering, crossings. Tie-ins, NDTand destructive testing and backfilling.
- Crossing by HDD/ moling / boring – Type of crossing i.e., HDD / Moling / Boring / cased / Uncased / Open-cut and the length of the crossing shall be as perprior written approval of EIC.
- Tap-off provision of all sizes made on proposed 4" NB pipeline network shall be kept underground.
- Entire pipeline network system shall be cathodically protected by providing TCP system including design & engineering, resistivity data collection.
- Line cleaning, flushing, Hydro testing, drying, nitrogen purging, pre- commissioning & assistance in commissioning of entire pipeline and piping system.
- Nitrogen purging and retaining pipeline at 2 kg/cm$^2$ pressure where required for preservationpurpose.
- M/s HNGPL reserves the right to change the pipeline sizes is above mentioned pipeline stretches and lay pipelines in any other areas in Haridwar Geographical Area, at the contracted SOR rates.

Description of the facilities covered in the above are described in following clauses.

**Main Pipeline for this section**

| | | |
|---|---|---|
| • Line Size | : | 4" NB size |
| • Line Length | : | Approx 100m approx. including all pipelinesizes. |
| • Class | : | 300 # |
| • Design Pressure | : | 49 kg/cm$^2$(g) |
| • Material of Pipe & Grade | : | API 5L Gr. X-52/X42 /Gr.B |
| • Wall Thickness | : | 6.4 mm |
| • Coating Material | : | 3 Layer PE |
| • Location Classification | : | Zone IV as per OISD 141 |
| • Design Code | : | ANSI / ASME B31.8 (Latest Edition) / T4SE |
| • Corrosion Allowance | : | 0.5mm |
| • Road Crossings | : | As per SOW |
| • Rail Crossings | : | As per SOW |
| • Drain Crossings | : | As per SOW |
| • Gas Temperature (Design) | | |
| - Buried | : | 45°C |
| - Over ground | : | 65°C |
| • Cathodic Protection Works | : | As per SOW & SOR |
| • Pipeline Safety System Works | : | As per SOW & SOR |

## 2.0 SCOPE OF WORK

The work shall be completed conforming to Engineering Design Basis, technical specifications, drawings, data sheets as furnished in the tender and any other information provided by Engineer-In-Charge. The general scope of work includes the following:

### I. SITE VISIT (PIPELINE & TERMINALS)

- Site visit: Contractor shall make site visits along the pipeline route, identify all the salient features ofterrain, availability of ROU and infrastructure along the pipeline route. Contractor shall also make site visits for terminal stations as per bid requirement.

### A. Materials to be Supplied by Company as Free Issue

i. Free issue material shall be supplied from M/s HNGPL designated stores in Haridwar. Further,Contractor shall also return any unused materials after completion of work to owners designated store in Haridwar.

### II. CONSTRUCTION: INSTALLATION, ERECTION & TESTING

a. Contractor shall carry out construction work as per "Issued for Construction" drawings, procedures,

specification and applicable codes and standards. Any changes at site shall need prior approval from the Engineer-In-Charge.

b. Contractor shall receive and takeover of all owner supplied free issue materials from the designated place(s) of issue. The transportation including loading, unloading, handling, storing tillinstallation of materials shall be the responsibility of contractor.

c. Contractor shall be responsible for delivery and handling of bought out material at site.

d. Contractor shall obtain no objection certificates (NOC) from authorities, land owners or any other statutory body. Company has obtained most of the clearances, No objection certificates (NOC) forlaying pipeline & for stations from concerned authorities. However, for some of the permissions, ifnot available, Contractor shall do the follow up with the concerned authorities to get the permissions to execute the job in time. In such cases, all statutory payments required for such permissions shall be reimbursed by Company at actuals. Contractor shall obtain permits/clearancefrom concerned authorities before actual commencement of the job at site including preparation and establishment of safety procedures for laying pipeline.

e. Contractor shall also coordinate and use his best deeds to carry out the construction of pipeline with the general permission provided by client.

f. Contractor shall mobilize adequate manpower, machinery, tools, tackles, consumables etc for construction.Immediately after award of individual work, Contractor shall make a visit to the route to establish the route and familiarize with the working conditions so as to plan for deployment of manpower and machinery.

g. Contractor shall do clearing and grading of ROU and station plots.

h. Contractor shall do stringing, welding and lowering of main pipeline.

i. Contractor shall do work in restricted ROU along with large number of utilities & utility crossing. Most of the areas the Pipeline shall be laid along the road and industrial area. The ROU shall be restricted. Excavated trench & pits in area near heavy traffic and other areas of movement, shall not be left open without barricading.

Contractor may plan to work in the Night shift to avoid traffic while crossing roads & utilities. But Contractor has to plan and take approval from Engineer-In-charge/ Client and Concerned Authorities before start of construction. Contractor to arrange all lighting and safety precaution for the same.

In some areas where mechanized excavation is not possible, Contractor shall have to do manual Excavation also.

j. Contractor shall do earthwork such as excavation, trenching for all depths and all types of soil,rock blasting and back filling including bottom/top padding as per specification.

k. To ensure adequate quality control, contractor shall make arrangement for stage wise inspectionand testing during construction work at site.

l. Contractor shall carry out NDT as specified in the tender along with selection of production jointsand carrying out the relevant tests as specified in the bid document.

m. Contractor shall carry out concrete coating of Line Pipes, wherever required in addition to the location specified in Alignment / Crossing Drawings as per approved design. All materials, equipment, instruments and consumables required for concrete coating for providing anti- buoyancy to the pipeline, concrete slabs for pipeline protection, crossing bank protection including slope breakers wherever required as per applicable specification/drawings.

n. Contractor shall make Cold Bends from API 5L Gr. X42 / X52 / X60 grade CS Line Pipe (Line Pipe shall be supplied free issue by owner/company). Line pipe grade can be changed dependsupon the requirement and availability by HNGPL.

o. Site restoration shall be done by Contractor as per original condition and to the satisfaction of HNGPL Project Manager/designated authority/owner and NOC to be obtained to this effect.

p. Contractor shall carry out Cleaning, Hydro-testing, Swabbing, Drying, Gauge Pigging, includingsupply of materials, consumables, tools and tackles, equipment/machineries and manpower.

q. Pipeline gauging shall be performed prior to install any elbow in between two sections. Allindividuals sections shall be checked in same method for pipeline gauging.

r. No branch connection or Tee, underground Valve shall be installed before hydrostatic test.

s. After welding of elbow with pipeline section, one-gauge pig run has to be carried out as per 95%ID of Elbow on or before water filling for hydrostatic test.

t. If any section is less than 50 meters then 98% Dia. of Mainline ID pull through shall be carried outinstead of section wise pipeline gauging.

u. If pipeline passes through the edge of small lined drain/ RCC Drain/ Stone Pitching required restoration shall be carried out after completion of laying works. Prior approval needs to be takenregarding construction and restoration procedure from Engineer-In-Charge.

v. Contractor shall carryout AC & DC interference surveys and shall take suitable measures for the mitigations of AC & DC interference.

w. Contractor shall carry out Installation, Testing &Commissioning of TCP (Temporary Cathodic Protection) and PCP (Permanent Cathodic Protection).

x. Contractor shall carry out Land and site development work for stations including earth filling wherever required.

y. Contractor shall carry out Civil works for stations including RCC approach road wherever required.

z. Contractor shall carry out Mounting/Installation of all field instruments like Pressure Gauge (PG),etc. as per P&ID.

aa. Contractor shall carry out HDD crossing (wherever applicable) as specified in the tender specification.

bb. Hydrostatic testing of Pipeline shall exclude valves at tap off stations, and terminals and facilitiesthat are to be installed as a part of the stations. Temporary test headers shall be provided and the pipeline shall be hydrostatically tested between the temporary test headers only. The pipelineshall be hydrostatically tested at least 1.5 times of Design pressure. But the maximum hydrotestpressure shall not exceed 90 % SMYS of the pipe material at any location and at any point of time of the lowest wall thickness of that section. The highest point of the test section shall be subjected to the minimum test pressure as specified above. Hydrotest shall be for 24 hours duration.

Hydrotest shall be done with corrosion inhibitor and dosage of corrosion inhibitor shall be suitablefor 3 months.

Subsequent to separate hydro testing of pipeline and associated facilities, tie-in/hook up shall be carried out by the Contractor. Pipes/prefabricated assembly used for such tie-in shall be pretestedto a test pressure specified for the pipeline. All materials required for the fabrication of the test headers shall be provided by the Contractor at no extra cost to Company. After successful completion of hydrostatic testing, the Contractor shall de water the pipeline as per the directions ofEngineer-in-charge.

cc. Piping facilities between the insulating joint and hook up point/battery limit and all above ground facilities installed by Contractor shall be hydrostatically tested to a test pressure equivalent to 1.5 times design pressure in accordance with “Standard specification for Inspection, Flushing and Testing of Piping System” enclosed with the Contract document. Duration of testing shall be minimum 6 hours. All valves in the piping network being hydrotested shall be kept in the crack open position.

dd. For any welding the electrodes, consumables and flux shall be of same manufacturer. Weld abilityTest Shall be carried out on line pipe segment of 12 meter each. Thereafter, RT will be taken of joint after 24hours and 72 hours followed by destructive testing as per QAP.

ii. Contractor shall carry out minimum one sample considered for Production Weld Test sample. Thesample selection shall be selected by TPIA/Client/Client Representative.

jj. Contractor shall carry out fabrication of station piping and construction & installation of pipe supports.

kk. Contractor shall carry out installation, commissioning of free issue material like filtration and metering skid including loading, unloading, transportation from anywhere of HNGPL designated store location.

ll. Contractor shall carry out Hook up / tie-in of pipeline and piping system with terminal facilities.mm.

Contractor shall carry out Idle time preservation of the pipeline (if required).

nn. It is envisaged that dewatering and swabbing operations shall be carried out as a part of pre- commissioning activities. Dewatering of pipeline after hydrostatic testing shall be taken up by Contractor only when Contractor is ready for swabbing operations.

oo. Contractor shall carry out Pre-hydro testing and Post-hydro testing of all cased crossings and after major crossings and or additionally imposed by Engineer-In-Charge/ Concerned authorities.

Contractor shall submit a detailed procedure for leak detection during hydrotest. Such method ofdetection

shall consume minimum possible time to complete the hydrotest activity within contractual completion schedules. This procedure needs approval of the Engineer-in-charge.

pp. Contractor shall make proper waste disposal system for construction and related works.

qq. Contractor shall carry out all incidental and associated works and any other works not specificallylisted there in but are required to be carried out to complete entire work related to pipelines and terminals.

rr. Contractor shall carry out Induction and strict implementation of Health, Safety & Environment (HSE) procedures including safety organization, HSE plan, providing PPE, providing adequate barricades at work site wherever required, conducting periodic audit and ensuring the implementation of HSE measures. Contractor shall be fully responsible & liable for ensuring & implementing HSE at site & shall hold Engineer-In-Charge fully indemnify from all liabilities & consequences.

ss. Welder qualification test shall be required for each welder, If welder is not working from last 3 months then destructive testing shall be compulsory for welder qualification.

**Following points shall be taken care by the contractor before/ during execution works.**

i) Contractor shall be responsible for taking necessary precautions regardingtraffic (installation of notice / warning boards).

ii) Contractor shall be totally responsible for the occurrence of any accident during excavation of road and shall be liable for damages / expenses due to the same.

iii) Concerned authority / Owner shall not be responsible for any loss / damage.

iv) One copy of the permission shall be made available with contractor's responsible workman at the place where excavation is undertaken.

v) While executing the subject work, excavation shall be done in consultationwith the concerned authority engineer of that area.

vi) Necessary safety measures shall be taken for the gas pipeline, since high tension lines and other services carriers are running alongwith in gas pipeline route in thearea.

## III. PRE-COMMISSIONING & COMMISSIONING

Contractor shall carry out Golden joints clearance. Contractor shall carry out Drying as per specifications.
Contractor shall carry out Gauge pigging of main line as described.
Contractor shall carry out Pre-Commissioning of complete system including, Filtration, meteringand Pressure Reducing skid (If applicable)

Overall commissioning activities including drying, nitrogen purging etc. for entire pipeline and terminals shall be performed the Contractor. Contractor shall mobilize all equipment, consumables,nitrogen and manpower for carrying out pigging, drying, inertisation and commissioning activities.

## IV. PROJECT CLOSE OUT

Submission of all as built documentation (2 Set), inspection reports, purchase orders, materialreconciliation report, NDT records both in soft and hard copy duly approved by Engineer-In-Charge.

Submission of operational acceptance report including all the documents, test certificates etc.Pre-

Commissioning and Commissioning

- Pre-commissioning activities such as Hydro-testing, Swabbing, Drying, Gauge Pigging,Vacuum drying and nitrogen purging for mainline & station piping system for mainline.
- Pre-Commissioning of complete system including Filtration and Pressure Reducing skid (If applicable)

- Commissioning with Natural Gas. This also includes commissioning of complete pipeline system i.e. pipeline, spurline, Civil, Electrical including Cathodic Protection, Instrumentation

and associated works / facilities.

- Commissioning of Pipeline and associated systems including supply of materials (temporary,permanent or consumables), tools and tackles (including special tools & tackles) andmanpower.

**3.0 DETAILED SCOPE OF WORK**

**3.1 PIPELINE LAYING WORKS**

I. "Receiving and Taking-over" as defined in the specifications stacking in the yards / dump site andstringing of pipes in Right-of-use (ROU), including arranging all necessary intermediate storage area(s) required there till the coated pipes are installed in permanent installation.

II. Transportation of pipes from the designated dumpsite to designated ROU/ROW for stringing.

III. Carrying out inspection of OWNER supplied materials if any at the time of receiving and taking- over.

IV. For pipes where cutting out involves more than 25 mm from pipe ends, ultrasonic inspection shallbe carried out at pipe ends as per relevant clause of line pipe specification enclosed with the tenderincluding supply of all equipment's . Contractor shall take prior approval from Company for the agency engaged for carrying out ultrasonic inspection.

V. Loading, unloading, handling stacking, storing and transportation to workshop / work site of all materials that may be used for the construction of pipeline system supplied by Client/Contractor attheir designated stack yard /dump site /store.

VI. The contractor shall notify the owner the probable date of commencement of work at ROU site at least two (2) weeks in advance to enable the owner to arrange handing over of the ROU / site on the date requested. Should contractor fail in such notification, the owner shall not be liable for anyclaim by contractor, of whatsoever nature, for delay in the available of a ROU / site.

VII. Mobilizing and providing all equipment's , manpower (skilled and unskilled), consumables and otherresource etc. as required for the execution of complete work and thereafter demobilizing the sameupon completion of work.

VIII. Contractor shall mobilize the machinery and manpower as defined in the tender document. Each contractor shall be responsible for the entire scope of work of individual part including commissioning and gas in and shall mobilize the equipment and manpower accordingly.

IX. The Company shall obtain a general permission from most of the authorities having jurisdiction over the area as necessary for construction of the pipeline. However, for some of the permissions,if not available, Contractor shall do the follow up with the concerned authorities to get the permissions to execute the job in time. However, all statutory payments required for suchpermissions shall be reimbursed by Company at actuals. Contractor shall also obtain the necessary permits like work permit/ excavation permit/ trench opening permit etc. for all works from the authorities having jurisdiction before the actual execution of various phases of the works and all stipulations/ conditions/recommendations of the said authorities shall be strictly complied with no extra cost to Company. Contractor shall also obtain all necessary permissions from the concerned authorities for installation of pipeline at railways, roads and water/nala, drain crossings. Companymay, however, assist Contractor in obtaining such permissions, wherever required, by issuing recommendation letters etc. In case of damage to other utilities/infrastructure, Contractor shall beresponsible and the required compensation, as per the directions of concerned authorities, shall be paid by the Contractor. After completion of work, Contractor shall obtain a certificate from the concerned authorities that the job has been completed as per their requirement and the area/landhas been restored to their satisfaction.

X. Staking, clearing, grading, fencing of Right-of-Use (ROU) as required, trenching to all depths in alltypes of soil including soft, hard rock, controlled rock blasting / rock blasting by special techniques, chiseling or otherwise cutting etc. to a width to also accommodate the cable conduit as per relevantstandards, drawings, specification etc. Transportation of coated pipes to ROU along the route, stringing, aligning, bending, welding, NDT including radiography by X-ray/Gamma and ultrasonic inspection, field weld joint coating including supply of all materials, protective coating of long radiusbends including supply of all materials, protective coating of long radius bends if applicable including supply of materials as per specification sand padding, laying and lowering of the pipeline,back filling, slope breakers as required, carrying out rail, road, canal, utility and submerged minor and major water course crossings including installation of carrier pipe inside casing pipe at cased crossing wherever required, bank stabilization of water course crossing as required, crossing of river / canal by conventional method and arranging all additional temporary land / area required for

construction purposes. Supply and installation of anti-buoyancy measures viz. continuous concrete coating, saddle weights, extra cover etc. on pipeline as shown in approved drawings and as directed by OWNER, installation of supports wherever required, supply of select backfill material as required, clean-up, pigging, flushing, gauging, hydrostatic testing with quantity of inhibitor as required, dewatering with the additive, at required dosage, swabbing, pre-commissioning and commissioning of complete pipeline system, including all associated works as per relevantspecifications, standards and approved drawings.

XI. Welding of all **Golden Tie**-in joints including tie-in joints and bends on either side of water body crossing / with adjoining pipeline installed by others / other facilities as required, cutting of test header, rebevelling and tie-in with adjacent pipeline segments. The welding shall be mainly semi- automatic/ manual type and contractor shall follow the technical specifications as defined in the tender document.

XII. Field weld joint coating shall be by heat shrink sleeve / other suitable material as per specificationenclosed with bid package compatible of pipe coating material. Any damage in coating shall be repaired as per the approved procedure and the same shall be holiday tested after joint coating.

XIII. Carrying out corrosion coating of Long Radius (LR) bends if any. Coating shall be carried out by heat shrink sleeve / other suitable material as per specification enclosed with bid package for fieldjoint coating.

XIV. Supply and Installation of casing pipes (by open cut / jacking / boring) assembly, including supply of all material viz. casing pipe, casing insulators and end seal, vents and drains etc. complete, at cased crossings as per the drawings / specifications enclosed with bid package.

XV. All works / provisions including installation of slope breakers to be provided in the trench in areas where slope is more than 1 in 10.

XVI. Sand / soft soil padding around pipe wherever required in areas where trenching has been done inrock including supply of sand / soft soil. The thickness of sand / soft soil padding at the bottom of pipe shall be 300mm in rocky areas.

XVII. Installation of all inline / online instruments / valves / insulation joints / appurtenances etc. as per requirements of approved drawings.

XVIII. Providing 300-micron high built abrasive resistant epoxy on the external surface of 6” CS conduitsmeant for OFC (in crossings) wherever required.

XIX. Indian Railways shall approve the crossing drawing for railway crossings and construction shall becarried out accordingly. The Contractor shall make these drawings available at appropriate time during the execution of the project. Pipeline at railway crossings shall be provided with a casing pipe. The railway crossing shall comply with the requirements of API 1102 and Indian Railway regulations.

XX. Contractor shall firm the method of crossing of roads such as open cut / boring / HDD up in consultation with concerned authorities and Company. The Contractor shall also take due care to identify and take due precautions so as not to disturb or damage the utilities like cables, water linesand other structures.

i. No damage should be caused to any irrigation sources, while laying the pipeline through road crossings.

ii. The flood banks of the River / Canal should be brought to the original condition, if they are damagedwhile the laying of the pipeline. Stabilization of banks shall be carried out as per requirements of concerned authorities.

iii. In general the top of the pipeline shall be taken at least 2.5 meter below the scour level of river crossing. The top of pipeline shall be at least 1.5m to 2.0m below the drain / canal bed unless specified otherwise. The minimum cover requirements shall be as defined in drawings/ technical specifications as defined in the bid document.

iv. Pre-construction survey, preparation of the detailed construction methodology / plan and time etc.shall have to be finalized by Contractor in consultation with concerned authorities having jurisdiction over canals / rivers. Company shall provide assistance by providing introductory letters.

v. Pre-construction surveys, preparation of detailed construction method statement and calculationsfor Owner’s approval.

vi. Surveys like Geo-technical, Hydrological and Topographical for pipeline route, Station plots, Rail and Road crossing etc and water crossings.

vii. Site preparation, arranging required land for setting up of string fabrication yard and obtaining necessary permissions from concerned authorities.

viii. Preparation of pipeline Launch way, continuous concrete coating of pipes, repair of damages to corrosion and concrete coating, string preparation, field welding, NDT including radiography, pre- test for completed strings, corrosion and concrete coating of field joints, trenching, laying at approved depth, stabilization of banks, post installation hydro-test, capping, providing and installingof markers, etc.

XXI. Contractor shall cross the road / canal etc. by HDD/ trench less method at locations as directed byOwner / Consultant as per crossings survey drawing done by contractor. Before start of HDD, thecontractor shall ascertain by pre-construction survey all underground obstacles namely electrical /telecommunication cable, foreign pipeline water line, drain / sewerage line and prepare crossing profile drawings showing all elevation & levels. The contractor shall also ascertain the type of soil & their terrain whether rocky or normal by way of trial pit etc. before start of job. The contractor shall submit procedure; profile drawing with complete design calculations of HDD as per requirement of ASME B31.8 / OISD norms and safety requirement that pipe is not under stress during and after crossing for Owner / Consultant's approval prior to start the execution of work.

XXII. Contractor shall ensure all safety norms regarding distances from end point or from bottom of crossing and also ensure that external coating of pipe is not damaged during pulling & handling ofpipe for crossing. For field joint coating in pipeline string made for HDD, special type of heat shrinksleeve shall be used as per specification enclosed with the tender. For line pipe coating repair, special type of high shear strength repair patch material shall be used which characteristic shall besame or equivalent as original wrap round heat shrink sleeve used in pipeline string for HDD crossing.

XXIII. The contractor shall ensure that no any underground existing utilities / pipelines / cable etc. is damaged. It shall be responsibility of contractor to compensate any loss or damage while crossing.Contractor shall arrange all statutory permission from concerned authority before start of job. Contractor shall deploy only HNGPL recommended HDD agency and approval of agency shall be sought before deploying HDD agency.

XXIV. Where the pipeline route passes through forest / plantation areas, Contractor shall clear only the minimum width required for laying the pipeline as per Owner approved procedure for pipeline construction. Number of trees / plants to be felled down shall be restricted to a minimum.

XXV. Clean-up and restoration of ROW and other conveniences like road, rail, canals, cultivable land etc. to original conditions as per specification and drawings to the entire satisfaction of OWNER and / or authorities having jurisdiction over the same, including disposal of surplus construction materials to a location identified by CONTRACTOR approved by local authority without causing any disturbance to environment, location and to the entire satisfaction of OWNER.

XXVI. Upon restoration of ROU the Contractor shall furnish documentary evidence in support of acceptance of he same duly signed by land Owner without any extra cost.

XXVII. Carrying out Intelligent Pigging & Electronic Geometric/calliper pigging (EGP) for feeder line as applicable including supply of all types of pigs, pig locating and tracking device, spares, consumables, manpower etc. as per specification enclosed with bid / contract document.

XXVIII. Carrying out repair of all defects found during Geometric/calliper pigging including locating, digging,cutting, welding, NDT etc.

XXIX. Carrying out cleaning, flushing, swabbing (as applicable), dewatering, testing and pre- commissioning of pipeline and associated facilities at Dispatch Station, Sectionalizing Valve

Stations, Tap-off and Receipt Station up to the respective battery limits. Locating all major andminor leaks during hydro testing if any.

XXX. Repair of any leaks / burst occurring during testing of main pipeline. In case of failure duringhydrotest the entire section shall be re-hydrotested.

XXXI. Tie- in with the pipeline at rail, road and other crossings including cutting of test headers as requiredand tie-in

with terminal piping & with existing facilities as applicable.

XXXII. Idle time preservation of the pipeline (if required) for the specified period by filling with nitrogen to a positive pressure of 1 bar (g) including supply of nitrogen etc. as required.

XXXIII. Installation of carrier pipe in canal / road (NH / Express Highway) / railway crossings by boring / HDD / Trench less method, as directed by Company. Contractor to note that the minimum elastic bend radius to be adopted, shall be as per pipeline engineering design basis enclosed with the tender.

XXXIV. Obtaining hot work permits from Company / concerned authorities having jurisdiction there of to work within existing and operating terminals including strictly complying with all stipulations / conditions recommendation of the concerned authorities and providing all safety appliances, gas detector, fire screens required during execution of the work as per the direction of Company / Engineer –in-Charge. Coordinating all activities with Company for movement of men and materialfrom and to existing and operating terminals shall be the responsibility of the contractor.

XXXV. All incidental and associated works not specifically listed herein but are required to be carried out to complete entire work related to pipelines and the associated facilities and making the entire pipeline system ready for operation.

XXXVI. The contractor shall be responsible for taking over of the material and subsequent handling, hauling, transportation to the actual work site(s) / fabrication yards(s) and storage & safe keeping of the materials.

XXXVII. The Contractor shall inspect all Company supplied free issue materials at the time of taking over form the Company and defects noticed, if any, shall be brought to the notice of Company / Company representative and jointly recorded. Once the material has been taken over by the Contractor, all the responsibility for safe keeping of the materials and repair of damage / defects topipe & pipe coating shall rest with the Contractor.

XXXVIII. Removal of dents in bevels less than 1 mm in depth shall be carried out by Contractor ahead of welding in the field at no extra cost to Company.

- Pipe off cut

The contractor shall keep a detailed inventory of the pipes received, per type of pipe & a note of their location.
The contractor shall provide summary of the above to the owner.
The pipes off-cut can still be used in the life time of the contract. Before the end of leak test the contractor shall provide the owner with an inventory of the surplus pipes.
The term" surplus pipe" defined as "Any pipe that can immediately be reused (undeformed, numbered, coating & is in good condition) bearing individual pipe number, stamp of the recognizedinspection agency, origin, type & length".
Only complete lengths of pipe element will be taken back by the owner. All other pipe surplus is the responsibility of contractor. Before termination of leak tests the contractor will draw up a final account of the pipes & transmit to owner as per following settlement formula.

**Settlement Formula**

X = Tr – (Tp + Tc + Cr + Lr)
Where,
Tr = Length of the pipes delivered & accepted on the working sites and issued to contractor.
Tp = Length of the pipes effectively laid.
Tc = Permitted loss (=0.3% of effective length of the pipe laid)Cr
= Length of the returnable pipe (2m & above)
Lr = Length of defective pipes element rejected for reasons which are not attributable to contractor.
X = Length involved to the contractor.

- **Returnable minimum length of pipe:**

Minimum length of pipe to be returned shall not be less than 2m. All pipe elements shall bear the individual pipe number, stamp of the recognized inspection agency, original typeand length.

- **Returning the Surplus Material**

Only the material supplied by the owner as free issue material should be returned in good conditions and while returning, should be accompanied by all needful certificatory. If the free issuematerial is damaged or misused by the contractor, he will be charged twice the cost of the material.The contractor shall be solely responsible for any damage or misuse of the material supplied by him and no extra compensation either by way of time or cost shall be admissible.

- On completion of the work contractor shall submit to the company, an account for the material issued to the Contractor in the Performa prescribed by Engineer – in –Charge.

All such works which are not indicated here but otherwise required to complete the work in all respect in accordance with the specifications, drawings & other requirements of bid package shallalso form part of Bidder's / Contractor's scope of work.

- Carrying out temporary and permanent cathodic protection works as defined in the bid package.
- Loading, unloading, handing over and transportation of all surplus Company supplied free issue line pipe after completion of works Company's designated warehouse as directed by Engineer-in-Charge and stacking the same. Stacking of surplus pipe shall be inclusive of supplying of sand bags etc. at Company store for proper stacking.

### 3.2 TERMINAL PIPING WORKS

I. Receiving and Taking-over" Company supplied free issue Filter, Metering and PRS skid from designated warehouse, loading, transportation, unloading, at Contractor's worksite(s)/ workshop tillthe skid is installed in permanent installation. The contractor shall make his own arrangement of crane for lifting of all free issue material.

II. Supply, fabrication and erection of pipe/ equipment supports (for all sizes/ thickness) including shoes, pipes, cradles, turn buckles, T-posts for all types of guides, anchors, all necessary equipment,consumables, labour etc. for completing all works including supply of bolts, nuts, washers, U-clamps,wooden blocks etc. as required for supporting.

III. Hook-up of piping with skids, equipment's & vessels, with the existing facilities, with the pipeline andat the battery limit with the facilities installed by others by welding or by flanged connection includingcutting, fit-up, welding, NDT, radiography, interface/coordination as required with other Contractor(s)/Agencies.

IV. Painting of all equipment's, structural steel elements for pipe supports, above ground piping and allrelated miscellaneous items as per company specification enclosed with the bid document. Application thickness shall be as per painting specification.

V. Protective coating of 500 micron thick two component epoxy (achieved by application of three coats) duly recommended by Company for all underground piping, valves, fittings, etc.as per specificationsincluding supply of all materials.

VI. Hydro testing, dewatering, flushing & pre-commissioning activities of piping system of all sizes as per specifications enclosed including supply of all materials and manpower that are required during pre-commissioning and all associated works. Identification of leaks during hydrotesting & repair of defects.

VII. Final clean up and restoration of site, facilities etc. as per the requirement of Company/Engineer-in-Charge.

VIII. Preparation of General Arrangement Drawings (GAD), isometrics and/or fabrication drawingsrequired for the purpose of fabrication during execution of work.

IX. Preparation of as-built drawings, documents and project records as per instructions of Engineer-in-Charge.

X. Co-ordination as required with other Agencies/Sub-Contractor(s) till the time the commissioning operations are complete.

XI. Any other works not specifically listed herein but required for completion of the works in all respects.

### 3.3 CIVIL / STRUCTURE WORKS

The scope of civil / structural and Architectural works under this Contract shall include Residual Engineering, detailing, supply and construction of all relevant civil / structural and Architectural worksas per Design Basis, Specifications, standards, Addendums and Drawings enclosed with the bid document.

The Civil scope of work shall consist of below ground / above ground RCC Valve Chambers at Sectionalizing Valve Stations & Tap-Off stations or as per the issued drawings.

The chambers shall be covered at top with removable Pre-cast RCC covers / slabs / chequeredplates and provided with an access steel ladder and floor sump.

Provision for bolting the precast /chequered plate covers shall be made.

The valve chamber shall be provided with a 750m wide walkway all around with 100 mm thick PCCsloping away from the chamber or as per the issued drawings..

Providing foundation for DRS / MRS unit, Pipe Supports (as applicable at Compressor / DRS /MRS end).

The foundation shall be 200 mm thick Rubble soling, 100 mm thick PCC and 300 mm thick RCC with reinforcement or as per the issued drawings.

### 3.4 CATHODIC PROTECTION WORKS

i. Scope is including Design, Engineering, supply, installation, field inspection, testing, commissioningof TCP. Preparation of Design package of TCP.

II. Issued for Construction drawings and documents and As-built drawings and documents.

III. Supply, installation, pre-commissioning and commissioning and monitoring TCP till handover to owner.

IV. Checking and Mitigation of any AC/DC interferences on pipeline.

V. TCP of Pipeline as applicable as per approved design document during detailed engineering.

VI. All equipment and materials including cables, CPTR/CPPSM units, various types of test stations, junction boxes, anodes, grounding equipment/items/anodes, polarization cells, polarization, coupons, surge diverters, spark gap arrestors, bonding stations along with diodes, shunts and variable resistors etc. as required for Temporary cathodic protection & Permanent cathodic protection system of pipelines in line with standard specification, design basis and datasheet are included in the scope of supply of the contractor.

VII. Installation, Commissioning & monitoring of TCP till commissioning o for main pipeline.

VIII. Post commissioning surveys as per defined in standard specifications of Cathodic Protection system.

IX. Pipeline is passing through many foreign lines & other utilities either parallel or diagonal, CP interferences shall be mitigated in permanent measures.

X. Any other work not specifically mentioned above, but required for the proper execution of the cathodic protection.

### 3.5 INSTRUMENTATION WORKS

The scope of work & supply shall generally be as follows, however Contractor to The scope of work& supply shall generally be as follows, however contractor to provide all materials/instrumentation,install & commission them as per P&IDs and other data provided in tender to complete the work inall respects.

- Supply, installation, calibration & commissioning of all the instruments (like Pressure Gauge etc.)as per P&IDs, Data sheets, Technical standard / specs.
- Supply of Firefighting system i.e. fire extinguishers as per PNGRB / OISD requirement.
- Installation, testing & commissioning of Filtration + PRS + Metering Skid as applicable.
- Any other work not specifically mentioned above, but required for the proper execution of the instrumentation erection work.
- As-built drawings and final documents etc.

## 5.0 CONTRACTOR'S RESPONSIBILITIES

Contractor's responsibilities, besides the scope of work to be performed by him defined earlier, shallalso include the following:

a. Appraisal and taking cognizance of site-conditions, pipeline route, Central Government, State Government rules and regulations/ bye-laws, applicable Indian Standards and Codes, authorities having jurisdiction over the work site(s), environmental and pollution concerns including conditions/stipulations laid down by the concerned authorities etc. The Contractor is deemed to have recognized any restrictive features and constraints of the site(s), pipeline route and /or specific requirements of the work and made due allowance for it in the work to be performed by him.

b. Company shall provide the available information and survey data along pipeline route and crossings.Company gives no guarantee or warranty as to the accuracy or completeness of the information provided. It is the Contractor's sole responsibility to obtain sufficient information / data along pipelineroute and crossings to allow safe and sound design and installation of the proposed pipeline. Wherever company's survey Alignment & crossing drawings are not available, Contractor shall survey for Pipeline Alignment & all crossings and collects all information to submit in the form of Pipeline Alignment and crossing drawings as per engineering standards. Contractor also carryout Topographic and soil investigation survey for the terminal plot within 7 days from LOI date and submitto company for finalisation of Plot Plan and foundation drawings to start the construction work.

c. Interpretation and verification of data/information furnished by Company in respect of pipeline routesurveys, crossing details, contained in the bid package. Any additional information/data/surveys etc. required by Contractor for detailed engineering and execution of the works shall be obtained by him.Company may assist him in obtaining such information/ data by issuing recommendatory letters.

d. Residual engineering including drawings and installation procedures, engineering for procurement & fabrication, engineering for installation including drawings, QA/QC procedures, etc performed by the Contractor shall be reviewed and approved by Company. Contractor shall submit engineering documents, drawings, procedures in hard copy to Company before start of construction work at site.All works shall be executed based on approved documents only.

Contractor shall prepare general arrangement drawing, isometric drawing & bill of materials, HDD design & drawing, Crossing drawings, Pipeline Alignment sheet including detour portion(wherever applicable), Topography & Geotechnical survey, CP design, vendor engineering drawing & documents etc. and submit the same from Owner/ consultant's approval/ record. Contractor shall prepare drawing for utilities line as required as per SOR and submit the same for Owner/ Consultant's approval /record.

e. Review and approval of Contractor's entire work(s) or approved IFC drawing provided by Companyshall in no way relieve the Contractor of his sole responsibility for safe and efficient design, engineering, installation and subsequent operation of pipeline system.

f. Furnishing and mobilizing at site(s) of all construction equipment, manpower, tools and tackles, construction spreads, fully equipped and fully manned with other required support facilities etc. commensurate for spreads needed for successful execution of the works.

g. Contractor shall depute independent third-party inspector for carrying out radiographic inspection/ UT and interpretation of radiograph/ UT of welds. Third party inspector shall be approved by Company.

h. Pre-commissioning/ commissioning of entire pipeline/piping system.

i. Preparing and furnishing calculation books, pipe books, material/ purchase requisitions, finalpurchase orders including specifications, Vendor's data books (including Guarantees), fabrication and construction drawings, all survey reports, inspection and testing reports, as-built records for allphases of work.

j. The Contractor is cautioned to exercise extreme care and take necessary precautions to prevent damage to the existing pipeline(s), facilities, electrical and other cables during execution of the entire works. Restoration/reconstruction of all structures/ facilities affected during pipeline construction shall be carried out by Contractor.

k. Wherever Contractor comes across water lines/open channels/drains in the fields used for cultivation, suitable arrangements similar to or higher specs than the existing type shall be made bythe Contractor for ensuring water supplies across the fields and maintain the same till construction is completed in that stretch. Any claims arising out of noncompliance to the above requirements, asgranted by competent authorities shall be to Contractor's account.

l. Contractor shall carry out all testing and inspection of materials, equipment etc. in independenttesting institutions, laboratories, if so desired by Company.

m. Disposal and treatment of treated hydro-testing water, excavated materials, surplus materials etc.as per local authority's requirements.

n. All works shall be carried out by Contractor strictly in accordance with the drawings/documents/specifications indicated in the list of attachment document.

o. Any other work not specifically listed but required for successful completion of entire pipeline system.

p. Contractor shall prepare the As-built drawings and documents parallel during the execution of work.

q. Contractor shall deploy the multiple welding crew and machinery like Rock cutter, Rock breaker, excavator, poclain, breaker with poclain etc. to execute the work successfully.

- **AS BUILT DOCUMENT**

On successful completion of hydrostatic testing, the Contractor shall prepare As Built drawings / reports for entire pipeline/piping system as specified in scope of work. All "As Built" drawings / reportsshall be submitted as below.

a. Main Pipeline

- As laid alignment sheets and crossing drawings/details.
- As built HDD crossing details, as applicable.

- All Inspection, Testing and NDT records. Radiographs/ UT of all weld joints.
- Pipe and calculation books/records.
- All WPS and WQT (if applicable)
- All NOC from authority (if applicable)
- All inspection & testing documents.
- All purchase specification & procurement documents. (if applicable)

After completion of construction & commissioning of Terminal, contractor shall incorporate all the correction in drawings, prepare and issue all the “As-built drawings“ to the owner as final submissionof drawings.

- For Mainline, pipeline alignment sheet, all X-ing details, all CP drawings, pipe book etc
- For Station, layout drawing, Piping GAD, Isometric, all electrical / instrumentation drawings, all civil drawings.

For final submission only 2 sets of document plus the original transparencies shall be handed over by the contractor. Any construction done by the contractor without duly approved by the drawings shall be wholly at risk and cost Contractor shall also submit soft copy of pipe book in excel along with hard copy. Soft copy of all as-built drawings shall be also submitted in AutoCAD. Videography/ photograph of all major activities/ milestone achieved shall also be arranged and submitted by the contractor. For details of documentation to be submitted form a inline and terminal refer “Specification for pipeline construction” enclosed elsewhere with tender.

# TECHNICAL SPECIFICATION FOR PIPELINE CONSTRUCTION

## CONTENTS

## 1.0 SCOPE

**1.1** This specification defines the minimum requirements for the various activities to be carried out by Contractor for the construction of pipelines.

**1.2** The various activities covered in this specification include all works during the following stages of pipeline construction :

- Clearing, grubbing and grading of Right-Of-Way
- Staking of the pipeline route ;
- Handling, hauling, stringing and stacking/storing of all materials ;
- Trenching ;
- Field – bending of line pipe ;
- Lining-up and Welding
- Pipeline laying ;
- Backfilling ;
- Tie-in ;
- Hydrostatic testing, dewatering and drying
- Installation of auxiliary facilities and appurtenances forming a part of pipeline installation;
- Pre-commissioning and commissioning
- Clean-up and restoration of right-of-way
- Maintenance during defects liability period

**1.3** CONTRACTOR shall submit detailed work procedures including drawings, calculations, as required equipment and manpower deployment details for the all pipeline activities to Owner for approval. Entire work shall be carried out as per approved procedures and to the satisfaction of Owner.

**1.4** CONTRACTOR shall, with due care and diligence, execute the work in compliance with all laws, by-laws, ordinances, regulations etc. and provide all services and labour, inclusive of supervision thereof, all materials, excluding the materials indicated as "Owner Supplied materials" in the CONTRACT, equipment, appliances or other things of whatsoever nature required in or about the execution of the work, whether of a temporary or permanent nature.

**1.5** CONTRACTOR shall be deemed to have obtained all necessary information regarding risks, contingencies and all other circumstances, which may influence the WORK.

**1.6** CONTRACTOR shall be deemed to have inspected and examined the work area(s) and its surroundings and to have satisfied himself so far as practicable as to the form and nature thereof, including sub-surface conditions, hydrological and climatic conditions, the extent and nature of the WORK and materials necessary for the completion of the WORK, and the means of access to the work area(s).

**1.7** CONTRACTOR shall, in connection with the WORK, provide and maintain at his own costs, all lights, guards, fencing, watching etc., when and where necessary or required by OWNER or by any duly constituted authority and/ or by the authorities having jurisdiction thereof for the protection of the WORK and properties or for the safety and the convenience of public and/ or others.

**1.8** CONTRACTOR shall take full responsibility for the stability and safety of all operations and methods involved in the WORK.

## 2.0 CODES AND STANDARDS

**2.1** Reference has been made in this specification to the latest codes, standards andspecifications:

| | | | |
|---|---|---|---|
| a.) | ASME B31.8 | - | Gas Transmission and Distribution Piping systems |
| a) | API 1104 | - | Standard for Welding Pipelines and related facilities |
| b) | API 5L | - | Specification for Line pipe |
| c) | OISD 141 | - | Design construction requirements for cross-country hydrocarbon pipelines. |
| d) | OISD 226 | - | Natural Gas Transmission Pipelines and City Gas Distribution Networks. |

In case of any conflict in the requirements of above codes and this specification, the moststringent requirement shall be followed.

## 3.0 RIGHT-OF-WAY (ROW)

### 3.1 General

CONTRACTOR shall, before starting any clearing operations, familiarise himself with all the requirements of the Authorities having jurisdiction over the Right of Way for work along the pipeline route or in connection with the use of other lands or roads for construction purpose.

Contractor shall notify Owner well in advance during the progress of work, the method of construction for crossing road, pipeline and other existing installations, services and obstacles.

The right of ingress and egress to the ROW shall be limited to points where such ROW intersects public roads, Arrangements for other access required by the CONTRACTOR shall be made by him at his own cost and responsibility, and for such access, and the conditionsof this specification shall also apply.

Where the ROW comes within the area of influence of high voltage electrical installations, the special measures shall be taken.

This distance depends on the voltage carried. For individual pipelines the minimum distanceof the pipeline from the footing of the transmission line shall depend on the voltage. The following shall be the minimum Owner requirement for the clearance from power transmission lines:

| Range of Voltage | Minimum Clearance |
|---|---|
| 0 - 50 KV | 3 m |
| 51 - 200 KV | 5 m |
| 201 - 380 KV | 8 m |

All necessary precautions shall be taken to prevent excavating and hoisting equipment from approaching high voltage lines to within above distances.

A minimum clearance of 500 mm shall be ensured when pipelines are to be laid parallel along underground power and/or communication cables, conductors or conduit. When such clearance cannot be maintained due to unavoidable reasons extra precautions shall be taken as approved by the Owner.

The Right-of-Way (ROW) will be handed over to Contractor by Owner as the work progresses. The Contractor is required to perform his construction activities within the width of ROW set aside for construction of pipeline, unless he has made his own arrangements with the land Owner and/or tenant for using extra land. Variation in the width of ROW caused by local conditions or installation of associated pipeline facilities or existing pipelines will be identified in the field or instructed to the Contractor by Owner.

The Right-of-Way boundary lines shall be staked by the Contractor, so as to prepare the strip for laying the pipeline. Contractor shall also establish all required lines and grades necessary to complete the work and shall be responsible for the accuracy of such lines and grades.

### 3.2 Staking

Prior to clearing operations Contractor shall carry out the following:

- Install bench marks, intersection points and other required survey monuments.
- Stake markers in the centerline of the pipeline at distances of maximum 100 meters for straight line sections and maximum 10 meters for horizontal bends.
- Stake two ROW markers at boundaries at least at every 100 meters.
- Install distinct markers locating and indicating special points, such as but not limited to:

Contract limits, obstacle crossings, change of wall thickness, including correspondingchainage etc.

- All markers shall be of suitable materials so as to last till replacement with permanent markers and shall be colored distinctly for easy identification. Type, material and coloring of stake markers shall be subjected to approval of Owner. Any deviation from the approved alignment shall be executed by Contractor after seeking Owner's approval in writing prior to clearing operations.

- Contractor shall be responsible for the maintenance and replacement of the reference line markers until the permanent pipeline markers are placed.

### 3.3 Fencing

If Owner demands, Contractor shall install temporary fencing on either side of ROW wherever it is required to ensure safety and non-interference with others. For convenience of construction, Contractor shall install temporary gates to the fencing as per Owner's guidelines.

### 3.4 Clearing and Grading

3.4.1 Clearing of Obstacles

Any obstacle, which may hinder the construction and laying of the pipeline along the approved pipeline route and for a strip of land of the size provided shall be removed.

3.4.2 Clearing of Vegetation

All grubbed stumps, timber bush, undergrowth and roots shall be cut and removed from the ROW and shall be disposed off in a method satisfactory to Owner and authorities having jurisdictions. ROW cross fall shall not exceed 10%.

3.4.3 Uprooting of Trees

All trees which may hinder the construction of the pipeline along the approved pipeline route that belong to the protected green belt, reserved forest and other areas demarcated by the government authorities and any other tree in the opinion of the Owner requiring relocation/ re-plantation shall be relocated and replanted by the Contractor at an alternate location as recommended by the jurisdiction authorities / Owner. All such uprooting and re-plantation of trees shall be carried out by the Contractor in a manner that is satisfactory to the jurisdiction authorities/ Owner.

Contractor shall submit a procedure for uprooting and replanting of trees to the Owner for approval.

Trees that are required to be uprooted and not specified / recommended for re-plantation by the jurisdiction authorities / Owner shall be disposed of as debris and cleared from the ROW/Project site by the Contractor.

3.4.4 Grading of ROW

Contractor shall grade the pipeline ROW as required for proper installation of the pipeline, for providing access to the pipeline during construction, and for ensuring that the pipeline is constructed in accordance with the most up-to-date engineering and construction practices. During entire period of pipeline construction and testing, Contractor shall maintain the ROW in motor-able condition. Final cleared & graded ROW shall be subjected to approval of Owner.

### 3.5 Approach roads

Grading operations should normally be carried out along the Right-of-Way (ROW) with mechanical excavators or manually. In certain areas, grading may have to be resorted exclusively by blasting.

In plain, rough or steep terrain, Contractor may have to grade access roads and temporary bypass roads for its own use. Where such access roads do not fall on the Right-of-way, Contractor shall obtain necessary written permission from land owners and tenants and be responsible for all damages caused by the construction and use of such roads at no extra cost to Owner. Where rocky terrain is encountered, grading shall be carried out in all typesof solid rocks which cannot be removed until

loosened by blasting, drilling or by other recognized methods of quarrying solid rocks. In certain areas where restricted ROU is available, contractor shall have to manage and follow other approaches to complete the job.

### 3.6 Provision of detours

Contractor shall be responsible for moving his equipment and men across or around watercourses and road crossings. This may require the construction of temporary bridges orculverts. Contractor shall ensure that such temporary works shall not interfere with normal water flow, avoid overflows, traffic, keep the existing morphology unchanged and shall not unduly damage the banks of water courses. No public ditches or drains shall be filled or bridged for passage of equipment until Contractor has secured written approval of the authorities having jurisdiction over the same. Contractor shall furnish Owner a copy of all such approval.

### 3.7 Off right-of-way damages

Any damage to property outside ROW shall be restored or settled to the Contractor'saccount.

## 4.0 HANDLING, HAULING, STRINGING AND STORING OF MATERIALS

### 4.1 General

Contractor shall be fully responsible for all materials and their identification until the timesuch that the pipes and other materials are installed in permanent installation.

Contractor shall be fully responsible for arranging and paying for stacking/storage areas forthe pipeline materials. However, method of stacking/ storage shall be approved by Owner.

### 4.2 Line pipes

The Contractor shall load, unload, transport and stockpile the bare/coated pipes using approved suitable means and in a manner to avoid damage to the pipe and coating. Contractor shall submit to Owner a complete procedure indicating the manner and arrangement used for handling, transportation and stacking of bare/coated pipes for Owner'sapproval prior to commencement of handling operations.

Stacks shall consist of limited number of layers so that the pressure exercised by the pipes own weight does not cause damage to the coating. Contractor shall submit the stacking height calculations as per API RP 5L1 to Owner for approval. Stacks of different diameters, wall thickness and damaged rejected pipe shall be separately segregated and identified properly. The pipes shall be stacked at a slope so that driving rain does not collect inside the pipe.

The ends of pipes during handling and stacking shall be protected with bevel protectors. Supports shall be provided for at least 10% of the pipeline length. These supports shall be lined with rubber protection. The second layer and subsequent layers shall be separated from each other by material such as straw in plastic covers or mineral wool strips or equivalent.

Materials excluding line pipes shall be stored in sheltered storages.

### 4.3 Stringing of pipe

Pipes shall be unloaded from the stringing trucks/trailers and lowered to the ground by means of boom tractor or swinging crane or other suitable equipment using lifting devices. Dragging or sliding of pipe shall not be permitted. Special precaution shall be taken during stringing of corrosion coated pipe as per the special requirements of previous paragraph. Stringing of pipe shall only be carried out in daylight and after clearing and grading operations have been completed. Pipes shall not be strung directly on the ground and shall be adequately supported with the help of sand bags or other soft material support in order to avoid damage to the pipe coating. Pipe shall not be strung on the Right-of-Way (ROW) in rocky areas where blasting may be required, until all blasting is complete and the area is cleared of all debris. Contractor shall submit to Owner for approval a complete procedure forstringing of line pipes.

### 4.4 Repair of damaged pipes

After the pipe has been strung on the Right-of-Way (ROW), it shall be inspected by the Contractor and the Owner and all defective pipes & pipe ends shall be repaired. Defective pipe shall be repaired or

rejected as the Owner may direct as per the requirements of specification.

**4.5 Identification**

CONTRACTOR shall provide all pipes, bends, etc. greater than 2" with serial numbers as soon as possible and measure their length and state is on the pipes, etc. Pipes to be bent shall be measured prior to bending. Identification (i.e. letter, number and length) shall be indelible.
All serial numbers shall be recorded in a list, which shall also state appurtenant pipe numbers.

Besides recording the stamped - in pipe numbers, length of pipe and painted-on serial numbers, the stamped-in numbers of T-pieces, bends, valves, etc. and the batch numbers ofbends, T-pieces, valves, etc. and the make of valves, shall also be recorded in said list.

Before a pipe length, pipe end, etc. is cut the painted serial number and stamped-in pipe number shall be transferred with the help of low stress punch by CONTRACTOR in the presence of OWNER to either side of the joint which is to be made by cutting, and the changes shall be recorded in the above mentioned list stating the (new) length. The results shall be such that all pipes, pups, etc. of diameter greater than 2" bear clear marks punched with a low stress punch.

CONTRACTOR shall explicitly instruct his staff that parts which cannot be identified must not be removed, except after permission by OWNER.

As a general rule parts must be marked as described above before being moved. In no conditions may unmarked parts be incorporated into the WORK.

**5.0 TRENCHING**

**5.1** Contractor shall excavate and maintain the pipeline trench on the stacked centre line of thepipeline taking into account the curves of the pipeline.

**5.2 Excavation**

5.2.1 Contractor shall, by any method approved by Owner, dig the pipeline trench on the clearedand graded Right-of-Way (ROW).

5.2.2 In cultivated land the arable soil shall be properly prescribed and same to be replaced atoriginal place during backfilling as advised by Owner.

Care shall be exercised to see that fresh soil recovered from trenching operation, intended tobe used for backfilling over the laid pipe in the trench, is not mixed with loose debris or foreign material. The excavated material shall never be deposited over or against the strungpipe.

5.2.3 In steep slope areas or on the hillside, before commencing the works, proper barriers orother protection shall be provided to prevent the removed materials from rolling downhill.

5.2.4 In certain sloppy sections, before the trench cuts through the water table, proper drainageshall be ensured both near the ditch and the right-of-way in order to guarantee soil stability.

**5.3 Blasting**

5.3.1 Contractor shall execute the blasting as per approved procedures, which will also detail outsafety precautions to safe guard the existing pipelines.

5.3.2 No blasting is allowed within 15m of any existing pipeline or structures (either above orbelow ground).

Where blasting is to be carried out, between 50m and 15m away from any existing pipelines or structures (either below or above ground), the Contractor shall submit a procedure for controlled blasting e.g. break-holes, slit trench etc. Contractor shall perform a trial blast for Owner’s approval.

**5.4 Normal covers and trench dimensions**

The trench shall be excavated to a minimum width maintaining clearance on both sides of the installed pipeline and to a depth to maintain the cover of the pipeline as indicated in the other contract documents or approved procedure.

Pipeline shall be laid with at least 500mm free clearance from the obstacles or as specifiedin the

drawings or wherever it is required by concerned authorities.
The following minimum cover shall be maintained:

| Location | | Minimum cover in meters |
|---|---|---|
| a) | Industrial, Commercial & Residential | 1.5 R2 |
| b) | Rocky Terrain | 1.5 R2 |
| c) | Minor water crossings/ canals / drain / nala / stream | 1.5 R2 |
| d) | River crossings for which scour depthis defined (below scour) | 2. 5 R2 |
| e) | River crossings (Bank width < 50 m) (below lowest bed level) | 2.5 R2 |
| f) | Other crossings (Bank width > 50 m)( below lowest bed level) | 2.5 (for normal soil) R2<br>1.5 (for rocky strata) R2 |
| g) | Water crossing by HDD (below leastbed level) | 2.5 R2 |
| h) | Uncased/ Cased Road Crossings/ Station approach | 1. 5 R2 |
| i) | Rail road crossings | 1.7 R2 |
| j) | Drainage, ditches at roads / railway crossings | 1.5 R2 |
| k) | Marshy land and creek area | 1.5 R2 |

Note:

a) In case pipeline is located within 15 m from any dwelling unit, the cover shall be increased by 300 mm over and above that specified.
b) The above-mentioned minimum cover requirements shall be valid for all class locations.
c) Minimum depth of cover shall be measured from the top of pipe coating**/** casing pipe to the top of undisturbed surface of the soil, or top of graded working strip whichever is lower.
d) In case of rivers, which are prone to scour and erosion, adequate safe cover (min.2.5m) shall be provided below the predicted scour profile during the lifetime of pipeline. Contractor shall establish the scour level based on data provided by authorities.

At points where the contour of the earth may require extra depth to fit the minimum radius of the bend as specified or to eliminate unnecessary bending of pipe or where deeper trench is required at the approaches to crossings of roadways, streams etc. contractor shall excavate such additional depths as may be necessary at no extra cost to Owner.

### 5.5 Negative buoyancy to the pipe

Contractor shall dewater if necessary, using well point system or other suitable systems, andthen install the pipe in the trench and backfill the trench. All underground utilities shall be located and protected as per the guidelines of jurisdiction authority/ Owner.

Contractor shall check if up-floating danger for the pipeline is present in open trench. If such danger of up-floating is present, Contractor shall take appropriate measures to prevent up- floating such as applying soil dams and dewatering of trench or temporary filling of water intothe line (in exceptional cases) as approved by Owner. Contractor shall furnish details of all negative buoyancy calculations to the Owner for approval. Contractor shall carry out any antibuoyancy measures only after obtaining Owner’s approval for such calculations.

In case of presence of water on the ditch bottom when the pipeline is being laid, the ditch shall be drained to the extent and for the time required to make a visual inspection of the ditch bottom. After such inspection, the presence of water will be allowed provided its level does not cause sliding of the ditch sides and pipe floating before backfilling.

Wherever up-floating of the pipeline after backfilling is indicated, anti-buoyancy measures shall be provided by Contractor for areas indicated in the drawings or as may be encountered during construction using the following method:

- Applying a continuous concrete coating around the pipe

Any other anti-buoyancy method adopted by the Contractor shall require prior written approval from the Owner.

The above provisions shall be in accordance with the relevant specifications and/or approved procedures / drawings and to the satisfaction of Owner.

## 5.0 Padding

In all cases where rock or gravel or hard soil is encountered in the bottom of the trench,extra padding shall be provided by Contractor as per Owner's instructions. The thickness of the compacted padding shall not be less than 150mm. In those areas that are to be padded,the trench shall be at least 150mm deeper than otherwise required, and evenly and sufficiently padded to keep the pipe when in place, at least 150mm above bottom ofexcavated trench.

The thickness of compacted padding on top of pipe shall be at least 150mm.Exact extent of trench padding shall be as per Owner's instructions. Padding materials that are approved byOwner shall be graded soil / sand and/or other materials containing no gravel, rock, or lumpsof hard soil.

Contractor shall keep the trench in good condition until the pipe is laid.

## 6.0 BENDING

Contractor shall preferably provide for changes of vertical and horizontal alignment by making elastic bends. Contractor may provide cold field bends, at his option for change of direction and change of slope. Owner at his option may authorize factory mad induction hot bends (LR bends) for installation at points where in Owner's judgments the use of such bends is unavoidable.

Over bends shall be made in such a manner that the centre of the bend clears the highpoints of the trench bottom. Sag bends shall fit the bottom of the trench and side bends shall conform and leave specified clearance to the outside wall of the trench.

### 6.1 Cold field bends

The minimum radius of cold field bends shall be as follows:

| Nominal Pipe Size (NPS) | Minimum Radius of Cold Bend |
|---|---|
| Less than 12" | 21D |
| 14 "- 16" | 30D |
| Greater than 16" | 40D |

Spiral SAW line pipes shall not be used for fabrication of cold field bends.
Contractor shall use a bending machine and mandrel and employ recognized and accepted methods of bending of coated pipe in accordance with good pipeline construction practice.

However, bending machines shall be capable of making bends without wrinkles, buckles, stretching and with minimum damage to the coating.

6.1.1 Contractor shall, before the start of the work, submit and demonstrate to Owner a bending procedure, which shall conform to the recommendations of the bending machine manufacturer. The procedure shall include amongst other steps – lengths, maximum degree per pull and method and accuracy of measurement during pulling of the bend. This procedure and the equipment used shall be subjected to Owner's approval.

6.1.2 For welded pipes, longitudinal seam shall be suitably placed as per approved procedure so that the weld seam shall not be overstressed.

6.1.2 The ends of each bend length shall be straight and not involved anyway in the bending. Thelength of the straight section shall permit easy joining. In no event shall the end of the bend be closer than 1.0m from the end of a pipe.

6.1.3 The ovality used on each pipe by bending shall be less than 2.5% of the nominal diameter atany point. Ovality is defined as the reduction or increase in the internal diameter of the pipe compared with the nominal internal diameter. A check shall be performed on all bends in the presence of Owner by passing a gauging pig / buckle detector consisting of two discs with a diameter equal to 95% of the nominal internal diameter of the pipe connected rigidly togetherat a distance equal to 300mm.

6.1.4 Cold bend pipes on site shall have the corrosion coating carefully checked with the aid of a holiday detector for cracks in the coating down to the pipe wall. It must also be checked whether the coating has been disbanded from the pipe wall during bending by beating with awooden mallet along the outer radius. Any defects or disbanding of the coating caused during bending shall be repaired at the Contractor's expense in accordance with Owner's approved procedures.

**6.2 Elastic Bends**

The minimum allowable radius for elastic bends in the buried pipeline including that for continuous concrete weight coated pipe shall be in accordance with relevant job standards. The elastic bend shall be continuously supported over its full length. A radius smaller than permitted in elastic bending shall require a cold bend.

**6.3 Miter and Unsatisfactory Bends**

All bends showing buckling, wrinkles, cracks or other visible defects or which are in any way in disagreement, in whole or in part, with this specification shall be rejected.

No miter bends shall be permitted in the construction of the pipe line. CONTRACTOR shall cut out and remove any bend or bends which do not meet the specifications and shall replace the same with satisfactory bends at no additional cost to the OWNER.

In the event the CONTRACT provides for supply of line pipe by OWNER, the pipes required for replacement will be furnished by OWNER, but the cost of replacement of such pipes shallbe borne by CONTRACTOR. Cutting of factory made bends and cold field bends for any purpose are not permitted.

**7.0 LINING UP**

Each length of pipe shall be thoroughly examined internally and externally to make sure that it is free from visual defects, damage, severe corrosion (sea water pitting), dirt, animals or any other foreign objects. Each length of the pipe shall be adequately swabbed, either by use of canvas belt disc of proper diameter or by other methods approved by the Owner. Damaged/ corroded pipes shall be kept separate. Each length of pipe shall be pulled through just before being welded. Contactor shall submit a detail procedure for Lining of linepipe to Owner for approval.

**7.1 Pipe defects and repairs**

7.1.1 Acceptability of defects in the pipe detected during inspection at the work site shall be determined in accordance with approved procedures or Code ASME B31.8/ API 5L whichever is more stringent.

7.1.2 Repair on line pipe shall be executed as specified in specification or Code ASME B31.8/ API 5L whichever is more stringent.

7.1.3 Repair of damaged pipe ends by hammering and/or heating is not allowed. Contractor shall submit detailed procedure for pipe defects and repairs to Owner for approval

### 7.2 Skid spacing

7.2.1 A strip of soft material shall be placed in between skid and pipe to protect the external coating of pipe from any damage.

7.2.2 The pipes shall be maintained from skids at the minimum distance of 500mm above ground.

### 7.3 Night Caps/ Temporary Caps

After each day's work or when work is interrupted, the open ends of the welded strings of pipes shall be capped with a securely closed metal cap as approved by Owner.

## 8.0 LAYING OF PIPE

### 8.1 Lowering in trench

8.1.1 Lowering shall follow as soon as possible, after the completion of the field joint coating of thepipeline. In the case of parallel pipelines, laying shall be carried out by means of successive operations, if possible without interruption. Contractor shall submit a detail procedure for lowering of pipeline to Owner for approval.

8.1.2 Before lowering in, a complete check by a full circle holiday detector for pipe coating and for field joint coating shall be carried out and all damages repaired as agreed by Owner at Contractor's cost. All the points on the pipeline where the coating has been in contact with either skids or with lifting equipment shall be properly checked. Where water is present in thetrench, no laying shall be permitted until the ditch has been drained.

8.1.3 The pipeline shall be lifted and laid using, for all movements, necessary suitable equipmentof non-abrasive material having adequate width for the fragility of the coating. Care shall be exercised while removing the slings from around the coated pipe after it has been lowered into the trench. Any damage caused to the coating shall be promptly repaired. Lowering in utilizing standard pipe cradles shall be permitted if Contractor demonstrates that pipe coatingis not damaged. No sling shall be put around field joint coating.

8.1.4 The portion of the pipeline between trench and bank shall be supported by as many side- booms as required and approved by Owner for holding the line in gentle S-curve maintainingminimum elastic bend radius as specified in approved procedure. Lowering in and back filling shall preferably be carried out at the highest ambient temperature.

In laying parallel pipelines in the same trench, the minimum distances between the pipelinesindicated in the approved drawings shall be maintained.

8.1.5 Over-head sections

a) The following works shall be completed before proceeding with the assembly and laying of overhead pipelines :

- Construction of the pipe support structures or of mounts on supports.
- Paints and/or coating of the pipe work, as indicated in the engineering specification.

b) The erection of the supports shall be carried out taking care that the elevation and alignment is in accordance with the drawings.

In the case of metal work supports, pre-fabrication and/or assembly shall take into account the maximum allowed free span and the supports shall not interfere with the pipeline welds.

c) In case roller supports are used, the rollers shall be lubricated, and then checked for smooth rotation. In case of seizure, the defect shall be repaired or roller shall be replaced. In the case of overhead section where the pipeline is slanting, the alignment of the end supports shall be made after placing the pipeline in position. Before installation of the pipe section, all the rollers shall be perfectly centered acting on the seat of the support plates.
The above alignment operations shall be carried out before connecting the overheadsection with the ends of the buried section.

d) Lifting, moving and laying of the pipeline shall be carried out in accordance with the provisions of this specification.

An insulation sheet shall be installed to isolate the pipe from the support or supportfrom the earth.
The sheet shall be hard polyethylene at least 5mm thick.
It shall extend to at least 25 mm outside the saddles or clamps.

e) Moving supports, if any shall be centered on their support and allow for a movement of at least 300mm in both directions.

f) A comprehensive report / method statement on the laying operation to be used shall be submitted to the Owner well in advance for approval. The report as a minimum shall include, but not limited to the following:

- Method of installation by lifting (as a preferred method).
- Pulling method and related calculations, whenever lifting method cannot beused.
- Pulling device and its characteristics.
- Method of anchoring the pulling device
- Characteristics of the pulling rope
- Braking device, if any.
- Pipeline assembly system.

**9.0 BACK-FILLING**

**9.1** Backfilling shall be carried out immediately after the pipeline has been laid in the trench, inspected and approved by the Owner, so as to provide a natural anchorage for the pipeline,thus avoiding long exposure of coating to high temperature, damaging actions of adverse weather conditions, sliding down of trench sides and pipe movement in the trench. If immediate back filling is not possible, a covering of at least 200mm of earth shall be placed over and around the pipe coatings. Contractor shall submit to Owner the detailed procedure for backfilling for approval.

**9.2** Warning sheet / mat made of Polyethylene with fluorescent color shall be laid after toppadding of 300 mm. Prior to use, approval of the same shall be taken from client.

**9.3** As directed by Client/ Consultant, wherever hard rocks/ soil are encountered, padding and rock shield shall be provided across the pipe to cover all exposed pipe area to avoid any possible damages during back filling of hard materials like rock, gravel, lumps of hard soil etc.

**9.4** When trench has been dug through roads, all back fills shall be executed by sand or suitablematerial as approved by Owner and shall be thoroughly compacted. In certain cases, special compaction methods, such as moistening or ramming of the backfill in layer may be requiredas advised by Owner.

**9.5** In areas prone to soil erosion, back filling shall be carried out as per approved procedures, carefully and to the satisfaction of the Owner/authorities having jurisdiction.

**9.6** Contractor shall furnish materials and install breakers in the trench in steep areas (slope generally 10% and more) for the purpose of preventing erosion of the backfill. The type of breakers installed shall be as per the approved drawings. Breakers shall be constructed of grout bags filled with a mixture of 4:1 of Sand: Portland cement at Owner's direction. Separate detailed procedure with sketch shall be prepared and get approved by owner / authority.

**10.0 TIE-IN**

**10.1** The unconnected sections of the pipeline at various locations have to be tied in after the sections are coated, lowered and backfilled. The sections to be connected shall have at the ends – sections of over lapping, uncovered pipe of sufficient length to absorb, without including excessive stresses in the steel, small displacements necessary for perfect alignment and connection of the ends.

**10.2** If a pup end cannot be avoided for tie-in, the minimum length that shall be added is 1.0 meters and two or more such pups shall not be welded together. All cut-off lengths greater than 1.0 meters shall be moved ahead in order to be welded into the pipeline at a suitable location. Tie-in with two or more pups may be used provided that they each have minimum length of 1.0 meter and are separated by an entire length of pipe. In no case more than three
(3) welds shall be permitted on a 10 meter length of pipeline.

**10.3** Tie-in shall preferably be carried out at ambient temperatures corresponding to the average operating temperature in the case of a pipeline conveying fluids at normal temperatures and at the maximum ambient temperature in the case where the pipeline is carrying fluids at hightemperature.

**10.4** CONTRACTOR shall carry out tie-in-welding (including necessary cutting, bevelling, grindingof pipe weld seams and line-up etc.) cleaning, priming, coating and backfilling for the tie-in portion as per relevant specifications. CONTRACTOR shall also excavate the required bell- holes for the connection. Bell-holes made to facilitate welding shall provide adequate clearance to enable the welders to exercise normal welding ability and skill. All tie-in welds shall be radio-graphically examined.

**10.5** The tie-in should be done in such a way as to leave a minimum of strain in the pipe. If necessary, with respect to the trench, realigning of the pipe shall be done to eliminate force or strain in the pipe by the CONTRACTOR at no extra cost to OWNER.

**10.6** For tie-in of adjacent sections of pipeline already pressure tested, the pup used for tie-in shall be of single length or off-cuts of pipe which have already been hydrostatically tested. CONTRACTOR shall take care that sufficient number of pretested pipes with different wall thicknesses are readily available.

## 11.0 CROSSINGS

Pipe line sections at all major crossings like State and National Highways, Railways, major canals and lined canal / distributaries shall be laid by boring with casing pipe complying with all other statutory requirements. All other crossings shall be executed by open cut method unless otherwise specified in the Contract or specified by statutory authorities.

## 12.0 SPECIAL INSTALLATION OF THE PIPELINE

### 12.1 Installation of Insulating Joints

12.1.1 Insulating joints shall be installed at the locations shown in the drawings. Contractor shall obtain approval from the Owner before installation of the insulating joints.

12.1.2 Handling and installation of the insulating joints shall be carried out with all precautions required to avoid damage and excessive stresses and that the original pup length is not reduced.

12.1.3 The insulating joints and the welded joints shall be protected by external coating as per the relevant specifications issued for the purpose.

### 12.2 Installation of Valves and Valve chamber

12.2.1 Isolation valve & its chamber shall be installed as shown on the approved drawings. It is CONTRACTOR's responsibility to have the units completely assembled, tested and made fully functional including all related instruments etc.

12.2.2 The civil and structural work shall be carried our in accordance with the relevant specifications issued for the purpose and in accordance with the approved drawings as directed by OWNER.

12.2.3 A suitable concrete foundation as directed by OWNER shall be constructed on which the valve shall be firmly installed, after embedding an insulating sheet of hard polyethylene with a thickness of at least 5mm or equivalent. Such insulating sheet is also to be installed under pipe clamps, etc.

12.2.4 Valves with flow arrows shall be installed according to the normal flow in the pipeline. During,welding, the valves shall be in fully open position. In addition all manufacturer's instructions shall be followed. Care shall be taken to avoid entry of sand particles etc. to valve body, seals etc. during transportation, storage, assembly and installation.

12.2.5 For valves and piping installed below ground and/or above ground, the anti-corrosion coating/ painting shall be as per the requirements of the relevant specifications issued for thepurpose. The anti-corrosion coating below ground shall extend up to 500 mm above grade atthe lowest point.

12.2.6 Isolation valves shall be installed on sections of the pipeline in the horizontal position only or with an inclination not greater than that allowed by the valve manufacturer. Installation shall be done in such a way that there is no strain in the welded joint while the pipeline atupstream and downstream sides are straight. Local venting option at upstream and downstream of isolation valve shall be installed with Ball & Globe Valve arrangement.

12.2.7 All valves shall always be handled using equipment and methods to avoid impact, shaking and other stresses. In particular, the equipment and tools for lifting and handling shall never be done through hand-wheel, valve stem, joints and other parts which may suffer damage.

**12.3 Installation of Scraper Launchers and Receivers, if applicable**

12.3.1 Scraper stations shall be fabricated and installed as per the approved drawings and whenever applicable. It is CONTRACTOR's responsibility to have the units completely assembled, tested and made fully functional including all instruments & related piping.

12.3.2 The civil and structural works for the scraper stations shall be carried out as per the relevant specifications, in accordance with the drawings and as directed by the OWNER. The work asa minimum shall include site survey, site preparation, clearing, grading, fencing, foundations,etc. as required.

12.3.3 It shall be CONTRACTOR's responsibility to maintain elevations shown on the approved drawings and to carry out any pipe work adjustments, necessary for this purpose. Field cuts shall be square and accurate and field welds shall not be performed under stress of pipe ends.

12.3.4 The painting for the scraper stations shall be carried out as per "Specifications for Painting". The underground sections shall be coated as specified for the pipeline up to at least 300mm above grade.

12.3.5 The hydrostatic testing of the scraper stations shall be executed after installation in accordance with the relevant specification issued for the purpose.

**13.0 WORKING SPREAD LIMITATIONS**

Contractor shall, in general, observe the following maximum distances between the workingmainline spread depends as the requirement is raised.

Between Row grading, clearing and backfilling : 100m.

Between Backfilling and final clean up : 100m.

The above limitations do not apply to point spreads such as continuous rock blasting, rivercrossing, etc.

**14.0 CLEAN-UP & RESTORATION OF RIGHT-OF-WAY**

**14.1** After all required tests have been concluded satisfactorily Contractor shall clean up the site as laid down in the specifications issued for the purpose. The site finish shall be graded in accordance with the approved drawings.

**14.2** Contractor shall restore the ROW and all sites used for the construction of pipelines, water crossings and other structures in accordance with Owner's instructions, and deliver them to the satisfaction of Owner.

**15.0 PIPELINE MARKERS**

**15.1** Contractor shall submit detailed drawings for pipeline markers to the Owner for approval. After approval, all markers shall be installed along the pipeline route as advised by Owner. As a minimum the markings shall be provided at intervals / spacing as follows:

| **Marker Type** | **Minimum Spacing Requirement** |
|---|---|
| Kilo Meter Post | One marker every one kilometer |
| Aerial Marker | One marker at every five kilometers |
| Navigable Water ways/ Notice board | One each on either bank of the navigable water way |
| Boundary Markers | One each on either side of the boundary ofthe ROW at intervals of 250 m. |

| | |
|---|---|
| Direction Markers | One at the centre of curvature of the turning point.<br>One each at a distance of 200 m on eitherside of the alignment. |
| Warning Signs:<br><br>All road / railroad crossings<br><br>Water course, nala, canal | One no. on either side of the road / railroad<br><br>a) One no. for width less than 15m<br><br>b) Two nos. on either side of the crossing for width greater than 15 m and all cased crossings |

**16.0 MAINTENANCE DURING DEFECTS LIABILITY PERIOD**

Defects liability Period (defined as period of liability in the CONTRACT) means the period of12 months calculated from the date certified in the Completion Certificate.

OWNER reserves the right to carry out instrumented pigging survey of the completed pipeline. CONTRACTOR shall be responsible for making good with all possible speed at his expense any defect in or damage to any portion of the Work which may appear or occur during the Defects liability Period and which arise either:

a) From any defective material (other than supplied by OWNER), workmanship or design (other than a design made, furnished or specified by OWNER and for which CONTRACTOR has disclaimed responsibility in writing), or

b) From any act or omission of CONTRACTOR done or omitted during the said period.

If such defect shall appear or damage occur, OWNER shall forthwith inform CONTRACTOR thereof stating in writing the nature of the defect or damage.

If any such defect or damage be not remedied within a reasonable time, OWNER may proceed to execute the work at CONTRACTOR's risk and expense, provided that he does so in a reasonable manner. Such defect or damage can be, but is not limited to:

- Clean up of ROW, including water courses
- Sagging or sinking of site level or pipe supports
- Sliding of ditch banks
- Repair of fencing or removal of construction fencing
- Repaving of pavements, repair of pavements, repair of coating, painting
- Realigning markers, signs
- Leak/burst of pipe, leaking flanges, washouts
- Short-circuit in casings
- Construction defects such as dents, ovality, welding offsets/defects, etc. detected duringintelligent pigging survey etc.

OWNER reserves the right to have the required Computerised Potential Logging Test executed during the DEFECTS LIABILITY PERIOD and whenever conditions are more favourable for this job.
CONTRACTOR shall finish the work, if any outstanding, at the date of completion as soon as possible after such date and shall execute all such work.

# TECHNICAL SPECIFICATION FOR PIPELINE WELDING FOR GAS TRANSPORTATION

## CONTENTS

## 1.0 SCOPE

This specification defines the minimum requirements for welding of carbon steel pipes made as per API 5L specification.

## 2.0 CODES AND STANDARDS

The related, standards referred to herein and mentioned below shall be of the latest editions prior to the date of the purchaser's enquiry:

| | | | |
|---|---|---|---|
| a) | ASME B31.8 | : | Gas Transmission and Distribution Piping Systems. |
| b) | API 1104 | : | Standard for welding of Pipelines and Related Facilities. |
| c) | ASME Sec. II C | : | Specification for welding Electrodes and Filler Materials. |
| d) | ASME Sec. V | : | Non Destructive examination. |
| e) | ASME Sec.VIII Div. I | : | Boiler and Pressure Vessel Code: Pressure Vessels. |
| f) | ASME Sec. IX | : | Boiler and Pressure Vessel Code: Welding and Brazing Qualification. |
| g) | ASTM E23 | : | Notched Bar Impact Testing of Metallic Material. |
| h) | ASTM E92 | : | Test Method for Vickers Hardness of Metallic Materials. |
| i) | ASTM E709 | : | Practice for Magnetic Particle Examination. |
| j) | ASTM A370 | : | Standard Test Methods and Definitions for Mechanical Testing of Steel Production. |
| k) | ASNT-SNT-TC-1A | : | Standard for Personnel Qualification and Certification in Nondestructive Testing |

## 3.0 CONFLICTING REQUIREMENT

In the event of any conflict in the requirements of this standard specification, job specification, datasheets, statutory regulations, related standards, codes etc., the most stringentrequirement shall be followed:

## 4.0 WELDING PROCESS AND CONSUMABLES

**4.1** This specification lays down minimum requirements for welding of various materials using Shielded Metal Arc Welding process (SMAW) with the approval of the Owner/ Consultant. Any other process of welding shall require prior approval from the Owner/ Consultant.

### 4.2 Welding consumables

4.2.1 The welding electrodes/ filler wires supplied by the Contractor shall conform to the class specified in the approved welding procedure specification. The materials shall be of the make approved by the Owner/ Consultant.
The Contractor shall submit batch test certificates from the electrode manufacturers giving details of physical and chemical tests carried out by them for each batch of electrodes to be used.

The certificates shall have as minimum, information such as batch number, date of manufacture, consumable cast number, consumable chemistry, weld metal chemical analysis, weld metal mechanical properties including Charpy impact energy.
Electrode Qualification test records shall be submitted as per relevant code requirements by the Contractor for obtaining the approval of the Owner/consultant. The following details shall be provided in qualification test records. All weld tensile test, base material used, pre-heat andpost weld heat treatment details, visual examination results, radiographic examination results, tensile test results (incl. UTS, and elongation), impact test values, chemical analysis report, fillet weld test results, other tests like transverse tensile tests and guide bend test results. The contractor shall give prior intimation to owner/ consultant regarding EQT. Each EQT shall be witnessed by owner/ consultant’s inspector.

4.2.2 The electrode shall be suitable for the production welding process recommended and the basemetal used. Physical properties of the welds produced by the electrode & brand recommendedfor the welding of particular base metal shall not be lower than the minimum values specified for the base metal unless otherwise specified in approved Welding Procedure Specification (WPS). The choice of electrode shall be made after conducting the required tests on the electrodes as per relevant standards, and acceptance shall be the sole prerogative of the Owner/Consultant.

4.2.3 All electrodes shall be purchased in sealed, containers and stored properly to prevent deterioration. Electrodes shall be kept in oven, if required, at all conditions as per manufacturer recommended temperature. Different grades of electrodes shall be stored separately. The electrodes used shall be free from rust, oil, grease, earth and other foreign matter, which affect the quality of welding.

4.2.4 The composition and purity of shielding gas when required by the welding processes other than shielded metal arc welding, when permitted by the Owner/Consultant shall be submittedto the Owner/Consultant for approval.

4.2.5 Contractor shall supply all necessary equipment's such as welding equipment current and voltage meters, temperature measuring instruments, fluxes, gases, filler metals and testing equipment for satisfactory completion of all the work.

## 5.0 WELDING PROCEDURE SPECIFICATION

**5.1** Contractor shall submit the welding procedure specification indicating the proposed welding process to Owner/consultant for approval. Any deviation desired by the Contractor shall be obtained through the express consent of the Owner/Consultant.

**5.2** A combination of different welding processes or a combination of electrodes of different classes/makes could be employed for a particular joint only after duly qualifying the welding procedures to be adopted and obtaining the approval of the Owner/Consultant.

Welding procedure qualification shall be carried out in accordance with the relevant requirements of API 1104 and other applicable codes and other job requirements by the Contractor. The Contractor shall submit the welding procedure specifications as per the formats given in API 1104 within one month after the receipt of the order indicating details of welding consumables, welding process, welding position, welders, destructive test sample positions, pre-heating requirements, voltage, current, heat input etc. The pipeline of maximum diameter and wall thickness shall be used for welding procedure qualification. Inter pass temperature shall be considered as an essential variable in the procedure qualification.

**5.3** Owner/Consultant's representative will approve the welding procedure submitted and shall release the procedure for qualification tests. The Contractor shall carry out under field conditions at their own expense the procedure qualification test. A complete set of test results shall be submitted to the Owner/consultant representative Inspector for approval immediately after completing the procedure qualification test and at least 2 weeks before the commencement of actual work. All tests shall be carried out as per provisions of these specifications.

**5.4** Radiography of the entire weld shall be carried out using the same source of radiation, radiographic technique and exposure time as that to be used for production weld.

## 6.0 QUALIFICATION OF WELDERS

**6.1** Welders shall be qualified in accordance with the API 1104 and other applicable specificationsby the Contractor at their expense. The butt weld test pieces of the welder qualification tests shall meet the visual and the radiographic test requirements of this specification. The welder qualification tests shall be carried out using the welding procedure and the equipment that will be utilised during production welding. The welder qualification shall be done only on project line pipe. The Owner/Consultant representative inspector shall witness the test and certify the qualification of each welder separately. Only those welders who have been approved by the inspector shall be employed for welding. Contractor shall submit the welder qualification test reports and obtain express approval, before commencement of the work. It shall be the responsibility of Contractor to carry out qualification tests of welders. Guided bend tests shall also be conducted for welders to be qualified for station pipe welding. Retesting of a welder who has failed the qualification test shall be done only after approval of the Owner/ Consultantwho shall decide on the training requirements.

**6.2** The welders shall always have in their possession the identification card and shall produce it on demand by the Owner/Consultant representative. It shall be the responsibility of the Contractor to provide the identity cards after it has been duly certified by the Owner/Consultant. No welder shall be permitted to work without the possession of identity card.

## 7.0 ALIGNMENT

**7.1** Temporary attachments of any kind shall not be welded to the pipe. Welds joining the sections of the pipeline, valve installation or similar welds classified as tie-in welds shall be made in the trench. Otherwise the alignment and welding shall be made alongside the ditch with the pipe supported on skids, and pack pads or other suitable means placed at least 500 mm above the ground unless approved otherwise by the Owner/ Consultant in specific cases.

**7.2** For welded pipes, longitudinal weld seams of adjoining pipes shall be staggered such that a minimum distance of 150 mm is maintained along the circumference and both longitudinal welds are at top 90º quadrant of the pipeline (Except for bends). A longitudinal joint shall pass an appurtenance of a structural element at a minimum distance of 50 mm. However theseshall not be applicable in case of a seamless pipe.

**7.3** For pipe of same nominal wall thickness the off-set shall not exceed 1.6 mm. The off-set may be checked from outside using dial gauges. The welds for linings shall be so located that the toe of the weld shall not come within 50mm of any other weld. Cold dressing is permissible

only in cases of slight misalignment and may only be carried out with a bronze headed hammer. Hot dressing shall not be permitted.

**7.4** When welding pipes of different wall thickness, end connection shall be as per ASME B31.8. Ifrequired transition piece shall be used. This shall have a minimum of 1:4 taper. The welds shall be subjected to both ultrasonic and radiographic inspection.

**7.5** The root gap shall-be accurately checked and shall conform to the qualified welding procedure. The use of internal Line-up Clamps is mandatory for pipe diameters 8" and above. However, in some cases (tie-in welds. flanges, fittings, small section etc.) where it is impossible to use internal Clamps, an external line-up clamp may be used.

**7.6** The internal line-up clamp shall not be released before the entire root pass has been completed.

**7.7** When an external line-up clamp is used, all spaces between bars or minimum 60% of the root pass length shall be welded before the clamp is released. The remaining pipe shall be adequately supported on each side of the joint.

Segments thus welded shall be equally spaced around the circumference of the pipe. Slag, etc. shall be cleaned off and the ends of the segments shall be prepared by grinding, so as to ensure continuity of the weld head.

## 8.0 JOINT PREPARATION

**8.1** Before welding, all rust and foreign matter shall be removed from the bevelled ends by power operated tools at inside and outside edges for a minimum distance of 25mm from the edge of the weld bevel. Joints shall be swabbed with canvas belt or leather if required as per Owner/ Consultant's discretion. If any ends of the pipe joints are damaged to the extent that, in the opinion of Owner/ Consultant, satisfactory weld spacing cannot be obtained, and local repairby grinding cannot be successfully done, then the damaged ends shall be cut and bevelled to the satisfaction of the Owner/ Consultant, with an approved bevelling machine.

**8.2** Manual cutting and repairing of bevels by welding is not allowed. In case laminations, split ends or inherent manufacturing defects are discovered in the pipe, then length of the pipe containing such defects shall be removed to the satisfaction of Owner/ Consultant. On pipes, which have been cut back, a zone extending 25 mm back from the new field bevel, shall be ultrasonically tested to the requirement of the line pipe specification to ensure freedom from laminations. The new bevel shall be 100% visual and 100% dye penetrate / MPI tested. A report shall be made and records maintained for all testing. The re-bevelled pipe heat number identification shall be maintained by transferring information to the new pipe end. Where the pipe is to be field cut and welded, the shop-applied coating shall be neatly peeled and grounded for a distance of 100 mm from the weld.

**8.3** The parts and joints being welded and the welding personnel shall be adequately protected from rain and strong winds. In the absence of such a protection no welding shall be carried out. All completed welding work shall be protected from bad weather conditions.

## 9.0 PRODUCTION WELDING

Production welding shall be performed as per qualified welding procedure. If any change in essential variables is made then a new welding procedure has to be established and qualified.

### 9.1 Welding Passes

a) Root pass is a critical welding activity, which shall be carefully carried out by the Contractor as per approved WPS. Root pass shall be made with branded electrodes/filler wires recommended in the qualified WPS. The size of the electrodes used shall be as per the approved welding procedure. It is recommend that immediately after the root pass the first hot pass is completed. However, Owner/Consultant's engineers at site can make this requirement mandatory as per site conditions.

b) Position or roll welding may be permitted. Separate procedures shall be submitted and qualified for up-hill, down-hill, vertical down and roll welding. Down hill welding shall be used when internal clamp is used. The vertical up method of welding shall be used for the root pass of the tie-ins, special crossings, fittings and special parts, fillet welds, repairs and when an external line up clamp is used. The down hill welding may be used for root run welding of tie- ins and special crossings when (i) the edges are machined or have equivalent preparation (ii) line up clamps are used and the fit up is geometrically and mechanically similar to one of the ordinary line welding without misalignment or unevenness.

c) Weld projection inside the pipe shall not exceed 2 mm.

d) Any deviations desired from the recommended welding technique and electrodes indicated in the WPS shall be adopted only after obtaining express approval of the Owner/Consultant.

e) Welding shall be continuous and uninterrupted during root pass. On completion of each run, craters, welding irregularities, slag, etc. shall be removed by stringing wire brush and chiselling. While the welding is in progress care shall be taken to avoid any kind of movement of the components, shocks, vibration and stresses to prevent occurrence of weld cracks.

f) The weld reinforcement shall not be in excess of 1/16” but the weld crown shall not be below the outside surface metal of the pipe.

g) Two welds shall not be started at the same location.

### 9.2 Joint completion

a) In general, single welder shall be used for welding of 6” pipe. The welding sequence shall be as per the qualified welding procedure specification. Once the deposit of the first pass has been started, it must be completed as rapidly as possible, reducing interruptions to the minimum. The welding and wire speed shall be approximately same as that established in the qualified welding procedure specification.

b) The interruption between completion of the first pass and starting the second pass shall be as stated in the procedure specification, normally not exceeding four minutes.

c) The time lapse between second and third pass shall be as stated in the procedure specification, normally not exceeding five minutes. Welding can be suspended, so as to allow the joint to cool down, provided that the thickness of the weld metal deposited is at least 50% of the pipe thickness. Upon restarting, preheating to at least of 100°C shall be carried out. Subsequent passes to weld completion shall be protected to avoid rapid cooling, if meteorological conditions so dictate. Cleaning between passes shall be done carefully so as toreduce the possibility of inclusions.

d) Electrode starting and finishing points shall be staggered from pass to pass. Arc-strikes outside the bevel on the pipe surface are not permitted, Arc-strike or arc-burn on the pipe surface outside the weld, which are caused accidentally by electrical arcs between the electrode, electrode holder, welding cable or welding cable round and the pipe shall be removed by grinding in accordance with a procedure approved by Owner/Consultant and the repair checked by ultrasonic, radiographic, magnetic particle or dye penetrate tests which the Owner/Consultant feels necessary. The pipe wall thickness after grinding shall not be lessthan the minimum thickness limit permitted for the pipe. Repair of arc strikes by welding is prohibited.

e) Tie-in weld shall be completed without delays and shall not be left incomplete overnight.

f) All Fillet weld and branch connections shall be as per ASME B 31.8. Pipes of equal diameter but unequal wall thickness shall be welded either with the help of transition piece or per weld design for unequal thickness as specified in ASME B 31.8. The completed weld shall be carefully brushed and cleaned and shall appear free from spatters, scales, etc.

g) During welding operation the coating shall be protected from weld spatter burning either by using a 600mm wide asbestos blanket or by Owner/Consultant approved procedures. The protection device shall be placed 50mm from the weld centre.

**10.0 HEAT TREATMENT**

**10.1 Preheating**

a) Preheating requirement for this project shall be minimum 100ºC or as per qualified welding procedure requirements if higher.

b) Preheating shall be performed using resistance, induction/heating methods or gas burners.

c) Preheating shall extend uniformly to at least three times the thickness of the joint, but not less than 50mm, on both sides of the weld. Preheating temperature shall be maintained over the whole length of the joint. During welding, temperature indicating crayons or other temperature indicating devices shall be provided by the Contractor to check the temperature.

d) Maximum interpass temperature shall be 250°C.

e) Pre-heating is also required prior to attachment of any branch connections or fittings on the line.

f) Asbestos blankets may be placed with the welds to slow the cooling rate as per procedure.

**10.2 Post-weld heat treatment**

a) The Heat treatment of welded joints shall be carried out as per the requirements laid down in ASME B.31.8 and other special requirements mentioned in approved WPS.

b) Post weld heat treatment shall be done by using an electric resistance or induction heating equipment, as decided by the Owner/Consultant.

c) While carrying out local post weld heat treatment, technique or application of heat must ensureuniform temperature attainment at all points on the portion being heat treated. Care shall be taken to ensure that, width of heated band over which specified, post weld heat treatment temperature attained is at least as that specified in the relevant applicable standards/codes.

d) Throughout the cycle of heat treatment, the portion outside the heat band shall be suitably wrapped under

insulation so as to avoid any harmful temperature gradient at the exposed surface of pipe.
For this purpose, temperature at the exposed surface of the pipe shall not be allowed to exceed 400°C.

e) Contractor shall submit detailed procedure for post-weld heat treatment specifying the temperature measurement, minimum no. of thermocouples to be used, details of the equipment to be used, method of execution etc. for approval.

f) Automatic temperature recorders that have been suitably calibrated shall be employed. The calibration chart of each recorder shall be submitted to the Owner/ Consultant prior to starting the heat treatment operation and its approval shall be obtained.

g) Immediately on completion of the heat treatment, the post weld heat treatment charts/records along with the hardness test results on the weld joints (whenever required as per the welding specification chart) shall be submitted to Owner/ Consultant for approval.

h) Proper identification of weld joint shall be maintained and same shall appear on the corresponding post weld heat treatment charts and in corresponding radiography films.

i) Hardness of the heat affected zone as well as of the weld metal, after heat treatment shall be measured using a suitable hardness tester by Vickers or Brinnel and shall not exceed the maximum hardness specified in the specification. The weld joint shall be subjected to reheat treatment, when hardness measured exceeds the specified Limit by the Contractor at his own expense.

## 11.0 INSPECTION & TESTING

### 11.1 Welding Procedure Qualification

For welding procedure qualification tests, standard tests as specified in the API 1104 shall be carried out in all cases. In addition to these tests, other tests like radiography, macro/micro examination, hardness tests, dye penetrate examination, Charpy V-notch etc. shall be carried out on specimens as per this specification. It shall be the responsibility of the Contractor to carry out all the tests required to the satisfaction of the Owner/consultant Inspector. The destructive testing of welded joints shall be as per Annexure-1.

### 11.2 Visual inspection of the weld joint

Inspection of all welds shall be carried out by Owner/Consultant as per the latest editions ofthe applicable codes and specifications. All finished welds shall be visually inspected for alignment, excessive reinforcement, concavity of welds, shrinkage, cracks, under-cuts, dimensions of the weld, surface porosity and other surface defects. Under-cutting adjacent to the completed weld shall not exceed the limits specified in the applicable standard/code.

### 11.3 Non Destructive Examination

a) The non-destructive examination shall mainly consist of Radiographic examination and Ultrasonic Testing of the weld as detailed in Annexure-2.

b) Radiographic examination of all girth welds with 100% coverage of the weld shall be done as per requirement. All welds shall meet the criteria as set forth in API 1104 and as modified in this specification below

| | |
|---|---|
| Cracks | Cracks of any type size and shape including crater cracks are not acceptable. |
| Incomplete root penetration | Not acceptable |
| Lack of fusion at the root | Not acceptable |
| Burn through | Not acceptable |
| Excess weld penetration (internal) | > 2mm Not acceptable |
| Excess weld reinforcement (External) | > 3mm Not acceptable |

c) Any weld which as a result of radiographic and/or ultrasonic examination in the opinion of Owner/Consultant exhibits imperfections greater than the limits stated in API-1104 latest edition or as superseded in this specification above shall be considered defective and shall be marked with an identification paint marker.

d) The Contractor shall make all the arrangements for the radiographic examination of work covered by the specification at his expense.

e) The Owner/Consultant will review all the radiographs of welds and inform the Contractor regarding unacceptable welds. The decision of the Owner/Consultant shall be final and bindingin this regard.

f) Ultrasonic inspection is required when 20mm or more are cut from the pipe. The pipe end as supplied shall be ultrasonically inspected for an additional length of 50 mm to assure no lamination exists.

i) In addition, ultrasonic inspection may be required for certain critical welding of the pipeline (i.e.tie-ins, welding of valves, flanges) randomly selected at Owner/Consultant's discretion. All tie- in welds shall be ultrasonically tested in addition to RT. All fillet and groove welds other than those, which are not radio graphically or ultrasonically examined, shall be examined by Dye Penetration or Magnetic Particle inspection techniques.

j) In case of gas cutting of pipe end, ultrasonic inspection shall be done for lamination/ checking before welding of Tie-in joints.

k) The Owner/ Consultant must approve all non-destructive test systems used for inspecting welds.

l) Suitable records shall be maintained by the Contractor as desired by the Owner/Consultant onthe day-to-day work done on welding radiography and ultrasonic testing. The Contractor shall present the records to the Owner/Consultant on a day-to-day basis and whenever demanded for approval.

**11.4 Destructive testing**

a) 0.1% of total number of welds completed shall be subjected to destructive testing by Owner/ Consultant as per Annexure - 1.

b) In addition, welds already cut out for defects for any reason may also be subjected to destructive testing. If the results are unsatisfactory, welding operations shall be suspended and may not be restarted until the causes have been identified and the Contractor has adopted measures which guarantee acceptable results. If it is necessary in the Owner/Consultant‘s opinion the procedure shall be re-qualified.

c) If one production weld fails to conform to the specified requirements, the Contractors shall cut two additional weld joints from either side of the failed one and shall carry destructive testing as per the specification requirement. If both the joints fail the destructive examination, the entire length of pipeline under investigation shall be removed and the entire weld has to be cutand re-weld to the satisfaction of the OWNER/ CONSULTANT after conducting a root cause analysis.

d) Along with production weld destructive testing, base metal from same location shall also be removed and tested for all properties (Chemical and Mechanical) which are already performedin pipe mill except DWTT for verification, validation and acceptance.

**12.0 REPAIRS OF WELDS**

**12.1** With the prior permission of Owner/Consultant welds which do not comply with the standards of acceptability, shall be repaired or the joint cut out and re-welded.

A separate welding procedure specification sheet shall be formulated and qualified by Contractor for repair welds simulating the proposed repair to be carried out. Separate procedures are required to be qualified for (a) through thickness repair (b) partial thickness repair. Welders shall be qualified in advance for repairs. Welders shall perform repair test weldbetween the 3 and 6 ‘O’ clock positions for welding peel-earned in the 5G position. The root pass, for repairs opening the root, shall be replaced by the vertical uphill technique. The procedure shall be proven by satisfactory procedure tests pertaining to AP1-1104 including thespecial requirements of the specification, and shall also be subjected to metallographic examination, hardness surveys and Charpy tests to determine the effects of repair welding on the associated structure.

Root sealing or single pass repair deposit shall not be allowed. Internal root defects shall be grounded thoroughly and welded with a minimum of two passes. However, while grinding for repairs, care shall be taken to ensure that no grinding marks are made on the pipe surface anywhere. LPT shall be carried out to confirm removal of repair before welding.

The repair weld shall be subjected, as a minimum requirement, to the same testing and inspection requirements as the original weld, the entire joint shall be re-radiographed. A 100% ultrasonic inspection shall be done at the repaired area externally. Any repaired area that is wide, irregular or rough shall be rejected and a full cut out shall be done. The repair welding shall have a minimum preheat of 100ºC and shall be preheated for at least 150 mm on either side of repair.

Welds not meeting the specification after one repair shall be cut out. A report of all repairsshall be maintained by Contractor. All repairs shall be carried out on the day after initial radiography or earlier. A full report of all repairs made shall be submitted every day to the Owner/Consultant.

**12.2 Elimination of repairs**

Only one attempt for repair of any region is permitted. Repairs are limited to a maximum 30% of the weld length. For internal repairs or external repairs which open the weld root, only 20%
of the weld length may be repaired. Repairs opening the root must only be carried out in the presence of Owner/Consultant. The minimum length of a repaired area shall be 100mm as measured over the-recapped length. Welds containing cracks shall be cut out and rebevelled to make joint. Owner/Consultant shall authorize all repairs.

### 12.3 Weather condition

Welding shall not be done in open areas during blowing sands, dust storms, high winds, rains or where relative humidity is higher than 75%. Welding at ambient temperature below 5ºC shall be done only with specially qualified procedure with controlled heating and cooling practices.

### 12.4 Marking

The Contractor according to the numbers assigned to the welders shall mark all welds on the top quarter of the pipe adjacent to the weld. Metallic dies shall not be used to mark on the pipe. Contractor shall furnish to Owner/ Consultant with all records of welder numbers and Joint numbers.

***ANNEXURE – 1***

## 1.0 DESTRUCTIVE TESTING OF BUTT WELDED JOINTS

### 1.1 Preparation

After the visual and the non-destructive inspection, the test weld shall be subjected tomechanical test.

After satisfactory completion of all visual and non-destructive testing the procedure test weld shall be set aside for a period not less than 72 hour. No further work on the test weld and no cutting of test specimens from the weld shall be performed until a period or at least 72 hours has expired.

Weld specimens shall be taken from the positions as per approved WPS. In addition to API 1104 tests the following tests of minimum numbers to be carried out as tabulated low:-

Type and Number of Test Specimens for Procedure Qualification Test and Production Welds

| PIPE SIZE, OUTSIDE DIAMETER-INCHES | NUMBER OF SPECIMENS | | |
|---|---|---|---|
| | MACRO | HARDNESS | IMPACT |
| **Wall thickness- under ½ inch** | | | |
| Under 2.375 | 0 | 0 | 0 |
| 2.375 to 4½ | 0 | 0 | 0 |
| Over 4½ less than 14¾ | 2 | 2 | 12 |
| 12 3/4 and over | 2 | 2 | 24 |
| **Wall thickness-over ½ inch** | | | |
| 4-½ and smaller | 0 | 0 | 0 |
| Over 4 1/2 less than 12¾ | 2 | 2 | 12 |
| 12¾ and over | 2 | 2 | 24 |

Macro and hardness shall be carried out, generally at the top and bottom of the joint suitablyas per approved WPS.

The test shall be carried out at laboratories approved by the Owner/Consultant. Thespecimens shall be prepared in accordance with the relevant standard code requirements.

### 1.2 Tensile strength

Specimens shall be taken from the position as per approved WPS. The test shall be carriedout in accordance with API 1104. Acceptance Criteria shall be as per API 1104.

### 1.3 Nick-break test

Specimens for nick-break test with notches, thus worked, can break in the base metal, instead of in the fusion zone; therefore an alternative test piece may be used after authorization by theOwner/ Consultant with a notch cut in the reinforcement of outside weld head to a maximum depth of 1.5 mm, measured from the surface of the weld head.

Acceptance Criteria shall be as per API 1104.

### 1.4 Macroscopic Examination

Specimens shall be taken from the positions as indicated in the approved WPS and shall be prepared in accordance with ASTM E2 and E3. One of the specimens shall be taken from the T-intersection at the line pipe seam weld.

The width of the macro-section has to be at least three times the width of the weld. The section is to be prepared by grinding and polishing and etched to clearly reveal the weld metal and heat affected zone.

Specimens shall be carefully examined under the microscope, with a magnification of at least 25 (25:1).

Owner/Consultant reserves the right to ask for a micrograph with 5 times (5:1) magnification, for Documentation purposes.

Under macroscopic examination, the welded joints shall show good penetration and fusion, without any defect exceeding the limits stated in the evaluation criteria of the Nick Break test.

### 1.5 Hardness Test

The prepared macro-section is to be used for hardness testing using the Vickers method (HV10). Test shall be made on selected specimen of weld joint. These series of reading shall be extended from unaffected base metal or one side across the weld to unaffected base metal on the other side. Three transverse shall be made as follows - first 2 mm from the outer edge, the second across the centre and third 2 mm from the inner edge. The specimen between the hardness impressions shall be 0.75 mm. The hardness impression nearest the fusion line shallbe within 0.5 mm.

Hardness value shall not exceed 235 HV10 or as specified in approved WPS.

All the hardness values contained from the heat affected zone shall not exceed 40 HV with respect to the average hardness values obtained for the base metal. If these additional tests give hardness within the specification limit the slightly higher value may be accepted.

### 1.6 Charpy-V-notch Impact test

Specimens shall be taken from the position as per approved WPS. The test shall be carriedout in accordance with ASTM-370.

Five test specimens shall be taken from each sample and they shall be cut and worked so thattheir length is transverse and perpendicular to the weld bead with the notch position. The notch shall be perpendicular to the rolled surface. The test specimen width shall depend upon the pipe wall nominal thickness as following:

| Nominal wall thickness in mm | Test specimen width in mm |
|---|---|
| 6.4 | 2.5 |

The test shall be carried out as in accordance with ASTM-370.
Test pieces shall be immersed in a thermostatic bath and maintained at the test temperature for at least 15 minutes. They shall then be placed in the testing machine and broken within 5 seconds of their removal from the bath.

The test temperature shall be 0º and -20 °C.

The acceptable values of the impact energy shall be as follows:

| Temp ( ° C) | Average of three specimens (Note 2) Joules (Minimum) | Any single value (Note1) Joules (Minimum) |
|---|---|---|
| 0 | 100 | 80 |
| -20 | 35 | 28 |

**Note:**

1. These values are specified for resistance to brittle fracture only. Where additional requirements are specified by Owner/Consultant, the same shall be followed.

2. Two samples of the highest and lowest values shall be discarded.

### 1.7 Bend test requirements

The Bend test Specimens shall be made and tested as per the requirements of API 1104.The

acceptance criteria shall be as per API 1104.

***ANNEXURE-2***

## 1.0 ULTRASONIC INSPECTION

Ultrasonic inspection is required to be performed on the pipeline field welds as per conditions listed in this specification. This section concerns manual ultrasonic Inspection. However ultrasonic inspection by automatic equipment shall be used only with Owner's/consultant's approval.

### 1.1 Equipment and Operators

The operators shall be qualified by a Third Party Inspection Authority. All operators shall bequalified as per AST-SNT-TC-1A minimum level II.

The Owner/Consultant has the option of checking the ability of personnel employed forultrasonic testing by means of qualification tests.

### 1.2 Specification for Ultrasonic Testing Procedure Qualification

Before work begins, the Contractor shall present a specification describing the proposedprocedure qualification and calibration methodology.

This specification shall state, as an indication only but not limited to the following information:

- Type of UT equipment used
- Details for calibration
- Type and dimensions of transducers
- Frequency range
- Coupling medium
- Inspection technique
- Record details
- Reference to the welding procedure where it is intended to adopt the weld location.
- Temperature range of the joints to be inspected.

The ultrasonic inspection procedure shall be approved by the Owner/ Consultant. The Contractor shall make welds (according to the same production procedure) having typical defects which are intended to be detected by ultrasonic testing.

This test shall be conducted in the presence of the Owner/ Consultant. The Ultrasonic inspection procedure shall be approved by the Company.

### 1.3 Test procedure

Circumferential welds shall be inspected from both sides using angled probes.

If, during the test, echoes of doubtful origin appear, it shall be necessary to inspect a convenient area on the pipe surface, close to the weld, with a straight beam transducer in order to check whether any manufacturing defects are present which could have interferedwith the ultrasonic beam.

The equipment shall include but not be limited to the following:

- Ultrasonic equipment and coupling medium
- Sample sections for calibration of instruments
- Equipment for cleaning of surface to be examined
- Rules calibrated in centimeters for exact location of the position of defects.

### 1.4 Reference Blocks

The efficiency of the equipment used, the effective refraction angle of the probe, and the beamoutput point, shall be checked using a $V_1$ and $V_2$ sample block, IIW type or the calibrationblock ASTM E-428.

### 1.5 Amplification during production testing

The amplification during production testing shall be obtained by adding 2-6 dB (according to the surface condition of the pipe and its cleanliness) to the reference amplification.

### 1.6 Qualification of Ultrasonic Testing Operators

At any time during the project, Owner/ Consultant may ask for a qualification test for the ultrasonic equipment operator. Minimum qualification of the operator shall be ASNT-Level–II.

### 1.7 Evaluation of indications given by ultrasonic tests

Each time that echoes from the weld head appears during production testing, the instrument amplification shall be altered to coincide with the reference amplifications and the probe shall be moved until maximum response is obtained, paying attention all the time to the probe-tube coupling.

If under these conditions, the height of the defect echo is equal to or greater than that of the reference echo, the defect shall be evaluated according to section 15.4 of this specification. If the detect has also been detected by the radiographic and/or visual examination, the dimensions shall be judged according to the type of examination which detects the greater defect. Returns which are less than 50% of the reference echo will not be considered. If returns are above 50% but lower than 100% of the reference echo, and if the operator has good reasons to suspect that the returns are caused by unfavorably oriented cracks, he shall inform the Owner/Consultant. Moreover, when there is a defect to be repaired, such defect shall be removed for a length corresponding to the one where no more return echo is given.

### 1.8 Other equipment

The use of rules calibrated in centimeters, attached if possible to the probe, for the precise location of the position of welding defects, is recommended. Defect location is effected by measuring the projection distance between the probe output and the reflecting surface.

The operators carrying out the tests shall have, besides the probing instrument, tools for cleaning the pipe surface (tiles, brushes, etc.) as well as the coupling liquid or paste appropriate for the temperature of the section to be examined.

## 2.0 RADIOGRAPHIC TESTING

**2.1** Proposed Radiographic examination procedure shall be submitted by the Contractor forapproval.

**2.2** The procedure of radiographic examination shall be qualified to the entire satisfaction of Owner/Consultant prior to use. It shall include but not be limited to the following requirements

i) Only Lead foil intensifying screens, at the rear of the film shall be used for all exposures.

ii) Type 2 and 3 films as per: ASTM E-94 shall be used.

iii) A densitometer shall be used to determine film density. The transmitted film density shall be between 2.0 and 3.5 throughout the weld. The unexposed base density of the film shallnot exceed 0.30.

iv) Radiographic identification system and documentation for radiographic interpretation reports and their recording system.

v) Film type and brand, film processing methods, exposure conditions (kV, mAmin, Cmin).

vi) Type of penetrameters, Radiographic technique and number of exposures.

vii) Type of radiation source (power, local spot size etc).

viii) Diameter and thickness of pipe to be inspected and weld/welder numbering system,

**2.3** The Contractor shall qualify each procedure in the presence of the Owner/Consultant prior to use.

**2.4** All the girth welds of mainline shall be subjected to 100% radiographic examination. Each weldshall be clearly and permanently numbered adjacent to weld or down stream side.

**2.5** When the radiation source and the film are both on the outside of the weld and located diametrically opposite each other, the maximum acceptable length of film for each exposure shall not exceed the values given in API 1104. The minimum film overlap, in such cases, shall be 40mm. The ellipse exposure technique may be used on nominal pipe sizes of 2 inch and smaller provided that the source of film distance used is a minimum of 12 inch. When such a procedure is used exposure of 90º to each other shall be obtained.

Penetrameters shall be placed on both source and the film side. The sensitivity level achievedshall be satisfied by penetrameter on the source side.

2.7 Films shall have no fogs, spots or makes and shall not be exposed to back scatter radiation.All weld spatter, debris, foreign matter and other detects which interferes with the interpretation of the radiograph shall be removed from the weld area.

2.8 Three copies of each acceptable radiographic procedure and three copies of radiographic qualification records shall be supplied to Owner/Consultant. One set of the qualifying radiographs on the job shall be kept by the Contractor's authorized representative to be used as a standard for the quality of production radiographs during the job. The other two sets shall be retained by Owner/Consultant for its permanent record.

2.9 Three copies of the exposure charts relating to material thickness, kilo voltage, source of film distance and exposure time shall also be made available to Owner/Consultant by the Contractor.

2.10 The Contractor shall provide all the necessary facilities at site, such as a dark room with controlled temperature, film viewer etc. to enable the Owner/Consultant to examine the radiographs.

2.11 The Contractor, if found necessary, may modify the procedure of radiographic examination suiting to the local conditions prevailing. This shall, however, be subject to the approval of the owner/Consultant. Owner/Consultant shall have live access to all the Contractor's work facilities in the field.

2.12 Any approval granted by the Owner/Consultant shall not relieve the Contractor of his responsibilities and guarantees.

**2.13 Radiation source**

Radiographic examination shall be carried out using X-radiation's. Radiographic examination by Gamma rays may be allowed, at the discretion of the OWNER, in ease of inaccessible joints. X-ray equipment shall have sufficient power (voltage and current) for the diameter and thickness of the pipeline to be inspected.

**2.14 Level of quality**

The quality level of Radiographic sensitivity required for radiographic inspection shall be 2%.

**2.15 Penetrameters**

The image quality indicator (abbreviation: IQI) shall be used for the qualification of the welding procedure and during normal line production. Radiographic sensitivity shall be measured with the wire image quality indicator (Penetrameter). The penetrameter shall be selected according to DIN54109 or IS01027. The placement of the penetrameter shall be as per approvedprocedures.

The sensitivity limit may be considered to have been reached when the outline of the IQI, its identification number and the wire of the required diameter show up clearly on the radiograph.

The Owner/consultant may authorize use of types of IQI other than those planned, provided that they conform to recognized standards and only if the Contractor is able to demonstrate that the minimum sensitivity level required is obtained. For this demonstration, a test shall be carried out comparing the IQI specified and the Contractor's to show up the identification number and other details of the proposed IQI, which must be visible in the test radiograph.

**2.16 Film Identification Markers**

All films shall be clearly identified by lead numbers, letters, and/or markers. The image of the markers shall appear on the films, without interfering with the interpretation. These markers positions shall also be marked on the part to be radio graphed and shall be maintained during radiography.

**2.17 Protection and Care of Film**

All unexposed films shall be protected and stored properly as per the requirements of API 1104 standard and ASTM E.94.

The exposed and unexposed film shall be protected from heat, light, and dust and-moisture. Sufficient shielding shall be supplied to prevent exposure of film to damaging radiation prior to and following the use of the film for radiographic exposure.

Film processing (development, fixing, washing etc.) shall comply with supplier’s requirements and as per ASME Section V SE-94.

**2.18 Re-Radiography**

The weld joints shall he re-radiographs in ease of unsatisfactory quality of the radiographs, at the expense of the Contractor.

All the repaired weld joints shall be re-radio graphed at no extra cost to the Owner/Consultant in the same manner to that followed for the original welds. In addition, the repaired weld areas shall be identified with the original identification number plus the letter R to indicate the repair.

When evaluating repair film, radiographers shall compare each section (exposure) of the weld wall the original film to assure repair was correctly marked and original defect removed.

The Owner/Consultant will review prior to any repair of welds, all the radiographs of welds which contain, according to the Contractor's interpretation unacceptable defects. The final disposition of all unacceptable welds shall be decided by the Owner/Consultant.

**2.19 Qualification of Radiographers**

Pipeline radiographers shall be qualified in accordance with the requirement of API 1104 andto the full satisfaction of Owner/Consultant and as per AST-SNT-TC-1A Level II.

Certification of all the radiographers, qualified as per above, shall be furnished by the CONTRACTOR to the Owner/Consultant before a radiographer will be permitted to perform production radiography. The certificate record shall include:

The radiographers shall be required to qualify with each radiographic procedure they use, prior to performing the work assigned to him in accordance with the specification.

**2.20 Preservation of Radiographs**

The radiographs shall be processed to allow storage of films without any discoloration for at least three years. All the radiographs shall be presented in suitable folders for preservation along with necessary documentation.

All radiographs shall become property of the Owner/ Consultant.

**2.21 Equipment and Accessories**

Contractor shall make necessary arrangements at his own expense, for providing the radiographic equipment, radiographic films and all the accessories for carrying out the radiographic examination for satisfactory arid timely completion of the job. The Contractorshall be responsible for obtaining necessary permits regarding, holding use and transport of sources.

**2.22 Radiation Protection**

Contractor shall be responsible for the protection and personnel monitoring of every man with or near radiation sources.

The protection and monitoring shall comply with local regulations. Contractor shall be responsible for complying with all rules and regulation set forth by Atomic Energy Commission or any other Government of India agencies in this regard and Owner/Consultant shall not be responsible. Owner/Consultant shall be kept indemnified at all times by the Contractor.

**2.23 Safety Instructions**

The safety provisions shall be brought to the notice of all concerned by display on a notice board at prominent place at the work spot. The person responsible for the "safety" shall be named by the Contractor.

**3.0 MAGNETIC PARTICLE & DYE PENETRANT TESTING**

**3.1** For welded joints and for detection of surface defects that cannot be radio graphed or ultrasonic tested either dye penetrant or magnetic particle inspection shall be called out after approval of the Owner/consultant.

**3.2** The procedure for magnetic particle examination shall contain as a minimum the following information for approval by the Owner/consultant.

- Type and size of material to be examined.
- Type of magnetization and equipment
- Type of ferromagnetic particles used
- Method of surface preparation
- Magnetization current
- Type of ferromagnetic particle used.

**3.3** The area being examined shall be magnetized in at least two direction perpendiculars to each other. The non-fluorescent particles (wet order) shall have sufficient contact with respect to the surface to be examined.

**3.4** The surface to be examined shall be made free of grease, dirt, oil, scale, oxides, etc.

**3.5** MPE shall not be performed on parts whose temperature exceeds 300°C.

**3.6** Magnetic particle operators and dye penetrant shall be qualified to ANSI-SNT-TC-1A Level II or equivalent as approved by Owner/ Consultant.

**3.7** Dye penetrant examination procedure shall also be submitted to Owner/ Consultant for approval.

# TECHNICAL SPECIFICATION FOR CONCRETE WEIGHT COATING

## CONTENTS

## 1.0 SCOPE

This specification defines the minimum technical requirements for the materials, workmanship, application, inspection, handling and other activities for anti-buoyancy measures using external concrete weight coating of pipeline.

## 2.0 CODES AND STANDARDS

Reference has been made in this specification to the following codes and standards:

| | | | |
|---|---|---|---|
| a) | ASTM A-185 | : | Specification for Steel Welded Wire Reinforcement, Plain for Concrete Reinforcement |
| b) | ASTM C-642 | : | Test Method for Specific Gravity, Absorption and Voids in Hardened Concrete |
| c) | ASTM C-138 | : | Test Method for Unit Weight, Yield and Air Content of Concrete |
| d) | ASTM C-309 | : | Specification for Liquid Membrane Forming Compounds for Curing Concrete |
| e) | ASTM A-82 | : | Specification for Steel Wire, Plain, for Concrete Reinforcement |
| f) | ASTM C-39 | : | Test Method for Compressive Strength of Cylindrical Concrete Specimens |
| g) | IS - 269 | : | Indian Standard Specification for Ordinary and Low Heat Portland Cement (1959; Reaffirmed1999) |
| h) | IS – 456 | : | Plain and Reinforced Concrete – Code of Practice (3rd Revision – 2000) |
| i) | IS – 6909 | : | Indian Standard Specification for Super Sulphated Cement (1990; Reaffirmed 1997) |
| j) | IS-8112 | : | Indian Standard Specification for Ordinary Portland Cement |
| k) | IS-383 | : | Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete |
| l) | IS-516 | : | Method of Test for Strength of Concrete |
| m) | IS:1566 | : | Indian standard for Hard-drawn steel wire fabric for concrete reinforcement |

## 3.0 MATERIALS

The Contractor shall supply all the materials necessary for the performance of the work.

All materials supplied by the Contractor, which in the opinion of Owner, do not comply with the appropriate specifications shall be rejected and immediately removed from site by Contractor at his own expense.

All materials for concrete coating shall comply with following requirements.

### 3.1 Cement

3.1.1 Portland Cement (conforming to IS-269), or High Strength Ordinary Portland Cement (conforming to IS-8112) shall be used. Cement which has hardened or partially set or has become lumpy shall not be used. Test certificates from the cement Manufacturer shall be supplied to the COMPANY for all cement delivered to site.

3.1.2 Super sulphated Cement shall be (conforming to IS 6909) used wherever the soil is corrosive.

3.1.3 Cement which is more than six months old shall not be acceptable.

3.1.4 In case concrete weight coating is to be provided at location affected by seawater tidal flats etc. Portland cement in accordance with ASTM C-150 Type III shall be used.

### 3.2 Aggregates

3.2.1 Aggregate shall comply with the requirements of IS: 383 and shall be tested in accordancewith

IS:2386.

3.2.2 Fine Aggregates

'Fine Aggregates' shall mean any of the following, as defined in IS: 383:

i) Natural sand;
ii) Crushed stone sand;
iii) Crushed gravel sand;

Sand shall be well-graded from fine to coarse in accordance with Table 4 of IS: 383.

3.1.3 Coarse Aggregates
Use of coarse aggregates shall be subjected to Owner's approval.

3.1.4 Aggregates shall be clean and free from injurious amounts of salt, alkali, deleterioussubstances or organic impurities.

**3.3 Water**

The water shall be fresh and clean and shall be free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. It shall not contain chlorides, sulphates, and magnesium salts.
Water from source shall be tested by the Contractor at his own expense before use and thetest reports shall be submitted to the Owner's representative for approval.

**3.4 Reinforcement**

Concrete coating shall be reinforced by a single layer or multiple layers of steel reinforcement according to the provisions hereinafter described. Reinforcement shall be Fe415.

3.4.1 Reinforcement shall consist of welded steel wire fabric manufactured in rolls (ribbon mesh) or in flat sheets and shall conform ASTM A-185. Steel wires in the ribbon mesh shall conform to ASTM A-82.

3.4.2 Steel wires shall be galvanized at finished size. The diameter of the wire and wire spacing (mesh) dimensions shall be selected according to the following criteria.

3.4.2.1 Wire fabric manufactured in rolls (ribbon mesh) shall be 25 x 50 mm of 14 gauge U.S. steelwires (2mm wire). The above dimensions will be applied unless otherwise specified by Owner.

3.4.2.2 Wire fabric manufactured in flat sheets shall be 50 x 100mm max. steel wire mesh, 13 gauge2.5mm thickness. As a rule wire fabrics (sheets) shall be used when concrete coating is applied by casting method, while ribbon mesh (rolls) shall be used when concrete coating is applied by impingement method.

**4.0 COATING REQUIREMENTS**

Pipes shall be concrete coated to a thickness as specified in the relevant drawings and as per the design documents. CONTRACTOR shall be permitted to select any proportioning of materials to achieve the specified requirements of concrete density and weight by doing mix design and trial tests. Concrete shall conform to the following standards:

| Property | Minimum Acceptable Value |
|---|---|
| Concrete Density | 2400 Kg/$m^3$ |
| Compressive Strength (After7 Days) | 235 Kg/$cm^2$ |
| Compressive Strength (After28 Days) | 350 Kg/$cm^2$ |

**5.0 APPLICATION METHOD**

Concrete coating shall be applied by casting or impingement method. Any alteration or modifications

to the method described in the specification shall be submitted to the Owner for approval. The application method shall however ensure the basic characteristics of concrete coating in compliance with the minimum requirements of this specification.

Contractor shall submit to the OWNER, prior to commencement of work, the procedure ofconcrete application for approval.
Wherever practical, the specified total thickness of concrete coating shall be applied in asingle pass.

**6.0 EQUIPMENT**

The equipment used for performing the concrete coating shall be capable of doing so witha reasonable degree of uniformity with respect to density, thickness and strength. The proportioning equipment and procedure shall be of the type to ensure consistently proportioned materials by weight. Concrete shall be mixed in a mechanical mixer, which shall ensure thorough mixing of all materials. Any equipment that tends to separate the ingredients shall not be used.

**7.0 MEASUREMENTS & RECORDS**

Contractor shall submit detailed methodology in their procedure for measurement and logging. All Measurements as mentioned below shall be taken during the work stages and clearly logged in a proper logbook. A special logbook shall be used for recording tests and trial results. A logbook shall refer to pipe lengths having the same nominal diameter, and wall thickness.

**7.1** The logging methodology shall include minimum the following details:

**a) Line pipe**

1) Field identification number
2) Mill serial Number
3) Length (m)
4) Average outside diameter (mm)
5) Weight (Kg)

**b) Concrete Weight Coating**

1) Batch identification number
2) Date of placing of concrete coating.
3) Average concrete coating thickness.
4) Wet weight of coated pipe (weight and date of weighing)
5) "Dry weight" of concrete coated pipe
   (Weight and date of weighing or related weight 28 days after placing of concrete andso identifiable).
6) "Unit dry weight" of concrete coated pipe.
7) "Negative buoyancy" (unit) of concrete coated pipe

**7.2** No concrete placing shall be done before items 1 to 5 listed in 7.1(a) have been logged. In addition, each batch / shift shall be identified and logged against cube samples taken for compressive strength and dry density.

**8.0 PROCEDURE QUALIFICATION**

Before commencement of the work, Contractor shall perform all tests, either in thelaboratory or in field to properly select type of mix, which meets the requirements of section 5.0 of this specification.

**8.1** The type of mix, i.e., the correct combination of the cement, aggregates and water which results in the desired properties of concrete shall be first determined. For each mix the following shall be accurately checked and recorded:

i) Proportions and weights of the respective materials used
ii) The water/ cement ratio
iii) The grading of the aggregates.

**8.2** Samples shall be prepared and tested in accordance with ASTM C-642 to determine the dry specific gravity (28 days after placing).

**8.3** 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.

**8.4** The mix so determined shall then be used for sampling of concrete to be submitted to compressive

strength tests as per IS 456/ ASTM C-39.

**8.5** Frequency of sampling for tests for density and compressive strength of concrete shall be asfollows:

| **Quantity* of Concrete ($m^3$)** | **Number of Samples** |
|---|---|
| Up to 25 | 3 |
| 26 to 50 | 4 |
| 51 and above | 4 samples and one additional sample for each additional 50 $m^3$ or part thereof. |
| * Quantity is the volume of concrete to be used for each qualified mix. | |

**9.0 APPLICATION OF REINFORCEMENT AND CONCRETE COATING**

**9.1** Two test cubes each per day shall be obtained from batches and tested at the end of 7 days after coating, for compressive strength and specific gravity.

**9.2** 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.

9.3 To maintain the water / cement ratio constant at its correct value, determination of moisturecontents in both fine aggregates and coarse aggregates (if used) shall be made as frequently as possible. Frequency for a given job shall be determined by the Owner according to weather conditions.

**9.4 Reinforcement application**

9.4.1 Prior to placing of reinforcement, the protective coating of each pipe length shall be carefullyinspected visually and by holiday detectors. If damages are found, they shall be repaired

before start of the work. Foreign matters, if any, shall be removed from the surface of theprotective coating.

9.4.2 Reinforcement shall be placed around the pipe in such a way as to cover whole pipe lengthor sections to be concrete coated. The reinforcement shall protrude a minimum 75 mm from the finished concrete coating at the pipe ends.

9.4.3 Splices and attachments shall be done by binding with steel wire having 1.5mm diameter.

Circular and longitudinal joints of wire fabric in sheets shall be lapped at least for onemesh. The spiral lap shall be one mesh while the spliced lap shall be three meshes.

9.4.4 Reinforcement shall rest on synthetic resin spacers forming a "Crown" whose number shall be such as to avoid contact of the steel reinforcement with the pipe's protective coating. Spacing between the two consecutive 'crown' centres shall be 500 to 1000 m.

9.4.5 One layer of reinforcement steel shall be provided for concrete thickness up to 60 mm. The reinforcement steel shall be embedded approximately midway in the concrete coating thickness. For concrete thickness above 60mm two layers of reinforcing steel shall be provided. If application method requires more than one pass of concrete, one reinforcement layer for each pass is to be applied irrespective of the concrete coating thickness.

**9.5 Concrete placing**

9.5.1 Concrete shall be placed within a maximum of 30 minutes from the time of mixing (adding water to mix) and shall be handled in such a way so as to prevent aggregate segregationand excessive moisture loss. Concrete containers shall continuously be kept clean and free from hardened or partially hardened concrete.

9.5.2 Placement of concrete shall be up to the specified thickness in one continuous course, allowance being made for splices of reinforcement and providing reinforcement in the right location.

9.5.3 No passes shall be stopped for more than 30 minutes. Before placing fresh concrete against the joint,

the contact surfaces shall be carefully cleaned and wetted to obtain a good bond between the fresh material and the previously placed material.

9.5.4 All pipes shall be kept clean and free from cement, concrete and grout either inside or outside of the uncoated sections.

9.5.5 The coatings at each end of the pipe shall be bevelled to a slope of approximately two-to- one (2:1).

9.5.6 Bevel protectors shall be kept in place throughout the coating application and even after the coating is complete.

Suitable means shall be provided to ensure that the temperature of the concrete, whenplaced, does not exceed 32□C.

**9.6 Winter concrete coating**

9.6.1 In ambient temperatures below 4 °C concrete must be protected from the effects of frost by warming the aggregates and / or warming of the mixing water and additionally ensuring anair temperature of 6 °C in the vicinity of the concrete.

9.6.2 Storing and curing of coated pipe shall not take place at temperatures below 1.5 °C, until theconcrete has aged sufficiently to have achieved a crushing strength of at least 10 $N/mm^2$.

**9.7 Reclaimed concrete**

9.7.1 Use of reclaimed rebound shall be done only with the written permission of the Owner and tothe satisfaction of the Owner's inspector.

9.7.2 When use of reclaimed rebound is permitted by the Owner, this material shall be added to and thoroughly intermixed with freshly batched concrete in a secondary mixture of a type, acceptable to the Owner's representative.

9.7.3 The amount of reclaimed material used shall not exceed 5% of the total mix by weight and shall only be added in an even flow during a continuous coating operation.

**9.8 Cut back on concrete coating**

Both ends of each joint for the distance of 250mm or as specified in the Contract documentshall be completely free of concrete to facilitate field joints.

**9.9 Handling after application**

Contractor shall take precautions to prevent detrimental movement of pipe after coating andto minimize handling stresses whilst concrete is hardening and curing.

Identity of each pipe shall be preserved during and after the coating process by transfer ofpipe information to and outside of concrete coating at each end of the all pipes.

**9.10 Curing**

9.10.1 Immediately after concreting, the exposed surfaces of the concrete shall be protected during hardening from the effects of sunshine, drying winds, rain, etc., and then after the initial set has taken place, the concrete coating shall be properly cured. The coated pipe section shall be handled gently by suitable means to prevent undue distortion.

9.10.2 Curing shall be performed by application of an approved curing membrane using sealing compounds and shall meet the requirements of ASTM C-309. The curing compound material shall be stored, prepared and applied in strict conformity with the instructions of the Manufacturer. 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 anti-corrosion coating or steel pipe. The application of the curing compound shall be done 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. The membrane curing period shall not be less than 4 days, during which period the freshly coated pipes shall not be disturbed. The pipe surface shall be kept wet during daylight hours for seven days after application of the concrete coating. The concrete coating shall not be allowed to dehydrate.

Before handling and hauling of the concrete coated pipes, a check shall be made to makesure that

the concrete coating is properly cured. Stacking and shipment of the coated pipes

shall be initiated only after seven days provided that the concrete coating suffers nodamage.

**10.0 TOLERANCES**

**10.1** Contractor shall maintain a surface tolerance of ± 6mm on outside diameter of the coated pipes measured by diameter tape. The diameter of each coated pipe shall be obtained at five (5) points, spaced at equal intervals between end points.

**10.2** The acceptance weight tolerance for any single pipe shall be limited to (-) 2% to (+) 5% ofthe calculated theoretical weight. The theoretical weight shall be calculated using total weight of the pipe with concrete and corrosion coating.

**10.3** Acceptable weight tolerance from the approved mix, during production shall be as follows:

i) ± 3% for each type of aggregate

ii) ± 2% for aggregate as a whole

iii) ± 3% for the total quantity of water

iv) ± 3% for cement

**11.0 WEIGHING**

**11.1** The test specimen shall be selected at equal intervals during the course of production.

**11.2** Contractor shall weigh each pipe when dry prior to shipment and 28 days after placing of concrete and mark the weight with paint on the inside of the pipe

**12.0 INSPECTION AND TEST**

**12.1** After curing, every length of concrete coated pipe shall be non-destructively tested by suitable means such as "ringing" to determine if any suspected defects are present. In case this indicates faulty coating, cores shall be removed from coating and inspected. When defective coating appears from cores, the concrete coating shall be removed from the pipe lengths.

**12.2** Every length of concrete coated pipe shall be checked to verify insulation between steel reinforcement and pipe by means of a megger or equivalent device. For this purpose provisions should be made during placing of concrete such as to leave at least a point of exposed steel reinforcement whenever the latter shall terminate inside of concrete coating.

**12.3** During the tests above and before transporting of concrete coated pipes, every pipe length shall be visually inspected to detect whether any damages and/or defects are present. Possible damages and/or defects with their allowable limits are described at following section. Repairable concrete coating shall be clearly marked while the non-repairable ones shall be removed from the pipe lengths.

**13.0 COATING OF FIELD WELDS**

**13.1** The CONTRACTOR shall coat the uncoated pipe surface at field welds in accordance with methods approved by OWNER. CONTRACTOR shall submit a detailed procedure for joint coating for OWNER's approval.

**13.2** The reinforcement for the field welds shall be same as that for line pipe coating with thesame number of layers and the same space between layers as for the existing coating. The edges of this netting must be carefully secured with galvanized wire to the reinforcement extending from the existing coating.

The reinforcement shall not make direct /electrical contract with the pipe.

Synthetic resin spacer blocks shall be used to keep the reinforcement away from thecorrosion coated pipe surface.

**13.3** The composition of the concrete shall be the same as that of the reinforcement free from the pipe coating.

**13.4** When moulds are used, the CONTRACTOR shall prevent air being trapped by applying mechanical vibrators or by striking the outside of the moulds with suitable sticks.

## 14.0 REPAIRS

The following are repairs that will be permitted to coating due to unavoidable damage inhandling and in storage (This applies only to concrete that has set).

**14.1** Spalling due to compression or shearing caused by impact against other objects. Spalling isdefined as damage, which causes a loss in concrete of more than 25 percent of the total thickness of the coating at the point of damage.

**14.2** Damage due to spalling of an area of less than 0.1 $m^2$ (1 square foot) where the remaining concrete is sound will be accepted without repairs.

**14.3** Damage due to spalling of an area of more than 0.1 $m^2$ and less than 0.3 $m^2$ shall have the concrete remaining in place over that area 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 aggregate shall be trowelled into and through the reinforcement and built up until the surface is level with the coating around the repair. The pipe shall then be carefully laid with the repaired area at the top. The repaired area shall be moist cured for a minimum of thirty six (36) hours before further handling.

**14.4** Should the damaged area be more than 0.3 $m^2$, coating shall be removed around the entire damaged area. A repair shall be made by satisfactorily restoring the reinforcement, forming the area with a metal form and pouring a complete replacement of materials similar to that from which the coating was made. The mixture shall be one (1) part of cement to three (3) parts of aggregate and the necessary water to produce a slump not to exceed 100 mm (four inches). The resulting coating shall be equal in weight, density, uniformity, thickness, strength and characteristics to the originally applied coating. The pipe shall then be carefullylaid in a position where it shall be allowed to remain for a minimum of 36 hours before furtherhandling.

## 15.0 MARKING

**15.1** Every concrete coated pipe length shall be clearly marked by a suitable type of paint (i.e.,red and/or white lead paint). Markings out of concrete coating shall be made inside of pipe close to bevel end, in such a way that the area involved by welding operations is not affectedby paint.

**15.2** For each concrete coated pipe length, at one of the two ends, the field identification number and the date of concrete placing shall be marked, while the dry as well as the wet weight along with number of days after coating shall be marked at the other end.

## 16.0 UNLOADING, TRANSPORTATION, STORING AND HAULING

**16.1** During loading, transport, unloading and hauling of inert aggregates, any contact and mixing with mud, earth, grease and any other foreign material shall be carefully avoided. Precautions shall be taken to prevent contamination, to maintain the cleanliness and against effects of hot or cold weather or other adverse climatologically condition.

**16.2** During the operations of loading, unloading and stock-piling, the pipe sections shall be handled in such a way so as to avoid damages to pipe ends, protective and/or concrete coating.

**16.3** 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. Stacking with more number of layersshall be agreed upon with the OWNER provided that each pipe section is separated by means of spacers suitably spaced so as to avoid stresses and compressed points of contact on the coated surface.

**16.4** 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.

# TECHNICAL SPECIFICATION FOR PIPELINE CROSSING RAIL, ROAD AND MINOR WATER WAYS

**CONTENTS**

## 1.0 SCOPE

**1.1** This Specification defines the minimum technical requirements for the various activities to be carried out by Contractor for the installation of pipelines at rail, roads, minor waterways and other service crossings.

The provisions of this specification are not applicable for pipelines crossing water courses,which are specifically designated as "Major Water Courses" in the CONTRACT.

## 2.0 CODES AND STANDARDS

Reference has been made in this specification to the latest edition/ revision of the followingcodes, standards and specification.

| | | | |
|---|---|---|---|
| a) | ASME B 31.8 | : | Gas Transmissions and Distribution Piping System |
| c) | API RP 1102 | : | Steel Pipeline Crossing Railroads and Highways |
| c) | RDSO report no. BS- 105 | : | Guidelines on Pipeline Crossings under Railway Track |

## 3.0 GENERAL

**3.1** Laying of pipeline at crossing of roads, railroads, buried services, canals and minor watercourses is allowed only after obtaining approval from the authorities having jurisdiction. Contractor shall make suitable arrangements for safeguarding the roads, etc., and the verges and/or banks thereof and the buried services with appropriate provisions.

**3.2** Highways, main-roads and railroads and their verges and banks of water crossings are not allowed to be used for loading, unloading or stacking of materials and/ or equipment. For secondary roads, such loading/ unloading is permitted only after prior approval from the concerned authorities CONTRACTOR is not allowed to close or divert roads or water courses without prior approval from the COMPANY and the concerned authorities. CONTRACTOR shall never unnecessarily hamper the users of the roads, railroads, buried services and/ or water courses. The water flow shall not be obstructed in any way.

**3.3** The Owner/ Consultant reserves the right to demand a detailed report including the following information for individual crossing for approval:-

- Time Schedule
- Working methodology
- Equipment and Manpower deployment
- Test Procedure
- Soil Investigation

**3.4** Pipeline sections for crossings of roads, railroads, canals and rivers etc., shall be hydrostaticallypre-tested ex-site, prior to joint coating and post tested after installation, whenever:

3.4.1 Crossing is executed by boring/ HDD;

3.4.2 Crossing is installed in casing pipe;

3.4.3 River crossing pipes which are to be continuously concrete weight coated (to be tested priorto concrete coating);

3.4.4 Whenever, in OWNER's opinion, the repair of pipeline at crossing, in case of a leak during final hydrostatic testing, would require inordinate amount of effort and/ or time;

3.4.5 Whenever pretesting is insisted upon by the Authorities having jurisdiction over the utility crossed.

**3.5** Cased crossings (rail/road) and rivers crossing sections shall be pressure tested before and after installation for a period of at least four (4 ) hours. Such sections shall be retested along with completed mainline sections.

**3.6** Pipeline sections at all major crossings like State/ National Highways, railways, major canals and lined canals/distributaries shall be laid by boring with casing pipe complying with all other statutory requirements.

**3.7** Contractor shall take suitable measures for the protection of pipeline from overhead high tension power lines by providing plastic gratings/concrete slabs as per approved drawings/ jobstandards.

**4.0 ROAD AND RAIL ROAD CROSSINGS**

**4.1** The work under crossing shall include necessary clearing, grading and trenching to required depths and widths, welding of casing (when required) and carrier pipes, coating, lowering-in, backfilling, clean-up, restoration to the original condition and further strengthening and protective works, testing, installation of assemblies, insulators and seals and temporary works such as sheet pilling, bridges, etc.

**4.2** The work shall be carried out in accordance with the approved drawings/ job standards, as directed by Owner/Consultant and to the satisfaction of Owner/Consultant and the authorities having jurisdiction over the facility crossed. The work carried out for road and railroad crossings shall meet the minimum requirements of API RP 1102, latest edition.

**4.3** Before the installation work of crossing commences the Contractor shall provide suitable barricade, temporary bridge/bypass work (especially where roads are open-cut) with railing, if required by Owner/Consultant for safety of traffic. Adequate traffic warning signals and/or traffic lights and suitable diversions shall be provided as directed by Owner/ Consultant or authorities having jurisdiction over these areas. Such diversions shall not cross the pipeline where it has already been installed, unless proper safeguarding at Owner's/ Consultant's opinion is ensured.

**4.4** Prior approval from the statutory authorities shall be obtained to lay the pipeline across highways/roads either by boring or by open-cut method. Installation of the crossing shall be by the method (i.e., boring/ open-cut) approved by Authorities having jurisdiction. Railroad crossings shall always be bored/ jacked.

**4.5** Pipeline can cross the road with open cut method without any casing pipe if there is no specificinstruction in concerned authority's permission. In such a case, crossing section shall be laid on soft soil/ sand bed of trench at specified required depth. The section shall be back filled with sand only. Subsequently the road shall be repaired/ constructed by appropriate methods to avoid sand erosion during monsoon. It shall be ensured that the road has been restored to it's original condition to the entire satisfaction of owner/ consultant and the authority having jurisdiction over the road.

**4.6** Boring/ jacking of carrier pipes for crossings is allowed only if the pipes for boring/ jacking are provided with a suitable corrosion coating and CONTRACTOR remains liable for the suitability of the pipe and weld-coating of carrier pipes to be bored and for which coatingand method of application are anyhow to be authorised by COMPANY without prejudice to CONTRACTOR's liability. In all other cases the carrier pipes shall be cased.

**4.7** Before start of the boring/ jacking CONTRACTOR shall execute a soil investigation and determine the ground water table. Based on these investigations CONTRACTOR shall prepare a construction drawing and submit to COMPANY for approval including time schedule and soil investigation report. The CONTRACTOR shall submit for approval of COMPANY the method of boring / trenchless to be carried out, depending on the nature of soil conditions, nature of crossing, local requirements etc.

**4.8** During the execution of boring the ground water table over the length of the boring shall be lowered up to at least 0.50 M below bottom of the pipeline. This water table is to be regularly inspected and maintained by CONTRACTOR and reported to COMPANY. To safeguard the stability of the bore pit, CONTRACTOR shall, if necessary in COMPANY's opinion, use a closed sheet piling which shall extend at least over 50% of the length in undisturbed soil. The length of the boring shall be in accordance with the length of the ROW of the crossing (road, railroad, etc.) with minimum 0.6 m extra on either side.

**4.9** In approaches to the crossing, CONTRACTOR shall eliminate unnecessary bending of pipe by conforming to the contour of the ground by gradually deepening the ditch at such approaches as directed by the OWNER.

**4.10** The bottom of the trench and/ or the pit for at least twelve (12) metres at the approachto each end of a casing shall be graded and if necessary backfilled with clean sand and compacted to an elevation that will provide sufficient and continuous support to the pipeline sothat the pipeline remains correctly aligned at the casing ends during and after backfilling.

**4.11** The diameter of the hole for a bored section shall have a hole diameter as close as practicable to the outside diameter of the carrier or casing pipe. If excessive void or too large hole results, or if it is necessary, in the opinion of OWNER, to abandon the bored hole, prompt remedial measures such as filling the hole with suitable material shall be taken to the entire satisfaction of the OWNER and Authorities having jurisdiction thereof at no extra cost to OWNER. Equipment used for installation of casing pipe shall be of the type approved by OWNER.

**4.12** An installation consisting of hydraulic jacks shall be provided with easily readable pressure gauges (in bar) and sealable pressure limits. Their proper operation shall be demonstrated before the work is started. COMPANY can request that the maximum pressing force be limited.

**4.13** At the front of the pipe there may be a cutting ring which may be 12mm larger than the outside diameter for the pipe or casing. A lubricating pipe can also be used in jacking, the nipples of which shall not protrude from the cutting edge. Said lubricating pipe shall not befixed to the pipe casing. When jacking, only biologically degradable lubricants shall be used

**4.14** Removal of soil from the pipeline during jacking shall be done mechanically by means of a standard, locked auger, which has to be safeguarded against jacking ahead of the pipe.

**4.15** During jacking the progress of the pipe to be jacked and the cutting capacity of the augershall be mutually adjusted, by regulating the speed of the auger, to prevent the road from bulging (rpm too low) or cave-ins (rpm too high). In any case no more soil shall be removed than the volume of the pipe. The auger drive shall be provided with a clutch.

**4.16** The progress in the work, the readings of the gauge pipes, the jacking pressures observed, etc., shall be recorded in a log book, to be shown to OWNER upon request.All information shall be supplied to OWNER on completion of the work.

**4.17** If the jacking fails, the casing shall not be withdrawn. It shall be filled with sand and pluggedat either end. The diameter of the casing pipe shall conform to API RP 1102 recommendations or as directed by the Engineer – in - charge.

**4.18** OWNER reserves the right to inspect certain lengths of pipes to assess damages, if any, to the corrosion coating of the carrier pipe used for boring. CONTRACTOR shall weld additional lengths of pipe and pull the required extra lengths of OWNER 's inspection. If during inspection any defects are noticed, CONTRACTOR, in consultation with OWNER, shallcarry out the remedial measures required.

**4.19** While welding of the casing and vent/ drain pipes, internal high or low is not allowed.

**4.20** Welding of casing and vent/ drain pipes need not be radio-graphed, however, only normal visual checks shall be carried out. Before welding, the single length of pipe shall be inspected in order to check that there is no out of roundness and dents. When such defects are noticed, these must be completely removed before joining the pipes. If these defects cannot be repaired, the defective section shall be cut out.

**4.21** In the case of crossing where excavation has been authorised, the welding for the casing pipe and for a continuous section of the pipeline corresponding to the expected length shall be carried out in the proximity of the crossing. Casing must be laid immediately after the trenching. Casing pipe must be laid with a single gradient in order to allow for an easy insertion and, if necessary at a future date, to allow for the removal or replacement of the pipeline, leaving the casing undisturbed.

**4.22** The assembly of vent pipe units as approved by OWNER shall be carried out by direct insertion and welding to the ends of the casing pipe before introducing the carrier pipe.The operation of assembling and extending the vent pipe shall be carried out in such a way that there is no contact with the carrier pipe. The painting/ coating of the vent pipes shall be applied before backfilling as per relevant specifications.

**4.23** The casing pipe shall be considered ready for installation of the carrier pipe, after careful inspection and internal cleaning with the removal of soil, mud, stones and other foreign materials.

**4.24** Insulators, as approved by OWNER, shall be securely fastened (cadmium plated) to the pipe with all bolts and fixtures firmly tightened. The number of insulators and spacing shall be as shown in the drawings or at 2.5m intervals (whichever is more stringent). At the end of both sides of the casing, a double set of insulators shall be installed.

**4.25** Care must be taken in pushing or pulling carrier pipe into the casing so that the pipe is aligned correctly in the casing and that the pushing or pulling force is evenly and constantly applied to avoid damages to the insulators. A nose piece having a diameter equal to that of thepipe shall be welded on the front and back end of the carrier pipe to facilitate installation ofthe carrier pipe properly in the casing and to keep it dry and clean.

**4.26** After installation of the carrier pipe section, the casing and the appurtenances, but prior to making tie-in welds and backfilling, an electrical test shall be conducted by the CONTRACTOR in the presence of the OWNER, to determine the resistance between the casing and the carrier pipe or the carrier pipe and the soil. These tests shall show at least a

resistance of 100 $k\Omega/m^2$. After backfilling and compaction, additional tests shall be conducted to determine if the casing is electrically shorted to the pipe. If the installation is found to be shorted, CONTRACTOR shall make the necessary corrections and repairs at his cost, until a test to the satisfaction of the OWNER is obtained.

## 5.0 CROSSING OF BURIED SERVICES

**5.1** The pipeline under construction may pass above or below the existing buried facilities such as pipelines, cables, etc. Type of crossing shall be such that a minimum depth of cover, as required in the drawings and specifications, is guaranteed. The minimum clearance required between pipeline and the existing facility shall be 500mm unless otherwise specified.

**5.2** Whenever buried services in the ROW are to be crossed by Contractor, Contractor shall safeguard the buried facilities and the required protecting precaution shall be executed as approved by Owner/Consultant of the buried service.

For buried services to be crossed by boring /jacking, the provisions of relevant Operator specification shall be followed.

## 6.0 MINOR WATER WAYS

**6.1** Minor water crossing are crossings of (future) ditches, distributaries, canals, water courses, rivers, streams, etc., whether the bed(s) contain(s) water or not, and not being specified as 'Major Water Crossing' in the Contract.

**6.2** Whenever minor water crossings in the ROW are to be crossed, Contractor shall install suitable temporary bridges as advised by Owner/consultant / Authority jurisdiction and further comply with the provision as laid down in this specification.

**6.3** Before executing the work, Contractor shall carry out detailed survey to determine the natureof flow rate of the watercourse with the object of determining what precautions are necessary to be taken care during period of execution.

**6.4** In the case of crossings of watercourses for which no special methods of laying are required, crossing spool piece shall be assembled and subsequently laid. Bends shall be of cold field type.

**6.5** Whenever required by Owner/Consultant, Contractor shall, before start of construction, execute a soil investigation. Based on such soil investigation he shall prepare construction drawings, work method, Equipment and Manpower deployment and time schedule for approval by Owner/Consultant.

**6.6** The depth of the existing bottom of a minor watercourse crossing shall be determined in relation to the adjacent ground level by taking the average of four measurements.

**6.7** Contractor shall take special care to check with the concerned authorities for special conditions applying to working on, over, under or through minor water crossing and Contractorshall comply with all such conditions. Written arrangements with authorities shall be drawn up in co-operation with Owner/Consultant.

**6.8** The minimum cover over the pipe shall be as specified in the relevant approved drawings and specifications.

**6.9** For crossings beneath the bed of watercourses, the pipe section shall be made in such a way that it conforms to the existing or future bed as indicated in the approved drawings. In crossings for which an individual drawing has not been prepared, the minimum cover of the pipeline shall not be less than that indicated in the standard drawings for a similar type of crossing.

**6.10** Whenever the crossing requires a straight section of pipe between the lower bends coinciding with the riverbed, this section shall be laid at a single horizontal level.

**6.11** For crossing of ditches, canals, banked channels, etc., by boring, the pipe section shall be prepared, laid and tested in accordance with the applicable provisions of Section 3.0 of this specification.

**6.12** The Contractor shall arrange temporary installation on diversion as may be necessary; to ensure the effective functioning of watercourses to be crossed, to the entire satisfaction of the concerned local authorities as well as the Owner.

**6.13** Banks and trenches of minor water crossings shall be backfilled with soil which is to be approved by Owner/Consultant and shall be thoroughly compacted to prevent soil and bank erosion as per the drawings and standards to the satisfaction of authorities having jurisdiction thereof and Owner/Consultant.

**6.14** Whenever boulders, rock, gravel and other hard objects are encountered, they shall not be placed directly on the pipe. Sufficient earth, sand or other selected and approved backfill material shall be placed initially around and over the pipe to provide a protective padding or cushion extending to a minimum thickness of 30 centimeters around the pipe before backfilling remainder of the trench with excavated or other material as per approved drawings and standards.

**6.15** After the trench has been backfilled and during the clean-up works, the minor water crossing shall be cleaned at least across the whole width of the ROW.

**6.16** When specified in the Contract, Contractor shall repair the ditch/ river/ stream bank with materials to be supplied by him. The excavation shall be backfilled with well compacted soil, followed by a minimum 0.25m thick layer of properly shaped boulders (75mm to 150mm) encased in a net of galvanized iron wire of dia 3mm spaced at a maximum distance of 50mm to be laid over the backfilled, compacted and graded banks.

**6.17** The crossing of any embankments shall be carried out strictly in accordance with approved drawings.

**6.18** No drilling work on embankments shall be permitted without prior written approval from the relevant Authorities.

## 7.0 CASED CROSSING

**7.1** Jacking of line pipe for crossing are not allowed at any circumstances. Whenever boring is to be carried out, casing pipe shall be used.

Before start of the boring/jacking, Contractor shall carry out a soil investigation and determine the ground water table. Based on such investigations, Contractor shall prepare construction drawing, methodology, equipment and manpower deployment details and submit the same to Owner/Consultant for approval which shall also include work schedule and soil investigation report.

During the execution of the boring the ground water table over the length of the boring shall belowered up to at least 0.50m below bottom of the pipeline. This water table is to be regularly inspected and maintained by Contractor and reported to Owner/Consultant.

To safeguard the stability of the bore pit, Contractor shall, if necessary in Owner/Consultant's opinion, use a closed sheet piling, which shall extend at least over 50% of the length in undisturbed soil. The length of casing pipe shall extend to the crossing (road, railroad, etc.), minimum 0.6m extra on either side of the crossing (Road, railroad, etc.).

In approaches to the crossing, Contractor shall eliminate unnecessary bending of pipe by conforming to the contour of the ground by gradually deepening the ditch at such approaches.

**7.2** The bottom of the trench and/or the pit for at least twelve (12) meters at the approach to each end of a casing shall be graded and if necessary backfilled with clean sand and compacted upto at least 95%

Proctor density to an elevation that will provide sufficient and continuous support to the pipeline so that the pipeline remains correctly aligned at the casing ends during and after backfilling.

**7.3** The diameter of the hole for a bored section shall have diameter as close as practicable to theoutside diameter of the carrier or casing pipe.

Equipment proper operation shall be demonstrated before the work is commenced to the satisfaction of Owner/Consultant.
Removal of soil from the pipeline during jacking shall be done mechanically by means of a standard, locked augur, which has to be safeguarded against jacking, ahead of the pipe. If, in the opinion of the Owner/Consultant, fluid sand may arise, an inner pipe with funnel shall be used.

**7.4** During boring/jacking the progress of the pipe to be jacked and the cutting capacity of the auger shall be mutually adjusted, by regulating the speed of the augur, to prevent the road from bulging (rpm too low) or cave-ins (rpm too high). In any case no more soil shall be removed than the volume of the pipe. Augur drive shall be provided with a clutch.

**7.5** During the progress of the work, readings of the gauge pipes, jacking pressure observed etc. shall be recorded in a logbook which should be presented to Owner/Consultant upon request. All information shall be supplied to Owner/Consultant on completion of the work.

**7.6** Owner/Consultant reserves the right to inspect certain lengths of pipes to assess damages, if any, to the corrosion coating of the carrier pipe used for boring. Contractor shall weld additional lengths of pipe and pull the required extra lengths for Owner's inspection. If during inspection any defects are noticed, Contractor, in consultation with Owner/Consultant, shall carry out the remedial measures required.

**7.7** All the execution of the work, loading/unloading of material shall be carried out within the proximity of the crossing as allotted by Owner/Authorities. Casing must be laid with a single gradient in order to allow for an easy insertion and, if necessary at a future date, to allow for the removal or replacement of the pipeline, leaving the casing undisturbed.

**7.8** Welding of casing and vent/drain pipes need not be radiographed, however, only normal visual inspection shall be carried out. Before welding, the single length of pipe shall be inspected in order to check that there is no out of roundness and dents. If these defects cannot be repaired, the defective section shall be cut out.

**7.9** The assembly of vent pipe units as approved by Owner/Consultant shall be carried out by direct insertion and welding to the ends of the casing pipe before introducing the carrier pipe. The operation of assembling and extending the vent pipe shall be carried out in such a way that there is no contact with the carrier pipe. The painting/coating on the vent pipes shall be applied before backfilling as per relevant specifications/approved procedures.

**7.10** The casing pipe shall be considered ready for installation of the carrier pipe, after careful inspection and internal cleaning with the removal of soil, mud, stones and all other foreign materials.

**7.11** Insulators, as approved by Owner/Consultant, shall be securely fastened to the carrier pipe with all bolts and fixtures firmly tightened. The number of insulators and spacing shall be as shown in the project drawings or at 2.5 meters whichever is more stringent. At the end of both sides of the casing, a double set of insulators shall be installed. Casing insulators and end materials are to be conformed as per Section 8.0 & 9.0 of this specification.

**7.12** Care must be taken in pushing or pulling carrier pipe into the casing so that the pipe is alignedcorrectly in the casing and that the pushing or pulling force is evenly and constantly applied to avoid damages to the insulators. A nose piece having a diameter equal to that of the pipeshall be welded on the front and back end of the carrier pipe to facilitate installation of the carrier pipe properly in the casing and to keep it dry and clean.

**7.13** After installation of the carrier pipe section, but prior to making tie-in welds and backfilling, an electrical test shall be conducted by the Contractor in the presence of the Owner/Consultant, to determine the resistance between the casing and the carrier pipe or the carrier and the soil. These tests shall show at least a resistance of 100000-ohm/$m^2$ after backfilling and compaction. Additional tests shall be conducted to determine, if the casing is electrically shorted to the pipe. If the installation is found to be shorted, Contractor shall make the necessary corrections and repairs, until a test to the satisfaction of the Owner is obtained.

## 8.0 CASING INSULATORS

Pipeline insulators shall be used to support the carrier pipe inside the casing pipe andelectrically isolate the carrier pipe from the casing pipe at the cased crossings.
Manufacturer shall obtain prior approval from Owner/ Consultant on drawing/design of casinginsulators.

**8.1** It shall be made in segments duly held together with cadmium plates. Bolts and nuts are to be supplied with casing insulators.

The number of segments shall be two for pipe diameters up to 12" (generally). For larger diameters, the number of segments may be more than two, but their number shall be kept minimum.

Casing insulators shall be made of injection moulded high density polyethylene or other material equivalent or superior as approved by Owner/Consultant and shall meet the requirements given in Table-1.

**TABLE – 1: MATERIAL PROPERTIES FOR CASING INSULATORS**

| PROPERTY | VALUE | ASTM TEST METHOD |
|---|---|---|
| Dielectric Strength | 450-500 Volts/Mil | D-149 |
| Compressive Strength | 3200 psi | D-695 |
| Tensile Strength | 3100-5000 psi | D-638, D-651 |
| Impact Strength | 4 ft.lb./inch of notch | D-256 |
| Water Absorption | 0.01% | D-570 |

## 9.0 CASING END-SEALS

Casing end seals are intended to be used for sealing the annular space between casing pipeand carrier pipe at casing ends so as to prevent ingress of moisture and water.

Manufacturer shall obtain approval from Owner/Consultant on design/ drawing of end seals.

The seals shall be suitable for the casing and carrier pipe diameter as applicable for each case.

The casing end-seal shall be flexible to cater for the expansion and contraction of carrier andcasing pipes and shall be able to tolerate both angular and concentric misalignment of casing pipe without loss of sealing efficiency.

The casing end-seals shall be made of heat shrink high density radiation cross linked polyethylene with an adhesive having a melt point suitable for the pipeline service temperature and ambient temperature foreseen during construction. End-seals material shallbe resistant to heat, cold, vibration, impact, abrasion, corrosive fluids, disbanding, organic and bio-deterioration.

Material for casing end seals shall meet the requirements given in Table-2.

**TABLE – 2: MATERIAL PROPERTIES FOR CASING END SEALS**

| PROPERTY | VALUE | ASTM TEST METHOD |
|---|---|---|

| | | |
|---|---|---|
| Backing<br>(Sleeve and closure patch)<br><br>Tensile Strength<br>Ultimate Elongation<br>Heat Shock | <br><br>2200 psi<br>400%<br>No visual cracks, flow or drips (at 250°C, 4 hours) | <br><br>ASTM D-638<br>ASTM D-638<br>ASTM D-2671 |
| Adhesive<br><br>Ring and Ball softening point<br><br>Lap Shear | <br><br>90°C<br><br>60°C – 25 psi<br>23°C – 250 psi<br>(2 inch/min.) | <br><br>ASTM E-28<br><br>ASTM D 1002 |
| System<br><br>Peel strength<br>(to casing and carrier pipe and closure patch) | <br><br>5 psi<br>(10 inch/min.) | <br><br>ASTM D-1000 |

**9.1 Inspection And Testing For Insulator & End Sealings:**

Manufacturer/ contractor shall furnish material test certificates of the components used in theassembly of casing insulators and end seal.

The manufacturer / contractor shall replace, at no extra cost, any material not conforming to the material and performance requirements of this specification.

Manufacturer / contractor shall submit detailed specification of the materials used in the assemblies, along with instructions for handling, use and installation of the material for OWNER approval prior to procurement.

**9.2 Documentation**

Manufacturer shall submit documentation for Casing insulators and End seals, which shallinclude the following as minimum:

a. General Arrangement Drawings
b. Test and material certificates of all components used in the assembly of casing insulatorsand end seals.
c. Application Procedures / Manuals

# TECHNICAL SPECIFICATION FOR FIELD JOINT COATING

## CONTENT

## 1.0 SCOPE

This specification establishes the minimum requirements of materials, equipment and installation of field joint anti-corrosion coating of buried onshore pipelines factory coated with three layer polyethylene or three layer polypropylene by heat shrink wraparound sleevesconforming to DIN EN 12068 class C– "Cathodic Protection – External Organic Coatings for theCorrosion Protection of Buried Steel Pipelines". Unless modified / replaced by this specification, all requirements of DIN EN 12068 shall remain fully applicable and complied with.

This specification shall be read in conjunction with the conditions of all specifications and contract documents between Owner/ Consultant and Contractor.

## 2.0 CODES AND STANDARDS

Reference has also been made to the latest edition (edition enforce at the time of floating the enquiry) of the following standards, codes and specifications:

| | | | |
|---|---|---|---|
| a) | ISO 8502 – 3 | : | Preparation of Steel Substrates before Application of Paints and Related Products – Part 3 - Assessment of Dust on Steel Surfaces Prepared for Painting (Pressure Sensitive Tape Method) |
| b) | ISO 8503 – 1 | : | Part 1: Specification and definitions for ISO surface profile comparator for the assessment of abrasive blast cleaned surfaces. |
| c) | ISO 8503 – 4 | : | Part 4: Methods for calibration of ISO surface profile comparator and for the determination of surface profile – Stylusinstrument procedure. |
| d) | SIS-055900 | : | Pictorial Surface Preparation Standard for Painting Steel Surfaces |
| e) | SSPC-SP1 | : | Steel Structure Painting Council. |
| f) | DIN EN12068 | : | Cathodic Protection – External Organic Coatings for the Corrosion Protection of Buried Steel Pipelines |
| g) | DIN 30672 | : | Coating of corrosion protection tapes and heat shrinking products for pipelines |
| h) | ASTM D-638 | : | Standard method of test for tensile properties of plastics. |
| **i)** | ASTM D-149 | : | Standard Test Methods of Dielectric Breakdown voltage and Dielectric strength of solid electrical insulating materials at commercial frequencies. |

j) ASTM D-257 : Standard Test Methods for D-C Resistance or conductance of insulating materials.

k) ASTM D-570 : Standard Method of Test for Water Absorption of Plastics.

In case of conflict between the requirements of this specification and that of above referred documents, the most stringent requirements shall be followed.

## 3.0 MATERIALS AND EQUIPMENT

Contractor shall supply joint coating materials, all equipment and manpower required for a skillful and adequate application of coating in the field in accordance with the specifications.

Contractor shall submit and demonstrate to Company proposed materials and works procedures for applying field coating and repair procedures for same. These proposed procedures and all materials, equipment and tools used in the work shall be subject to Owner's approval.

### 3.1 Field Joint Corrosion Coating Material

Field joint anti-corrosion coating material shall be either heat shrinkable wraparound sleeve orcold applied tape suitable for a maximum operating temperature of (+) 65°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 3.3 of this specification. Also suitable coating material shall be applied for 3LPP coated pipes (if any) subject to the owner's approvals,other than Dirax sleeve for HDD crossings.

### 3.2 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 strengththermoplastic/ co-polymer hot melt adhesive. The joint coating system shall consist of a solventfree epoxy primer applied to the pipe surface prior to sleeve application. The backing shall beprovided 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 tosuit the pipe diameter and the requirements of overlap.

The total thickness of heat shrinkable wraparound sleeve in the as applied condition shall be asfollows:

| **Pipe Size (Specified Outside Diameter)** | **Thickness (mm)** | |
|---|---|---|
| | **On Pipe Body (Min.)** | **On Weld Bead (Min.)** |
| 4" (114.3 mm) to 10" (273.0 mm) | 2.5 mm | 2.0 mm |
| 12" (323.9 mm) to 18" (457.2 mm) | 2.5 mm | 2.0 mm |
| 20" (508.0 mm) to 30" (762.0 mm) | 3.0 mm | 2.5 mm |
| ≥ 32" (812.8 mm) | 3.0 mm | 2.5 mm |

The heat shrink wraparound sleeve shall have the required adhesive properties when appliedon 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 ofthe pipe coating.

The Contractor shall propose the specific grade of field joint coating system meeting the requirements of this specification from manufacturers. In case the Contractor proposes to supply heat shrinkable wraparound sleeve then the Contractor shall propose only those coatingsystems that have been previously used in pipelines of same or higher than the size indicated intender and above in a single project for similar operating conditions.

**3.3 Functional Requirements of Field Joint Coating**

3.3.1 Properties of the PE backing shall be as follows:

| Sl. No. | Properties | Unit | Requirement | Test Method |
|---|---|---|---|---|
| a. | Tensile Strength @+25ºC | $N/mm^2$ | > 12 | DIN EN 12068 |
| b. | Ultimate Elongation @+25ºC | % | > 250 | DIN EN 12068 |
| c. | Dielectric withstand with 1000 Volts/ sec | KV | > 30 | ASTM D 149 |
| d. | Water absorption, @+25ºC for 24 hours | % | <0.05 | ASTM D 570 |
| e. | Volume Resistivity @+25ºC | Ohm-cm | > 10 15 | ASTM D 257 |

NOTE: Thermal Ageing Resistance is as per DIN EN 12068.

3.3.2 Functional Properties of Joint Coating System (As applied) As applied field joint coating systemshall comply the requirements of DIN EN 12068, Table 1 and 2 corresponding to designation DIN EN 12068 – C HT 60 UV, except as modified below :Cathodic Disbondment Resistance at $T_{max}$ i.e. (+) 60°C shall be 20 mm when tested as perAnnexure K of DIN EN 12068. Test shall be carried out at (+) 60°C Peel Strength shall be as follows:

| Peel Strength | Temp | Unit | Requirement for Mech. Resistance Class C (minimum) | Test Method as per DIN EN 12068 |
|---|---|---|---|---|
| Inner to Inner + Outer to Inner | @ 23ºC | N/mm | 1.5 | Annexure B |
| | @T max | N/mm | 0.3 | |
| Outer to Outer | @ 23ºC | N/mm | 1.5 | |
| | @T max | N/mm | 0.3 | |
| To Pipe Surface | @23ºC | N/mm | 3.5 | Annexure C |
| | @T max | N/mm | 0.5 | |
| To Factory Coating | @23ºC | N/mm | 3.5 | |
| | @T max | N/mm | 0.5 | |

Contractor shall obtain prior approval from Owner/Consultant regarding the Manufacturer of the joint coating material and the specific grade of the joint coating system. Complete technical details along with test certificates complying with the requirements of clause
3.2.1 and 3.2.2 shall be submitted to Owner/ Consultant for this purpose. The Contractor shallfurnish test certificates from an independent DIN recognized/approved laboratory for all the properties required for the specified EN designation of field joint coating and the requirements ofthis specification.

**3.4** The materials shall not be older than their period of validity at the time of application by Contractor. Deteriorated/decomposed material shall be disposed off and replaced by Contractorat his own expense.

Contractor shall ensure that the coating materials supplied by him are properly packed andclearly marked with the following:

Manufacturer's name

Material qualification

Batch number

Date of manufacturing and date of expiry

CONTRACTOR shall be responsible for arranging all equipment and manpower required for application, testing and inspection of coating and all required materials for field joint coating inaccordance with this specification.

**3.5** Contractor shall ensure that the Manufacturer has carried out all quality control tests on each batch and manufacturer shall provide test certificates to certify that the supplied materials meetthe manufacturer's specifications as indicated in the purchase order and as approved byOwner/Consultant. Certificates and data sheets certifying the qualities of the coating materialsshall be submitted by Contractor to Owner/Consultant prior to application. Owner/Consultantreserves the right to have the materials tested by an independent laboratory.

**3.6** Materials shall be stored in sheltered storage in the manufacturer's original packing and awayfrom direct sunlight and in accordance with manufacturer's instructions.

**3.7** Contractor shall provide and maintain mobile facilities which contain all necessary equipmentand its spares for cleaning, coating, repairs, inspection and tests.

3.7 Contractor shall furnish sufficient number of the following equipment and the required spares as a minimum for inspection and test purposes for each crew:

a) Fully automatic full circle adjustable holiday detector with a visible and audible signal systemfor inspection of coatings.

b) Thickness gauge for measuring thickness.

c) Contact type temperature recording thermometer.

d) Roughness profile measuring (Stylus) instrument

## 4.0 APPLICATION PROCEDURE

### 4.1 General

4.1.1 The application procedure shall be in accordance with manufacturer's instructions and the minimum requirements specified below, whichever are the most stringent and shall be demonstrated to and approved by the Owner/Consultant. Manufacturer's expert shall supervisethe application and shall be available at site upon request during qualification of application procedure and during construction at Contractor's cost.

4.1.2 Operators for coating application shall be given necessary instructions and training before startof work, by the Contractor. To verify and qualify the application procedures, all coating applied during the qualification test shall be removed for destructive testing as detailed subsequently inthis specification. Contractor shall only utilize those operators who have been approved/pre- qualified by the field joint coating manufacturer.

4.1.3 Oil, grease and salt shall be removed from steel surface by wiping with rags soaked with suitable solvents such as naphtha or benzene. Kerosene shall not be used for this purpose.

4.1.4 Each field joint shall be blast cleaned using a closed cycle blasting unit. Steel or chilled shot andiron grit shall be used and Garnet material with the second one. During blast cleaning the pipe surface temperature shall be simultaneously more than 5°C or more than 3°C above ambientDew Point, while the ambient Relative Humidity shall not be greater than 85%. Prior to surfacecleaning the surfaces shall be completely dry. The surface shall be cleaned to a grade Sa 2½in accordance with Swedish Standard SIS-055900 with a roughness profile of 50 – 70 microns. Surface roughness profile shall be measured using an approved profile comparatorin accordance with ISO 8503-1 and shall be calibrated prior to the start of the work in accordance with ISO 8503-3 or ISO 8503-4. The blast cleanliness shall be checked on every joint and the roughness profile shall be checked for 1 out of every 10 joints.

Dust, girt or foreign matter shall be removed from the cleaned surface by a suitable industrial cleaner. The dust contamination allowed shall be of a rating max 2 as per ISO 8502 -3. The frequency of checking for dust contamination shall be 1 out of every 10 joints.

Blast cleaned field joint shall be coated within 2 – 4 hours according to the conditions below :

- Relative Humidity (RH) > 80 % - 2 hours
- Relative Humidity (RH) 70 - 80 % - 3 hours
- Relative Humidity (RH) < 70 % - 4 hours

Pipes delayed beyond this point or pipes showing any visible rust stain, shall be blast cleanedagain.

4.1.5 The field joint surface shall be inspected immediately after blast cleaning and any feature of the steel surface such as weld spatter, scabs, laminations or other imperfectionsconsidered injurious to the coating integrity made visible during blast cleaning shall be reportedto the Owner/Consultant and on permission from Owner/Consultant, such defects shall be removed by filing or grinding. Pipes affected in this manner shall be then re-blasted cleaned ifthe defective area is larger than 50 mm in diameter.

4.1.6 The ends of existing pipe protective coating shall be inspected and chamfered. Unbounded portions of the coating shall be removed and then suitably trimmed. Portions where parent coating is removed shall be thoroughly cleaned as specified. The adjacent chamfered areasof the line pipe coating shall be cleaned and abraded, to expose a clean uniform fresh surface of uncontaminated factory applied coating.

4.1.7 All steel joint surfaces shall be thoroughly examined before the application of the coating in order to ensure the surfaces are free of oil, grease, rust, mud, earth or any other foreign matter.All these substances shall be removed before coating, to the procedures herein described.

4.1.8 Protection coating shall be applied on the joints immediately after the completion of cleaning operation.

### 4.2 Application Procedure for Heat Shrink Wraparound/Sleeves

In addition to the requirements stated above, following shall be complied with:

4.2.1 The wrap around sleeve shall be of a size such that a minimum overlap of 50 mm is ensured (after shrinking) on both sides of the yard applied corrosion coating of pipes.

In the cases where carrier pipe is installed by direct boring/jacking, the overlap on the mill coating for the leading edges of the joints shall be minimum 200 mm. When this extra overlapis achieved by providing an additional patch of heat shrink tape/wraparound, it shall be applied in such a manner that the square edge of the patch on the joint coating is in the direction opposite to the direction of boring / jacking.

4.2.2 Before centring the wraparound sleeve, the bare steel surface shall be preheated either with atorch moved back and forth over the surface or by induction heating. The minimum pre-heat temperature shall be as recommended by manufacturer and shall be checked by means of contact type temperature-recording thermometer. Temperature indicating crayons shall not beused. Pre-heat temperature shall be

checked on every joint. Care shall be taken to ensure thatthe entire circumference of the pipe is heated evenly. Temperature measuring instruments shallbe calibrated immediately before the start of the works and thereafter at intervals recommendedby the manufacturer of the instrument.

4.2.3 Upon pre-heating, the pipe surface shall be applied with two pack epoxy primer of wet film thickness 200 microns or as per manufacturer's recommendation whichever is higher, to coverthe exposed bare metal of the welded field joint and 10 mm min. onto the adjacent pipe coatingif recommended by the manufacturer. The wet film thickness of the primer shall be checked onevery joint with a wet film thickness gauge prior to installation of sleeve. Thickness gauge shallbe calibrated once per shift.

4.2.4 Immediately after application of epoxy primer, the wraparound sleeve shall be entirely wrapped around the pipe within the stipulated time recommended by the manufacturer. Sleeve shall be positioned such that the closure patch is located to one side of the pipe in 10 or2 O'clock position, with the edge of the undergoing layer facing upward and an overlap of min. 50 mm. Gently heat by appropriate torch the backing and the adhesive of the closure and pressit firmly into place.

4.2.5 A heat shrinking procedure shall be applied to shrink the sleeve in such a manner to start shrinkage of the sleeve beginning from the centre of the sleeve and heat circumferentially around the pipe. Continue heating from the centre towards one end of the sleeve until recoveryis completed. In a similar manner, heat and shrink the remaining side. Shrinking has been completed when the adhesive begins to ooze at the sleeve edges all around the circumference.

Visual appearance and void after installation on the body, area adjoining the weld and area adjoining the factory applied coating. (To establish voids adjoining the weld and factory coating, a strip of 50 mm wide and 200 mm long shall be stripped and examined.)

Owner/Consultant shall witness the tests and inspection. Regular application of field joint coating shall commence only upon successful completion of the pre-qualification testing.

After successful completion of the pre-qualification testing as above, the entire field joint coatingshall be removed, the pipe surface re-blasted and field joint coating re- applied as per the requirements of this specification.

**4.3 Pre-Qualification of Field Joint Coating System**

The field joint coating system materials and the procedures proposed by the Contractor shall bepre-qualified during the sleeve installation start-up phase. Five joints (5) shall be coated with therequirements of this specification and then inspected and tested in accordance with the requirements of this specification with respect to the following:

- Surface preparation, cleanliness, roughness profile and dust contamination
- Pre-heat temperature (as applicable)
- Primer thickness
- As applied coating thickness
- Holiday detection

Peel test at (+) 23°C & (+) 80°C on pipe surface & factory applied coating and at over laps (asapplicable). If required to achieve the temperature of (+) 80°C, suitable thermal blanket may beused.

Visual appearance and void after installation on the body, area adjoining the weld and area adjoining the factory applied coating. (To establish voids adjoining the weld and factory coating,a strip of 50 mm wide and 200 mm long shall be stripped and examined.)

Owner/ owner's representative shall witness the tests and inspection. Regular application of field joint

coating shall commence only upon successful completion of the prequalification testing.

After successful completion of the pre-qualification testing as above, the entire field joint coatingshall be removed, the pipe surface re-blasted and field joint coating reapplied as per the requirements of this specification.

### 4.4 Application Procedure for Cold Applied Tapes

4.4.1 Cold applied joint protection tape shall be of the type, which can be applied by spiral wrappingon the pipe.

4.4.2 Immediately after the completion of surface preparation, the approved primer of wet film thickness 150 microns or as per manufacturer's recommendation whichever is higher, to coverthe exposed bare metal of the welded field joint and 10 mm min. onto the adjacent pipe coating if recommended by the manufacturer. Any dirt on the primed surface shall be removed. If the primer is damaged, the damaged area shall be cleaned and re-primed.

4.4.3 Approximately 100 mm of inner wrap interleaving paper shall be peeled back and inner wrap shall be applied with the thicker adhesive side to the pipe. Whilst continuously removing the interleaving paper, the tape shall be spirally applied through a machine to provide a minimum of55% overlap. Sufficient tension shall be applied to ensure good conformity, avoiding air pocketsand also continuously smooth out as the wrapping proceeds. The wrapping shall start and finish to give a minimum 50 mm overlap on to the adjoining yard applied coating. Outer wrap shall also be applied in similar method.

## 5.0 INSPECTION AND TESTING

### 5.1 Visual Inspection

Visual inspection of the as applied coating shall be carried out on every joint, for the following:

- Mastic extrusion on either ends of the sleeve shall be examined
- There shall be no sign of punctures or pinholes or bend failure. The external appearance ofthe sleeve shall be smooth, free of dimples, air entrapment or void formation. All sleeves shall be tested for the presence of voids by knocking on the sleeves. A hollow sound compared to the remainder of the sleeve may indicate the presence of voids under the sleeve.Such sleeve shall be tested for adhesion at the discretion of the Owner/ Consultant.
- Weld bead profile shall be visible through the sleeve
- Visual indicator provided on the backing and the closure patch showing desired heat is achieved.

### 5.2 Holiday Inspection

The entire surface of each joint shall be inspected by means of a full circle holiday detector approved by Owner/Consultant set to a DC voltage applicable as per the requirementsof factory applied mainline coating specification of Owner/ Consultant. Inspection of the sleeves shall be conducted only after the joint has cooled below 50°C. The holiday detector used shall be checked and calibrated daily with an accurate DC voltmeter. The detector electrode shall be in direct contact with the surface of coating to be inspected.

No field joint shall be covered or lowered in the trench until it has been approved by the Owner/Consultant.

### 5.3 As-applied Coating Thickness

Coating thickness shall be checked by non-destructive methods for each field joint. Average thickness of the as-applied coating on pipe body shall be established based on measurements at min. eight locations i.e. four measurements on either side of the girth weld at 3, 6, 9 & 12 O'clock positions. To establish the minimum thickness on the girth weld, four measurements shall be taken on apex on the weld at 3, 6, 9 & 12 O'clock positions. All such measurements shall be recorded. Owner/ Consultant reserves the right to ask for additional measurements atany location on the field joint coating, whenever doubt arises.

### 5.4 Peel Strength Testing

5.4.1 One out of every 50 joint coatings or one joint coating out of every day's production, whicheveris stringent, shall be tested to establish the peel strength on steel and factory applied coating.Contractor shall carry out such testing in the presence of Owner/Consultant.

5.4.2 From each test sleeve selected as above, one or more strips of size 25 mm x 200 mm shall becut perpendicular to the pipe axis and slowly peeled off.

The required peel strength shall meet the requirements of this specification as applicable for (+) 23°C or (+) 80°C whichever is feasible. This test shall be conducted between wrapping & metal and mill coating & between layers at overlap with joint coating (wherever applicable).After removal of strip, the

bulk of adhesive shall remain adhered to the pipe showing no bare metal, otherwise, test shall be considered failed. The adhesive layer that remains on the pipe surface shall generally be free of voids resulting from air or gas inclusion. In case the peel strength test at a different temperature than that specified is warranted due to the ambient site conditions, then the peel strength shall comply the recommendation of the manufacturer. Manufacturer shall be asked to furnish peel strength values corresponding to various expectedtemperatures, prior to start of the works.

5.4.3 If the sleeve does not meet the requirements of above clause 5.4.2, the adjacent two sleevesshall also be tested. If the adjacent two sleeves are acceptable the test rate shall be increasedto one sleeve every twenty five until Owner/Consultant's is satisfied. The test rate can then bereduced as per clause 5.4.1. If either or both of the adjacent two sleeves do not meet the requirements of clause the field coating shall be stopped.

5.4.4 Owner/Consultant reserves the right of 100% removal of sleeves if he is not convinced that the requirements of clause 5.4.2 are achieved.

## 6.0 REPAIRS

**6.1** If a field joint is detected to be unacceptable after testing as per section 6.0 of this specificationthe Contractor shall, at his own cost:

- determine the cause of the faulty results of the field coating.
- mobilise the expert of manufacturer, if required.
- Test to the complete satisfaction of the Owner/Consultant, already completed field coatings
- stop field coating until remedial measures are taken against the causes of such faults, to theentire satisfaction of the Owner/Consultant.

**6.2** Contractor shall replace all joint coating found or expected to be unacceptable as per section 6.0 of this specification.

**6.3** Contractor shall, at his own cost repair all areas where the coating has been removed for testingby the Owner/Consultant.

**6.4** After the coating work on welded joints and repairs to the coating have been completedthe coating as a whole shall be tested with a spark-tester before lowering or jacking the pipeline.

**6.5** Owner/Consultant shall be entitled to check the coating on buried pipelines or parts of pipelineswith equipment such as the "Pearson Meter" and the resistance meter. If coating defects are established, the Contractor shall be responsible for excavation at such points, repairing the coating, spark testing and backfilling the excavations without extra charge.

## 7.0 DOCUMENTATION

**7.1** Prior to procurement of coating materials, Contractor shall furnish the following information for qualification of the Manufacturer and material:

a. Complete information as per clause 3.1, DIN EN 12068 along with descriptive technical catalogues.

b. Test certificates and results of previously conducted tests, for all properties listed in clause 3.2of this specification.

c. Reference list of previous supplies, in last 5 years, of the similar material indicating the projectdetails such as diameter, quantity, operating temperature, year of supply, project name, contactperson and feedback on performance.

d. Once the Owner/Consultant's approval has been given, any change in material or Manufacturer shall be notified to Owner/Consultant, whose approval in writing of all changes shall be obtained before the materials are manufactured.

**7.2** Prior to shipment of materials from the Manufacturer's Works, Contractor shall furnish thefollowing documents:

a. Test certificates/results as per Manufacturer's Quality Control Procedure for each batch of materials.

b. Specific application instructions with pictorial illustrations.

c. Specific storage and handling instructions.

# TECHNICAL SPECIFICATION FOR CASING INSULATORS & CASING END SEALS

## CONTENTS

## 1.0 SCOPE

This specification covers the minimum requirements of design, material, manufacture and supply of casing insulators and end seals intended to be used for cased pipeline crossings.

## 2.0 CODES AND STANDARDS

The related, standards referred to herein and mentioned below shall be of the latest editions prior to the date of the purchaser's enquiry:

a) ASME B 31.8 : Gas Transmission and Distribution Piping System

b) API 1102 : Steel Pipeline Crossing Railroads and Highways

## 3.0 FUNCTIONAL REQUIREMENTS

### 3.1 Casing Insulators

Pipeline insulators shall be used to support the carrier pipe inside the casing pipe andelectrically isolate the carrier pipe from the casing pipe at the cased crossings.

The Casing insulators shall have the following properties:

- Resist cold flow and will not soften at design temperature.
- Resist mechanical damage while being pulled into the casing
- Resist corrosion.
- Have high electrical insulating value and low water absorption, thus preventing leakageand maintain electrical isolation between carrier and casing pipes.
- Have high compressive strength in order to ensure a permanent support to the carrierpipe.

Manufacturer shall obtain prior approval from OWNER on drawing/design of casinginsulators.

### 3.2 Casing end-seals

Casing end seals are intended to be used for sealing the annular space between casingpipe and carrier pipe at casing ends so as to prevent ingress of moisture and water.

Manufacturer shall obtain approval from OWNER on design/drawing of end seals.

## 4.0 DESIGN REQUIREMENTS

### 4.1 Casing Insulators

It shall be made in segments duly held together with cadmium/ xylan plated bolts and nuts,to be supplied with casing insulators.

The number of segments shall be two for pipe diameters up to 12" (generally). For largerdiameters, the number of segments may be more than two but shall be kept to minimum.

The skid height shall be obtained by the following formula & shall be ≥2 inch (min):-

$$\frac{\text{Casing Internal Dia - Carrier Outer Dia}}{2}$$

Manufacturer shall obtain prior approval from COMPANY on casing insulators drawings/ designs. Double insulators shall be installed at ends and shall be located at 300 mm from the end of the casing. Another insulator shall be placed at a distance of approx. 1250 mm (max) from the double insulators. The remaining insulators shall be installed at an equal spacing of approx. 2500mm (max.) each (Refer Fig. 2 attached at the end for installation details). The support point of successive collars shall be regularly staggered.

**Material:**

Casing insulators shall be made of injection moulded high density polyethylene or other material equivalent or superior as approved by Owner and shall meet the requirements given in Table-1.

**Table 1 : Material Properties for Casing Insulators**

| Property | Value | ASTM Test Method |
|---|---|---|
| Dielectric Strength | 450-500 Volts/Mil | D-149 |
| Compressive Strength | 3200 psi | D-695 |
| Tensile Strength | 3100-5000 psi | D-638, D-651 |
| Impact Strength | 4.0 ft.lb./inch of notch | D-256 |
| Water Absorption | 0.01% | D-570 |

## 4.2 Casing end seals

The seals shall be suitable for the casing and carrier pipe diameter as applicable for eachcase. The casing end-seal shall be flexible to cater for the expansion and contraction of

carrier and casing pipes and shall be able to tolerate both angular and concentric misalignment of casing pipe without loss of sealing efficiency.

The design of the casing end seal shall permit easy installation of the seal to the cased pipeline crossing. It shall provide moisture-proof seals when installed for the entire anticipated life of the buried pipeline

**Material:**

The casing end-seals shall be made of heat shrink high density radiation cross linked polyethylene with an adhesive having a melt point suitable for the pipeline service temperature and ambient temperature foreseen during construction. End-seals material shall be resistant to heat, cold, vibration, impact, abrasion, corrosive fluids, disbonding, organic and bio-deterioration. The manufacturer shall confirm compatibility of end seals with carrier pipe coating.
Material for casing end seals shall meet the requirements given in Table-2.

**Table 2 : Material Properties for Casing end Seals**

| Property | Value | Test Method |
|---|---|---|
| Backing<br>(Sleeve and closure patch)<br><br>Tensile Strength<br>Ultimate Elongation<br>Heat Shock | <br><br><br>2200 psi<br>400%<br>No visual cracks, flowor drips (at 250 °C, 4 hours) | <br><br><br>ASTM D-638<br>ASTM D-638<br>ASTM D-2671 |
| Adhesive<br>Ring and Ball softening point<br><br>Lap Shear | <br>90 °C<br><br>60 °C - 25 psi<br>23 °C - 250 psi<br>(2 inch/min.) | <br>ASTM E-28<br><br>ASTM D 1002 |
| System (as applied)<br>Peel strength<br>(To casing and carrier pipe and closure patch) | <br>5 pli<br>(10 inch/min.) | <br>ASTM D-1000 |

## 5.0 DOCUMENTATION

Manufacturer shall submit documentation for Casing insulators and End seals, which shall include the following as minimum.

i) General Arrangement Drawings

ii) Test and material certificates of all components used in the assembly of casing insulators and end seals as per section 4.0 of this specification.

iii) Application Procedures / Manuals

## 6.0 SUPPLEMENTARY REQUIREMENTS

**6.1** The manufacturer shall replace, at no extra cost, any material not conforming to thematerial and performance requirements of this specification.

**6.2** Manufacturer shall submit all the documents, test reports, records and other informationto the OWNER for record after approval.

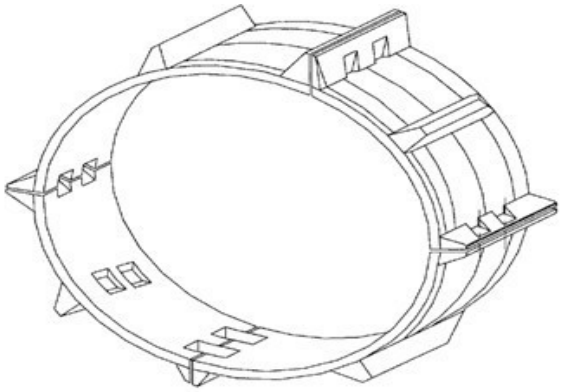
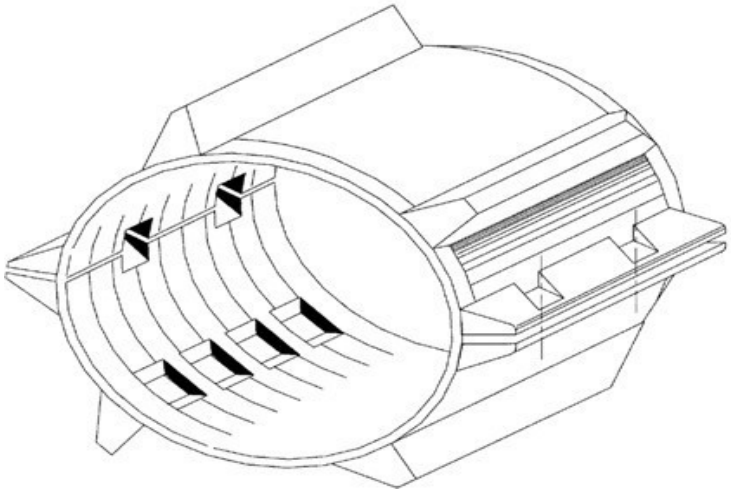
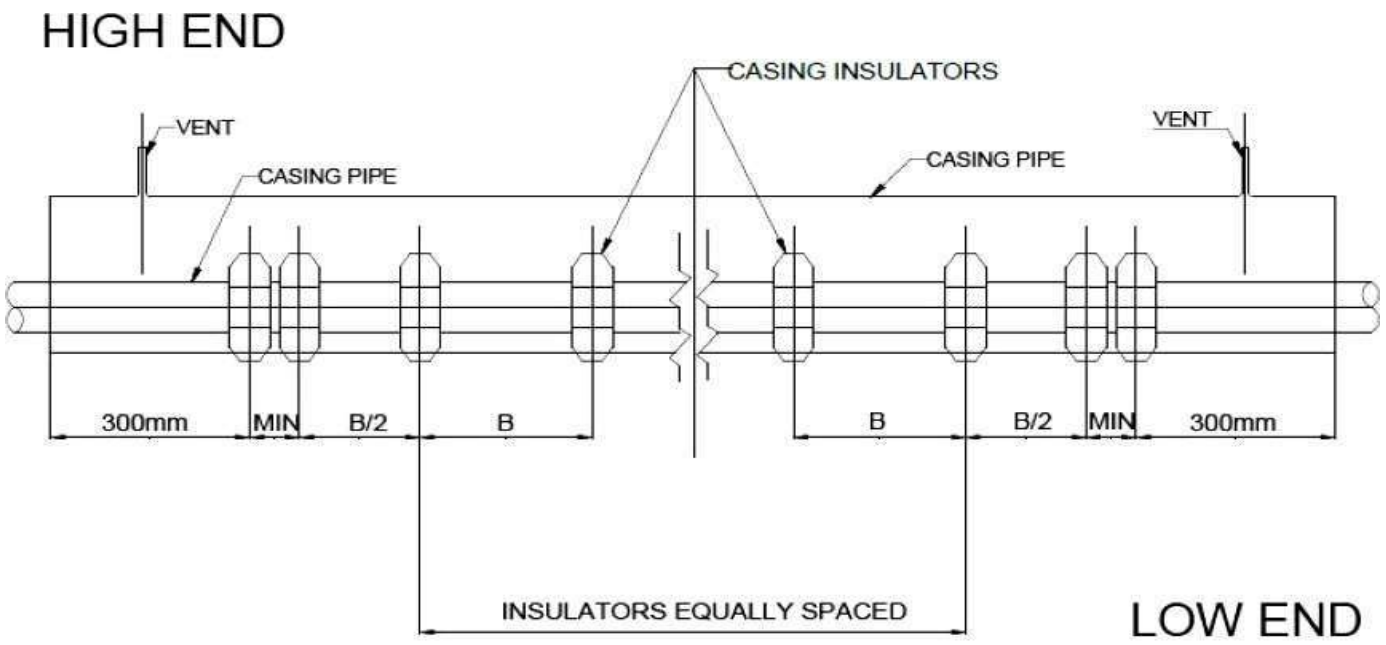


**Fig 1: Casing Insulators**






DISTANCE 'B' = MAXIMUM 2500mm

**Fig.2 Typical Installation Diagram**

# TECHNICAL SPECIFICATION FOR LONG RADIUS BENDS

## CONTENTS

## 1.0 SCOPE

This Specification defines the minimum requirements for design, manufacture, inspection, testing, transportation and supply of Long Radius Bends made from carbon steel line pipes for use in onshore gas pipeline systems.

## 2.0 CODES AND STANDARDS

The manufacturer shall perform work in accordance with the latest edition of the following codes, standards and specifications:

| | | | |
|---|---|---|---|
| a) | ASME Sec. V | : | Method for non-destructive examination |
| b) | BS EN 10204 | : | Metallic Products- Types of inspection documents |
| c) | ASME B 31.8 | : | Gas Transmissions and Distribution Piping System |
| d) | BS EN ISO 6507-1 | : | Methods for Vickers Hardness Test – Testing of Metals |
| e) | MSS-SP-75 | : | Specification for High Test Wrought Weld Fitting |
| f) | API-5L | : | Specification for Line Pipe |
| g) | API RP 5L1 | : | Recommended Practice for Rail Road Transportation of Line Pipes |
| h) | ASME Sec. II Part A | : | Ferrous Material Specification |
| i) | ASME Sec VIII Div 1 & 2 | : | Boiler and Pressure Vessel Code. |

j) ASME B 16.49 : Factory made wrought steel Butt-welding Induction Bends for Transportation and Distribution Systems

k) ASTM A370 : Standard Test Methods and Definitions for Mechanical Testing ofSteel Products.

l) ISO 15590-1 : Petroleum and natural gas industries- induction bends, fittings, and flanges for pipeline transportation system- Part 1: Induction Bends

In case of conflict between the requirements of this specification and the referencedocuments, the requirement whichever is more stringent shall prevail.

## 3.0 MATERIALS

Bend shall be fabricated from bare steel line pipe of heaviest thickness available. Pipes withpositive wall thickness shall be used for fabrication of bends. The type of pipe to be used in fabrication of bends shall be seamless API 5L Gr. X-52 or as indicated in the purchase order.

Unless specified otherwise in Purchase Order, the Line pipes for fabrication of bend shall be provided by the CONTRACTOR. Only pipes with positive wall thickness shall be used for fabrication of bends.

All mechanical properties of the bends after finishing shall be same as pipe specification.

One additional bend for each heat, nominal diameter and wall thickness shall be made by the manufacturer for test purposes. Each test bend shall be bent to an angle of 90º. All examination and test shall be performed on the test bends after final stress relieving. The result of all tests shall be in accordance with the requirements of this Specification. The following tests shall be conducted:

a) The bend shall be non-destructively tested in accordance with 6.2 of this specification.
b) The dimensions of the bends shall meet the requirements of section 7.0 of this specification.

c) The bend shall be hydrostatically tested in accordance with Section 6.1 of this specification.

d) Tensile tests shall be performed in accordance with API-5L on transverse and longitudinal specimens one each taken from the inner and outer radius and from the stop and start transition areas of the bend. Tensile properties shall be in accordance with the Specification.

e) One transverse weld tensile test shall be performed by the Manufacturer to determine the yield and tensile strengths. Such test shall be performed as per API-5L.

f) One set of three Charpy V-notch impact test specimens shall be taken from each of the innerand outer radii and from the stop and start transition areas of the bend. Impact test shall be carried out as per ASTM 370 at -20 & 0 °C and impact energy shall be in accordance withthe specification / approved QAP.

g) One set of three Charpy V-notch impact test specimens shall be taken from each of the following locations for Welded Pipe Bend (for seamless Pipe, bend as per coupon):

Centre of the weld
Fusion line 2mm from
fusion line 5mm from
fusion line
Min. impact energy value at -20 °C shall be 35 J Avg. and 28 J Ind. and 100 J Avg & 80 JInd. for testing at 0 °C

h) One full wall macro section taken parallel to the longitudinal axis of the bend shall be removed from the inner and outer radii and from the stop and start transition areas in the body of the bend. The macro sections shall be polished and Vickers hardness tested in accordance with BS EN ISO 6507-1 shall be performed.

i) Guided bend test shall be conducted in accordance with the requirements of API-5L as specified in specification.

j) The fracture toughness test shall be determined by manufacturer at 0º C & -20 ºC.

k) Hardness test shall be carried out for each heat of steel. Hardness shall not exceed 248 HV10.

l) Metallographic examination (X200 & X400) shall be carried out as per material / manufacturing specification. The grain size shall be 8 or finer as per ASTM E 112. Optical microphotograph shall be provided along with final documentations.

## 4.0 PROCESS OF MANUFACTURE

### 4.1 Manufacturing Procedure Specification

The Manufacturer shall submit a manufacturing procedure specification (MPS) which shall meet all the requirements of these specifications. The MPS shall include but not limited to a complete and detailed procedure for the manufacture of high frequency induction bends and shall include all proposed operations, in the correct sequence, together with all appropriate parameters and methods by which the manufacturer proposes to monitor the parameters as listed below:

a. Sequence of operations;
b. Description of equipment and instrumentation;
c. Bending speed (mm/min);
d. Bending load;
e. Bending temperature;
f. Dimensional Control Procedure;
g. Hydrostatic Testing Procedure;
h. Quench variables (including flow rate);
i. Stress Relieving procedure;
j. Mechanical testing and inspection procedures;
k. Marking details;
l. Handling, transport and storage

Bidder has to submit work procedure with QA/QC plan for approval. Work shall commence after approval from Owner/Consultant.

Failure of any of the qualification tests listed above shall cause rejection of the MPS and all induction bends. Owner / Consultant reserve the right to demand re-qualifications in the caseof any changes to the Owner / Consultant approved MPS or interruptions in the production ofinduction bends.

### 4.2 Manufacturing Procedure Qualification

Manufacturer shall perform the Manufacturing Procedure Qualification to demonstrate that the procedure will produce bends with the requirements set forth in this specification. Test bends shall be provided by Manufacturer for qualification of the MPS. Owner / owner representative reserves the right to select the test bends.

Once the bending operation has commenced any stoppage of the activity shall not be permitted until the entire bending process is completed.

Post bend stress relieving shall be applied over the entire bend and tangent lengths.

## 5.0 MANUFACTURE OF PRODUCTION BENDS

**5.1** Bends shall be manufactured in accordance with the Owner / Consultant approved MPS.Any deviations from the MPS or any changes in the bend forming parameters used for the Manufacturing Procedure “Qualification Test Bend shall be cause of rejection of MPS” or the performance of additional test bends for re-qualification of the MPS at Manufacturer’s expense.

**5.2** All bends shall be manufactured by hot bending of the pipe by using high frequencyinduction heating and forming.

**5.3** All bends manufactured by induction welding shall be subject to post bend stress relieving bytempering. Post bend heat treatment procedure including temperature and time shall be included in the bend manufacturing procedure.

**5.4** All bends shall be manufactured by using a type of bending equipment approved by the Owner/ Consultant.

**5.5** The longitudinal weld seam shall be located at approximately 10º from the neutral zone, measured from the outside of the bend made with welded pipe. Manufacturer shall provide a drawing which shows the orientation of weld seam.

**5.6** The Manufacturer shall, at no additional expense to the Owner / Consultant, furnish and use an internal bending mandrel to achieve smooth and undistorted bends.

**5.7** All bends having a difference between the maximum and minimum outside diameters in excess of 2.0% of the nominal outside diameter of the pipe, or having buckles, shall be rejected.

**5.8** The minimum wall thickness of the pipe after bending shall not be less than the required nominal design wall thickness of the pipeline.

**5.9** Bends shall not have any circumferential joints.

**5.10** All bends shall be provided with tangent length at both ends. Tangent length shall be 500mm or pipe OD whichever is more.

**5.11** The Manufacturer shall supply all the bends with machined bevel at both ends in accordancewith API-5L. Bend angle and bend radius shall be as indicated in the Material/Purchase requisition. All bends shall be non-destructively examined in accordance with the requirements of Section 6.2 of this specification.

**5.12** Each bend shall be tested using a gauging pig consisting of 2 gauging plates. The diameter of the gauging plates shall be 95% of the nominal internal diameter. The gauge plates shall be mounted 2D or 300 mm (whichever is more) apart on each end of the gauging pig. Detailsof the gauging pig shall be submitted to the Owner / Consultant for approval.

**5.13** No repair by welding shall be allowed on any part of the bends.

**5.14** Maximum allowable ripple in any section of the bend shall not exceed 1.0% of the outside diameter of the pipe.

5.14 Any bend that is buckled or gouged by the bending operation shall be rejected.

5.15 Spiral / HSAW pipes shall not be used for fabrication of bends. LSAW pipes or seamlesspipes shall be used for bend formation as indicated by owner.

## 6.0 INSPECTION AND TESTING

The Manufacturer shall perform all inspection prior to shipment and tests as per the requirement of this specification at his works prior to shipment. Inspection/ Material certificate shall confirm to EN 10204 3.2 certification.

### 6.1 Hydrostatic testing

All induction bends shall be hydrostatically tested at the Manufacturer's works in accordance with the requirements of API-5L. The test pressure shall be 100% SMYS with a hold time of 30 min.

The Manufacturer shall submit hydrostatic test pressure calculations to the Owner / Consultant for approval.

All gauges used for measurement of pressure during hydrostatic testing of bends shall be calibrated against a dead weight tester to the satisfaction of the Owner / Consultant before and after the test. All pressure gauges used shall have an upper range of 1.5 to 2 times the minimum test pressure.

All hydrostatic pressure tests shall be chart recorded. The identification number of the induction bends being tested shall be clearly recorded on the hydrostatic pressure charts.

Orientation of the weld seam of the pipe bends fabricated from welded pipes shall be such that any pin hole leak in the seam area shall be clearly visible to hydrostatic testing operators and inspection personnel.

### 6.2 Non-destructive examination

6.2.1 Manufacturer shall submit a detailed procedure for all non-destructive Tests to be performedon the bend. The NDT procedure shall, as a minimum, include the following:

a) Equipment Details and Calibration Techniques
b) Qualification of NDT operators (shall be minimum ASNT-TC-1A level 2)
c) Scanning Techniques (100% coverage)
d) Examination Techniques
e) Testing evaluation method
f) Preparation of Reports

6.2.2 All bends shall be subjected to non-destructive testing in accordance with the requirements of specification.

6.2.3 Non destructive examination shall be performed on all bends that have passed the hydrostatictesting.

6.2.4 The surface of the bends to be examined shall be clean and smooth, free from dirt, paint or any other foreign matter which would affect/influence the results of testing.

6.2.5 The entire outer surface of each bend and bevels shall be inspected for laminations and cracks by Magnetic Particle Inspection in accordance with ASME Section V, article 7.

6.2.6 The Manufacturer shall ultrasonically examine the weld areas of all induction bends for defects. Also full body surface shall be examined ultrasonically for bends made by SMLS / welded pipes.

6.2.7 All seam welds of bends fabricated from welded pipes shall be fully radiographed.

6.2.8 The full circumference of both ends of each bend after beveling shall be ultrasonically testedfor laminations over a length of 100 mm add lamination is not acceptable.

6.2.9 Acceptance levels for MPI, UT and RT inspections shall be in accordance with specification.

6.2.10 The entire outer surface included extrados surface of each bend and bevel ends shall be inspected for lamination by MPI in accordance with ASME Sec V.

### 6.3 Residual Magnetism

Manufacturer shall use a digital or analogue gauss meter with directional probe with an accuracy of 0.1 Gauss to determine the residual magnetism of the induction bend.

No residual magnetism in either longitudinal or transverse direction to the pipe axis shall be greater than 15 Gauss.

Demagnetization shall be applied if the magnetic measurement shows values greater than theacceptable limit of 15 Gauss.

The Manufacturer shall include the procedure for degaussing in the Manufacturing Procedure Specification.

### 6.4 Surface Finish

Any irregularities in the surface contour of the bend caused by the bending operation shall be rejected. Manufacturer shall include a description of how surface irregularities shall be avoided and themethods proposed to inspect such irregularities in the MPS.

### 6.5 Inspection by Owner/ Consultant

Owner/ Consultant's representative reserves the right to perform stage wise inspection and witness tests on all bends as indicated in 6.1 and 6.2 at manufacturer's work, prior to shipment.

Manufacturer shall give reasonable notice of time and shall provide without charge reasonableaccess and facilities required for inspection to the Owner / Consultant.

## 7.0 DIMENSIONAL REQUIREMENTS

All induction bends shall be of a minimum radius as specified in Purchase Order.
All bends shall be supplied to the dimensional tolerance specified in this specification and relevant data sheets.

**Tolerances**

The finished bends shall conform to the following dimensional tolerances in addition to MSS- SP-75 requirements. However the ends of the tangent length of the finished pipe bend shall meet the dimensional tolerances of the relevant line pipe specification referred in Section 2.0.

**7.1** Bend Angle : (±) 0.5º
Bend Radius : (±) 0.5% of nominal bend radius.

**7.2** The manufacturer shall check the wall thickness of the pipe ultrasonically before bending a 6Dbend both the inside and outside rail, at approximately 15 degree intervals or 300mm whichever is less. The wall thickness shall be measured ultrasonically after bending at the same locations measured before bending. These measurements shall be taken at four equallyspaced locations around the pipe circumference at both welding ends of the bend. The measured wall thickness shall be at least equal to the pipeline nominal wall thickness specified in the purchase requisition.

**7.3** Ovality in any plane in the finished bend shall not exceed 2% at body and 1% at the ends. Ovality shall be calculated using the following formula:

$$\text{Ovality} = \frac{2(OD_{max} - OD_{min})}{OD_{nom}}$$

Where
OD max- Maximum Outside Diameter
OD min - Minimum Outside Diameter OD
nom- Nominal Outside Diameter

The measurements shall be made over the circumference of the bend either at distances approximately equal to pipe diameter or 300mm whichever is less. Minimum three measurements shall be taken for each bend.

**7.4 Off Plane**

Off plane of bends shall not exceed (θ/90) x 10mm, where θ is the bend angle in degree or the tolerance limit specified in MSS-SP-75, whichever is less. The measurement shall be inaccordance with MSS-SP-75.

**7.5** Any type of repair and sizing is not acceptable until unless approved by owner/ owner's representative.

**8.0 MARKING, PACKING AND SHIPMENT**

**8.1** All bends shall be marked as per MSS-SP-75

**8.2** The original pipe number and bend suffix shall be marked by die stamping at both ends on thebevel of all bends. No die stamping shall be permitted on any other part of the bend.

**8.3** As a minimum, for each bend, following markings are stenciled at both ends internally with indelible paint.

**8.4** Pipe original individual identification number and bend suffix heat number and original pipe number

a) Purchase order/Item number
b) Bend angle
c) Heat number
d) Owner/Consultant name
e) API-5L material grade
f) Specified wall thickness, outside diameter, bend angle, bend radius
g) Heat treatment
h) Measured weight
i) Any other information required by API-5L.

**8.5** All loose and foreign material such as rust, grease etc. shall be removed from inside and outside of the bend.

**8.6** All bends except bevelled ends shall be coated internally and externally with a thin film of zinc chromate red oxide paint for protection against corrosion during transit and storage. The coating shall be easily removable in the field. Manufacturer shall furnish the details for the same

**8.7** Both ends of the bends shall be suitably protected to avoid any damage to the bevel during transit by means of metallic or high impact plastic bevel protectors.

**8.8** Package shall be marked legibly with indelible marking ink to indicate the following:

a) Order Number
b) Tag Number
c) Manufacturer's Name
d) Size (Inches) and wall thickness (mm)
e) Radius of bend (mm) and bend angle

## 9.0 DOCUMENTATION

Documentation relating to the supply of goods shall be provided by the Manufacturer. All documents shall be reviewed and approved by the Owner / consultant.

Full certification of the procedure and results of bending, inspection and testing shall be provided by the Manufacturer.

Certification shall cover all results required by this specification. All certificates shall be marked with sufficient information to enable full traceability to the items it represents and the relevant specifications and procedures.

# TECHNICAL SPECIFICATION FOR INSPECTION & TESTING OF PRODUCTION WELD

## CONTENTS

## 1.0 SCOPE

This Specification defines the minimum technical requirements for the various activities to be carried out by Contractor for Inspection & Testing of Production Weld.

## 2.0 GENERAL

Except otherwise stated by the Owner / Consultant for the number of field butt weldsselected for non-destructive examination, the provisions of ASME B 31.8 shall govern.

The Owner/ Consultant shall determine the non-destructive examination method applicableand their specific field application.

The Owner/ Consultant shall supervise and inspect the welding activities in accordancewith the provisions laid down in the Codes.

The Owner/ Consultant are also exclusively responsible for its personal interventions and decisions as supervisor and inspector of the welding activities.

Except otherwise stated by the Owner and the Consultant. The inspection and testing of production welds will be carried out in accordance with the provisions of the ASME B 31.8 code and the standard mentioned in this chapter.

## 3.0 TESTING OF WELDED JOINTS AND ACCEPTANCE CRITERIA

The welded joints shall be tested prior to painting or coating.

### 3.1 Non – Destructive testing

#### 3.1.1 Visual Inspection

Inspection of all welds shall be carried out by owner/ consultant as per the latest editions of the applicable codes and specifications. All finished welds shall be visually inspected for parallel and axial alignment of the work, excessive reinforcement, concavity of welds, shrinkage, cracks, under-cuts, dimensions of the weld, surface porosity and other surface defects. Undercutting adjacent to the completed weld shall not exceed the limits specified in the applicable standard/ code.

The visual inspection shall be interpreted in accordance with API 1104 with the following additional requirements:

- Arc ignition Points
  - ≤ 0.5 mm: acceptable if ground out
  - > 0.5 mm: unacceptable and cut out
- Clamp Crates
  - ≤ 0.5 mm: acceptable if ground out
  - > 0.5 mm: unacceptable and cut out

#### 3.1.2 Radiographic Testing

3.1.2.1 Test method and acceptance criteria

Radiographic testing with X rays or gamma rays shall be carried out in accordance with theprovisions of API 1104. All butt welded joints of mainline as well as of station piping shallbe 100% radiographic tested irrespective of the class location.

#### 3.1.3 Ultrasonic Testing

3.1.3.1 Test Method and Acceptance criteria

The ultrasonic testing shall be carried out in accordance with ASME V-Art. 5 and API 1104.

The number of field joints welds selected for ultrasonic examination is specified by the Owner / Consultant.

3.1.3.2 Scope of the Test

a) Minimum test planned

- For the stations and valves stations all welds shall be inspected by ultrasonictesting.
- Welded joints, which are welded using external clamps (e.g. tie-in welds) shall be100% ultrasonically tested.
- If any pipe end is cut by more than 50 mm, the re-bevelled end shall beultrasonically tested for any lamination.

b) Supplementary Tests

Further to a decision by the Owner / Consultant (for example in the event of cracks)all the welds carried out in the course of that day may be tested with ultrasonic testing and if necessary this inspection may be extended to all welds. If these tests bring to light any defective welds, the Contractor shall carry out the repairs at his own expense.

## 3.2 Other test method

As well as the non-destructive tests describe above, the Owner / Consultant, decide to carry out additional destructive or non-destructive tests, such as:

- Magnetic Particle Test
  - All tie-in weld & Fillet weld shall be 100% Magnetic particle tested.
  - All re-bevelled pipe end shall be magnetic particle tested.
  - All repair areas shall be verified by either LPT / MPT as directed by site in-charge
- Liquid Penetrant test
  - All repair areas shall be verified by either LPT / MPT as directed by site in-charge
- Weld Sampling
- Any other destructive or non – destructive test methods

The acceptance criteria for the magnetic partial test and liquid penetrant test are defined onthe basis of the following standards:

- Magnetic particle test
  - Method: ASME V-Art 7
  - Acceptance criteria ASME VIII Div II – App. 6 and API 1104.
- Liquid penetrant test
  - Method: ASME V-Art 6
  - Acceptance criteria ASMEVIII – Div II – App. 8 and API 1104

The acceptance criteria for the weld samples shall be the same as for the weldingprocedure qualification.

## 3.3 Destructive test

At least one production weld (to be checked by Owner / Consultant) will be cut out during the first week of welding production and sent for destructive testing. Other production welds(Cut-out) to be sent for destructive testing shall be chosen by Owner / Consultant. The frequency of other production weld shall be one joint / 10 km with a minimum of 50 cm of material on either side of the weld.

Contractor will not be entitled for any type of compensation for any destructive test deemednecessary by Owner/ Consultant.

The destructive testing shall be carried out in accordance with section 5.6 of API 1104. Alltests shall be carried out in Owner /Consultant approved laboratory.

## 4.0 IMPLEMENTATION OF THE NON-DESTRUCTIVE TESTS

Radiographic tests will be carried out daily after the completion of the welding on the day'swelding pipeline stretch.
No tests shall be carried out on strings, which are still being welded even if the usualdeadlines are compromised as a result.
Ultrasonic tests shall in principle be carried out 24 hours after welding.

## 5.0 ANNOUNCEMENT OF TEST RESULTS

The NDT results shall be sent to contractor by Owner / Consultant / TPI during normal working hour in the following day as agreed with Owner.

### 5.1 Welding of tie-ins and repairs

5.1.1 Radiographic Testing

Subject to the approval of the Owner / Consultant, in urgent cases, TPI shall inform the Contractor verbally of the provisional test results within the hour following the photograph by interpreting the wet film.

The results shall not be definitive until the dry firm has been examined.

The deadline for verbal communication of the definitive results shall be twelve hours following the announcement of the results when they have been interpreted from the wet film.

5.1.2 Visual and ultrasonic Testing

The results of these tests shall be given verbally at the time of the test.

Written communication of the results shall be by means of inspection test report.

## 6.0 INSPECTION OF FILMS BY CONTRACTOR

Before carrying out any repairs, the Contractor may inspect the relevant film himself. Thefilm remains the property of the Owner.

## 7.0 LOCAL REPAIRS AND CUT OUT DEFECTIVE WELDS

### 7.1 General

The Contractor shall be obliged to repair welds or re-weld or cut out welds which are deemed defective by the owner/ consultant/ TPI. This shall be carried out within normal working hours.

Each repair of defective weld, whether local or total, shall be carried out within two workingdays following the announcement of the results by owner/ consultant/ TPI.

Section 10 of API 1104 is applicable with the following requirements.

- All cracks other than carter cracks or star cracks (ref 9.3.10 of API 1104) shall not be repaired by welding. The cracks must be removed by cutting out the weld.
- All other defects except superficial defects detected by NDT can only be repaired by welding after approval by owner/ consultant/ TPI on site.
- Superficial defects can be removed by grinding provided min. thickness of pipe is respected. After grinding, the ground area will be inspected by liquid penetrant test or magnetic particle test.
- The weld repairs shall be tested by X-rays, UT and / or MT as required by owner/ consultant/ TPI at site.
- A second repair on weld is not acceptable and weld must be cut out if defects are detected in repair.
- In case of cut out of weld, & zone of at least 5 cm of the pipe material shall be removed on both side of the weld. The new bevel should be checked by penetrant test in the absence of defect.
- The cut out welds shall be preserved in the weld number for further investigation.

# TECHNICAL SPECIFICATION FOR DRYING AND CLEANING OF PIPELINE

## CONTENTS

## 1.0 SCOPE

This specification covers the minimum requirements to be followed by the contractor incarrying out cleaning, dewatering, swabbing and drying operation of pipeline after testing.

## 2.0 CODES AND STANDARDS

The related, standards referred to herein and mentioned below shall be of the latest editions prior to the date of the purchaser's enquiry:

| | | |
|---|---|---|
| ASME B 31.8 | : | Gas Transmission and Distribution Piping System |
| OISD 226 | : | Natural Gas Transmission Pipelines and City Gas Distribution Networks |

## 3.0 DRYING ACTIVITIES

The contractor shall perform the following for drying the pipeline:

**DEWATERING** - Removal of hydrotest water from pipelines

**SWABBING** - Reducing the amount of remaining water in the pipeline, left after dewatering operations, and spreading it as a thin film on the inside wall on the pipeline

**DRYING** - Drying the gas pipeline to the required degree of dryness

**PURGING** - Purging or filling the pipeline with nitrogen (as applicable) and keeping it under positive pressure if commissioning is delayed

Contractor shall develop procedure accordingly and carry out applicable activities after obtaining owner's approval for the same.

## 4.0 DEWATERING

Dewatering shall be performed to remove major amount of test water from the pipeline using apropellant and a pig train.

The dewatering operation shall consist of at least two dewatering runs when air is used as propellant for pig trains. In case the propellant is the product that the pipeline will ultimately carry, only one dewatering run is required.

CONTRACTOR shall ensure that continuous operation can be performed without the pigs getting stuck. Necessary calculations shall be submitted by CONTRACTOR in this regard. CONTRACTOR shall also submit a contingency plan for retrieval of stuck pigs if any.

The pig velocities during the first and second dewatering runs shall not exceed 1.5 km/hr and 3.5 km/hr respectively. The pigs shall be removed immediately by the CONTRACTOR in the presence of OWNER Representative upon arrival at the receiving end. CONTRACTOR shall ensure that the bulk of the water has been removed from the pipeline before taking up thenext stage of the drying operations. CONTRACTOR shall specify when the dewatering phase is to be considered complete and shall take approval of the OWNER before proceeding further.

As a minimum the CONTRACTOR shall continue the dewatering operation till majority of water is removed from the pipeline.

## 5.0 SWABBING

The swabbing operation consists of running several pig trains through the pipeline. During the swabbing operation, the remaining water in the pipeline shall be reduced and spread out inthe form of a thin water film over the pipeline wall to obtain a more efficient drying operation.
The CONTRACTOR shall submit the detailed procedure and the duration of the swabbing operation and obtain OWNER approval before starting the operation.

CONTRACTOR shall weigh and measure the pigs prior to launching and on arrival of the pigs at the receiving end.

The pig velocities during the complete swabbing operations shall not exceed 7.0km/hr.

Swabbing shall be considered as completed only when the difference in final and initial weight of the pig does not exceed 25%.

## 6.0 DRYING

The CONTRACTOR may choose any of the following methods of drying as applicable:

### 6.1 Vacuum Drying

The residual water in the pipeline left after the swabbing operation shall be removed by meansof boiling the water below the vapor pressure in the pipeline. The vapor shall be drawn from the pipeline until the specific dryness has been achieved.

The vacuum drying operation shall commence as soon as possible after the swabbing is completed but not later than 30 hours after the swabbing operation has been completed. The vacuum drying operation shall consist of four stages i.e., evacuation stage, boiling stage, air purge dryness test and the final reduction of line pressure.

During air purge dryness test the dew point measured at the suction end shall not deviate by more than 1 °C from the dew point measured at the inlet end during the 24 hour test period. Ifit is more than 1 °C it is implied that the pipeline still contains free water.

The pipeline shall be dried up to a dew point of at least (-) 8 °C at atmospheric pressure.

The dew point at the input and output ends shall be measured to ensure that required dew point is achieved. As a final acceptance the dew point stated above shall be maintained for a period of 48 hours.

Upon completion of the drying operation CONTRACTOR shall submit evidence to substantiatethat the pipeline has been dried to the required dryness level. This evidence shall consist of data related to the following stages of the operation.
- A rapid decrease of pressure at the end of the boiling stage
- A conclusive result of the air purge dryness test
- A steep pressure drop rate during the final draw down, which shall correspond with a calculated rate.

If any of the aforementioned criteria do not give a conclusive result that the pipeline has been dried to the required level, CONTRACTOR shall repeat the vacuum drying operation by continuing the boiling stage followed by the air purge test and the final draw down, until a conclusive result of the required dryness of the pipeline has been established and proven to the satisfaction of OWNER.

### 6.2 Super Dry Air Method

The residual water in the pipeline left behind after the swabbing shall be removed by means ofabsorption of the water into dry air blown through the pipeline.

Contractor shall specify the procedure and duration of the air drying method, which shall be approved by owner.

The air drying operation shall commence as soon as possible but not later than 24 hours afterthe

swabbing is completed.

The air drying operation consists of two stages namely, the pigging stage and the air purgedryness test. Oil free and dry air shall be used.

The air shall have dew point below the required dew point in the pipeline. The pipeline shall bedried up to a dew point of (-) 8 °C at atmospheric pressure.

The dew point at the inlet and outlet ends shall be monitored to ensure that the required dewpoint is achieved.
As a final acceptance, the dew point stated above shall be maintained for a minimum period of48 hours.

**7.0 PURGING**

During the purging operation the air left in the pipeline shall be replaced by dry nitrogen beforeadmitting the hydrocarbon that the pipeline will ultimately carry.

The purging operation shall start as soon as possible after the drying operation has been completed and approved by the owner. If nitrogen purging is carried out after the 24 hours of completion of drying CONTRACTOR to re-perform the air dryness test prior to commencement of the purging operation.

Nitrogen with dryness corresponding to a water dew point of (-)50 °C or better shall be used. The maximum allowable oxygen content shall be 1% by volume.

The carbon dioxide content shall not exceed 5% by volume.

The purging operation procedure may vary as per the drying procedure. CONTRACTOR shallsubmit the detailed purging procedure for approval of the OWNER prior to its implementation.

**8.0 ACCEPTANCE OF WORK**

Upon completion of the dewatering, swabbing, drying and purging operations written approvalshall be obtained from the OWNER to terminate the operations.

Approval for such termination shall be given only after completion of the following conditions:
- The required accuracy of measuring equipment and records has been demonstrated.
- All data, records, calculations and duly completed forms have been submitted.
- The drying criteria as specified and detailed in the approved procedures in terms of residual water, required dew point and/or other requirements established have been satisfactorily attained.

The work shall only be considered to be completed after receipt and approval of the final report.
The CONTRACTOR shall repeat part or the whole of the dewatering, swabbing, dryingoperations under any of the following circumstances as determined by the OWNER.
- The accuracy of the measurements is considered to be insufficient.
- The submission of data, records, calculations, and other documentation is considered to be insufficient or inconclusive.
-The acceptance criteria established for the drying and purging operations have not been met to the satisfaction of the OWNER.

**9.0 DOCUMENTATION**

Final report shall be submitted to the OWNER not later than 30 days after acceptance of the work.
CONTRACTOR shall submit to the OWNER for approval the complete description, detailed procedure and time schedule of all the dewatering, swabbing drying and purging operations.
CONTRACTOR shall ensure that the documents are related to the as-built conditions of the pipeline.
All documents, procedures, calculations, schedules and details of the equipment shall be in SIunits.
Documents shall also contain all safety plans procedures to be followed while carrying out the activities.

Upon successful completion of the work CONTRACTOR shall prepare a final report of the work which shall include necessary charts, diagrams, graphs, calculations, recordings/daily logs, measurements and details of the operation etc. Report shall also include all certificates of calibration of instruments required together with records of calibration performed at site just prior to the start of operation.

# TECHNICAL SPECIFICATION FOR MAJOR CROSSING BY HDD

## CONTENTS

## 1.0 SCOPE

**1.1** This specification defines the minimum technical requirements for the various activities to be performed by the Contractor for the engineering, design and construction of pipeline at major crossings using horizontal directional drilling technique.

**1.2** This specification shall be read in conjunction with the requirements of specification and other documents included in the CONTRACT between owner and Contractor.

**1.3** Contractor shall, execute the work in compliance with laws, by laws, ordinance and regulations.Contractor shall provide all services, labour, inclusive of supervision thereof, supply of all materials (excluding "Owner supplied Material), equipment, appliances etc.

**1.4** Contractor shall take full responsibility for the stability and safety of all operation and methodsinvolved in the work.

**1.5** Contractor shall be deemed to have inspected and examined the work area and its surroundings and to have satisfied himself as far as practicable with the surface conditions, hydrological and climatic conditions, the extent and nature of the work and materials necessary for the completion of the work, and the means of access to the work area.

**1.6** Contractor shall be deemed to have obtained all necessary information with regard to risks, contingencies and all other circumstances, which may influence the work.

**1.7** Contractor shall, in connection with the work, provide and maintain at his own costs all lights,guards, fencing, as necessary or directed by Owner or their representative.

## 2.0 CODES AND STANDARDS

Reference has been made in this specification to the latest edition/ revision of the following codes, standards and specification.

a) ASME B 31.8 - Gas Transmission and Distribution Piping System.

b) API RP 1102 - Steel pipeline crossing railroads and highways

c) OISD 226 - Natural Gas Transmission Pipelines and City Gas Distribution Networks

## 3.0 DESIGN & ENGINEERING

**3.1** The limits of each crossing shall be determined by the Contractor on the basis of crossing profile based on survey drawings, design, equipment, installation technique and site condition.Contractor shall furnish all engineering design calculation and crossing drawings etc. to ownerfor their approval prior to execution of the work.

**3.2** Within the entire limits of crossing, the minimum cover to top of coated pipe shall be asspecified in the Special Conditions of Contract (SCC).

However, wherever the drilled length for a crossing includes the crossings of obstacles such as roads, railroads, canals, streams, etc. The following minimum requirements of cover to the pipe shall be satisfied unless specified otherwise in the scope of work in SCC.

For Road Crossing : 1.5 m from top of road to top of pipe.
For canal crossing : 1.5 m from lowest bed level to top of pipe.

For river crossing : a) 2.5 m below scour level in case of normal soil
b) 1.5 m below scour level in case of rocky strata

In case the pipeline crosses other utilities, viz., other pipelines, sewers, drain pipes, water mains, telephone conduits and other underground structures, the pipeline shall be installed with at least 500 mm free clearance from the obstacle or as specified in the drawing or such greater minimum distance as may be required by authorities having jurisdiction. Also in all cases, the minimum covers specified above shall be maintained within the entire limits of crossing.

**3.3** The entry and exit points of the pipeline at ground level shall not come within the limits of crossing as defined in the crossing drawings.

**3.4** Level of the pipeline considering the Geo-technical hydrological data provided by the ownerfor basic route detail. However, detailed survey data shall be collected by the Contractor before execution of work.

**3.5** Contractor shall carry out calculations for determining the maximum permissible overburden onpipe, to check that the empty pipeline is safe from collapse at any point along the drilled crossing section. Contractor shall submit these calculations to Owner for approval.

The minimum requirements of limits of each river crossing shall be as defined in the preliminary drawings furnished by Owner/Consultant. Contractor may change the limits slightlyto suit his requirement and installation technique, with prior written approval from Owner/Consultant and authorities having jurisdiction.

**3.6** Following survey/ test shall be performed by the contractor before detail engineering:

3.6.1 Detailed soil investigations and hydro-geological data collection in the proposed crossing locations so as to obtain site specific soil data.

3.6.2 Boring/ coring into all types of soil/ rock shall be done in each of the river crossing location.

3.6.3 Conducting standard penetration tests and collecting disturbed and undisturbed soil samples from boreholes.

3.6.4 Collection of soil and ground water samples for chemical testing

3.6.5 Record water tables in boreholes

3.6.6 Laboratory tests on soil/ water samples collected from boreholes.

**3.7 Pipeline Axis**

The plane containing the pipeline route axis shall be perpendicular to the horizontal plane. There shall be no bending of the pipeline route axis at depths shall lower than 2 meters below ground level.

**3.8 Back-reamed hole and Pipeline Interface**

3.8.1 Contractor shall derive combination of:

- Back-reamed hole diameter
- Bentonite density
- Pipeline submerged weight in bentonite (and means to achieve that weight) to optimise thecrossing design in terms of pipeline stresses and power requirement

3.8.2 Contractor shall indicated what maximum shear stress in the pipeline coating will result from his choice of above parameters and other characteristics described in this section.

3.8.3 Contractor shall furnish all calculations for Owner's approval. If shear stress in pipe coating is, in the opinion of Owner, beyond the permissible limits, Contractor shall revise his choice of parameters to reduce shear stress on pipe coating to permissible value.

**3.9** Contractor shall determine in the minimum allowable elastic bend radius for pipe from the following consideration:

**3.9.1 Maximum Longitudinal Stress During Installation**

Total maximum longitudinal stress in the pipeline due to tension and bending at any locationshall not exceed 90% of the SMYS of the pipe material.

Contractor shall, in order to check this requirement, evaluate the maximum tensile forces towhich the pipeline is subjected to at any phase of its installation during the pulling operation.

Contractor shall, evaluate the maximum tension forces to which the pipeline is subjected forfollowing phase of its installation during the pulling operation

a) Stress in the pipe at the beginning of the pull

b) Stress in the pipe upon finish of the pull-in

c) Stress in the pipe due to over-bend

**3.9.2 Maximum Equivalent Stress during Final Hydrostatic Test**

After installation, the pipeline shall be hydrostatically tested to a minimum test pressure equal to 1.5 times the design pressure or at a pressure stipulated in the Special Conditions of Contract whichever is higher. However, during hydrostatic testing, the combined equivalent stress in the pipeline due to bending and test pressure shall not exceed 90% of the SMYS of pipe material.

**3.9.3 Maximum Equivalent Stress during Service**

Permissible values of maximum equivalent stress during services shall be governed by the requirements of ASME B 31.8. The details of pipeline operating parameters are provided inthe Special Conditions of Contract.

3.9.4 The minimum allowable radius of curvature for the pipeline shall be the highest value of the minimum pipeline elastic radius as computed from the considerations outlined above after correction for drilling inaccuracies or multiplication by the factor 1.85, whichever results in the highest permissible value of minimum elastic bend radius.

3.9.5 Contractor shall submit all calculations for Company's approval along with procedure.

**3.10 Pipeline Configuration along the Support String before Entry Point**

3.10.1 Contractor shall determine the required pipeline configuration in order to allow smooth pull in the crossing entry point and admissible stress in the supported pipeline string.

Pipeline combined stress shall not exceed 90% of the specified minimum yield strength forline pipe material.

3.10.2 Contractor shall furnish all calculation and specify the number of required supports,description of the supports, their co-ordinates and capacity in metric tons.

3.10.3 Contractor shall also furnish a drawing of the launching ramp indicating the pipelineconfiguration.

3.10.4 The distance between each roller shall also be specified and justified.

**3.11** Contractor shall, based on result of design and engineering carried out by him, prepare construction drawings for the crossing and shall submit the same for Owner's approval.

Construction drawings shall indicate the pipeline profile with levels furnished at sufficient intervals for proper control during construction. Other relevant details viz., entry & exit point co-ordinations details, Bore hole location as wells as survey details to be included in the Drawings.

Contractor shall also submit the following details:

a. Plan drawings showing drill axis, co-ordinates of entry/ exit point, north direction, existing utilities close to the drilled hole, obstacles, shortest distance between the drill axis and obstacles, minimum radius of curvature, planned work area for rig site and pipe string site, and markers and signage.

b. Profile drawing showing entry/ exit angle, horizontal and effective length of drilling, elevations of drill profile at sufficient intervals, scour profile where applicable, cover, minimum radius of curvature, obstacles and pipe data.

c. Work area preparation drawing on the rig and pipe side showing location of variousdrill rig components (rig, cabin, pump, etc.), method of anchoring the rig, location and size of the drill fluid storage pit and access roads shall also be provided.

d. Pipe roller supports/ trench line drawing showing the number of rollers/ supports, location of rollers in plan and elevation, pipe string configuration on launch ramp and detailed drawing of the roller support.

e. Bundle drawing showing cross section of the bundle, diameters of individual pipes, method of securing the bundle.

f. Pipe break-over entering into the hole.

g. Arrangement of accessibility to rig and pipe side.

Contractor shall also calculate the total length of pipeline required as well as the maximum tension required on the pull head of the rig.

**3.12** All construction works shall be carried out in accordance with the construction drawingsapproved by Owner.

**3.13** Before commencement of any field work, Contractor shall furnish for Owner's approval alldesign calculations and construction drawings as stipulated in the above clauses.

## 4.0 CONSTRUCTION

The method of Construction shall comply with all the conditions and requirement issued by Authorities having jurisdiction in the area where the work is to be performed.

If no public road exists, Contractor shall arrange for access to his work area at no extra cost to Owner/consultant.

Contractor shall carry out geo-technical and hydrographical survey and the same shall besubmitted to Owner/ consultant for review and approval.

CONTRACTOR shall use three layer Polypropylene coated pipes (3LPP) for execution of HDD. 3LPE coated line pipes may also be used in case of emergency and for that required HDD hole with its soft bedding has to be ensured with prior approval from owner. Spiral SAW line pipes shall not be used for HDD crossings.

### 4.1 Installation Procedure

HDD shall be done by approved / registered HDD contractor in HNGPL vendor list. Contractorshall take approval from HNGPL / Owner in case of an unapproved HDD contractor.

HDD contractor shall submit Site organogram to HNGPL / Client before starting the work at site.The

installation procedure as a minimum shall include the following:

a. Project Manpower deployment at site and co-ordination office.

b. Time schedule for construction.

c. Details of equipment: Contractor shall furnish the complete list of all equipment to be deployed for preparation of pipe string and installation of crossing including technical characteristics and capacity of each equipment including instrumentation, monitoring and control equipment.

d. Preparation of fabrication yard and launching areas.

e. Pipeline string preparation (hauling, stringing, welding, etc.).

f. Pre & Post hydrostatic test procedure.

g. Method of installation covering all stages of construction, viz. Rig up, Pilot Hole, Back- reaming, Pulling Rig Down, Back filling, etc.

h. Calculations for maximum pulling force on the rig.

The time schedule shall be in accordance with overall time schedule for the project.

Approval by Owner/Consultant of the methods used by Contractor shall in no way relieveContractor from the sole responsibility for safe and satisfactory installation of the crossing.

## 4.2 R.O.W. Preparation

Contractor shall arrange additional land required for pipeline string preparation, rig set-up and launching operations. Contractor shall clear and grade the length of ROW required for

installation of the land portion and drilled river-crossing portion. Contractor shall do such grading on ROW as is necessary and properly to perform the pipeline construction operations,to provide access to the pipeline construction and to ensure safe construction of pipeline.

Contractor shall ensure that his construction activities shall not cause inconvenience to public nor shall there be any undue interference with the normal use of the land and watercourses.

## 4.3 Handling, Hauling, Storing and Stringing Of Pipes and Other Materials

Contractor shall be fully responsible for arranging and paying for storage areas. Contractor shall load, unload, transport and stock-pile the coated pipes using approved suitable means and in a manner to avoid damage to the pipe and coating. Transportation and handling of coated pipes shall also comply with requirements of API RP 5L-1 & 5LT.

## 4.4 Pipe String

Complete pipe string shall be prepared as a single string for pulling.

## 4.5 Installation

4.5.1 Installation shall be taken in accordance with approved installation procedures.

4.5.2 The lateral offset of the actual exit point of the pilot hole from the calculated and theoretical exit point shall not exceed +/- 0.5% of the length of the crossing, however the actual exit point shall not come outside the ROU limits of the pipeline.

The length tolerance shall not exceed +/- 0.5% of the crossing length, subject to the condition that the actual exit point shall be within the limits of crossing as defined in the approved drawings.

4.5.3 Back reaming shall be done separately from the pipeline pulling operation. The size of the back-reamed hole shall be adequate (approximately 1.5 times the pipeline diameter) to allow enough clearance for smooth pull-back of the pipeline.

4.5.4 Contractor shall be responsible for maintaining the drilled hole till such time the pipeline is pulled in.

4.5.5 During pulling operation, the buoyancy of the pipeline shall be controlled by suitable approved methods so as to maintain the buoyancy as close as possible to zero during pull-back in order to reduce friction forces of the pipeline in the hole.

Bentonite slurry of specified viscosity shall be pumped into the hole, preventing the wall from collapsing and protecting the pipeline coating.

4.5.6 Contractor shall provide suitable facilities to Owner/consultant's personnel to witness all stages of construction.

4.5.7 Contractor shall be responsible for the integrity of the corrosion coating and shall apply necessary approved protective coatings.

Coating inspection of the pipeline after completion of pulling operation shall be made by:

a. Pulling the pipe to the extent possible with normal rig set tip at the exit point;

b. Excavating the adjacent portion tip to and including the first held joint.

The pipeline and joint coating shall be examined visually and with holiday detectors for defect. The length to be inspected shall, as a minimum, be one pipe length and one joint coating. In case damages/holidays are detected in the first pipe length/ joint, the subsequent pipe length /joint shall be exposed and coating integrity checks shall be made. If found acceptable by Owner/consultant, the first pipe length/ joint shall be repaired and/or replaced as directed by Owner/consultant. If the coating of second pipe length/ joint is also found damaged, Contractor shall propose further course of action and Owner/consultant's instructions shall be followed. All such works shall be done at no extra cost to Owner/consultant.

4.5.8 Before final hydrostatic testing, Contractor shall prove the diameter of the pipeline by passing a gauging (calliper) pig through the pipeline. The gauging pig shall have a diameter equal to 95% of the nominal internal diameter of the pipe. Contractor shall supply and install all temporary scraper launchers/ receivers and other equipment, piping and materials and consumables for the purpose.

4.5.9 Contractor shall obtain plans and full details of all existing and planned underground services from the relevant Local Authorities and shall be responsible for location and protection of the same. Contractor shall execute the work at the crossings as per guidelines of the authorities having jurisdiction and to the satisfaction of the Owner/consultant.

4.5.10 After pulling the pipeline across the drilled crossing, Contractor shall cut the extended portionof the pipeline at the entry and exit points. Thereafter, the drilled portion of the pipeline shall be cut at suitable location/depth and extended on either bank by installing a cold field bend with minimum bend radius as specified in the relevant specification and a straight pipe length of 12m, such that at the ends the top of the pipeline is minimum 1.2 m below the natural ground level.

### 4.6 Hydrostatic Testing

#### 4.6.1 Pre- testing

Contractor shall hydrostatically pre-test the complete pipe string of each river crossing before installation as per approved procedure.

The section of the pipeline corresponding to the crossing shall, before installation, be subjected to a minimum hydrostatic test pressure not less than 90 % SMYS and test pressure shall be maintained in between 90 to 95 % SMYS of minimum wall thickness of HDD string forsix (06) hours. At any cost highest pressure shall not be exceeding the maximum mill test pressure and recorded by manothermograph. During the test, Contractor shall check all welds for leakage. Failure, if any, during the test shall be rectified by the Contractor to the satisfaction of Owner/consultant at no extra cost. The method adopted for pre-hydrotesting shall be in accordance with Specification.

#### 4.6.2 Post-testing

Post hydro test shall be carried out for HDD portion of the pipeline at a pressure not less than 1.5 times the design pressure. After the temperature has been stabilized, the pressure shallbe maintained for at least 6 hours and shall be recorded.

#### 4.6.3 De-watering, Cleaning, Drying

Once the tests have been declared satisfactory, the pipeline shall be de watered and properly cleaned and dried as per Specification No. ENG-STD-PL-DOC-TS-009.

The disposal of the water shall be performed such that no harm is done to the environment and the dewatering procedure, to be submitted by the pipeline contractor for Company/Company's representative's approval, should indicate this safe disposal methodology.

### 4.7 Fencing

Contractor shall supply all materials and install G.I. Wire Chain link security fencing at HDDsite.

### 4.8 Idle Time Preservation of Pipeline

If directed by Owner/consultant, Contractor shall supply all materials and consumables including water, corrosion inhibitor and shall install all piping connections, valves, instrumentation, etc., perform all works for preservation of pipeline by pressurization with inhibitor added water. Contractor shall use approved inhibitors and shall determine the required dosages of inhibitors and pressure for idle time preservation of the pipeline for a period of maximum six months from the date of completion of construction.

Corrosion inhibitors and dosages shall be subjected to Owner/ consultant's approval prior touse.

### 4.9 Final Clean Up

After completion of construction, Contractor shall clear the sites of all balance material and debris to the satisfaction of owner/consultant and authorities having jurisdiction.

The ground occupied during the work shall be reinstated to its original condition as quickly as possible after the completion of work.

Contractor shall take due care in disposing off inhibitor added water so that it doesn't cause any adverse affect on the surrounding environment.

**4.10 Markings**

The location of the pipe shall be clearly marked by suitable means: conventional yellowmarkers, overhead markers, sign etc.

**5.0 DOCUMENTATION**

**5.1** In addition to the documents specified elsewhere in this specification, Contractor shall submit to the Owner/consultant six copies each of the following documents/records.

**5.2** During the course of execution of the crossing contractor shall generate/compile the following data. It shall be obligatory on part of the Contractor to furnish this data to Owner/consultant forthe event it is required for.

Detailed drilling log and down hole data, including but not limited to, the following:

a) Torque and pulling/pushing force

b) Data on drilling fluid consisting of the following:

i) Density

ii) Type of mud and additive employed

iii) Mixing, pumping & cleaning.

Wash and drill pipe data, viz.

a) Dimension and material properties,

b) Data on APT classification,

c) Type of inspection previously carried out on these pipes.

d) Topics of the permits obtained from authorities having jurisdiction for the various works.

e) Detail profile of the drilled hole along with the water level variations.

f) Records of hydrostatic pre-testing and final testing

g) Record of Non Destructive Testing of welds.

h) Clearance certificates from the land Owner/consultant, authorities having jurisdictionregarding satisfactory clean-up and restoration of pipeline ROU and work areas.

**5.3** After completion of construction, contractor shall prepare and furnish six sets of copies and two sets of reproducible of As-Built drawings for the crossings. As built drawings shall, as a minimum include the following information:

- True profile of the river bed and banks along the pipeline;
- True profile of the pipeline as installed;
- Depth of cover to top of-pipe at regular intervals;
- Location of entry and exit points and angles of entry and exit, along with lateral offset ofexit point from the original pipeline alignment;
- Location and angle of field bends;
- Location of pipeline markers.

# TECHNICAL SPECIFICATION FOR PIPELINE MARKERS

**CONTENTS**

## 1.0 SCOPE

This specification covers the minimum requirements for supply, fabrication and erection of pipeline markers to be installed by Contractor at various locations along the route of cross- country pipeline.

## 2.0 REFERENCE CODES

Reference has been made in this specification to the latest revision of the following code:

API RP 1109 : Recommended practice for marking liquid petroleum pipeline facilities OISD 226: Natural Gas Transmission Pipelines and City Gas Distribution Networks

## 3.0 GENERAL

**3.1** Contractor shall supply, fabricate and install the pipeline markers along the pipeline route. The locations of markers as indicated in the approved drawings shall be treated forguidance purposes only and the exact location of the markers shall be based on AS- BUILTdrawing and as directed by the Owner.

**3.2** The pipeline markers shall be fabricated, painted (painting shall be done as per standard specification) and installed in accordance with the standard drawings included herein. Before start of fabrication of the markers, Contractor shall prepare and submit for Owner's approval the detailed scheme for the marker plates as applicable for the project.

**3.3** The pipeline markers shall be installed, as far as possible, at locations such that they do not cause any hindrance to the regular use of the land or to the traffic.

## 4.0 AERIAL MARKERS

Aerial markers shall in general be installed along the pipeline at every five (5) kilometers intervals and at places specified by Owner. Refer standard drawing no. for more details.

## 5.0 KILOMETER MARKERS

Kilometer markers shall in general be installed along the pipeline between the aerial markers at every one (1) kilometer interval. Markers shall indicate cumulative chainage in kilometers from the reference station, as directed by OWNER. A kilometer marker is not required if the relative length between its location and any pipeline warning sign is less than
200 meters. Refer standard drawing no. for more details.

## 6.0 PIPELINE WARNING SIGN

Pipeline Warning Sign shall in general be installed at

- National, State Highway & Other Road Crossings (above 15m width) : 2 Nos.
- Other Road Crossings (less than 15m width) : 1No.
- Railway Crossings : 2 Nos.
- Water Crossings (less than 15m width) : 1No.
- Water Crossings (above 15m width) : 2No.
- SV Stations & TOP Station : 1No.
- And at any other location of importance as observed by Owner /Owner's Representativeduring construction.

Pipeline Warning Sign shall identify the existence of the pipeline and display the name of the Company, with an emergency telephone number, as shown in standard drawing no.

## 7.0 ROW BOUNDARY MARKERS

Right-of-Way boundary markers shall be fabricated and installed as per the drawings at every 250 metres interval along the entire pipeline route. These shall be installed on either side of the pipeline route to define the ROW boundary limits. These shall also be installed at pipeline turning points to maintain the continuity of the ROW limits. Refer standard drawing No. for details.

## 8.0 DIRECTION MARKERS

Direction markers as shown in standard drawing no. shall be installed to identify the significant turning points of the pipeline during serial traverse. One direction marker shall be installed at each turning point along the pipeline alignment. Two more directional markers shall be installed along the Pipeline alignment on either side of the Turning Point at 200 m from Turning Point of the pipeline route.

## 9.0 SPECIAL MARKERS

As directed by Company, Special Marker shall be installed at Location where the followingchanges take place:

- Change in pipeline diameter and wall thickness.
- Change in type of pipe.
- Change in class locations for pipeline conveying gas.

The above data may be provided on other types of marker (except RoU boundary marker), ifthe relative distance between the two does not exceed 100 m.

# TECHNICAL SPECIFICATION FOR HYDRO TESTING OF PIPELINES

**CONTENTS**

## 1.0 SCOPE

**1.1** This specification defines the minimum technical requirements for supply, works and operations to be performed by Contractor for hydrostatic testing of cross country pipelines transporting hydrocarbons in gaseous phase.

## 2.0 CODES AND STANDARDS

a) ASME B31.8 : Gas transmission and distribution piping system

b) API RP1110 : Pressure testing of liquid petroleum pipelines

c) ASME Sect. VIII : Boiler & Pressure Vessel code Div. 1

## 3.0 GENERAL

**3.1** Hydrostatic test shall be performed on the entire length of the pipeline. Hydrostatic test shall be performed in accordance with approved test diagrams for each test section. The maximum length of each test section shall not exceed 50 kilometers. The hydrostatic testing shall exclude all the facilities that are installed as a part of the scrapper station. For hydrostatic testing, temporary test headers shall be provided and the pipeline section between the headers shall be tested as per approved procedure. The test shall not commence until the pipeline has been cleaned, gauged and flooded as per this specification.
Wherever pipeline is installed through casing or by HDD, the pipe strings/sections, shall be pre-tested and post-tested. Hydrostatic test shall include all those sections, which have beenpreviously tested i.e. rail, road and water crossings.

**3.2** In addition to the above, for pipeline sections, which in Owner's/Consultant's opinion, once installed would require an inordinate amount of effort for repair in case of a leak, a provisional pre-test shall be conducted in consultation with the Owner/consultant. However, after installation, all such pre-tested sections shall be tested again along with the entire pipeline.

**3.3** Hydrostatic testing of the mainline shall be done only after completion of all mechanical and civil works i.e., all welds have been accepted and the pipeline has been laid and backfilled according to the specifications. Further, the test shall commence only after the pipeline has been cleaned, pigged, gauged and flooded as per this specification. Contractor shall performall works required for testing after obtaining written approval from the Owner/consultant. All pipe work in test sections shall be adequately supported to hold loads imposed by weight of water.

**3.4 Corrosion Inhibitor**

If considered necessary by Owner/Consultant the Contractor shall provide corrosion inhibitorto the water to be used for hydrotesting.

Contractor (not the inhibitor manufacturer) shall get the inhibitor tested for corrosion inhibition and microbiological control efficiency from competent Govt./ PSU Laboratory. The test report shall be submitted to company for approval prior to undertaking hydrotesting works.

The dosage as recommended by inhibitor supplier shall only be adopted.
Contractor is to ensure that the numbers of golden welds that remain untested are a minimum. The hydrotest for the total pipeline system indicating the estimated number of subsections, which will hydrotested, shall be part of the procedure. The consecutive test sections shall be constructed with adequate overlap and planning so that tie-in can be carried out with a single weld. If tie-in cannot be carried out with a single weld, then that length of pipe shall be pre-tested at the specified test pressure for duration not less than six hours. All golden tie-in welds shall be welded and subjected to radiographical and ultrasonic inspection. Further in case of golden tie-ins, DPT or MPT shall be performed after completing root/ hot pass.

**3.5** The maximum variation in altitude within the test sections shall be restricted as far as possible within 60 meters. However, contractor shall ensure that the test pressure shall not exceed 100% of SMYS at the lowest portion of the test section due to altitude difference.

**3.6** Contractor shall prepare a detailed test procedure and submit for Owner/Consultant's approval at least one month before the scheduled commencement of tests. The procedure shall strictly comply with the requirements of this specification. The procedure shall include all temporary materials and equipment, but not limited to the following items:

a) A test diagram indicating all fittings, test ends, vents, valves test headers, temporary connections, instruments, thermocouples, relevant elevations and ratings. The diagram shall also indicate injection location and intake and discharge lines. The P&ID and pipeline drawings shall be marked up showing the battery limit of the test section.

b) The hydrostatic test diagram shall also indicate pipeline wall thickness, length of testsections, Specified minimum test pressure, points of maximum and minimum elevations and theirrelationship to the pressure at the test point.

c) Estimated amount of test water, water sources, results of test sample, including required concentration of corrosion inhibitors and additives, procedure for inhibitor injection andcontrol of concentration.

d) Cleaning, gauging, filling and flushing procedures, including a complete description of allproposed equipment and instruments (including spares), their location and set-up.

e) The type and sequence of pigs and the pig tracking system for cleaning and removal of air pockets. Drawings of pigs, pig inspection procedures, including procedures to be followed.

f) Pressure testing procedure including a complete description of all proposed equipment and instruments (including spares), their location and set-up, and proposed system for observation and recording of data during the pressure test.

g) Procedure for filling, pressurization and residual air volume determination.

h) Procedure for thermal stabilization and pressure and temperature monitoring during stabilization and hold period.

i) Theoretical pressure volume and pressure temperature curves including calculatingsteps.

j) Procedure for detection and location of leaks.

k) Procedure for depressurization, dewatering the pipeline section after testing, including a complete description of all proposed equipment and instruments (including spares), their location and set-up, the type and sequence of pigs and the pig tracking system ifrequired along with the pig specification.

l) Formats for recording the test data, calculation sheets etc.

m) HSE requirements during filling, hydro testing, water disposal, use of chemicals, etc.

n) An emergency procedure in the event of a test failure through rupture.

o) Contingency procedure for removal of stuck pig/ blocked pigs in pipeline.

### 3.7 Equipment and Instrumentation

The Contractor shall furnish all necessary equipment for performing the work as stated incleaning, flushing, filling, leveling, stabilizing, testing and dewatering procedures.

This shall include, but not be limited to the following equipment and instruments.

1) Pigs for filling, cleaning and gauging of the pipeline include:
   - Cleaning pigs with spring loaded steel wire brushes except for internal coated pipes. In this case pigs to be provided with nylon / polyurethane brushes.
   - Four cup batching pigs
   - Calliper pigs with gauge plate diameter equal to 95% of the heavy wall pipe in the pipe sections. Gauging pig fitted with gauge plate.
2) Air compressors for cleaning, gauging & dewatering of minimum 3000 $Nm^3/h$ capacity0-100 bar.
3) Calibration of all measuring instruments in Owner/ Consultant approved laboratory.
4) Fill pumps: The Contractor shall determine the type and number of fill pumps in orderto guarantee the following:

a) Differential head 20% greater than the maximum required.

Flow rate - Minimum 400 $m^3/h$

Maximum 1000 $m^3/h$

If a single pump is used, a standby unit must be available. The stuffing boxes of thepumps must be sealed to prevent air from entering the internals of the pump.

5) Variable speed positive displacement pumps equipped with a stroke counter to pressurize the line with a known volume per stroke and capable of exceeding the maximum test pressure by at least 20 bar.

6) Breakwater tanks with filters for water filling and chemical dosing.

7) Two positive displacement meters and/or turbine flow meters with flow straightners to measure the volume of water used for filling the line. These meters shall be providedwith a calibration certificate not older than six months. However all instruments used for measurement of volume of water added for pressurization shall have calibration certificates not older than one month.

8) Pressure recording instruments with pressure sensors and 24-hour charts. These shall be calibrated against dead weight tester.

9) Dead weight testers with an accuracy of 0.01 bar measuring in increments and sensitivityof 0.05 bar shall be provided with a calibration certificate no older than one month. The pressure range of the dead weight tester shall be 1.5 times the hydrotest pressure.

10) Large diameter (6" Minimum) Bourdon Pressure gauges of suitable pressure range (1.5x test pressure to be measured) and accuracy of $\pm$ 0.1% of the full-scale value. These shall be calibrated at site with dead weight tester. Its calibration shall be checked at the beginning, end and during the hydrotest period. The pressure gauges shall be installed at both ends of the test section.

11) Two temperature recorders for fill water with an accuracy of $\pm$ 1% of full-scale range. Thescale range shall be 0º to 60ºC and the sensitivity shall be 0.1ºC. The temperature shall be recorded throughout filling stage.

12) Thermocouples for measuring the pipe wall temperature with an accuracy of $\pm$ 0.2ºC.

13) Ambient/Environmental temperature shall be recorded throughout hydrotest duration from the beginning of pressurization. The recorder shall have a range of 0ºC to 60ºC andshall have an accuracy of $\pm$ 1% of full-scale range. Two recorders one at each end shall be used.

14) A barograph with an accuracy of $\pm$ 0.8 millibar and measuring increments of 1 mbar.

Two laboratory thermometers (thermocouples based) of 0ºC to 60ºC range, with an accuracy of $\pm$ 0.1ºC to be used in thermowells. The temperature measuring instruments shall be provided with NPL calibration certificate not older than one month. These shallbe used for calibration of the temperature recorders.

15) Portable tanks of sufficient size to provide a continuous supply of water to the pump during pressurizing.

16) Means to measure the volume of water necessary to drop the line pressure by 0.5 bar (container on scales or graduated cylinder). Resolution shall be 0.0005% of fill volume of the pipeline.

17) Injection facilities to inject additives for anti-corrosion, oxygen scavenger and bactericides into the test medium in the required proportions.

18) The temporary test headers shall be installed according to the testing sections fixed inthe test procedure manual. Proper piping and valve arrangements shall be available to allow launching and receiving of each pig independently. The test heads, manifolds etc., shall be pre-tested for four hours at a pressure equal to 110% of maximum test pressure.The manifolds, test heads, end closures and other temporary testing equipment shall be designed as per recognized codes and shall be either flange/bolted or welded to the pipeline section.

19) A good and well laid out test cabin shall be located at a safe distance and shall have sufficient space to house all instruments and record of data.

20) Communication equipment suitable for a continuous connection between the beginning and the end of the test section and with the inspection team along the line, in accordancewith the requirements of Local Authorities.

21) Thermocouples for measuring the temperature of the pipe wall shall be installed on the pipeline to be tested:

- 1 thermocouple at about 500 m distance from the pumping head.
- 1 thermocouple every 2500 m of the pipe. The spacing may be increased to 5000m depending upon the terrain and nature of sub-soil
- 1 thermocouple at about 500 m distance from the terminal head.

These instruments shall be installed at least 2 days before the commencement of test sothat the ground temperature trend is well established.

22) All instruments used for measurement shall be certified for accuracy, repeatability and sensitivity.

23) The temperature along the pipeline section shall be measured prior to start of water filling, during filling, during thermal stabilization, and during hydrotest. The recording frequency shall be in terms of every four hours or lesser based on site condition or as directed by the Owner.

In addition to above, Owner/Consultant reserves the right to demand installing more thermocouples as per site conditions.

Thermocouples shall be attached on the external surface of the pipe after removal of external coating and shall be adequately protected. Owner/Consultant coating instruction shall be followed.

## 4.0 TEST DURATION AND PRESSURE

**4.1** The duration of hydrostatic test shall be minimum 24 hours after stabilization and the test pressure shall be as indicated in approved hydrostatic test diagram.

**4.2** Unless otherwise specified in the Contract, natural gas pipelines shall be tested at a minimum test pressure of 1.5 times the design pressure irrespective of the class location. However, the maximum test pressure at the lowest point of the test section or at the section with the least wall thickness shall be limited to hoop stress resulting in 100% of SMYS.

**4.3 Pre-testing:**

Pre-testing of pipe shall be carried out of carrier pipes in case of cased crossings, pipe strings in case of HDD, pipe before concrete coating and as specified elsewhere in the tender document at a test pressure limited to hoop stress resulting in 100% of SMYS.
The test duration shall be 6 hours and shall be properly recorded.

## 5.0 PROCEDURES

The test medium shall be soft non-aggressive water. The water to be used shall be filtered, potable and free from sand or silt. The water shall be free of dissolved substances, harmful chemicals, bacteria etc., which could be harmful to the pipe or which could form internal deposits in the pipeline. The water quality shall correspond to filtration through a 50 micron filter and the average content of suspended matter shall not exceed $20g/m^3$. Contractor shallsubmit laboratory test reports of water used for testing.
Contractor shall provide Owner/ Consultant approved corrosion inhibitors, oxygen scavengers and bactericides to be added to the test water as required. The Contractor shall furnish and install all temporary piping which may be necessary to connect from source of water to its pumps and manifolds/tankages. All temporary piping shall be adequately supported during the pressure test. Pressure hoses used shall be properly armoured and shall have a safe working pressure at least equal to twice the hydrostatic test pressure. The hoses shall be anchored to prevent pipe whip and shall not be used inside the test cabin. All hoses shall be pre-tested at least for one hour at their rated working pressure.

## 5.1 Cleaning & Calliper Pigging

Before filling operation the Contractor shall clean the pipeline by air driven pigs to remove all mill scale, rust/sand, weld debris and other metallic particles from the internal of pipe sections. The finishing touch shall be executed with pigs provided with air jet holes or nozzles to keep the internal dust in turbulence ahead of the pigs. Contractor to ensure that the cleaning pigs does not damage pipeline components and facilities. The number of pig runs shall depend upon the cleaning results and shall be determined by the Owner/ Consultant Representative at site. In case of stuck/ blocked pigs, contractor to submit detail action plan at site for Owner's approval before proceeding with any remedial measures. Pig train speed shall be maintained between 0.5 m/sec to 1 m/sec. Progress of pig train shall be monitored. Contractor has to furnish detailed procedure including placement of pig locators on the line.

During filling the pigs used shall be capable of providing positive air/water interface and minimize air entertainment. All spaces in which air could be entrapped such as valve bodies; bypass pipe work etc. should be vented and sealed. The cleaning fluids shall remove chemical particles and organisms. The cleaning and gauging train design, number of pigs, train velocity etc., shall be based on pipeline size and gradient along pipeline route. Care should be taken in downhill pipe sections where air pressure shall be maintained to ensure that pigs do not move ahead of line fill resulting in air pockets being trapped at the uphill.The pressure produced by downhill point of water column on the pig shall be balanced by sufficient back pressure.

After cleaning, pipeline will be flushed with minimum 1 km of pipeline volume and water shallbe filled with corrosion inhibitor by propelling minimum 2 pigs with water column of 100 meters.

## 5.2 Thermal Stabilization

After a check has been made to confirm whether the pressure has attained at least 1 bar (g) on the highest section, the thermal stabilization can be started.

Thermal equilibrium between the pipeline and environment shall be checked through the thermocouples installed on the pipeline.
Temperature readings shall be taken at every 2 hour intervals. Thermal stabilization shall be done for 24 hours and shall be considered to have been achieved when a difference not higher than 1ºC is attained between the average values of the last two readings. Owner/Consultant shall approve thermal stabilization completion before pressurization.

## 5.3 Pressurization

The pressurization rate shall not be more than 2 bar/ min. Pressure shall be recorded byusing a dead weight tester and confirmation shall be done with pressure gauge on the same header. Water volume shall also be recorded with respect to pressure.

- Each 5 bar increments upto 80% of test pressure as recorded by the dead weight tester.
- Each 2 bar increment between 80% of test pressure as recorded by the dead weighttester.
- Each 0.2 bar increments between 90% of the test pressure up to full test pressure asrecorded by dead weight tester.

Pressure cycling and Air volume ratio calculations requirements:

i) Pressurise to 33% of test pressure, hold pressure for 1 hour, and collect water for airvolume calculations. Check for any leaks.

ii) Drop pressure to static head of test section at test head.

iii) Re-pressurise to 75% of test pressure, hold pressure for 1 hour and check for anyleakage

iv) Drop pressure to static head of test section at the test head.

v) Re-pressurise to test pressure and hold for stabilization.

## 5.4 Air Volume Calculation

In order to check the presence of air in the pipeline, two separate consecutive pressure lowering of 0.5 bar shall be carried out.

For calculation of air in the pipeline the second pressure lowering shall be used, and the relevant drained water shall be accurately measured ($V_1$). This amount measured shall be compared to the

theoretical amount ($V_2$) corresponding to the pressure lowering that has been carried out, by using the procedure outlined in the specification.

If no air is present in the length under test:

$$\frac{V_1}{V_2} = 1$$

The above ratio is acceptable, provided it shall not differ from '1' by more than 0.2% (i.e. 1.002).

If ratio is found to be above within limits, then pressurization can proceed. If not, water refilling shall be carried out by another run of batching pigs after depressurizing the pipeline.

Simultaneously contractor shall also construct a plot of pressure volume from the initial stage of pressurization until a definite linear relationship is obtained. The theoretical P/V plot shall also be plotted on the same graph. Once 33% of test pressure is reached, the linear curve shall be extrapolated backwards to cut the volume axis. The measured air volume and its percentage of pipeline test section volume shall be calculated. On completion of the air inclusion P/V plot, a separate P/V plot should commence and continue until the test pressureis reached. The slopes of the actual P/V plot and theoretical P/V plot shall be compared and all calculations and graphs shall be submitted to Owner/Consultant for information.

Percentage of air = (volume of air / volume of line) X 100

Air content shall not exceed 0.2 % of the line volume. In case, air content exceeds the limit, testing shall be terminated. The test section should be emptied and refilled at the discretion of the Owner/ Consultant.

### 5.5 Testing (pressure holding test)

After the section has been pressurized and the air column test has given acceptable results the test pressure shall be held for a minimum of 48 hours (24 hours for strength test and 24 hours for leak test) after stabilization for 24 hours. After temperature and pressure are stabilized, (for the 24 hours leak test) the injection pump shall be disconnected and all connections at the test heads shall be checked for leakage. The pressure and temperature recorders shall then be started once again with the charts in a real time orientation for continuous recording throughout the test duration. No further pumping is permitted duringthe test period.

During the testing period the following measurements shall be recorded/ reported:

- Every one-hour pressure measurements from dead weight testers.
- Every two hours the ambient temperature and the pipe temperature at the thermocouplesand fill water temperature.
- Barometric pressure for every one hour.

All data shall be recorded on appropriate formats attached to the hydrostatic test proceduremanual. Care shall be taken that the maximum test pressures are not exceeded.

## 6.0 ACCEPTANCE

The hydrostatic test shall be considered as positive if pressure has kept a constant value throughout the test duration, except for change due to temperature effects. Such changes shall be evaluated as described below.

The pressure change value as a function of temperature change shall be algebraically added to the pressure value as read on the meters. The methodology for calculation of pressure change due to temperature shall be as per section 8.0 of this specification. The pressure value thus adjusted shall be compared with the test and shall be considered as acceptable if the difference is less than or equal to

0.3 bar of test pressure. In case of doubt or if for any reason the test pressure has been reduced other than for bleed-off excess pressure, the test duration shall be extended by 24 hours.
If test section doesn't meet the above requirement, Contractor shall determine by search the location of leakage or failure. All leaks and failures within the pipe wall or weld seam shall berepaired by replacement of entire pipe or pipes in which leakage or failure occurs. In those cases, where leaks occur in circumferential welds the Owner/ Consultant shall determine themethod of repair. Contractor shall comply with instructions of the Owner/ Consultant's representative whether to replace a section of the line pipe that includes the line leak or whether to repair the circumferential weld. The repair shall be carried out as per specifications. Where failures occur in pipeline field bends, bends shall be replaced with same degree bends. After completion of repairs, the hydrostatic test shall be repeated as a complete cycle, as per this specification. All repairs and retesting shall be carried out at the expense of the Contractor. All work of reinstalling line pipes to replace failed pipes shall be carried out as per specifications. For Owner/Consultant verification, all failed pipes shall be stored, marked, and tagged indicating date and location of failure and pressure at which failure occurred. The failed areas shall be greased to prevent corrosive action.

## 7.0 TERMINATION

After the positive results of testing and all the data have been gathered, the test shall be terminated upon written approval given by Owner/Consultant.

The pipeline shall be slowly depressurized at a moderate and constant rate as instructed by Owner/Consultant.

Contractor shall dispose of test water in a responsible manner to the satisfaction of the local authorities, client and contiguous property owners. There shall be minimum damage to environment and shall not result in any ground water contamination.

All thermocouples installed on the line shall be removed and coating repaired to satisfaction of the client. All piping and instrument connections shall be blanked, plugged or capped as per requirements.

## 8.0 CALCULATIONS

The theoretical water amount that is necessary for filling the section to be tested shall be obtained from the geometrical volume of the section considering the pipe tolerances.

The theoretical water amount that is necessary for pressurizing the section shall be calculated by means of the following formula:

$$Vp = (0.884\, r_1/t + A) \times 10^{-6} \times V_t \times \Delta P \times K$$

Where:

Vp = Computed water amount required to raise the pressure by 'ΔP' in the section to be tested ($m^3$)

Vt = Geometrical volume of the section ($m^3$)

ΔP = Pressure rise (bar)

$r_1$ = Nominal inner radius of the pipe (mm)

t = nominal pipe thickness (mm)

A = isothermal compressibility value for water at the pressurization temperature in the P range ($bar^{-1}$).

K = a dimensionless coefficient that is equal to a value of 1.02 for Longitudinally welded pipe, and 1.0 for seamless pipe.

The pressure change due to a water temperature change shall be calculated through thefollowing formula:

$$\Delta P = B * \Delta T / \{ ( 0.884 r1 / t )+ A \}$$

Where;

ΔP = Pressure change resulting from a temperature change (bar).

ΔT = Algebraic difference between water temperature at the beginning of the test and water temperature as measured at the end of the test (ºC).

B = Value of the difference between the thermal expansion of water at the pressure and temperature as measured at the end of the test and that of Steel (ºC). Refer Table-1.

A = Isothermal compressibility value of water as estimated at the pressure and temperature values obtained at the end of test ($bar^{-1}$). Refer Fig-1.

$r_1$ = Nominal inner radius of the pipe (mm).t =

Nominal pipe thickness (mm).

## 9.0 TEST REPORT / DOCUMENTATION

A complete report signed by Contractor and the Owner/ consultant Representative shall besubmitted upon completion of the hydrostatic testing operations for each test section.

The report shall contain as minimum:

- Cleaning, flushing, filling and testing procedure used
- Schematic layout of cleaning, filling and testing facilities
- All Instruments calibration certificates
- A profile of the pipeline that shows the test sites, all instrument and injectionconnections.
- Pipe filing logs and records.
- Hydrotest chemicals specification, dosage, injection records specifications andcertificates.
- Pig specifications
- Pigging records including details of pig runs.
- Pressurization and stabilization records and charts with all information specified.

- Pressure and temperature recording charts with appropriate information inscribedthereon.
- Dead weight tester logs and recordings
- Air volume calculations and plots
- Pressure – temperature change calculations
- Profiles of pipelines with elevations
- Environmental data, barometric data
- Depressurisation logs and records
- Disposal method of test water
- Records and photograph of all leaks/failure, location of failure and method of repair
- Schematic isometric drawing of test header with all auxiliaries.
- Daily log of events.

## 10.0 PRECAUTIONS DURING THE TEST

In addition to all that has been expressly described in the procedures for carrying out thetest, the following requirements shall also be complied with.

**10.1** During the hydrotest, no other activities shall be performed on or near pipeline being tested. Further, the test sections shall be kept under continuous surveillance by regular patrols during test and with continuous communication.

**10.2** Signs stating “PIPE UNDER TEST – KEEP OFF” shall be placed where the test ends are located. Such areas shall be suitably guarded throughout the duration of the test. In case pressurizing is done from the shore end, the entire operational area shall suitably be fenced to prevent entry of unauthorized personnel. The warning sign shall also be in Local Language.

**10.3** All personnel working on the hydrotest spread shall be instructed on the possible dangers connected with the high-pressure test operations. During the testing, operations, unauthorized personnel shall not be allowed near by the test head location. Test cabin shall be at least 10 m away from the pipeline so that it is not affected by any pipeline failure.

**10.4** All precautions pertaining to handling and disposal of chemicals shall be as per manufacturer’s standards.

**10.5** All pumps shall have overprotection devices set @ 5 bar above test pressure.

**10.6** The pressure shall be reduced to a safe level of 1 bar before any work is permitted on the pipeline section.

**10.7** All crossing areas and areas of public access should be patrolled during test.

**10.8** Contractor to ensure that all safety precautions comply with statutory and other national/state and local regulations and shall give notice to the concerned authorities regarding the intention to carry out the test.

**10.9** Contractor to ensure that a hydrotest organization chart is made and all personnel are fully aware of their responsibilities and scope of work.

**Table 1**

Difference between the water thermal expansion factor and the steel thermal expansionfactor ($^{o}C^{-1}$).

| °C<br>Bar | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 0.98 | -98.62 | -79.89 | -61.81 | -44.34 | -27.47 | -11.14 | 4.66 | 19.98 |
| 10 | -95.55 | -76.94 | -58.99 | -41.65 | -24.89 | -8.67 | 7.02 | 22.23 |
| 20 | -92.15 | -73.68 | -55.86 | -38.64 | -22.01 | -5.92 | 9.65 | 24.74 |
| 30 | -88.74 | -70.4 | -52.72 | -35.63 | -19.14 | -3.16 | 12.29 | 27.26 |
| 40 | -85.32 | -67.12 | -49.58 | -32.62 | -16.24 | -0.41 | 14.93 | 29.78 |
| 50 | -81.9 | -63.84 | -46.43 | -29.6 | -13.36 | 2.36 | 17.57 | 32.31 |
| 60 | -78.47 | -60.55 | -43.27 | -26.58 | -10.46 | 5.15 | 20.23 | 34.85 |
| 70 | -75.03 | -57.25 | -40.1 | -23.54 | -7.56 | 7.92 | 22.89 | 37.39 |
| 80 | -71.6 | -53.96 | -36.94 | -20.51 | -4.65 | 10.7 | 25.55 | 39.94 |
| 90 | -68.16 | -50.66 | -33.77 | -17.47 | -1.73 | 13.5 | 28.23 | 42.5 |
| 100 | -64.72 | -47.35 | -30.6 | -14.43 | 1.18 | 16.29 | 30.9 | 45.05 |
| 110 | -61.28 | -44.05 | -27.43 | -11.38 | 4.1 | 19.08 | 33.58 | 47.61 |
| 120 | -57.84 | -40.74 | -24.26 | -8.34 | 7.02 | 21.88 | 36.26 | 50.18 |
| 130 | -54.4 | -37.44 | -21.08 | -5.29 | 9.95 | 24.68 | 38.94 | 52.75 |
| 140 | -50.96 | -34.13 | -17.9 | -2.25 | 12.87 | 27.49 | 41.63 | 55.32 |
| 150 | -47.53 | -30.83 | -14.73 | 0.8 | 15.79 | 30.29 | 44.31 | 57.89 |
| 160 | -44.1 | -27.53 | -11.56 | 3.85 | 18.72 | 33.1 | 47 | 60.46 |
| 170 | -40.67 | -24.23 | -8.4 | 6.89 | 21.64 | 35.9 | 49.69 | 63.04 |
| 180 | -37.24 | -20.94 | -5.23 | 9.94 | 24.56 | 38.7 | 52.37 | 65.62 |
| 190 | -33.83 | -17.65 | -2.06 | 12.98 | 27.48 | 41.51 | 55.06 | 68.19 |
| 200 | -30.42 | -14.37 | 1.09 | 16.01 | 30.4 | 44.3 | 57.75 | 70.77 |
| 210 | -27.02 | -11.09 | 4.25 | 19.04 | 33.31 | 47.1 | 60.43 | 73.34 |
| 220 | -23.63 | -7.82 | 7.4 | 22.06 | 36.22 | 49.9 | 63.12 | 75.9 |
| 230 | -20.24 | -4.56 | 10.54 | 25.08 | 39.13 | 52.69 | 65.8 | 78.48 |
| 240 | -16.87 | -1.3 | 13.67 | 28.1 | 42.03 | 55.48 | 68.48 | 81.05 |
| 250 | -13.58 | 1.94 | 16.79 | 31.11 | 44.92 | 58.26 | 71.15 | 83.61 |
| 260 | -10.14 | 5.17 | 19.9 | 34.12 | 47.81 | 61.04 | 73.81 | 86.81 |
| 270 | -6.8 | 8.39 | 23 | 37.11 | 50.69 | 63.8 | 76.48 | 88.73 |
| 280 | -3.48 | 11.6 | 26.11 | 40.09 | 53.56 | 66.57 | 79.14 | 91.29 |
| 290 | -0.17 | 14.8 | 29.19 | 43.07 | 56.43 | 69.33 | 81.78 | 93.83 |
| 300 | 3.13 | 17.98 | 32.27 | 46.03 | 59.29 | 72.06 | 84.83 | 96.38 |

Difference between the water thermal expansion factor and the steel thermal expansionfactor ($ºC^{-1}$).

| ºC<br>Bar | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|
| 0.981 | 34.82 | 49.22 | 63.2 | 76.78 | 89.99 | 102.83 | 115.34 |
| 10 | 36.97 | 51.26 | 65.15 | 78.64 | 91.75 | 104.51 | 116.93 |
| 20 | 39.36 | 53.55 | 67.33 | 80.71 | 93.72 | 106.39 | 118.71 |
| 30 | 41.76 | 55.84 | 69.51 | 82.79 | 95.7 | 108.26 | 120.49 |
| 40 | 44.18 | 58.14 | 71.7 | 84.87 | 97.68 | 110.14 | 122.28 |
| 50 | 46.6 | 60.45 | 73.9 | 86.96 | 99.68 | 112.04 | 124.07 |
| 60 | 49.02 | 62.76 | 76.1 | 89.07 | 102.67 | 113.93 | 125.88 |
| 70 | 51.44 | 65.08 | 78.32 | 91.17 | 103.68 | 115.84 | 127.69 |
| 80 | 53.88 | 67.4 | 80.53 | 93.29 | 105.69 | 117.76 | 129.5 |
| 90 | 56.32 | 69.73 | 82.75 | 95.41 | 107.7 | 119.67 | 131.32 |
| 100 | 58.77 | 72.07 | 84.98 | 97.53 | 109.73 | 121.59 | 133.15 |
| 110 | 61.21 | 74.41 | 87.22 | 99.66 | 111.75 | 123.52 | 134.98 |
| 120 | 63.67 | 76.74 | 89.45 | 101.79 | 113.79 | 125.46 | 136.82 |
| 130 | 66.12 | 79.09 | 91.69 | 103.93 | 115.83 | 127.39 | 138.67 |
| 140 | 68.58 | 81.45 | 93.93 | 106.07 | 117.67 | 129.34 | 140.51 |
| 70 | 71.05 | 83.8 | 96.18 | 108.21 | 119.9 | 131.2 | 142.37 |
| 160 | 73.51 | 86.15 | 98.43 | 110.36 | 121.96 | 133.74 | 144.22 |
| 170 | 75.97 | 88.51 | 100.68 | 112.51 | 124.01 | 135.19 | 146.08 |
| 180 | 78.44 | 90.87 | 102.94 | 114.66 | 126.06 | 137.15 | 147.94 |
| 190 | 80.91 | 93.23 | 105.19 | 116.82 | 128.12 | 139.11 | 149.81 |
| 200 | 83.37 | 95.59 | 107.45 | 118.97 | 130.17 | 141.07 | 151.68 |
| 210 | 85.84 | 97.95 | 109.71 | 121.13 | 132.24 | 143.03 | 153.55 |
| 220 | 88.3 | 100.31 | 111.97 | 123.29 | 134.29 | 144.99 | 155.42 |
| 230 | 90.67 | 102.67 | 114.23 | 125.45 | 136.36 | 146.96 | 157.3 |
| 240 | 93.22 | 105.03 | 116.48 | 127.6 | 138.42 | 148.93 | 159.18 |
| 250 | 95.69 | 107.39 | 118.74 | 129.76 | 140.48 | 150.9 | 161.05 |
| 260 | 98.14 | 109.74 | 121 | 131.92 | 142.54 | 152.87 | 162.93 |
| 270 | 100.6 | 112.1 | 123.25 | 134.08 | 144.61 | 154.84 | 164.81 |
| 280 | 103.05 | 114.44 | 125.5 | 136.24 | 146.67 | 156.84 | 166.69 |
| 290 | 105.5 | 116.79 | 127.75 | 138.39 | 148.73 | 158.78 | 168.57 |
| 300 | 107.94 | 119.13 | 130 | 140.54 | 150.79 | 160.75 | 170.45 |

Table 1

Difference between the water thermal expansion factor and the steel thermal expansionfactor ($ºC^{-1}$).

**Table 1**

| ºC<br><br>Bar | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
|---|---|---|---|---|---|---|---|---|
| 0.981 | 127.52 | 139.41 | 151 | 162.31 | 173.37 | 184.18 | 194.75 | 205.08 |
| 10 | 129.02 | 140.83 | 152.36 | 163.58 | 174.56 | 185.3 | 195.79 | 206.07 |
| 20 | 130.71 | 142.42 | 153.85 | 165 | 175.9 | 186.55 | 196.96 | 207.16 |
| 30 | 132.4 | 144.02 | 155.35 | 166.42 | 177.23 | 187.8 | 198.14 | 208.26 |
| 40 | 134.1 | 145.62 | 156.87 | 167.85 | 178.58 | 189.07 | 199.33 | 209.37 |
| 50 | 135.8 | 147.24 | 158.39 | 169.85 | 179.93 | 190.34 | 200.52 | 210.49 |
| 60 | 137.51 | 148.86 | 159.92 | 170.73 | 181.29 | 191.62 | 201.72 | 211.61 |
| 70 | 139.22 | 150.49 | 161.46 | 172.18 | 182.66 | 192.91 | 202.93 | 212.74 |
| 80 | 140.95 | 152.11 | 163 | 173.64 | 184.03 | 194.2 | 204.14 | 213.88 |
| 90 | 142.67 | 153.75 | 164.56 | 175.1 | 185.41 | 195.5 | 205.36 | 215.03 |
| 100 | 144.42 | 155.4 | 166.11 | 176.58 | 186.8 | 196.8 | 206.59 | 216.17 |
| 110 | 146.15 | 157.04 | 167.66 | 178.05 | 188.2 | 198.12 | 207.82 | 217.33 |
| 120 | 147.9 | 158.7 | 169.24 | 179.54 | 189.59 | 199.44 | 209.06 | 218.49 |
| 130 | 149.65 | 160.36 | 170.81 | 181.02 | 191 | 200.75 | 210.31 | 219.66 |
| 140 | 151.4 | 162.03 | 172.39 | 182.51 | 192.41 | 202.09 | 211.56 | 220.84 |
| 70 | 153.16 | 163.7 | 173.98 | 184 | 193.82 | 203.42 | 212.81 | 222.02 |
| 160 | 154.93 | 165.37 | 175.56 | 185.51 | 195.24 | 204.76 | 214.08 | 223.2 |
| 170 | 156.69 | 167.05 | 177.15 | 187.02 | 196.66 | 206.1 | 215.34 | 224.39 |
| 180 | 158.47 | 168.73 | 178.75 | 188.53 | 198.09 | 207.45 | 216.61 | 225.55 |
| 190 | 160.24 | 170.42 | 180.35 | 190.05 | 199.52 | 208.8 | 217.89 | 226.79 |
| 200 | 162.01 | 172.1 | 181.95 | 191.57 | 200.97 | 210.16 | 219.17 | 227.99 |
| 210 | 163.8 | 173.8 | 183.55 | 193.09 | 202.4 | 211.53 | 220.46 | 229.2 |
| 220 | 165.58 | 175.43 | 185.16 | 194.62 | 203.85 | 212.89 | 221.74 | 230.41 |
| 230 | 167.36 | 177.19 | 186.78 | 196.14 | 205.3 | 214.26 | 223.04 | 231.63 |
| 240 | 169.16 | 178.89 | 188.39 | 197.68 | 206.75 | 215.63 | 224.33 | 232.85 |
| 250 | 170.94 | 180.59 | 190.01 | 199.21 | 208.2 | 217 | 225.63 | 234.08 |
| 260 | 172.73 | 182.3 | 191.63 | 200.75 | 209.66 | 218.4 | 226.93 | 235.31 |
| 270 | 174.53 | 184 | 193.25 | 202.29 | 211.12 | 219.77 | 228.24 | 236.54 |
| 280 | 176.32 | 185.7 | 194.88 | 203.83 | 212.59 | 221.16 | 229.55 | 237.77 |
| 290 | 178.11 | 187.42 | 196.5 | 205.37 | 214.05 | 222.54 | 230.86 | 239.01 |
| 300 | 179.9 | 189.13 | 198.13 | 206.92 | 215.51 | 223.93 | 232.18 | 240.26 |

**Table 1**

Difference between the water thermal expansion factor and the steel thermal expansionfactor ($^{o}C^{-1}$).

| °C<br>Bar | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|---|
| 0.981 | 215.22 | 215.14 | 234.88 | 244.41 | 253.79 | 263 | 272.03 |
| 10 | 216.13 | 225.99 | 235.66 | 245.13 | 254.44 | 264.27 | 272.57 |
| 20 | 217.15 | 226.94 | 236.53 | 245.94 | 255.18 | 264.59 | 273.18 |
| 30 | 218.18 | 227.88 | 237.41 | 246.75 | 255.93 | 264.95 | 273.8 |
| 40 | 219.21 | 228.85 | 238.3 | 247.58 | 256.69 | 265.64 | 274.42 |
| 50 | 220.25 | 229.82 | 239.2 | 248.4 | 257.45 | 266.33 | 275.07 |
| 60 | 221.3 | 230.79 | 240.11 | 249.24 | 258.22 | 267.04 | 275.7 |
| 70 | 222.35 | 231.78 | 241.02 | 250.08 | 258.99 | 267.75 | 276.35 |
| 80 | 223.42 | 232.77 | 241.94 | 250.93 | 259.78 | 268.47 | 277.01 |
| 90 | 224.48 | 233.76 | 242.87 | 251.79 | 260.57 | 269.19 | 277.66 |
| 100 | 225.56 | 234.76 | 243.79 | 252.66 | 261.36 | 269.92 | 278.33 |
| 110 | 226.64 | 235.78 | 244.73 | 253.53 | 262.17 | 270.77 | 279.01 |
| 120 | 227.73 | 236.79 | 245.68 | 254.4 | 262.98 | 271.41 | 279.69 |
| 130 | 228.82 | 237.81 | 246.63 | 255.28 | 263.69 | 272.16 | 280.38 |
| 140 | 229.92 | 238.84 | 247.59 | 256.18 | 264.62 | 272.92 | 281.08 |
| 150 | 231.03 | 239.87 | 248.55 | 257.07 | 265.44 | 273.69 | 281.78 |
| 160 | 232.14 | 240.91 | 249.52 | 257.97 | 266.28 | 274.46 | 282.49 |
| 170 | 233.26 | 241.96 | 250.49 | 258.88 | 267.12 | 275.23 | 283.2 |
| 180 | 234.38 | 243.01 | 251.47 | 259.79 | 267.97 | 276.01 | 283.92 |
| 190 | 235.51 | 244.06 | 252.46 | 260.71 | 268.82 | 276.8 | 284.64 |
| 200 | 236.64 | 245.12 | 253.45 | 261.63 | 269.67 | 277.59 | 285.37 |
| 210 | 237.77 | 246.18 | 254.45 | 262.5 | 270.54 | 278.39 | 286.11 |
| 220 | 238.91 | 247.26 | 255.45 | 263.49 | 271.4 | 279.19 | 286.85 |
| 230 | 240.06 | 248.33 | 256.46 | 264.43 | 272.28 | 280 | 287.59 |
| 240 | 241.21 | 249.41 | 257.46 | 265.37 | 273.16 | 280.82 | 288.35 |
| 250 | 242.36 | 250.49 | 258.48 | 266.31 | 274.04 | 281.63 | 289.11 |
| 260 | 243.52 | 251.58 | 259.49 | 267.27 | 274.92 | 282.46 | 289.86 |
| 270 | 244.68 | 252.66 | 260.52 | 268.23 | 275.82 | 283.29 | 290.64 |
| 280 | 245.84 | 253.76 | 261.54 | 269.18 | 276.71 | 284.12 | 291.4 |
| 290 | 247.01 | 254.86 | 262.57 | 270.15 | 277.61 | 284.95 | 292.18 |
| 300 | 248.18 | 255.96 | 263.6 | 271.11 | 278.51 | 285.79 | 292.95 |

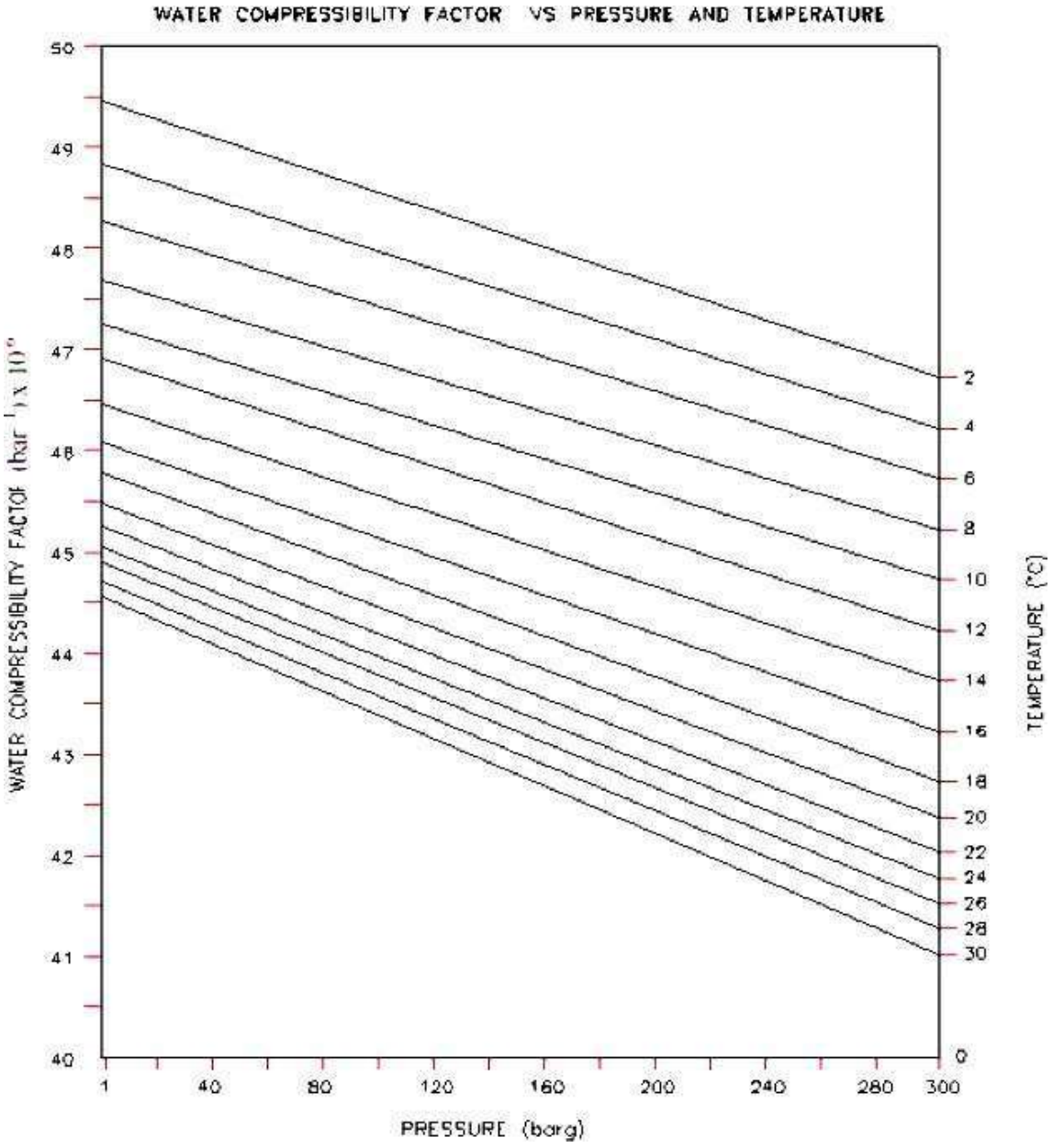



Fig.1 Water Compressibility Factor

# TECHNICAL SPECIFICATION FOR CALIPER PIGGING

## CONTENTS

## 1.0 SCOPE

The intent of this specification is to set forth the requirements of the caliper pigging. The specification is not intended to be all-inclusive and the use of this specification will not absolve the contractor of his responsibility of generating valid, interpretable and physically verifiable data.

## 2.0 OBJECTIVE

The objective of the present pigging programme is to access the internal geometry of the following pipelines and detect significant geometry defects if any, which may affect safe operation of the pipeline.

## 3.0 SCOPE OF WORK

To achieve the above objective, contractors SCOPE OF WORK includes running of adequate numbers of foam pigs, cleaning pigs (magnet, brush, combination of brush and magnet, scraper, pin wheel etc.), gauge pig and caliper pig.

Further the scope of work comprises supply of skilled personnel, all equipment e.g. foam pigs cleaning pigs, gauging pig, caliper pigs, pig locating and pig tracking devices, spares consumables, communication and transportation including their mobilisation and demobilisation. It is expressly understood that this do not limit the scope of work of the CONTRACTOR in any way. The quantities to be mobilized for different equipment (differenttypes of pigs pig tracking device, marker device) accessories, spare and consumables need to be carefully evaluate by the CONTRACTOR taking in to the consideration that caliper pigging of various pipelines in the scope of work should be carried out without any constraint and turn around time.

The contractor shall submit the details of each type of pig including foam, gauge and caliper for approval of OWNER / CONSULTANT, which he proposes to use. Pigs shall be launched in the pipeline only after their design and size has been approved by OWNER / CONSULTANT. Due care shall be taken not to damage internal coating by the contractor, while proposing the pigs for internally coated pipeline.

The detailed scope of work shall be, but not limited to under

- Supply of all equipment, personnel and consumables.
- Running of foam, Gauge, Cleaning and Caliper pigs and Tracking to generate valid data.
- Placement of marker devices along the Row over the pipeline.
- Identification of defects in the field as found
- Preparation of work reports.

## 4.0 VELOCITY OF DIFFERENT PIGS

Contractor shall be required to maintain velocities of propelling medium in such a way that the objective of each pig run shall be achieved.

## 5.0 FOAM PIG RUN

Contractor to carry out adequate number of foam pigs runs in each pipeline covered under Scope of Work prior to running of cleaning pigs to make a final assessment of the line pig-ability to the satisfaction of the Contractor and provide detailed daily site report for each runin the approved format before commencing the subsequent run. Contractor to select size ofthe foam pigs in such a way that the objective shall be achieved.

## 6.0 GAUGE PIG RUN

Contractor to carry out adequate number of gauging pig runs in each pipeline covered under Scope of work including pig tracking for pipeline to assess any internal restriction in the pipeline that may restrict the passage of cleaning and caliper pig. Contractor to provide detailed daily site report for each run in the approved format before commencing the subsequent run Gauge pig shall be equipped with a gauge plate made of Aluminium havingits diameters 95% of minimum pipeline Internal Diameter (I.D.). The gauge pig should be able to pass over or negotiate lateral tees or bends on the pipeline.

## 7.0 CLEANING PIG RUN

### 7.1 Pipelines with Internal Coating

Contractor to carry out adequate number of cleaning pig runs by running suitable cleaning pigs in the pipelines including pig tracking till the time owner/ owner's representative is satisfied about the degree of cleanliness of pipeline. The contractor shall provide detailed daily site report for each run in the approved format before commencing the subsequent run. Choice of the type of cleaning pig has been left to the contractor. The contractor shall assure that the pigs, which are proposed to be used, are adequately soft and they do not damage internal coating under any circumstances. The brushes and scrappers used shall be of non-metallic/ plastic material. However, the details of these pigs including their construction details of brushes, scrappers etc. (if applicable) shall be submitted to OWNER / CONSULTANT for approval before their usage.

### 7.2 Pipelines without Internal Coating

CONTRACTOR to carry out adequate numbers of cleaning pig runs by running suitable cleaning pigs in pipeline including pig tracking till such time CONTRACTOR is satisfied withhimself about the degree of cleanliness of pipeline and provide detailed daily site report for each run in the approved format before commencing the subsequent run. Choice of the type of cleaning pig has been left to the contractor. Contractor may deploy brush cleaning pig, magnetic cleaning pig, combination of brush and magnet, scrapper pig etc. the cleaning pigs should be able to pass over negotiate lateral tees or bends on the pipeline.

## 8.0 CALIPER PIG RUN

CONTRACTOR to carry out adequate number of electronic geometry (caliper) pig runs each pipeline including pig tracking for each pipeline decided after findings of gauging pig run to generate valid and interpretable geometry data of the pipeline and analysis of data ofthe caliper survey to detect the nature, extent and location of geometry defect. Contractorto provide detailed daily site report for each run in the approved format before commencingthe subsequent run. The caliper should be capable of inspecting entire length of the pipeline i.e. from launcher to receiver in single run. Battery life should be adequate to commensurate with the run time required to travel the pipeline length. The electronic recorder system should have requisite data storage capacity. The drive cups should have requisite resistance to wear and tear to maintain effective seal throughout the entire run time.

The measurement shall cover the entire 360° of internal pipe wall circumference using properly oriented and sufficient quantity of sensors. For internally coated pipelines adequate care shall be taken by using soft cups so that no damage takes place to the internal coating of pipe. The tool shall be capable to identify and locate the followingfeatures as minimum.

- Individual Girth weld
- Dent, ovality, buckles, or any other out of roundness, change in pipeline I.D. anddifference of thickness.
- Bend with bend radius and degree of bend.
- Valves or any partially closed valves.
- Tees/ off-takes.

The caliper pig should have minimum capability to identify and detect the defects offollowing threshold.

| | | |
|---|---|---|
| Dent | : | 3% of outer diameter (O. D.) |
| Ovality | : | 5% of outer Diameter (O. D.) |
| Location accuracy | : | Axial ± 2.0m |
| | | Circumferential ± 10° |

(For dents, ovalities and pipeline feature as detailed above).

Caliper Pig shall be calibrated on predetermined dent on same size and thickness of thepipeline to be examined and witnessed by Owner/ Consultant

## 9.0 PIG TRACKING

The movement of any type of pig (Except, foam pig) put into the line during caliper pigging shall be required to be monitored along the pipeline length. The Contractor shall detail out the complete methodology of pig tracking proposed to be deployed by him including complete technical details of the equipment and device proposed to be used for this purpose.

It is proposed that pig tracking would be done in a discrete manner at regular intervals(Max 5 km) on each pipeline. The exact KM chainage of these locations shall be decided atsite in consultation with the Contractor and Owner / Consultant.

## 10.0 MARKER DEVICES

The contractor shall submit the details of marker devices, which he proposes to place for relocating the defect accurately in the field, when the same has been identified as a resultof Caliper survey.

The contractor shall be responsible for placing these devices (Marker Magnets or Locator coils or any other device) at suitable interval so that the defect can be easily located in the field with minimum above ground measurement. It may be noted that placement of marker devices, their retrieval and locating the identified defect in the field shall be the responsibility of the contractor. The liquidation of defects, if any, is however, not included inthe scope of work of the contract.

## 11.0 DEFECT VERIFICATION

At the discretion of the Owner/ Consultant identify at least two verification dig sites for eachpipeline jointly with Owner and Consultant from the recorded data and provide Owner / Consultant with their distance from the nearest pipeline feature or reference marker to facilitate location of defect in the field.

The contractor shall depute his representative to observe the verification at verificationsites for proving that filed log detected anomalies conform to sizing including linear and circumferential positions.

## 12.0 ABNORMAL SITUATIONS

The objective of this section is to write down foreseeable abnormal circumstances for taking appropriate measures, should such a condition arise during implementation of project.

The following abnormal condition has been foreseen by the Owner. However, if the Contractor foresees any other abnormal condition, he is free to make a mention of thesame in his technical BID offer.

### 12.1 Tool Failure

Contractor is required to get valid interpretable and verifiable data for pipeline. In case Contractor's equipment fails to perform electronic geometry inspection to generate valid data for any of the pipeline, Contractor will make extra runs of pigs to get valid and physically verifiable data.

### 12.2 Stuck-Up Tool

The Contractor shall details out a contingency plan as proposed by him in case any of the pigs get

stuck up. The plan shall identify procedure for exactly locating the stuck up pig, detail procedure for retrieval of pig, equipment, including support facilities required to retrieve the pig.

If pig does not move from stuck up location, by any measure, then the pipeline section shallhave to be cut for retrieval of Pig. Necessary erection, fabrication and modification of pipe with new pipe piece after retrieval of pig shall be done by Contractor. The cost for this works shall be borne by Contractor on actual. After fabrication & erection, pigging contractor shall run Gauge pig to check internal restriction, if any. Locating the stuck up pig and its retrieval shall be the responsibility of the Contractor.

## 13.0 WORK REPORT

The work report shall be prepared and submitted in hard copy (4 sets) and Soft Copy.The work report shall consist of following as a minimum.

- All field activities.
- Equipment description
- List of installations
- List of significance with feature information and installation reference.
- Survey log and enlargement areas of special interest to suitable scale.

## 14.0 DOCUMENTATION

- Specification of foam pigs, cleaning pigs, gauge pig and caliper pig for pipelines with andwithout internal coating respectively.

- Details of caliper pig in following respects:
  Max. % of Nominal pipeline ID tool can pass (% of ID)
  Minimum deformation level reported (as % of ID)
  Accuracy of measurement (% of ID)
  Bend radius tool able to negotiate
- Details of pig tracking equipment and pig tracking procedure.
- Pig contingency plan.
- Proposed methodology for execution of pipeline pigging.
- Sample reporting format.
-Minimum velocity of various pigs acceptable to bidder for generation of valid data.

# TECHNICAL SPECIFICATION FOR DOCUMENTATION OF PIPELINE CONSTRUCTION

## CONTENTS

## 1.0 SCOPE

**1.1** This specification covers the minimum requirements of the various records, reports and drawings for all aspects of pipeline construction to be prepared by Contractor and submitted to the Owner at intervals as described in this specification and as directed by Owner.

**1.2** All documents required to be prepared and submitted by Contractor as per this specification shall be in addition to the various reports, records, methodology statements, calculations, drawings etc. to be submitted by the Contractor for Owner's record, review or approval as per the requirements of all other specifications included in the Contract between the Owner and the Contractor.

**1.3** This specification shall be read in conjunction with the condition of all specifications and documents included in the Contract between Owner and Contractor.

## 2.0 RECORDS

Contractor shall submit daily, weekly, monthly and after completion to the Owner various records and reports, for Owner's documentation purposes during and immediately after the construction. This shall as a minimum include, but not limited to the following:

### 2.1 Daily

- Planning Sheet
- Separate progress reports of all crews
- Daily welding results and repairs
- Actual weather conditions
- Application for variations, if any
- Accidents
- Damages
- Activities required from OWNER at short notice.
- Materials Receipts
- Urgently required materials etc

### 2.2 Weekly

- Up-to-date list of confirmed site instructions issued by OWNER
- Materials procured
- Material defects and repairs

- Outstanding activities of Owner
- List of installed markers, chainage
- Required approvals from Owner
- Progress planned
- Report of manning of all crews, equipment and plant
- Report of equipment and plant
- Report of accidents
- Report of damages
- Report of acquired releases, permits
- Priced variations
- Required materials for next month etc.

**2.3 Monthly**

- Progress report for payment, safety report, report of accidents, security report, health and environment report, material balance, approved variations.

**2.4** Further Contractor shall supply (for approval, if required, to the Owner with documents such as but not limited to:

- Organogram for the construction of the work.
- Bio-data of key personnel (including foremen).
- List of addresses of personnel in particular of medical staff, safety and security officers.
- List of approved codes.
- List of approved sub-contractors.
- Time schedule.
- Acquired permits and/or approvals from authorities, endowments, if any.
- Minutes of meeting with Owner with comments, if any.
- Material certificates, material receipts, etc.
- Guarantees from Vendors and Sub-contractors
- Calculations, temporary works, buoyancy, blasting, etc.
- Drawing issued by Contractor
- Vendor drawings
- As-built drawings of route maps, profile drawings, detail drawings and isometric drawings.
- Procedures such as surveying, staking, fencing etc.
- Welder procedure qualification record, radiographic procedure qualification, Welder qualification.

- Coating procedure.

- Installation of crossings.

- Hydrostatic testing procedure,

- Blasting procedure.

- Radiographic report along with original radiographs.

- Pipe and welding book

- Material records and accounting book

- **Reports:**

  - Materials tests (coating, welding, painting, etc.)
  - Computerized Potential Logging Test
  - Water samples
  - Cleaning, pigging report before hydrostatic test
  - Hydrostatic test
  - Calibration test
  - Rock blasting trials
  - Equipment certificates (dead weight tester, instruments, vessels, equipment, etc.)
  - Manuals
  - Major water crossings
  - Releases.

**2.5** Contractor shall submit to Owner color photographs of various construction activities/ operations at regular intervals. Size, number and frequency of the photographs shall be mutually agreed upon ata later stage. Also Contractor shall make video recordings of all operations right from the start of construction till the completion of works, covering to the extent as instructed by Owner and submit to the Owner.

## 3.0 "AS-BUILT" DRAWINGS AND PIPE BOOK

### 3.1 General

Contractor shall prepare "as-built" drawings of all by or on behalf of Owner issued drawings and of all Contractor work drawings including Vendor drawings, such as but not limited to:

For pipeline section:

- Route maps
- Profile maps
- Alignment Sheets

- Detail drawings (road, railway, minor water crossings, major water crossings, etc.)
- Isometric drawings of installations
- Special installations, etc.

Further Contractor shall prepare a pipe and weld book.

### 3.2 "As-Built" Drawings

Contractor shall prepare a complete set of "as-built" drawings. From the start of construction, Contractor shall daily process any changes into two sets of drawings. Deleted parts shall be indicated in red, new parts in blue, remarks in green and unchanged parts in yellow. Said drawings shall be kept in site and be available to Owner at all times. Contractor shall prepare "as-built" drawings based on

these data and as laid down hereafter. One set of these drawings with data shall be sent to Owner before taking over of the work, while the other set shall be handed to Owner at the same time. On completion of the work, one revised film transparency of all drawings made “as-built” by Contractor containing the “as-built” information shall be handed to Owner as well as onecomplete set of microfilms of same as will be specified by Owner. Contractor shall prepare and submit a specimen of the layout of the drawings for Owner approval.

The required measurements for “as-built” drawings shall be executed by Contractor by experienced, qualified surveyors.

The surveyors shall daily take care of all measurements required such as but not limited to:

- Horizontal location of the pipeline with regard to deviations and permanent grid pillars.
- Vertical levels with regard to Mean Sea Level of pipeline and grade.
- Location and type of bends, fittings etc. and grades, points of intersections, etc.
- Changes of wall thickness, materials.
- Location and details of valves, insulating flanges, fencing etc.
- Location and details of buried services.
- Location and details of road, railway, water crossing etc.
- Location and details of casing pipes, vents etc.
- Location and type of coating
- Location and type of weighting, anchoring
- Location and type of markers.
- Location of further appurtenances (pig – signallers, etc.)
- Location of ROW and of pipeline with respect to ROW.
- Type of soil
- Type of rock.
- Type of blasting or ripping
- Sand padding.
- Type of road pavement
- Details of bank protection, number of insulators, seals etc.

Contractor shall also prepare isometric drawings of all installations (facilities) etc. for which the data as mentioned in or required for the pipe and welding book can be identified as such and which drawings can also be used for material accounting.

**3.3 Nameplates of equipment**

All permanent equipment supplied and installed by CONTRACTOR shall be provided with nameplates by CONTRACTOR. All texts size of the plate shall be submitted to OWNER for approvalbefore plates may be manufactured.

**3.4 Pipe Book**

Every page of the pipe and welding book shall mention.

- Data relevant to the project and section thereof.

- Sequential number

- Length brought forward (for pipes and other materials)

- Length to bring forward (for pipes and other materials).

Alignment sheet number and at least the location thereon of two welds on every page of the pipe book.

Further,

- Diameter of pipeline

- Length of each pipe

- Wall thickness
- Pipe number
- Heat number, certificate number
- Cut and re-numbered pipe ends
- Coating
- Date of stringing
- Data of welding
- Direction of working
- Weld number
- Welder number
- Type of welding, electrode, diameter
- Weld treatment
- Used equipment for radiography
- Limits of valve stations, water crossings, etc
- Test pressure, data and test (hydrostatic)
- Length of section per page in line separated in the pipes including field bends and factory bends and/or other inline fittings.
- Length to bring forward (pipes and other materials)
- Length brought forward (pipes and other materials)

In order to achieve this CONTRACTOR shall identify all pipe elements. Sample format of pipe book shall be submitted for Owner/ Consultant approval.

### 3.5 As-Built Documents

Contractor shall prepare all documents in the prescribed format as indicated below. In addition to the hard copies, softcopies of final documents shall also be submitted inelectronic media i.e. CD / DVD format.
Software used for the preparation of these documents shall be as follows:

| **Type document** | | **Software** |
|---|---|---|
| a) Reports/ Documents | - | MS Office |
| b) Drawings | - | Auto CAD |

For the purpose of preparation of as-built drawings, Contractor shall update the “Issued for construction” drawings issued by the Company. It shall be the Contractor’s responsibility to covert the drawings furnished by the Company in hard copy into CAD drawings including scanning, digitising and converting the drawings into a suitable format compatible with the AutoCAD and above. As-built drawings shall be prepared only on AutoCAD drawings.

# TECHNICAL SPECIFICATION FOR FABRICATION AND INSTALLATION

## CONTENTS

## I GENERAL

### 1.0 SCOPE

This specification covers general requirements of fabrication and installation of aboveground and underground piping systems at site. The specification covers the scope of work of contractor, basis of work to be carried out by contractor and standards, specifications and normal practice to be followed during fabrication and erection by the contractor. Its scope is essentially the same as that of ASME Code B31.3. This specification shall apply to all piping installed by or pre-fabricated for installation by CONTRACTOR.

The welded pipe joints shall include the following and shall not relieve the contractor of hisresponsibilities and guarantee.

a) All pipe joints, longitudinal butt welds, circumferential butt welds and socket welds.
b) Attachments of forging, flanges and other supports to pipes.
c) Welded manifold headers and other sub assemblies.
d) Welded branch connections with or without reinforcing pads.
e) Joints in welded / fabricated piping components.
f) The attachments of smaller connection for vents drain drips and other instrument tapings.

### 2.0 CODES AND STANDARDS

Unless otherwise stated the design of piping systems shall confirm to the requirement oflatest edition of following Codes and Standards.

i) AWS (American Welding Society).
a) A2.4 (Symbols for Welding and Non destructive Testing).
b) A3.0 (Standard Welding Terms and their Definitions).
c) A5.1 (Specification for Mild Steel Covered Arc Welding Electrodes).
d) A 5.17(Specification for Bare Carbon Steel Covered Electrodes).
e) A 5.18 (Specification for Carbon Steel Filler Metals for Gas Shielded Arc Welding).
f) A 5.20 (Specification for Mild Steel Electrodes for Flux Cored Arc Welding Electrodes).iI)

| | | | |
|---|---|---|---|
| | ASME B31.8 | - | Gas Transmission and Distribution piping systems |
| iiI) | ASME B31.3 | - | Process piping for refineries and chemical plant and terminals.iV) |
| | API 1104 | - | Standard for Welding Pipelines and related facilities. |
| v) | API 1105 | - | Bulletin on construction practices for oil and products pipelines. |
| i) | OISD 118 | - | Layout of Oil & Gas Installations |
| vii) | API 598 | - | Valve Inspection and Test |
| viii) | ASME Sec. VIII Div. 1 | - | Pressure Vessels. |
| viii) | ASME Sec. IX | - | Welding and Brazing Qualifications |
| ix) | PNGRB NOTIFICATION- | | Technical Standards and specifications including safety standards for city or local natural gas distribution Schedule-1 network. |

All welding procedures used by fabricators and CONTRACTORS shall have been establishedand qualified in accordance with the appropriate sections of one or more of the codes and standards listed above, and approved by the OWNER.

Where a conflict occurs between these specifications and / or any of the above codes orstandards the more stringent shall apply.

**Dimensional Standards**

| | |
|---|---|
| Flanges | - ASME B16.5, B 16.47 |
| Welding Fitting | - ANSI B16.9, B16.11 |
| Pipe | - ANSI B36.10 |
| Gaskets | - ANSI B16.20, B16.21 |
| Butt Weld Ends | - ANSI B 16.25 |
| Spec. for line pipe | - API 5L |
| Valves – Flanged, Threaded end Welding end | - ASME B 16.34 |

In the event of any conflict between the requirements of this specification and any code/standard, the most stringent requirement shall be followed.

## II PIPING FABRICATION

### 1.0 GENERAL

Fabrication and erection of all piping systems by CONTRACTOR shall be in accordance withthis specification and applicable drawings and standards.

a) Fabrication and erection of supporting elements i.e. shoes, guides, stop anchors, clips, cradles etc, shall include applying one coat of epoxy red oxide zinc phosphate primer (Minimum DFT 100µ) and two coat of final painting of high build epoxy paint 125µ for each coat.

b) Fabrication and erection of supporting fixtures i.e. brackets, cantilever struts etc. shall include application of one coat of epoxy red oxide zinc phosphate primer (Minimum DFT 100µ) and two coat of final painting of high build epoxy paint (Min. 125µ per coat)

c) Fabrication and erection of drain assemblies

The contractor shall fabricate all pipe work in conformity with the requirements of pertinent general arrangement drawings and specifications where specific details of fabrication are notindicated on the drawings or not specified, herein, fabrication and erection shall be done in accordance with ASME B 31.3/ ASME B 31.8 latest edition.

### 2.0 CUTTING

Following shall be applied for all cutting works:

**2.1** For laying out headers, tees, laterals and other irregular details, cutting templates shall beused to ensure accurate cutting and proper fit-up.

**2.2** Machine cut bevels to form the welding groove are preferred in carbon steel pipe. However,smooth, clean, slag free false cut bevels are acceptable.

**2.3** Cutting of pipes may be done either by mechanical means or by thermal cutting. Whenever cutting is employed all oxides and traces of previously melted metal and occasional notches shall be removed from edges by grinding or machining.

**2.4** Pipe cutting is to be performed using sawing only for galvanized, stainless steel and coppernickel materials.

**2.5** Cutting shall be made with suitable allowance taken in to account for shape of connectionsand shrinkage due to cutting and welding.

**2.6** All cutting shall follow the outline of the templates.

**2.7** Special care shall be taken to remove internal burrs resulting from cutting especially on pipesequal to or less than 2” NPS in diameter.

## 3.0 WELDING

**3.1** Welders shall be qualified in accordance with the Welding Specification ENG-STD-PI-DOC- TS-009 and other applicable standards i.e. ASME SEC. IX.

**3.2** The joints to be field welded shall be beveled as per ASME B 16.25.

**3.3** Adjacent sections of longitudinally welded pipe that are joined by butt-welding shall have the longitudinal weld seams positioned so that they are at least 30 degrees apart from the horizontal centerline.

**3.4** Wherever possible, longitudinal weld seam should not be located on the top or bottom of theline so that branch connections are not positioned on the seam.

**3.5** No backings strips/ rings shall be used.

**3.6** Welding shall be is per approved as per Welding Procedure Specification (WPS) andProcedure Qualification Record (PQR).

**3.7** Non-Destructive Testing (NDT) such as Radiography Testing (RT), Ultrasonic Testing (UT),etc. should be carried out, after Post Weld Heat Treatment (PWHT).

**3.8** Tack welds with full penetration shall be used and shall become the part of the finished weld,defection welds or tack welds with lack of penetration are not acceptable and shall be chipped/ ground out.

## 4.0 INTERNAL MISALIGNMENT

The pipes to be joined by welding shall be aligned correctly with existing tolerances on diameters, wall thickness and out of roundness. The same alignment shall be preserved during welding for the internal misalignment due to difference in wall thickness of the mating components exceeding 1/16"; the component with higher wall thickness shall be internally
machined/ grounded so that the adjoining surfaces are approximately flushed.

**4.1** Internal misalignment shall be as per the criteria set out in ASME B 31.3 and as per the following guidelines:

a) 24" NPS and smaller pipe-to-pipe fitting: 1.5mm maximum deviation.

b) Greater than 24" pipe-to-pipe or pipe-to-fitting: 3.2mm maximum Deviation when permitted by the relevant WPS.

c) Dimensional tolerances for the fabrication and installation of piping systems shall be ± 1/8 inch and ± 2 degrees. Misalignment of flange faces and welding ends shall be limited to 3/64 inch per foot measured across any diameter.

**4.2** If the deviation factors are exceeded, one of the following procedures shall be used:

a) Rotate the pipe or fittings to reduce misalignment to the acceptable tolerances (before attempting any of the following methods) allowing for seam alignment.

b) Use spreaders or internal or external line-up clamps to correct moderate out-of- round Condition.

c) Taper the wall of the component internally after obtaining approval from OWNER for the proposed method and ensure wall thickness is not reduced below the minimum required by the ASME B 31.8 code.

d) If allowable deviations are exceeded beyond repair methods, the fabrication shall be redone.

**4.3** All flange facing shall be true and perpendicular to the axis of the pipe to which they are attached. Flange bolt holes shall span the normal center lines unless different orientation is shown in drawings to match the equipment connections etc.

## 5.0 FLANGES

Flange bolt holes are to be oriented as follows, unless otherwise indicated in the fabricationdrawings:

**5.1** Flange faces vertical - bolt holes to straddle vertical centerline.

**5.2** Flange faces horizontal - bolt holes to straddle the horizontal plane centerline.

**5.3** Where line taps are called for, the hole shall be drilled square to the axial centerline clean, sharp, free from burrs, wire edges, or other irregularities. The hole shall be drilled after first attaching the connection fitting.

**5.4** Where slip-on flanges are called for, they shall be welded inside and outside (See Figure 328.5.2B of ASME B 31.3). The weld shall be applied so that the flange face shall be free of weld spatter and does not require facing.

**5.5** Orifice flanges shall be installed with the taps in the exact orientation shown in the isometric. The sections of pipe to which the orifice flanges are attached may be standard mill run pipe, but shall be choice selected pieces and shall be round, smooth and free from blisters and scale. The interior of the pipe, at welds, shall he ground smooth, Welds to be performed on site shall be kept at a maximum distance hack from the face of the orifice flange.

## 6.0 NON PRESSURE ATTACHMENTS

**6.1** The CONTRACTOR shall be responsible for working to the exact dimensions as shown on the drawings irrespective of individual tolerances permissible. Where errors and/ or omissions occur on the drawings, it shall the Contractor's responsibility to notify the Engineer-in-charge prior to fabrication or erection.

**6.2** Non-pressure attachments shall he installed in accordance with the isometric and anysupplemental data provided by the detailed engineering CONTRACTOR.

**6.3** Piping requiring post weld heat treatment shall have all welded-on non-pressure attachmentsinstalled by the shop fabricator. Piping not requiring post-weld heat treatment may have the welded-on non-pressure attachments installed by the installation CONTRACTOR. If field welding is required on post weld heat-treated piping, then localized field post weld heat treatment shall be done after welding as approved by the OWNER.

## 7.0 FABRICATION TOLERANCES

**7.1** The CONTRACTOR shall be responsible for working the exact dimensions as shown on the drawings irrespective of individual tolerances permissible. Where errors and/ or omissions occur on the drawing it shall be the contractor’s responsibility to notify the OWNER prior to fabrication or erection.

**7.2** Thinning of Wall Thickness and Quality in Bends.

The maximum decrease of wall thickness shall not exceed 10% of the nominal wall thickness as specified in the line classes and in any case shall not be less than that required by the design.

The tolerances for the maximum flattering of a bend shall be per ASME B 31.3 section 332.2.

**7.3** Flange Face Alignment

The maximum deviation measured in any direction shall not exceed 2.5mm. When branches are in the same plane and their flanges are also positioned in one plane, the flange facings shall not deviate more than 1 mm from the latter plane in the same direction.

**7.4** Position of Bolt Holes for Flanged Piping

The maximum deviation allowed from the required position as measured along the bolt circleis 1.5mm.

**7.5** Field-Fit Weld

Where the requirement is called for in the isometric, a field-fit weld is used when the exact piping dimension cannot be predetermined, to allow the installation CONTRACTOR adjustability of two spool pieces. 150mm to be added the calculated length of one of the spools. The installation CONTRACTOR is to verity the dimension before trimming and beveling. The isometric will indicate only the calculated length.

**7.6** Pup-pieces installed to make-up a spool length shall be a minimum of (2) pipe diameters long or 150mm whichever is higher unless stated otherwise by the OWNER.

**8.0 EXAMINATION AND INSPECTION**

**8.1** Examination and Inspection shall be as per NDT Specification of document No. ENG-STD- PI-DOC-TS-011

**8.2** In case of fillet welds where carrying out radiography is not possible, magnetic particle test or dye penetrant test shall be carried out. The extent of inspection shall be same as for radiography. Finished weld shall also he visually inspected for parallel and axial misalignment of the work, cracks, inadequate penetration and shall present neat workman like appearance.

**8.3** All the lines, which are stress relieved or have design pressure more than 50 kg/cm$^2$ shall befully radiographed (100%)

**9.0 SURFACE PREPARATION AND PAINTING**

Applicable surface preparation and painting shall be in accordance with paintingSpecification document No. ENG-STD-PI-DOC-TS-008 attached elsewhere in the bid document.

**10.0 PROTECTION, PRESERVATION AND STORAGE**

Piping shall be protected as follows:

**10.1** After fabrication, flange faces shall be cleaned, coated with rust preventative, & protected with non-metallic flange covers, secured to the flange prior to erections/ installation/ shipment. Other methods and products for flange protection may be acceptable, subject to OWNER approval.

**10.2** Socket-weld connections shall be cleaned and plugged, or capped with metal or plastic protectors.

**10.3** The open ends of pipe shall be protected with metal or plastic caps.

**10.4** A metal cap secured by a steel strap around the pipe shall be used to protect open end "O- lets".

**10.5** Fabricated spool pieces shall be carefully loaded with the proper amount of tonnage and ample tie-downs to protect each piece during shipping. Tie-downs shall be nylon straps; chains or cable are prohibited.

**10.6** Adequate protection shall be provided to prevent mechanical damage and atmospheric corrosion in transit and at the job site.

**10.7** Fabricated spool pieces and materials shall be protected to withstand ocean transit and extended period of storage at the job site for a minimum period of 18 months. Fabricated spool pieces and piping components shall be protected to safeguard against all adverse environments, such as humidity, moisture, rain, dust, dirt, sand, mud, salt air, salt spray, and seawater.

**10.8** Field weld joints shall be coated and wrapped as per specification.

**III PIPING INSTALLATION**

**1.0 GENERAL**

Unless specified otherwise, the piping in general shall:

**1.1** Be run level and plumb.

**1.2** All piping shall be fabricated and installed to the configurations as shown in the Isometric.

**1.3** Be run on the North-South and East-West axis

**2.0 ERECTION**

The intent of pre-fabrication at the shop is to accelerate progress of pipe work and to minimize work in the field. Such prefabrication should be based on approved isometric and piping layouts furnished to the CONTRACTOR. Field weld is indicated by "FW" on isometrics. Field weld means position weld of prefabricated piece at site or near the plant.

However the contractor shall bear in mind that there can be variations in dimensionsbetween those appearing at the site due to minor variations in the location of equipment, inserts etc. The CONTRACTOR shall, therefore, provide adequate field joints, if required, other than shown in isometrics and fit-in sections permitting the pre-assembly to be installed without any modification.

All piping shall be routed and located as shown in piping drawings keeping in view the piping specifications.

While fitting up mating flanges, care shall be exercised to properly align the pipes and to check the flanges for trueness, so that faces or the flanges can be pulled up together withoutinducing any stresses on the pipes. The bolt holes of flanges in the vertical plane shall straddle the vertical center line of the pipe in the erected position and for flanges in the horizontal plane, the bolt holes shall straddle horizontal plane unless otherwise indicated on the drawings.

The CONTRACTOR shall maintain slopes specified for various lines in the drawings. In casethe CONTRACTOR is unable to maintain the indicated slope he shall check the sagging of the pipe with a precision spirit level. Vents and drains are shown in the isometric of each line and these are intended, during hydrostatic test for releasing the trapped air and draining out the test fluid after testing. Valves vents and drains are also shown wherever required.

Where practicable and except when otherwise shown on the drawings, valve stems shall be installed in a vertical direction and shall not be installed with stems below the horizontal axis.

**3.0 UNDERGROUND PIPING**

**3.1** Underground piping shall be laid according to piping general arrangement drawingIssued during the course of construction

**3.2** Pipeline trenches shall be dug wherever necessary according to drawing, true to line andgradient as per specification

**3.3** No excavation material shall be deposited within 1.5m from excavated trench.

**3.4** Coated pipes shall not be placed in trenches until sharp, hard stones, skids, welding rods etc.have been removed.

**3.5** Coated pipe shall not be handled or moved by means of cables or chains or by prying.

**3.6** With skids or bars, it shall be tied and lowered by using lowering-in belts of a Standard Widthfor the size of pipe being used.

**3.7** Coated pipe shall not be dragged along the ground or otherwise handled in a manner that willbe detrimental to its coating.

**3.8** Backfilling with the excavated material shall be done in layers of 200 mm. well watered and rammed to avoid settling afterwards.

**4.0 FLANGE BOLTING**

**4.1** Use a logical sequence of bolt tightening to ensure even gasket compression, as indicated inANSI B16.5.

**4.2** Prior to bolt up, inspect flange faces. Flange faces shall be in “as-new" condition and shall be wiped clean of any debris excess oil or grease and dirt. Do not perform weld repairs on flange faces or flanges.

**4.3** Do not use washers or spacers to make-up bolt length. Bolt lengths are specified prevent oversizing.

**4.4** While fitting up mating flanges, care shall be exercised to properly align the pipes and check the flanges for trueness, so flanges can be pulled together without inducing stresses at pipes.

**5.0 JOINTS**

The relevant piping class will be assigned to each line identified on the isometric. In general, joining for lines 2" and above in utility piping system shall be accomplished by butt-welding connections. Pipe lines of size 1½” and below shall have socket welded/butt welded/screwedjoints as specified in the piping materials specifications.

**5.1** Do not apply insulation over any joints until testing has been completed.

**5.2** Gaskets on flanged joints shall be used only once.

**5.3** Gaskets shall be selected in accordance with Piping Materials.

## 6.0 SUPPORTS

**6.1** Installation of supports shall be as indicated in the isometric / support piping layouts.

**6.2** Supports, guides and anchors for piping shall be fabricated and provided as shown in the drawings. No anchors on piping shall be used except at locations shown in the drawings.The pipe shall be secured firmly at anchor supports.

**6.3** Fabrication and erection of supporting elements and structural fixtures wherever required whether indicated in drawings or not, to prevent vibration, excess sag etc. shall be carried out by the CONTRACTOR.

**6.4** Erection of these additional supports will be deemed as part of piping erection work scope.

## 7.0 CLEANLINESS OF PIPING

**7.1** On completion of fabrication, all pipes and fittings shall be cleaned inside and outside by suitable means (mechanical cleaning tool, Wire brush, etc.) before erection to ensure that assembly is free from all loose foreign materiel such as scale, sand, weld spatter particles, cutting chips etc.

**7.2** All field fabricated piping shall also be cleaned at the completion of the fabrication. All burrs, welding circles and weld spatter shall be removed by any suitable means (mechanical tools, wire brush etc.).

**7.3** Both shop and field fabricated piping shall be blown out with compressed air at the termination of cleaning and capped.

**7.4** Open end and flanges protection shall be used throughout installation. Protect open pipes at all times when work on them is not actually taking place.

**7.5** Inspect individual pipe section, prefabricated spools and pipeline items internally during installation and remove any foreign matter before final welding or bolting.

**7.6** Adjoining Piping with special equipment or piping within a packaged, vendor provided "skid", which requires cleaning in accordance with the equipment's Manufacturer's procedures, shall be inspected by, and have cleaning supervised by, the Manufacturer's representative.

## 8.0 INSTALLATION PROCEDURE FOR SOCKET WELDED SMALL BORE VALVES

As well as complying with all applicable code requirements for quality and strength of the weld, it is necessary to avoid damage to soft seats and distortion of "small bore" valve bodies by excessive heat input.

a) Process

The process to be used shall be manual metal arc, metal inert gas or $CO_2$ with preference for the lower heat input high deposition (dip transfer) processes. Gas welding shall not be used because of its excessive heat input.

b) Preparation

Ensure that valve is in open position. Correctly locate and align the pipe in the valve socket with a clearance of approximately 1.6 mm (1/16 inch) between the end of the pipe and the bottom of the socket.

c) Procedure

Deposit the first run of weld metal around the pipe. Deposit metal for making additional runs as required,

ensuring that each run of weld metal is cleaned and any visible defects such as cracks, cavities or other faults are removed before deposition of further weld metal.

**9.0 DRAIN AND VENT CONNECTION**

High point vents and low point drains required for the purpose of hydro testing shall be ofsize 1" and consist of sockolet, Plug & Ball valve for vent, Globe & Ball Valve for drain, flange & blind flange.

All low points in a line shall be provided with drain connections of nominal size as given in table below. All drains shall be with valve and blind except for water lines where valves are not required.

**10.0 LINE MARKING / IDENTIFICATION**

Process and utility type shall be identified stenciled lettering used to identify service and flow direction. Lettering shall be identified every 10 meters in pipe rack and should be visible fromground level.

**IV TESTING**

**1.0 PIPING**

Pressure tests shall be performed as per ANSI B 31.8 latest edition or as per design basis and appropriate piping material specification class chart per Piping Material Specification document No. ENG-STD-PI-DOC-TS-001.

The field test pressure shall not be less than the highest of the following:

a) 1.4 times the design line class pressure.
b) 1.4 times the maximum operated pressure
c) 1.4 times the maximum pipeline static pressure
d) Sum of the maximum sustained operating pressure or maximum operating or maximumpipe line static pressure and the maximum calculated surge pressure.

The hold period shall be minimum 6 hours.

The testing shall be carried out in convenient section as approved by site engineer. Thejoints of pipe connecting the testing section shall be 100% radiographed and UT tested and shall be tested with other applicable NDT method as specified in specification.

If some defects are noticed during the hydrostatic testing, the same shall be brought to the notice of the OWNER. Joints, if leaking, shall be rectified as per welding specification and instructions and tested to the complete satisfaction of the OWNER.

The following items shall not be subjected to field pressure testing

a) Pressure relieving devices such as rupture discs and pressure relief valves.

b) Locally mounted pressure gauges.

c) Control valves, shutdown/ isolation valves etc.

d) Any other equipment designated by the OWNER.

All the elements, which are not to be tested along with the piping, shall either be blanked off during testing or spool pieces inserted during testing.

Any temporary corrosion protection coating given on piping at manufacturer's shop/fabrication yard is to be removed at all inspection points, before final testing.

Prior to Hydro testing, vessels and piping are to be flushed by high pressure, high volumefresh water or inhibited water.

Following are the general requirements for testing of piping:

a) Test pressures shall be maintained for a sufficient length of time to permit through inspectionof all the joints for a leakage or sign of failure. The duration shall in no case be less than six (6) hours.

b) Instrument take-off piping up to the first block valve shall be tested with the connectedpiping.

c) Lines open directly to atmosphere such as vents, drains, safety valve discharge etc. shall beleak tested and all the joints shall be visually inspected.

**2.0 MAXIMUM ALLOWABLE VALVE TEST PRESSURE**

Test pressure applied to valves under closed position shall not be greater than the manufacturer's recommendations nor less than required API 6D latest edition where the required test pressure is greater than the allowable seat pressure, test shall be made through the 50% open valve.

**3.0 HYDROSTATIC TEST FLUID**

**3.1** Fresh potable water shall be used as the testing medium for hydrostatic testing of piping in fabrication yard and at site.

**3.2** The lines shall be completely drained and dried by air immediately after the successful completion of testing.

**3.3** Salt water shall not be used for testing.

**3.4** A strainer shall be installed in the line to minimize the possibility of foreign matter beingintroduced into the system during the pressure test and flushing operations.

**4.0 PNEUMATIC TESTING**

**4.1** Pneumatic testing of instrument air, utility air, starting air and instrument gas piping shall be performed with compressed air. The test pressure shall be 110% of design pressure or 49 bar (g) whichever is higher in case of 300# rating piping.

**4.2** In addition to hydro test, all the station piping shall be pneumatic tested. The test pressureshall be per clause 4.1 above.

**4.3** When pneumatic testing at over 25 psi, a preliminary test at 25 psi shall be made to locatemajor leaks. Then the pressure shall be increased gradually to test pressure.

**5.0 TEST PROCEDURE**

**5.1** All events and other connections, which serve as vents, shall be open during filling so that allair is vented prior to applying test pressure to the system.

**5.2** Gauges used for testing shall be installed as close as possible to the highest point of thepiping system.

**5.3** Care shall be exercised to avoid increase in pressure due to temperature variation during thetest.

**5.4** After completion of the recorded test pressure recorder, the pressure shall be reduced to thedesign pressure and all valves, including check valves, in the section of the line shall be tested by being closed for a ten (10) minutes period with pressure contained by specific valve at one end and by positive closure at the other to determine whether each valve is in turn positively shutting off and holding pressure.

**5.5** After completion of hydrostatic test, the pressure shall be released gradually in steps. All the vents and drains shall be kept open till the lines are fully drained. The CONTRACTOR shall then dry the system by blowing compressed dry air and reinstall items removed during Hydrotesting.

**5.6** Record shall be made of each piping system during the testing. These records shall beprepared in tabulated foams and shall include.

a) Date of Test

b) Identification of piping and equipment tested with medium

c) Test medium

d) Test Pressure

e) Test Duration

f) Acceptance of Test Results by OWNER

g) Calibration certificates of test gauges, recorders and PSV's.

**5.7** Testing shall be deemed as complete only after defects noticed during testing have been rectified and testing of the system / line has been done to the satisfaction of the OWNER's representative.

**5.8** The CONTRACTOR shall supply all plain test blanks required for the pressure testing.

**5.9** Gauges and pressure recorders used for testing shall be calibrated at a reputed laboratory atleast every 6 months.

**5.10** Temporary supports shall be provided wherever required during testing to the satisfaction ofOWNER.

# TECHNICAL SPECIFICATION FOR NDT

## CONTENTS

## 1.0 SCOPE

This specification covers the general requirements for non destructive examination of shop & field fabricated and inspection of all pressure Piping and Distribution Pipeline.

## 2.0 CODES AND STANDARDS

Referred codes/ standards are as follows. Latest editions of the Codes/ Standards referred to shall befollowed.

a) ASME Boiler & Pressure Vessel Codes, Section V & VIII (Div. 1) including addenda.

b) ASME B31.3 Chemical Plant and Petroleum Refinery Piping.

c) ASME 31.8 -Gas Transmission and Distribution Systems.

d) Standard Specification for Fabrication & Installation of Piping

e) ASNT/PCN/CGSB Standards for certification of Non Destructive testing Personnel.

Work shall also be carried out in compliance with all general specification dealing with welding and fabrication of various equipment / piping.

## 2.1 CONFLICT

Where a conflict occurs between this Specification and any of the above Codes or Standards the more stringent shall apply. The contractor shall inform the OWNER in writing and receive written certification form the OWNER. The contractor shall have readily available for use at the request of the OWNER, latest editions of all codes, specification and standards necessary for execution of the work atwork site.

## 3.0 NDE COMPANY CERTIFICATION

All Non Destructive Examination (NDE) CONTRACTORs contracted by the OWNER, or working for fabricators or CONTRACTORs carrying out work on the OWNER's behalf shall have in place an up-to- date Quality Control Manual and Code of Practice which shall cover the following:

i) All aspects of NDE of which the CONTRACTOR / SUB-CONTRACTOR is qualified.

ii) Current resumes of all presently employed personnel including their certifications (PCN, ASNT,CGSB or equivalent).

iii) All proposed specific NDE procedure.

A registered copy of QC manual shall be reviewed by the OWNER.

All equipment shall be certified and current, to recognized calibration standard and in first class working condition. There shall be full compliance with all government and local regulatory requirements of HSE which shall be fully complied with.

## 4.0 VISUAL EXAMINATION

**4.1** Visual examination shall be carried out before, during and after fabrication in accordance with ASMESec. V article 9 and ASME B31.3.

**4.2** Cracks, (regardless of size and location) and under cutting or any evidence of poor workmanship,materials, etc., if not repairable shall be cause for rejection.

**4.3** Weld shall be visually inspected wherever accessible in accordance with the following requirements:

| | | |
|---|---|---|
| a) | Internal misalignment | 1.5 mm or less |
| b) | Cracks or lack of fusion | Not permitted |
| c) | Incomplete penetration | Not permitted<br>(For other than 100% radiography butt-weld) |
| d) | Surface porosity and exposed slag inclusions | Not permitted<br>(For nom. wall thickness 4.7 mm and less) |
| e) | Concave root surface (Suck up) | For single sided welded joints, concavity of the root surface shall not reduce the total thicknessof joint, including reinforcement, to less than the thickness of the thinner of the components being joined. |
| f) | Weld ripples irregularities | 2.5 mm or less. |
| g) | Lack of uniformity in bead | 2.5 mm or less width |
| h) | Lack of uniformity of leg | 2.5 mm or less length |
| i) | Unevenness of bead | 2.0 mm or less. |
| j) | Weld undercutting | 0.8 mm or 12.5% of pipe wall thickness, whichever is smallerand there shall not be more than 2 in. (50 mm) of<br>undercutting in any continuous 12-in. (300 mm) length ofweld |
| k) | Overlap | 1.5 mm or less |
| l) | Bead deflection | 2.5 mm or less |

m) External weld reinforcement and internal weld protrusion (when backing rings are not used) shall be fused with and shall merge smoothly into the component surfaces. The height of the lesser projection of external weld reinforcement or internal weld protrusion from the adjacent base material surface shall not exceed the following limits:

| Wall thickness of thinner component joined by butt weld (mm) | Weld reinforcement or internal weld protrusion (mm) max |
|---|---|
| 6.4 and under | 1.6 |
| Over 6.4 -12.7 | 3.2 |

| | |
|---|---|
| Over 12.7 -25.4 | 4.0 |
| Over 25.4 | 4.8 |

n) Throat thickness of fillet welds: Nominal thickness of the thinner component x 0.7 or more.

p) Flattening

Flattening of a bend, as measured by difference between the nominal outside diameter and minimum or maximum diameter at any cross section shall not exceed 5 % of the nominal outside diameter of pipe.

q) Reduction of wall thickness

Reduction of wall thickness of a bend, as measured by difference between the nominal thickness and minimum thickness shall not exceed 10 % of the nominal wall thickness of pipe.

**4.4** Welds having any of imperfections which exceed the limitations specified in various clauses of 4.3shall be repaired by welding, grinding or overlaying etc. However a weld shall be allowed to be repaired only once.

**5.0 NON DESTRUCTIVE TESTING**

The type and extent of weld examination shall be in accordance with Table-1. All visual and supplementary methods of girth weld examination shall be in accordance with ASME B31.8 & the requirements of this standard specification.

5.2 Welds between dissimilar materials shall be examined by method & to the extent required for thematerial having the more stringent examination.

5.3 All non-pressure tie-in welds and all field welds, regardless of pipe class shall be examined by 100%visual, radiography and MPI / DPI.

5.4 Contractor shall not deviate from any requirement of this specification without written approval to doso from OWNER.

5.5 Welds between dissimilar materials shall be examined by method & to the extent required for thematerial having the more stringent examination.

**5.6 RADIOGRAPHIC EXAMINATION**

5.6.1 General

a) The Contractor shall be responsible for carrying out Radiography, rectification of defects and re- radiography of welds repaired/rectified at his cost.

b) The quality of radiographs shall meet or exceed all requirements of the appropriate International standards and applicable general specifications.

c) X – Ray is the preferred radiographic method. Use of Gamma ray for examination is permitted wherever X-ray is not possible; however contractor has to get prior approval from client /consultant before start of the work.

d) Particular attention shall be paid to using radiographic ultra fine grain film suitable for the application, maintaining correct radiographic geometry during exposure, obtaining correct density as required by the appropriate standard and the correct placement and exposure of image qualityindicators (IQI's or Penetrometers).

e) ASTM wire type IQI's are preferred. The OWNER may permit the use of ASTM hole type IQI's on a pre-approved basis, provided the NDT CONTRACTOR can demonstrate satisfactory results.

f) Radiographic technique shall produce maximum contrast and good definition of IQI wires and shall obtain minimum radiographic density of 2.0 in the weld image. Fluorescent intensifying screens shall not be used.

g) Max radiographic density shall be 4.0 in all areas of the weld and parent metal.

h) The inability to view the appropriate wire or hole on any radiograph shall be cause for automatic rejection of that radiograph which shall be re-radiographed at no expense to the OWNER.

i) The Contractor shall fulfil all the statutory and owner's safety requirements while handling X-ray andGamma-ray equipment's .

j) The joints for Radiography shall be selected by the Owner's Inspector and the Radiography shall be performed in his presence, if he instructs the contractor to do so. The contractor shall furnish all the radiographs, to the Owner's Inspector immediately after processing along with evaluation by a person
qualified to ASNT Level-II in Radiographic testing. The certificate of ASNT Level-II (RT) personnel shallbe submitted to owner's inspector for his approval prior to start of job.

k) The Contractor shall provide the Owner's Inspector all the necessary facilities at site such as a dark room with controlled temperature, illuminator (viewer) suitable varying densities, a duly calibrated electronic densitometer with batteries, magnifying glass, tracing papers, ruler marking pencils etc. to enable him to review the radiographs.

5.6.2 Operator Certification

a) Radiographers supplied by the contractor shall be certified to ASNT Level II, AWS QC1 and as per AWS B1.10 (guide for non-destructive inspection of welds).

b) An operator qualified to ASNT Level I may assist the Level II operator but all film and sentencing interpretation shall be carried out by a Level II or higher operator who shall sign off all report sheets.

c) Visual welding inspection shall be conducted only by a qualified welding inspector, who should preferably have a minimum AWS (QC.1) CWI or CSWIP 3.1 certification.

d) The OWNER shall review and approve all QA/QC personnel prior to deployment on the project.

**5.6.3 MAGNETIC PARTICLE INSPECTION (MPI)**

a) MPI shall be carried out in accordance with the requirements of ASME, Section V. Article 7, & Section VIII DIV 1, Appendix 6, and as modified by this specification.

b) AC electromagnetic yokes shall be used. A background of white contrast paint shall be used in conjunction with a black magnetic ink (wet particle). The technique shall be carried out in the continuous mode and two examinations shall be carried out right angles to cover for both transverse and longitudinal defects. There shall be sufficient overlap to allow 100% coverage.

c) All unacceptable or spurious indications found by this method shall be investigated and removed bygrinding followed by thickness check.

**5.6.4 DYE PENETRATE INSPECTION (DPI)**

a) DPI shall be carried out in accordance with the requirements of ASME BPV Section V, Article 6, & ASME Section VIII DIV 1, Appendix 8, and as modified by this specification.

b) Unless requested otherwise, DPI shall be carried out using the solvent removable method.

c) If necessary, welds may be lightly dressed to facilitate DPI testing or to assist in the interpretation ofany indications.

d) All unacceptable or spurious indications found by this method shall be investigated and removed bygrinding followed by thickness check.

**5.6.5 ULTRASONIC WELD EXAMINATION (UT)**

a) Ultrasonic operators supplied by the NDE CONTRACTOR shall be certified to General Standards Board (ASNT/PCN) approved by the OWNER.

**6.0 TABLE-I (with applicable notes)**

TABLE 1: CLASS, TYPE & EXTENT OF WELD EXAMINATION

| INSPN. CLASS | SERVICE | MATERIAL | TEMP (DEG.C) | PRESS. CLASS | TYPE OF EXAMINATION | TYPE OF WELD EXAMINED | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | GIRTH BUTT WELD | SOCKET WELD | ATTACH - MENT/ BRANCH WELD |
| I | RLNG/ NG | CARBON STEEL | -29 TO 65 | 300# | a) VISUAL | 100% | 100% | 100% |
| | | | | | b) RADIOGRAPHY | 100% | 10% for gap check | 100% |
| | | | | | c) LP, MP & UT | - | 100% | - |
| | | | | | d) HARDNESS | NOTE a | NOTE a | NOTE a |

**Notes:**

a. Hardness Test:

i. Hardness test shall be in accordance with ASTM specification E10. Hardness tests of the heat affected zone shall be made at a point as near as practicable to the edge of the weld. One test perweld shall be performed.

ii. Hardness test where specifically called out in QAP (attached elsewhere in the bid document) or in Piping Material Specification (PMS), shall be carried out irrespective of thickness and to the extent (% age) as mentioned therein.

iii. All welds which are given heat treatment shall be hardness tested. Hardness test shall be performed after final heat treatment.

iv. A minimum of 10% of welds of hot formed and hot bent materials in each heat treatment batch which are furnace heat treated and 100% of those which are locally heat treated, shall behardness tested.

v. For C-0.5 Mo steels, a minimum of 10% of welds shall be hardness tested.

vi. Hardness test requirement not covered in ii) & v) above shall be as per ASME B31 .3.

vii. The hardness limit applies to the weld and heat affected zone. Following hardness values shall be maintained:

| **Base Metal Group** | **Maximum Hardness (BHN)** |
|---|---|
| CS | 238 BHN |

b. For branch connections, LP/ MP test shall be done on root pass and final pass.

# TECHNICAL SPECIFICATION FOR INSPECTION, FLUSHING AND TESTING

## CONTENTS

## 1.0 SCOPE

This specification covers the general requirements for inspection, flushing and testing of piping systems.

Flushing and testing of all piping systems shall be witnessed by the owner/ consultant.

## 2.0 CODES AND STANDARDS

ASME B31.8 : Gas Transmission and Distribution piping systems

## 3.0 INSPECTION

During various stages and after completion of fabrication and erection, the piping system shall be inspected by the Engineer-In-Charge to ensure that:

- Proper piping material has been used.

- Piping has been erected as per drawings and instructions of Engineer-In-Charge.

- All supports have been installed correctly.

- Test preparations mentioned in this specification have been carried out.

## 4.0 FLUSHING

Flushing of all lines shall be done before pressure testing.

Flushing shall be done by fresh potable water or dry compressed air, wherever water flushing is not desirable, to clean the pipe of all dirt, debris or loose foreign material Required pressure for water flushing shall meet the fire hydrant pressure or utility water pressure.

For air flushing, the line / system will be pressurized by compressed air at the required pressure which shall be 50 psi maximum. The pressure shall then be released by quick opening of a valve, already in line or installed temporarily for this purpose. This procedure shall be repeated as many times as required till the inside of the pipe is fully cleaned.

In line instruments like control valves, orifice plates, rotameters, safety valves and other instruments like thermowells which may interfere with flushing shall not be included in flushing circuit.

The screens / meshes shall be removed from all permanent strainers before flushing. Screens/meshes shall be reinstalled after flushing but before testing.

During flushing temporary strainers shall be retained. These shall be removed, cleaned andreinstalled after flushing but before testing.

In case of equipment such as column, vessel, exchanger etc. form part of a piping circuit during flushing, this shall be done with the approval of Engineer-In-Charge. However, equipment's thus included in the circuit shall be completely drained and dried with compressed air after flushing is completed.

During flushing discharged water/air shall be drained to the place directed by the Engineer- In-Charge. If necessary, proper temporary drainage shall be provided by the contractor.

Care shall be taken during flushing so as not to damage/spoil work of other agencies. Precautions shall also be taken to prevent entry of water/foreign matter into equipment's , electric motors, instruments, electrical installations etc. in the vicinity of lines being flushed.

The contractor shall carry out all the activities required before, during and after the flushing operation, arising because of flushing requirements, such as but not limited to the following

Dropping of valves, specials, distance pieces, inline instruments and any other piping part before flushing. The flanges to be disengaged for this purpose shall be envisaged by the contractor and approved by the Engineer-In-Charge. These flanges shall be provided with temporary gaskets at the time of flushing.

After flushing is completed and approved, the valve distance pieces, piping specials etc. shall be

reinstalled by the contractor with permanent gaskets. However, flanges at equipment nozzles and other places where isolation is required during testing, only temporary gaskets shall be provided.

Records in triplicate shall be prepared and submitted by the contractor for each piping system for the flushing done in the Performa provided/approved by the Engineer-in-Charge.

## 5.0 TESTING

Pressure testing, in general shall be as per requirements of ASME B31.8, unless otherwise specified.

### 5.1 Extent of Testing

With the exclusion of instrumentation, piping systems fabricated or assembled in the field shall be tested irrespective of whether or not they have been pressure tested prior to site welding of fabrication.

To facilitate the testing of piping systems, vessels and other equipment's may be included inthe system with the prior approval of Engineer-In-Charge if the test pressure specified is equal to or less than that for the vessels and other equipment's .

Pumps, compressors and other rotary equipment's shall not be subjected to field test pressure.

Lines which are directly open to atmosphere such as vents, drains, safety valves discharge need not be tested, but all joints shall be visually inspected. Wherever necessary, such lines shall be tested by continuous flow of fluid to eliminate the possibility of blockade.

Seats of all valves shall not be subjected to a pressure in excess of the maximum cold working pressure of the valve. Test pressure applied to valves shall not be greater than the manufacturer's recommendation nor less than that required by the applicable code. Where allowable seat pressure is less than test pressure, test shall be made through an open valve.

Instruments in the system to be tested shall be excluded from the test by isolation orremovals, unless approved otherwise by the Engineer-In-Charge.

Restrictions which interfere with filling, venting and draining such as orifice plates etc. shallnot be installed unless testing is complete.

Control valves shall not be included in the test system. Where bypasses are provided testshall be performed through the bypass and necessary spool shall be used in place of the control valve.

Pressure gauges which are part of the finished system, but cannot withstand test pressure shall not be installed until the system has been tested. Where piping systems to be tested are directly connected at the battery limits to piping for which the responsibility rests with other agencies, the piping to be tested shall be isolated from such piping by physical disconnection such as valve or blinds.

### 5.2 General Requirements / Test Preparation for Testing

Testing shall be carried out with permanent gaskets installed unless specified otherwise or instructed by the Engineer-in-Charge.

No pressure test shall be carried out against closed valve unless approved by the Engineer-in-Charge.

The Engineer-in-Charge shall be notified in advance by the Contractor, of the testingsequence and program, to enable him to be present for witnessing the test.

Before testing, all piping shall be cleaned by flushing to make it free from dirt, loose scale,debris and other loose foreign materials.

All piping systems to be hydrostatically tested shall be vented at the high points and thesystems purged of air before the test pressure is applied.

Wherever in the line any void exists due to any reasons, like absence of control valves,safety valves, check valves etc. it shall be filled with temporary spools.

All joints welded, screwed or flanged shall be left exposed for examination during the test. Before pressuring the lines, each weld joint shall be cleaned by wire brush to free it fromrust and any other foreign matter.

Where a system is to be isolated at a pair of companion flanges, a blank shall be inserted between the companion flanges. Minimum thickness of the blank shall be designed in accordance with applicable design code.

Open ends of piping system where blanks cannot be used, such as pumps, compressors, turbines or wherever equipment or pipe spools have been recovered or disconnected prior to hydrostatic testing, shall be blinded off by using standard blind flanges of same rating as the piping system being tested.

Pressure gauges used in testing shall be installed as close as possible to the lowest point inthe piping system to be tested, to avoid overstressing of any of the lower portions of the system. For longer lines and vertical lines, two or more pressure gauges shall be installedat locations decided by the Engineer-in-Charge.

For lines containing check valves any of the following alternatives shall be adopted forpressure testing:

Whenever possible pressurize up-stream side of valve.

Replace the valve by a temporary spool and reinstall the valve after testing.

Provide blind on valve flanges and test the upstream and downstream of the line separatelyand remove the blind after testing. At these flanges, temporary gaskets shall be provided during testing and shall be replaced by permanent gaskets subsequently.

For check valves in lines 1 1/2" and below flapper or seat shall be removed during testing (ifpossible). After completion of testing the flapper/seat shall be refitted.

Gas lines when hydrostatically tested shall be provided with additional temporary supports during testing as directed by the Engineer-in-Charge.

Piping which is spring or counter-weight supported shall be temporarily supported, where the weight of the fluid would overload the support. Retaining pins for spring supports shall be removed only after testing is completed and test fluid is completely drained.

When testing any piping system, air or steam of approximately 2 kg/cm$^2$ (g) may be used as preliminary test to detect missing gaskets etc. as this avoids the necessity of draining the line to make repairs. However, steam shall not be used for this purpose, if the steam temperature is more than the design temperature of the line.

For jacketed pipes testing of core pipes shall be done on individual pieces where the pipe is continuously jacketed, before it is jacketed. The outer jacket shall be tested separately as a system. For piping with discontinuous jacketing the core pipe and the jacket shall be tested as separate continuous systems.

## 5.3 Testing Media, Test Pressure and Test Pressure Gauges

### 5.3.1 Testing Media

In general all pressure test shall be hydrostatic using iron free water, which is clean andfree of silt. Maximum chlorine content in water for hydrostatic testing shall be 15-20 PPM.Air shall be used for testing only if water would cause corrosion of the system or overloading of supports etc. in special cases as directed by Engineer-in-Charge.

Where air/water tests are undesirable, substitute fluids such as gas oil, kerosene, methanol etc. shall be used as the testing medium, with due consideration to the hazards involved. These test fluids shall be specified in the line list given to the contractor.

### 5.3.2 Test Pressure

The hydrostatic/pneumatic test pressure shall be as indicated in the line list or as per the instruction of Engineer-in-Charge.

The selection of the piping system for one individual test shall be based on the following:

a. Test pressure required as per line list.

b. Maximum allowable pressure for the material of construction of piping.

Depending upon the above requirements and based on construction progress, maximum length of piping shall be included in each test.

5.3.3 Test Pressure Gauge

All gauge used for field testing shall have suitable range so that the test pressure of the various system falls in 35% to 65% of gauge scale range. Pressure gage shall be minimum of 150 mm. Size of Bourdon shall not be less than 75% of nominal diameter of dial range. Gauge shall be of a good quality and in first class working condition.

Prior to the start of any test or periodically during the field test programmes, all test gauges shall be calibrated using a standard dead weight gauge tester or other suitable approved testing apparatus. Any gauge having an incorrect zero reading or error of more than ± 2% of full scale range shall be discarded. The Engineer-in-charge shall check the accuracy of master pressure gauge used for calibration.

## 5.4 Testing Procedure

5.4.1 Hydrostatic Test

All vents and other connections used as vents shall be left open while filling the line withtest fluid for complete removal of air. In all lines for pressurizing and depressurizing the system, temporary isolating valves shall be provided if valves vents, drains do not exist in the system.

Pressure shall be applied only after the system / line is ready and approved by the Engineer-in- charge.

Pressure shall be applied by means of a suitable test pump or other pressure source which shall be isolated from the system as soon as test pressure is reached and stabilized in the system.

A pressure gauge shall be provided at the pump discharge for guidance in bringing the system to the required pressure.

The pump shall be attended constantly during the test by an authorized person. The pump shall be isolated from the system whenever the pump is to be left unattended.

Test pressure shall be maintained for a sufficient length of time to permit thorough inspection of all joints for leakage or signs of failure. Any joint found leaking during a pressure test shall be retested to the specified pressure after repair. Test period shall be maintained for a minimum of three hours.

The pump and the piping system to be tested are to be provided with separate pressure indicating test gauges. These gauges are to be checked by the standard test gauge before each pressure test.

Care shall be taken to avoid increase in the pressure due to temperature variation duringthe test.

5.4.2 Air Test

When testing with air, pressure shall be supplied by means of a compressor. The compressor shall be portable type with a receiver, after cooler and oil separator.

Piping to be tested by air shall have joints covered with a soap and water solution so that the joints can be examined for leaks.

All other details shall be same as per hydrotesting procedure (specified above)

## 5.5 Completion of Testing

After the hydrostatic test has been completed, pressure shall be released in a manner and at a rate so as not to endanger personnel or damage equipment's .

All vents and drains shall be opened before the system is to be drained and shall remain open till all draining is complete, so as to prevent formation of vacuum in the system. After draining, lines / systems shall be dried by air.

After testing is completed the test blinds shall be removed and equipment/ piping isolated during testing shall be connected using the specified gaskets, bolts and nuts. These connections shall be checked for tightness in subsequent pneumatic tests to be carried out by the contractor for complete loop/ circuit including equipment's (except rotary equipment's ).

Pressure test shall be considered complete only after approved by the Engineer-in-Charge. Defects, if any, noticed during testing shall be rectified immediately and retesting of the system / line shall be done by the contractor at his cost.

## 5.6 Test Records

Records in triplicate shall be prepared and submitted by the contractor for each piping system, for the pressure test done in the Performa provided/approved by the Engineer-in- Charge.

# TECHNICAL SPECIFICATION FOR TCP & PCP

## 1.0 GENERAL

Cathodic protection system is envisaged to protect the outer surface of the Carbon steel pipeline laid underground. The protection is provided in two(2) stages: Temporary Cathodic Protection (TCP): using sacrificial [Zn or Mg] Anodes for an initial One (1) year construction period, followed by Permanent Cathodic Protection (PCP) with Jumper connection from existing pipeline ICCP or Impressed Current Cathodic Protection [ICCP] system using [MMO] Anodes & external Power source for a Design Life of forty (40).
This specification defines the basic guidelines to develop a suitable temporary Cathodic protection [TCP] system followed by permanent [PCP] Cathodic protection [ICCP] system for the underground pipeline [external surface coated with 3LPE required to be protected from ravages of soil side corrosion. All data required in this regard including site surveys to verify the design data shall be taken into consideration by the CP contractor to develop an acceptable state of the art [TCP], [PCP] design and for proper Engineering & detailing of the [TCP], [PCP] systems.

This specification also defines the requirements of site surveys for design data generation, CP design, detailed Engineering, supply of materials, quality assurance (QA) and quality control (QC), installation, testing and pre-commissioning, commissioning of temporary Cathodic protection system [TCP] and permanent Cathodic protection system [PCP] including detection of A.C & D.C. interference / interaction with neighbouring structures all along the pipeline ROW, as well as Installation of requisite mitigating measures for the [A.C/D.C.] interaction / Interference mitigation. Post-commissioning surveys such as CIPL ("On" & "Off") computerized logging along ROW and Coating conductance measurements along the pipeline ROW, Pearson detection followed by DCVG [for defect classification] at defect locations are also in supplier's scope. .

Compliance with these specifications and/or approval of any of the contractor's documents shall in no case relieve the contractor of his contractual obligations of providing adequate Cathodic protection [TCP],[PCP] system suitable for desired number of service [1+40] years free of interference.

Attenuation calculations for PCP shall be submitted for approval. TR unit and associated work shall be considered.

## 1.1 Codes and Standards

The vendor has to follow the requirements of latest relevant applicable standards, as listed below, for system design, performance and materials to be supplied shall unless otherwise specified:

i. ANSI Standards
ii. ASTM Standards
iii. API Model code of safe practices
iv. BIS Standards
v. BS Standards and codes of practice
vi. DIN Standards
vii. DNV Standards
viii. IEEE Standards
ix. IEC Standards
x. NACE Standards and Recommended practices
xi. NFPA Standards
xii. OISD Standards & CCE Norms
xiii. CLIENT Safety Standards
xiv. PNGRB Standards

## 1.2 Conflicting Requirement

In the event of any conflict between this standard specification, job specification, datasheets, statutory regulations, related standards, codes etc. the following order of priority shall govern:

i) Statutory Regulations
ii) Standard Specification
iii) Codes and Standards

## 1.3 Additional Responsibility of Vendor

In addition to compliance to purchaser's specifications/datasheets, vendor's extent of responsibility shall include the following:

a) Activities of permanent [PCP] system which are common to temporary [TCP] system shall be completed as part of temporary [TCP] system. The facilities installed for [TCP], if useful & required in [PCP] system (such as TLP, permanent Reference CSE electrodes, Cable to Pipe connection, Corrosion coupons, etc.) shall be utilized for [PCP] also & hence are to be designed & installed as per [PCP] requirements.

b) All works to be performed and supplies to be effected as part of this contract shall require specific approval of owner or his authorised representative. Major activities requiring approval shall include, but not be limited to, the following:

i. Quality Assurance Control [QA/QC] methodology.
ii. Methodology of Corrosion survey site data generation and interpretation report and design basis for [TCP],[PCP] system.
iii. CP System design package including formulae used, design calculations, BOQ, Technical Specifications, Installation work procedure, and Post Commissioning Monitoring Methodology, Data Recording Formats etc.
iv. Procedures for A.C and D.C. interference testing and mitigation.
v. Procedure for field testing and commissioning.
vi. Procedure for Post Commissioning surveys.
vii. As-Built Documentation.
viii. O&M Manual.

c) The Intending Bidder shall be deemed to have visited the Site pipeline ROW and familiarized before submitting the tender. Non familiarity with site conditions will not be accepted as a reason either for extra claims or for not carrying out the work in total conformity with these tender specifications.

d) The CP vendor will have to accordingly mobilize work and deploy adequate skilled & trained manpower conversant with work procedure, adequate number of tools, tackles, testing and Construction equipment's requisite for smooth work progress so that CP work could also be completed within Schedule specified for the project. The CP vendor shall work in close coordination with the main pipeline contractor.

## 1.4 Design Report

1.4.1 On completion of all field work a composite report incorporating all the results generated from site surveys for data generation and details of additional data collected and complied with in the attached Compliance Report format clause wise as above shall be furnished to owner for Approval. The report shall also contain detailed interpretation of survey results and resistivity data enclosed, probable interference prone areas etc. to form design basis for the scheme of Cathodic protection [TCP] & [PCP] system. This report shall also include various drawings prepared in connection with the above work. The soil resistivity values shall be plotted on semi-log graph sheets and in Histograms. Log mean resistivity values to be calculated and used for the Design of CP system.

1.4.2 The Cathodic Protection Design of [TCP] and [PCP] systems should be part of this composite Report. The Bill Of Materials [B.O.M.], Technical Specifications, CLIENT approved Vendor list etc. will be included in this Report for Approval of Owner. The Drawings for Owners Approval shall be part of this composite report.

## 1.5 Drawings and Documents

1.5.1 Within three weeks from the date of issue of PURCHASER ORDER, CONTRACTOR shall submit four copies of the list of all drawings/ data manuals/procedures for approval, identifying each by a number and descriptive title and giving the schedule date.

1.5.2 All drawings and documents shall be in English and shall follow metric system. Number of copies of each submission shall be as per Scope of work document.

## 1.6 Document List For Submission

1.6.1 As a part of the contract, drawings and documents shall be furnished which shall include but not be limited to the following:

a. Report on corrosion survey
b. Basis of system design and design calculations, equipment selection criteria and sizing calculations.
c. Bill of material, material requisitions, purchase requisitions.
d. Quality assurance / Quality control procedures

1.6.2 Detailed construction drawings (including as built status)

a. Sacrificial anode fabrication drawings
b. Typical layout drawing for anode ground bed installation and connection.
c. Equipment layout, cable layout and schedules.
d. TLP & Junction Box Erection / Installation Details Drawing
e. Permanent Cu-$CuSO_4$ reference electrode installation Drawing
f. Fabrication, installation details of surge diverter, grounding cell and polarisation cell with its enclosure and housing.
g. Cable- to-pipe joint details for charged and non charged pipelines.
h. Incorporation of anode beds, polarisation cell, surge diverters, test stations, etc. and other relevant features of CP system-design in Pipeline alignment sheet and other related drawings.
i. Identification of section of pipeline affected by interference, source of interference and details of interference mitigation arrangements provided. Various measurement data at all relevant test stations with and without mitigation measures provided.
j. Detailed commissioning report including various measurement data at all test stations etc.
k. Vendor drawings and catalogues, test certificates.
l. Operation and maintenance manual.
m. Miscellaneous
   - Equipment inspection and testing procedure
   - Construction, installation procedures
   - Field testing and commissioning procedures
   - Procedure for monitoring of Cathodic protection after commissioning
   - Quality control procedures.
   - Post Commissioning Testing/Monitoring Periodicity and Methodology

# 2.0 TECHNICAL DATA

## 2.1 Site Conditions

The system shall be designed to conform following design conditions:

| | |
|---|---|
| Max / Min. Temperature | 60°C / -5°C |
| Design Temperature | 55°C(for outdoor installation) |
| Design Temperature | 45°C (for indoor installation) |
| Relative Humidity Max / Min. | 90%/ 41% |
| Altitude above Sea level | Less than 1000 Meters. |
| Atmospheric condition | Tropicalised to withstand the Site condition, dust, vapour etc. |

| | |
|---|---|
| Hazardous Area classification for Plant | Zone-1 or Zone-2, Gas group IIA, IIB. Temp class T3 |
| Battery, TRU room | Safe Area |

**2.2 Pipeline Data**

The Pipeline details are:

| | | |
|---|---|---|
| Line Size | | Refer Schematic Diagram |
| Line Length | | Refer Schematic Diagram |
| Class | | 300 |
| Design Pressure | | 49 Bar (g) |
| Material of Pipe | | API 5L X42 |
| Coating Material | | 3 LPE |
| Wall Thickness | | 6.4 mm |

**2.3 Corrosion Survey Data**

Corrosion Survey Data collected from site [pipeline ROW & Anode bed locations] viz: Soil Resistivity, Soil Chemical analysis for chemical and microbial loading shall be enclosed as follows:

i. Soil Chemical Analysis

ii. Soil Resistivity

It will be entire responsibility of the CP contractor.

**2.4 Additional Data Collection- Vendor scope**

**The CP contractor shall have to generate/collect additional Data** from site such as:

The CP contractor shall carry out a site survey along pipeline ROW and at proposed Anode bed locations, in order to verify design data, prior to the final design of the [TCP], [PCP] system. The site survey shall generally include the following:
General information [Topographic] of terrain along which the pipeline is to be routed.

Measurement of soil resistivity [ ρ ] along ROW and at Anode bed plots. Each selected Anode bed plot shall be sub-divided into sub-plots. Size of the sub-plots shall depend upon investigation of soil resistivity upto requisite depth. Each of these sub-plots shall be investigated individually. Sufficient observations at each of these plots shall be recoded as recommended hereunder:

1) Soil Resistivity at every 1 Kms along ROW to be carried out at 1,2,3 M depths. Wherever, abrupt changes are observed additional readings to be recorded in between.
2) Soil Resistivity at Anode-bed plots to be recorded at 1,3,5,7M for shallow Anode beds and 1,3,5,7,10,15,20,25,30,35,40… M for Deep well Anode beds.

Chemical Analysis of Soil / Water samples collected from two depths [1.0M] and [2.0M] of pipeline ROW at every 5 Kms. and at each intersection of a grid from sub-plots for each anode beds location. Theair dried soil samples to be quartered, coned and aqueous extract prepared for chemical and microbial analysis of following:

| S. No. | Sample from Locations Kms. | 0 | 0 | 5 | 5 |
|---|---|---|---|---|---|
| 1 | Depth in M | 1 | 3 | 1 | 3 |
| 2 | pH | | | | |
| 3 | Redox Potential V | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 4 | Total Dissolved Solids ppm | | | | |
| 5 | Chloride ppm | | | | |
| 6 | Sulphate ppm | | | | |
| 7 | Sulphide ppm | | | | |
| 8 | Carbonate ppm | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 9 | Bi-carbonate ppm | | | | |
| 10 | Nitrate ppm | | | | |
| 11 | Nitrite ppm | | | | |
| 12 | Phosphate ppm | | | | |
| 13 | Sodium ppm | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 14 | Potassium ppm | | | | |
| 15 | Calcium ppm | | | | |
| 16 | Magnesium ppm | | | | |
| 17 | Sulphate Reducing Bacteria (SRB) Counts | | | | |

This data to be used for calculating soil/water corrossivity based on which and clause 3.1 of this specification, the protective current density and Anode material shall be selected/decided.

**Stray Current Survey:**

Survey for investigating possible sources of stray currents along ROW so that requisite Mitigative measures are included in the CP design. The CP contractor carrying out CP Interference survey due to DC current will have to get necessary permissions from other utilities such as underground pipelines of ONGC, IOCL, BPCL, BPCL, GAIL, etc., over ground water pipeline running parallel on concrete pedestal, and DC rail traction etc. so that composite studies for interference detection are done and recommended Mitigative measures are installed. At the time of handing over the interference free systemto owners (CLIENT), the contractor will hand over these permissions of other utility owners, for further needful by CLIENT.

Where a site survey is not possible the C P contractor shall ensure that requisite data is available for him to fulfil requirements of the work order.

Survey for knowing the location of **Cathodic Protection system** to maintain appropriate clearance between the existing and upcoming C P Systems. CP contractor, prior to CP Design for, shall carry out extensive site surveys and attenuation calculations and data collection, from pipeline ROW and proposed Anode bed locations. Likely interfering elements along ROW, survey for sources of stray currents likely to cause interference, and shall base the CP System Design on this Data collected from site.

Ground Water Table Data to be collected either from GSI [Geological Survey of India] by CP contractor or measured at site to ensure Anode bed location in appropriate perennially moist environment round the year throughout service life.

The following data shall be collected to generate design data for evaluation of interaction/ interference possibilities due to presence of other services in ROW/ in close vicinity:

i. Route and types of foreign service/pipeline in and around or crossing the right of way (including those existing and those which are likely to come up during contract execution or any abandoned pipelines).
ii. Diameter, wall thickness, pressure, pipeline coating against corrosion, soil cover used in case of pipelines.
iii. Details of the existing pipeline Cathodic protection systems protecting the services i.e. location, rating, type of protection, anode beds, test station locations and their connection schemes.
iv. Graphical representation of existing structure/pipe-to-soil potential [P-S-P] records, T/R unit current/ voltage input/output ratings, present current/Potential Input/Output Data etc for the existing pipelines.
v. Remedial measures existing on foreign pipeline/ services to prevent interaction.
vi. Possibility of integration/ isolation of existing CP systems, which may involve negotiations with owners of other existing pipeline services.
vii. Crossing and parallel running of electrified and non-electrified traction (along with information regarding operating voltage, type AC/DC etc.) as well as abandoned tracks near ROW having electrical continuity with the tracks in use.
viii. Crossing or parallel running of any HT AC/DC overhead line (existing/proposed) along with details of distance from pipeline, voltage, type AC/DC, distance from pipeline of earthing of towers etc.
ix. Voltage rating, number of cores and sheathing details of underground power cables, along ROW or in its vicinity.
x. Information on existing and proposed DC/AC power sources and system having earth as return path, in the vicinity of the entire pipeline route such as HV DC sub stations, fabrication yards with electric welding etc.
xi. Any other relevant information that may be needed in designing and implementing proper protection scheme for the proposed pipeline.

Unless otherwise mentioned, CP contractor shall conduct necessary potential gradient survey for any existing anode ground bed that may interfere with the CP system of the pipeline covered under this project.

## 3.0 CATHODIC PROTECTION DESIGN PARAMETERS

Unless expressly varied and otherwise specified in the project specifications, following parameters shall be used for design of temporary Cathodic protection [TCP] system and permanent Cathodic protection [PCP] system.

Those parts of sacrificial anode Cathodic protection [TCP] system which will be integrated with permanent CP system [PCP] such as Reference Cu-$CuSO_4$ electrodes, Test Lead Points, Junction Boxes, Thermit welds epoxy encapsulation, Markers, Polarization coupons etc. shall be designed based on permanent CP parameters.

### 3.1 Protection Current Density

| Pipeline surrounding | Protection Current density * | |
|---|---|---|
| | Temporary CP (μA/m2) | Permanent CP (μ A/m2) |
| Normal soil | 35 | 35 |
| Marshy area | 45 | 45 |

However, the Protective Current Density to be chosen at site as per measured Environmental conditions obtained as per Detailed Chemical & Microbial Analysis and presence or absence of interfering elements in close vicinity of CLIENT pipeline ROW.

Pipe to soil potential shall not be more negative than (-) 1.5V (“ON”) or (-) 1.18V (“Off”) w.r.t. Cu- CuSO4 Reference electrode.

*Actual current density to be adopted shall be decided based upon soil/water corrossivity and other environmental conditions, proximity of foreign pipelines and structures resulting in interference. Where considered necessary for satisfactory protection of pipeline the current density shall be suitably increased by contractor with appropriate justifications.

### 3.2 Other Parameters for Design

Other parameters to be considered for [TCP] and [PCP] design:

3.2.1 Safety Factor for Current Density : 1.3

3.2.2 Anode Utilization Factor : 0.85 for centre connected Anode
: 0.5 for Ribbon Anode

3.2.3 Pipeline natural potential (-) 0.45V [as measured from existing /upcoming structure in the same soil matrix].

3.2.4 Unless otherwise specified in project specification the design life of the TCP system shall be (1) year or till PCP commissioning whichever is earlier and that of [PCP] permanent CP shall be (40) Forty years.

3.2.5 Along the ROW where soil resistivity is higher than 100 Ω m temporary CP for the pipeline may not be necessary subject to Owner's Approval.

3.2.6 Steel Resistivity 2.2 X $10^{-7}$Ω M

3.2.7 Maximum Loop Resistance 1 Ω

## 4.0 CATHODIC PROTECTION DESIGN CRITERIA

Cathodic protection system shall be designed to meet the following criteria.

### 4.1 Temporary Cathodic Protection [TCP]

4.1.1 The pipe to soil potential measurements shall be between –0.95V ("On") and –1.5V ("On") both "On" Potentials w.r.t. Cu-$CuSO_4$ reference electrode. In case sulphate reducing bacteria [SRB] are present in soil the minimum protective potential shall be (-) 0.95V ("On"), the maximum remaining the same (-) 1.5V ("On") w.r.t. Cu-$CuSO_4$ reference electrode. At the location of Polarization coupons, the coupon to soil potential measurement shall be between (-) 0.95 ("Off") minimum and (-) 1.18 V("Off) maximum w.r.t. $CuCuSO_4$ reference electrodes, both being "Off" potential. During [TCP] monitoring using Reed Magnetic switch "Off" potentials to be recorded.

4.1.2 In rare circumstances a minimum polarisation shift of (-) 100 millivolts w.r.t. Cu-$CuSO_4$ reference electrode shall indicate adequate levels of cathodic protection for the pipeline.
Discretion to use any of the criteria, listed above, shall solely rest with the Owner/ Owner's representative.

4.1.3 A positive potential swing of ›20 mV [P-S-P] shall be considered as the criteria for presence of an interaction situation requiring investigation and incorporation of suitable mitigation measures by the C P Contractor.

### 4.2 Permanent Cathodic Protection [ PCP ]

4.2.1 The pipe to soil potential measurements [PSP] shall be between (–) 0.95V ("Off") minimum and (-) 1.18V ("Off") maximum [both "Off" Potentials] w.r.t. Cu-$CuSO_4$ reference electrode, the maximum remaining the same (-) 1.5V ("On") w.r.t. Cu-$CuSO_4$ reference electrode. At the location of Polarization coupons, the coupon to soil potential measurement shall be between (-) 0.95 ("Off") minimum and (-) 1.18 V ("Off") maximum w.r.t. $CuCuSO_4$ reference electrodes [both being "Off" potential].

4.2.2 In rare circumstances a minimum polarisation shift of (-) 100 millivolts w.r.t. Cu-$CuSO_4$ reference electrode shall indicate adequate levels of Cathodic protection for the pipeline.
Discretion to use any of the criteria, listed above, shall solely rest with the Owner/ Owner's representative.

4.2.3 A positive potential swing of ›20 mV [P-S-P] shall be considered as the criteria for presence of an interaction situation requiring investigation and incorporation of suitable mitigation measures by the C P Contractor.

## 5.0 SYSTEM COMPONENTS

## 5.1 Temporary Cathodic Protection (TCP)

The [TCP] system unless specified otherwise, may include the following major equipment/ sub-systems.

- Sacrificial anodes [Zn or Mg] ground beds in carbonaceous back-fill
- Test stations [TLP]
- Junction Boxes with shunts and resistors [AJB] & [CJB]
- Permanent Reference Cu-CuSO4 Electrodes [CSE]
- Pin Brazing epoxy encapsulated
- Surge diverter/ Grounding cell at Insulation Mono – blocks, or
- Grounding cell at Insulation mono - blocks
- Solid state DC Decoupling device at A.C. Interference locations
- Earthing of Motor Operated Valve [MOV] and other Electrical equipment's without disturbing CPSystem through Sacrificial anodes
- Polarization ER Coupons for corrosion monitoring
- Interconnecting cables
- Cable to pipe connections-Pin Brazing.
- Markers for Cable,Anode bed etc.
- CP System at Cased Railway Crossings

## 5.2 Permanent Cathodic Protection (PCP)

The [PCP] system may include the following major equipment/ sub-systems unless otherwise specified.

- Digital Power Source AC Input DC Output [TRU] with built-in Current interrupter and GPS based timer.
- Distribution Board [dB]
- MMO [LIDA Single] anodes and anode ground beds in carbonaceous back-fill
- Test stations [TLP]
- Computerized Test Stations [CTSU]
- CPPSM
- Junction Boxes with shunts and resistors [AJB] [CJB]
- Permanent Reference Cu-CuSO4 Electrodes [CSE]
- Pin Brazing for pipe to cable connection [ epoxy encapsulated ]
- Surge diverter/ Grounding cell across Insulation Mono - blocks
- Grounding cell at Insulation mono - blocks
- Solid state DC De-coupling device at A.C. Interference locations
- Polarization ER Coupons for Corrosion monitoring
- Interconnecting cables
- Cable to pipe connections.
- Markers [for cable route, anodebed etc.]
- Insulating fittings

## 5.3 General Requirements for Components

5.3.1 All equipment shall be new and supplied by CP contractor sourcing from approved manufacturers of repute with proven track record and approved by the owner for the supply for this project. Equipment offered shall be field proven. Equipment requiring specialised maintenance or operation shall not be acceptable hence should be avoided, as far as possible, and prototype equipment shall not be accepted. Make and construction of all the material shall be as per CLIENT Vendor list and Standard specification of this document.

5.3.2 The detailed specification of each system and equipment shall be furnished by the contractor. However, certain minimum requirements for the major equipment are highlighted in this document.

5.3.3 Equipment Location In Hazardous / Non Hazardous Area

As far as possible equipment including Power source, test stations, anodes, junction boxes, TLP etc. shall be located in safe area. However, all equipment located in hazardous areas shall be of flame proof type as per BIS: 2148, IEC 79 for gas groups IIA & IIB and temp. Class T3 ($200^0$ C). All equipment to be located in Hazardous area should conform to and comply with BIS 2148 and IEC 79 (or equivalent) code requirements. All indigenous flame proof equipment should be certified by CMRI. All flame proof equipment of indigenous origin should also be **BIS** marked.

## 6.0 ANODE GROUND BEDS

### 6.1 Anode Ground Beds –TCP

6.1.1 Along ROW where soil resistivity predominantly remains low and ranges from 0-10 Ω m Zinc (Zn) anodes shall be provided.However,at locations where soil/water pH is more than 9,Zn anodes not to be used as these get Passivated.

6.1.2 Along ROW where soil resistivity is predominantly higher than 10 Ω m Magnesium (Mg) anodes shall be provided.

6.1.3 At high resistivity area where resistivity is of the order of 50 Ω m and above Magnesium (Mg) ribbon anodes shall be provided.

6.1.4 Anodes shall be installed along the pipeline at suitable intervals as per pipeline protection voltage attenuation calculations and ground bed resistance/current output of anode installations.

6.1.5 Each electrically continuous section of pipeline shall preferably be protected totally by one type (material) of anodes [either Zn or Mg] to avoid inter-anode [Zn ↔ Mg] circulation currents. Grounding cell should also conform to this specific requirement.

6.1.6 The anodes shall be installed at sufficient depth to reach perennially moist soil [ascertained by ground water table data] but minimum 2M depth from grade level and shall be separated linearly from the pipe line by at least 5m and 2m for Magnesium (Mg) and Zinc (Zn) anodes respectively. The ribbon anodes should be laid at least 0.5 M away from pipe. The anode connections to pipe line shall be routed through test stations.

6.1.7 However, environment suitability [such as pH, excessive carbonate, bi-carbonates, sulphates, chlorides, nitrates etc. which could result in anode passivation] should be checked prior to lowering of sacrificial anodes suitability in the anode beds. Zn should not be used if soil/water pH is over 9.

6.1.8 At the temporary CP anode ground bed, the leads of all the anodes shall be connected individually through Shunt and Resistor [for controlling each anode output individually] in the TLP/ junction box. The junction boxes should contain 20% extra terminals points.

6.1.9 For sacrificial anode ground beds which shall be integrated with permanent CP system the leads of all the anodes shall be brought up to the test station and shall be terminated individually with shunts inserted in between so that individual anode current output can be regulated & measured as required.

6.1.10 For Sacrificial anode CP system the Anodes shall be supplied with Tail cable [6 mm2 PE PVC copper conductor single core multistrand cable] of sufficient length so as to reach Junction box, for termination, without difficulty. No joints are permissible on the cable run from anode tail to junction box.

6.1.11 The tail cable connection with the Iron Insert of Cable should be tightly done followed by Epoxy encapsulation so as to ensure that no Necking takes place which could result in snapping of cable connection due to spark. Anode cap of heat shrinkable PE material should be able to ensure this.

### 6.2 Anode Ground Beds –PCP

6.2.1 Anode beds(if applicable) to be installed at every CP Station and located at least 100 M away from pipeline ROW to ensure adequate remoteness which should also be calculated.

6.2.2 All [MMO] Anodes to be placed in Petroleum coke breeze, in appropriate [deep –horizontal or vertical, or semi-, deep well, deep well] configuration as per design to achieve requisite circuit resistance and protective Current output throughout the [40 years] service life. However, anode bed configuration selected should be technically justified.

6.2.3 The MMO anode should be supplied with sufficient length of 10 mm2 XLPE PVC cable so as to run up to junction box for termination in the junction box without in-between joints. No joints are permitted in cable run from Anode tail to junction box. This cable size is minimum only and wherever necessary, for appropriate operation of the CP system, higher sized cables should be provided.

6.2.4 Appropriate tamping of carbonaceous backfill [petroleum coke breeze] should be done so as to ensure appropriate compaction around [MMO] anode.

6.2.5 Anode bed Plot: CP contractor shall acquire[for CLIENT] & anode bed plot to be as per design requirement) & at least 100 M away from pipeline ROW for locating anode bed, at each Anode bed location along the pipeline ROW. CP Contractor to indicate the location of anode beds along pipeline ROW and mark it on As-Built Drawings and handover the requisite ownership documents to CLIENT at the time of Handing over of the system.

## 7.0 ANODES

### 7.1 Sacrificial Anodes

7.1.1 Magnesium Anode

The anode shall be of low voltage (-) 1.5 V type Magnesium [**Mg**] alloy packed in special back fill and suitable for use with three layer extruded polyethylene coating. The anode to conform to ASTM B 843 specifications such as the metallurgical composition, potential and consumption rate of anode shall be as below:

i. Composition:

| | **Element** | **Weight** |
|---|---|---|
| | Manganese | 0.15 – 0.7% |
| | Copper | 0.02% max. |
| | Silicon | 0.10% max. |
| | Zinc | 2.5 – 3.5%% max. |
| | Aluminium | 5.3 – 6.7% max |
| | Iron | 0.003% max |
| | Nickel | 0.002% max |
| | Other metallic elements | |
| - | Each | 0.05% max. |
| - | Total | 0.3% max. |
| | Magnesium (Mg) | Balance |
| ii. | Anode open circuit potential | (-)1.5 volts. W.r.t. CSE |
| iii. | Anode consumption rate | 7.9 kg / (A Yr) Max. |

7.1.2 Zinc Anode

The Zinc [**Zn**] anode shall conform to ASTM B 418 standard. The anode (other than ribbon anode) shall be packaged with special back fill. The metallurgical composition of anode, potential and consumption rate shall be as below:

Composition:

| **Element** | **Weight** |
|---|---|
| Aluminium | 0.3 – 0.5% max. |
| Cadmium | 0.075-0.1% max. |
| Copper | 0.005% max. |
| Iron | 0.002% max. |
| Silicon | 0.005% max. |
| Lead | 0.005% max. |
| Zinc | Remainder |
| Anode open circuit potential | (-) 1.1 volts w.r.t. CSE |
| Anode consumption rate | 11.24 kg / (A yr) Max. |

7.1.3 Contractor shall furnish spectrographic analysis from each heat both for Zinc (**Zn**) and Magnesium (**Mg**) anodes along with electrochemical test results .CP Contractor shall mention specifically the method of Spectrography (Atomic Absorption/Emission Spectrometry/Photometrics) for Owner's Approval.

7.1.4 Special Backfill For Sacrificial Anodes
The composition of special backfill for sacrificial anodes shall be as below:

| | |
|---|---|
| Gypsum | 75% |
| Bentonite | 20% |
| Sodium sulphate | 05% |

7.1.5 Some Specific Requirements for sacrificial anodes are as follows:
The anodes shall be provided with cable tail of sufficient length to reach junction box/test station [TLP] as applicable in single run without tension and without in between joints.

7.1.6 Tolerance In Fabrication Of Sacrificial Anodes
Visual Inspection shall be carried out on all the Anodes regarding surface finish, excessive shrinkage, cracks, cable joint to anode core etc.

- The anode surface shall be free from cracks (which may reduce the performance of the anode.).
- Any cracks which follow the longitudinal direction of elongated anodes shall not be acceptable.
- Small cracks in the transverse direction of elongated anodes and in anodes of other shapes may be accepted provided the cracks would not cause any mechanical failure during service of the anode considering that the combination of cracks and lack of bond to the anode core is detrimental.
- For transverse cracks the acceptable limits shall be furnished by the bidders along with the offer.
- The anode shall be free from excessive shrinkages. The following limits shall be used.

Maximum 10% of the depth of anode or 50% of the depth of the anode core whichever is less. The depression may be measured from the edges of one side.

- The surface of the anodes shall be free from coatings and slag/ dross, inclusions etc.
- The maximum deviation from straightness shall not exceed 2%.
- The weight tolerance on individual anodes may be taken as ± 5%. The total weight of the anodes shall not have negative tolerance.
- Recommended dimensional tolerance shall be as follows:

| | |
|---|---|
| Length | ± 2.5% |
| Width/ thickness | ± 5% |

- One Anode per heat shall be radiographed to evaluate slags, voids, inclusion etc.
- At least 10% number of Anodes from each heat to be checked for conformity to Dimensions & Weight.
- One Anode, at least shall be Tested Destructively to check bond between Anode material and steel insert, slag, inclusion etc. Failure of one anode during the test shall make the entire anode lot liable for rejection.

**7.2 Mixed Metal Oxide [MMO] Anodes: LIDA SINGLE**

The Permanent Cathodic Protection [PCP] system will have Mixed Metal Oxide [MMO] Strip Anodes also known as LIDA [Linear Distributed] Anodes and LIDA single. The [MMO] LIDA single anodes shall be centre connected sealed tubular type. These Anodes shall be of Noble metals [group VIII] MixedMetal Oxide coated Titanium [having Ti substrate composition conforming to ASTM B 338 Grade I and/or Grade II]. The LIDA [MMO] anodes shall be dimensionally stable.

7.2.1 The characteristics of the [MMO] LIDA singe anodes are as follows:

- Shape and Dimension
  1,000 mm ± 5 mm long
  25 mm ± 0.2 mm wide
  3 mm ± 0.1 mm thick

- Weight 0.27 Kgs ± 0.020 Kgs. Recommended Maximum

7.2.2 Operating Current Density

| | |
|---|---|
| ➢ With Carbonaceous Backfill | 75 Amp / $M^2$ |
| ➢ Current Output with Carbonaceous Backfill | 3 Amp /$M^2$ |
| ➢ Electrical Resistivity | 6 x 10-5 Ω cms. |
| ➢ Type of Joint | Epoxy Splicing |
| ➢ Contact Resistance of Anode to Cable joint | 9 x 10-5 Ω {maximum} |
| ➢ MMO Coating thickness | ≥ 6 gms/M2 |
| ➢ Anode Consumption Rate | 1 mg/Amp. Yr. |
| ➢ Type of Cable | XLPE PVC 10 $mm^2$ |
| ➢ Length of Cable | As Required so as to reach JB |
| ➢ Design Life | 40 Years |

7.2.3 The Anodes shall be provided Bare for Deep well, and with sheet steel canisters and petroleum coke breeze for deep bed configuration

7.2.4 The Anodes to be Installed at a distance of 5m (Minimum) apart and shall be **electrically remote to the pipeline [to be ascertained by calculations]**. Normally the nearest part of anode for deep horizontal/vertical type of anode beds shall not be less than 100M from the pipeline. However, the actual distance will be as per site conditions. For Deep well anode bed the first anode should be at least more than 15 M deep [as per NACE RP 0572 Standard] and the actual depth shall be as per Approved Design. However, for Deep well Anode bed also LIDA Single [MMO] anodes (& not LIDA String Anodes) shall be used.

- Anode LIDA [MMO] Single to cable [XLPE PVC 10 mm2] jointing and insulation shall be done by anode manufacturer at MMO anode fabrication shop.
- Dimension & weight of all anodes to be checked & recorded. Negative tolerance will not be acceptable.
- Routine & type test certificates of cable manufacturer to be furnished for anode lead cable as per IEC 502 – 1983 or relevant BIS code. Length and identification tag to be verified by measurement
- Each anode to cable joint shall be tested for it's electrical contact resistance & its value in Ω shall be recorded.
- First Anode to cable joint shall be subjected to accelerated ageing test & destructive test to determine pullout strength of cable to anode joint as well as effectiveness of the joint insulation.
- Manufacturer shall furnish detailed dimensioned fabrication drawing of anodes as well as details of cable connection& it's insulation sealing to owner for approval. Manufacturer of anode will commence only after this Approval from owner.
- Vendor shall furnish, for Owner's Approval, the following information
  - type & make of Heat Shrink cap & it's properties
  - procedure for making the joint
  - procedure for accelerated ageing test
  - Vendor shall submit all test reports for Owners review.

## 8.0 PETROLEUM COKE BREEZE

Lubricated calcined petroleum coke breeze backfill material for use with LIDA Single [MMO] Anodes in [PCP] system shall have a carbon content of 91.77% minimum and a bulk density of 74 pounds per cubic ft. Zero percent shall be retained by a screen size of 16 mesh.
The coke breeze shall have low resistance carbon lubricant added for lowering the combined resistance while developing the pumping qualities. Earth contact resistance shall be 0.1 Ω cm at 150 PSI.

### 8.1 Backfill Data Sheet

| | |
|---|---|
| Carbon | 91.770% |
| Volatiles | 00.700% |
| Ash | 02.230% |
| Sulphur | 05.850% |
| Silicon | 00.060% |
| Iron | 00.020% |
| Moisture | 00.000% |

**8.2 Typical Particle Analysis**

| Screen Size | % Retained | % Retained (Cumulative) |
|---|---|---|
| 16 Mesh | 00.000 | 000.00 |
| 28 Mesh | 02.100 | 002.10 |
| 48 Mesh | 21.100 | 023.20 |
| 100 Mesh | 60.300 | 083.50 |
| 200 Mesh | 15.000 | 099.50 |
| 200+Mesh | 01.500 | 100.00 |

**8.3 Typical Physical Analysis**

| | |
|---|---|
| Bulk Density | 54 lb/cu ft. |
| Real Density | 02 gm/ml |
| Porosity | 40.8% |

The Petroleum Coke Breeze Material shall be tested for chemical composition, bulk density, real density, particle size and resistivity, sieve analysis.

**9.0 AC OPERATED AUTO/MANUAL TRANSFORMER RECTIFIER UNIT [TRU]**

The TRU shall be supplied in accordance with the following specifications and Data sheets:

**9.1 General Description**

This specification covers the requirements of design, manufacture, inspection, testing and supply of Automatic Controlled Transformer Rectifier Unit for Cathodic Protection of underground structures. Reliability of equipment and ease of maintenance is of utmost importance. The workmanship shall be of highest grade and entire design and construction in accordance with the best modern practice. The C.P. Units shall be capable of continuous trouble free operation at full load rating specified. The protection devices and control components shall be of standard design and carefully chosen to meet the requirements of the sets.

All similar materials and parts of similar equipment's shall be interchangeable with each other. Special care shall be exercised in the design and manufacture for aging effects, low input voltage, DC voltage fluctuations, high forward current through the rectifying elements and high temperature conditions during operation.

Apart from the derating for site conditions an additional derating of 20% shall be considered for the specific use. The components of the units shall be designed for maximum operating efficiency. The C.P. Units shall be provided with all the necessary protections required as detailed in the following pages. The

C.P. Units shall have Automatic/Manual control and shall be metal clad, compact, indoor installation type, air natural cooled, dust and vermin proof systems exactly confirming to the following specificationsand no deviations shall be allowed.

**9.2 Technical Requirement**

9.2.1 The CP Transformer Rectifier Units' scheme for protection, monitoring, control, metering and indication shall be designed to meet requirements of this specification. The control shall be achieved using thyristors and fully solid state logic only. The various features of the unit will be as per the details provided in the data sheet in this specification.

9.2.2 Transformer shall be of double wound, air cooled type with an electrostatic shield between the windings. The transformer insulation shall be Class F. The winding size shall be based on maximum current density of 1.6 Amps/sq. mm of copper conductor.

9.2.3 Rectifier shall be silicon type of approved make with adequate cooling arrangement and with moisture and humidity resistant finish. It shall be mounted on spindles or other suitable supports. It shall have configuration suitable for full wave rectification. Adequate filtering in the form of L-C filtering circuit shall be provided on output side to smoothen out the D.C. output to limit ripple content to less than 5% at rated output.

The input and output of rectifier shall be protected by fast acting fuses of suitable ratings. Lightning

Arrestors/Surge Suppressors shall also be provided across D.C. output terminals and A.C. input terminals to protect the rectifier against surges. Each diode and SCR shall be provided with suitable surge suppressers.

## 9.3 Operation of The CP Transformer Rectifier Unit

The T/R unit shall be provided with two modes of working as under. A mode selector switch shall be provided to select the desired mode of operation. Both the modes shall be independent of each other and failure of the unit in one mode shall not affect working of the unit in other mode. A brief description of these modes is given below.

### A) Auto Ref. Mode

The unit will be generally working in this mode. The operation of the unit in this mode shall be controlled by a reference signal. The output D.C. voltage of the unit in this mode shall vary right from 0V to rated voltage and form 0A to rated current to maintain the reference signal within ± 20 mV of the set value under all operating conditions. The response of the unit shall be instantaneous to suppress extremely fast acting external stray currents if present. The typical reference regulation in this mode shall be within ± 20mV under all conditions.
Fully solid state Automatic Reference Selector logic shall be provided to select the lowest of the Three Reference Inputs automatically. Facility shall also be provided for Manual selection of any one out of the three reference inputs for control. Suitable metering arrangement shall also be provided to monitor all the three external reference signals as well as the internal reference signals independently.
In the event of failure of all the reference signals, the unit will provide alarm - " All Reference Fail" and the output of the unit shall get adjusted to a preset value, which will be operator adjustable from 0V to rated voltage.
Independent ultra fast acting electronic current limit circuit shall be provided to limit the output current of the unit in Auto mode to any value from 0 A to rated value as desired by the operator. The current limit circuit will be capable of protecting the unit even under dead short circuit across output. The unit will be capable of sustaining dead short circuit across output indefinitely without degrading or damaging any internal components in this mode.

### B) Automatic Voltage-Current Control mode (AVCC mode)

This will be the second mode of operation. The working of this mode shall be totally independent of the Auto mode and failure of the unit in Auto mode shall not affect operation in this mode.
The output voltage of the unit shall be adjustable to any value from 0V to rated voltage by means of a stepless voltage setter. The set voltage shall be maintained within ±0.25V of the set value for change in DC input voltage within specified limits and change in load from 0A to full load.
The output current of the unit shall also be adjustable to any value from 0A to rated current by means of a stepless current setter. The current shall be regulated within ± 0.5A of the set value for change in DC input voltage within specified limits and change in load from zero to the rated value. The response of both current controller and voltage controller shall be ultra fast, instantaneous type. The current limit circuit will be capable of protecting the unit even under dead short circuit across output. The unit will be capableof sustaining dead short circuit across output indefinitely without degrading or damaging any internal components in this mode.

## 9.4 Local & Remote Monitoring & Control

The unit will be capable of working in Local Mode of control as well as Remote mode of control. For this purpose a mode selector switch will be provided on the unit. With this switch in ‘Local Mode’ it will be possible to control the various parameters of the unit by means of local controls located in the unit.

Facility will be provided for monitoring and control of various parameters by means of controls provided on the front panel of the unit. The details of the parameters to be monitored and controlled locally are as under:

9.4.1 Local Monitoring

Facility will be provided for local monitoring of following:

### A) Metering on Panel

- AC Input Voltage - Digital Voltmeter
- AC Input Current - Digital Ammeter
- DC Output Voltage - Digital Voltmeter
- DC Output current - Digital Ammeter
- PSP (Set & Actual) - Digital Voltmeter with 10 Meg Impedance

**B) LED Indications on Panel**

- AC Supply ON - LED indication
- Pipeline Under protection - LED indication
- Pipeline Overprotection - LED indication
- Reference 1 Lowest - LED indication
- Reference 2 Lowest - LED indication
- Reference 3 Lowest - LED indication
- Reference 1 Fail - LED indication
- Reference 2 Fail - LED indication
- Reference 3 Fail - LED indication
- All Reference Fail - LED indication
- Overcurrent (Current Limit) - LED indication
- Unit Working in Auto Mode - LED indication
- Unit Working in AVCC Mode - LED indication
- Unit Working in Local Mode - LED indication
- Unit Working in Remote Mode - LED indication

9.4.2 Local Control

Facility will be provided for local control of following:

- O/P Voltage - By means of potentiometer on panel
- DC O/P Current - By means of potentiometer on panel
- PSP - By means of potentiometer on panel
- Selection of Auto/AVCC Mode - By means of selector switch on panel
- Start/Stop of Current Interrupter - By means of Keypad on Timer

**9.4.3 System Software**

The vendor will supply the necessary system software such as all programs for the PLC, PLC display etc. which are required to perform all the PLC functions including communication and self-diagnostics. Logic program with necessary instructions shall be recorded on compact disc (CD) and shall be delivered with the system.

The PLC system shall be rated for 24 V DC power supply voltage. The 24 V DC power supply shall be derived from 230V AC power supply for the TR unit, through a suitably rated 24 V DC Power supply module.
The PLC and the DC for power supply module for the PLC shall be mounted inside the TR Unit panel.

### 9.4.4 Parameters For Remote Monitoring

Facility will be provided for remote monitoring of following:

**A) Analog Signals**

- DC Output Voltage - Hardwired
- DC Output current - Hardwired
- Lowest/Selected PSP - Hardwired

**B) Digital Status Signals**

- Pipeline Underprotection - Through PLC / RS 485
- Pipeline Overprotection - Through PLC / RS 485
- All Reference Fail - Through PLC / RS 485
- Unit Working in Auto Mode - Through PLC / RS 485
- Unit Working in AVCC Mode - Through PLC / RS 485
- Unit Working in Local Mode - Through PLC / RS 485
- Unit Working in Remote Mode - Through PLC / RS 485

### 9.4.5 Parameters For Remote Control

Facility will be provided for Remote control of following:

- Setting of DC O/P Voltage - Through PLC / RS 485
- Setting of DC O/P Current - Through PLC / RS 485
- Setting of PSP - Through PLC / RS 485
- Selection of Auto/AVCC Mode - Through PLC / RS 485
- Start/Stop of Current Interrupter - Through hard wired potential free contact

## 9.5 Reliability And Factor Of Safety

Due to very harsh conditions under which the units are going to operate, prime importance shall be given to ensure reliability and trouble-free operation. To take care of high transient voltages and high peak current demands adequate factor of safety shall be provided in choosing all the components. Minimum factor of safety to be provided for critical components is as under.

| Components | | Factor of Safety |
|---|---|---|
| All wound components | : | 50% additional capacity |

| Components | | Factor of Safety |
|---|---|---|
| Thyristor & diodes | : | PIV : 1200V minimum<br>Iav : At least 3 times actual max. average current at full load. |
| Passive components like switches, resistors | : | 50% safety margin in current rating. |

| | | |
|---|---|---|
| Overall system | : | The unit shall be capable of delivering 125% rated current output at rated voltage for 1 hour. |
| Electronic Control | : | The entire electronic circuitry shall be assembled on plug-in type glass epoxy PCBs. The control circuit shall be designed using the latest advanced ICs to minimize the component count. Status indicator LEDs shall be provided on each control card to indicate functioning of the card. All the control cards shall be completely sealed usingprotective coatings.<br><br>The control circuit shall be capable of operating at elevated temperatures of upto 70 □C without any degradation in performance or life expectancy. |

**9.6 Working Life**

The TR Unit shall be designed for a working life of minimum 40 years.

**9.7 Technical Specifications And Data Sheet – TR Unit**

| | | | |
|---|---|---|---|
| A) | A. C. Input Voltage | : | 230V ± 10%, 1Ph, 50 Hz ± 5%, AC |
| B) | A. C. Input Current | : | 8.0 A (max) |
| C) | D. C. Power Output | : | 625W |
| D) | D. C. Output Voltage | : | 0 to 25V DC |
| E) | D. C. Output Current | : | 0 to 25A DC |
| F) | Controls | : | 1. Auto PSP<br>2. AVCC (Manual) |
| G) | Full load efficiency of the TR unit | : | Not less than 70% |
| H) | Power Factor at full load | : | Better than 0.8 Lag |
| I) | Insulation Level | : | 2 KV for 1 minute |
| J) | Cable entry | : | A.C. input, D.C. output, Ref. Cells and Alarm cables. From the bottom plate of the unit, thru suitable cable glands. |
| K) | Filtering circuit | : | L. C. Filter |
| L) | Ripple & Hum | : | Less than 5% at rated load |
| M) | Surge Diverters for diodes/SCRs/Transistor | : | Metal oxide varistors / capacitors / R-C Networks |

| | | | |
|---|---|---|---|
| N) | Lightning Arrestor | : | At both input & output side of the unit<br>R.M.S. Voltage Rating : 500V<br>R.M.S. Current Rating : 1.5KA<br>Type : LT 0.5 or Eqv. |
| O) | Protection | : | - 2 pole MCB in AC input for overload protection & Isolation.<br>- 2 pole MCB in DC output.<br>- HRC fuses in input & output.<br>- Glass cartridge fuses in the live line of all lamps, auxiliary power lines to control circuit.<br>- Built in electronic current limit and short circuit protection feature.<br>Current limit adjustable from 0 to rated value.<br>- All reference fail indication and automatic setting of O/P DC voltage to preset value. |
| P) | Ref. Fail Safe Feature | | In the event of failure of all the Reference Electrodes the unit will provide "All Reference Fail" indication and the DC O/P voltage will get adjusted to a programmable preset value. |
| Q) | Reference Electrode [Permanent] | : | 3 Nos. Cu/CuSo4<br>Automatic Reference Selector Logic shall be provided to automatically select the lowest (least protected) reference signal out of three reference signals fed to the unit simultaneously.<br>Facility shall also be provided to select one out of three ref. |

| | | | |
|---|---|---|---|
| | | | Electrodes by means of a Manually operated Reference Selector switch. |
| R) | Control element | : | The DC output will be controlled using latest solid state SCRs.<br>These SCRs will be controlled by the commands from the control circuits.<br>All the electronic circuits will be assembled on plug-in type control cards. |
| S) | Modes of operation | : | Following modes of control shall be provided.<br>a) Auto Ref. Mode:<br>The operation of the unit in this mode will be fully Automatic and will be controlled by the Reference electrode feedback (PSP). The unit will automatically maintain Reference voltage or P.S.P. within □ 20mV of the set value under all conditions.<br>b) AVCC Mode:<br>This will be the second mode of operation. In this mode the unit can be operated in either constant voltage or constant current mode.<br>The output voltage will be adjustable from 0 to rated value by means of stepless voltage setter potentiometer.<br>The output current will be adjustable from 0 to rated value by means of stepless current setter potentiometer. |
| T) | Voltage Setting Range in AVCC Mode (Manual) Mode | : | 0 to 25V |
| U) | Current Limit setting Range | : | 0 to 25A |
| V) | P. S. P. setting Range | : | -0.8V to –2.5V |
| W) | Ref. Regulation in Auto Mode | : | Better than □ 20mV |
| X) | DC Voltage regulation in AVCC (Manual) Mode | : | Better than □ 0.25V |
| Y) | Current Regulation in current limit mode | : | Better than □ 0.5A |

Z) Indications :

a) Underprotection

b) Overprotection

c) Reference cell 1 Lowest

d) Reference cell 2 Lowest

e) AVCC mode of operation

AA) Annunciations :

a) Under protection

b) Overprotection

c) Reference cell 1 Lowest

d) Reference cell 2 Lowest

e) Reference cell 3 Lowest

f) Reference cell 1 fail

g) Reference cell 2 fail

h) Reference cell 3 fail

i) Reference cell All fail

j) Overcurrent (Current Limit Mode)

AB) Meters/Instruments : Digital Meters as under:

AC Input Voltage : 0 to 300V AC

AC Input Current : 0 to 10A with CT

3-1/2 Digit Digital Meters as under:

Output Voltage : 0 to 50V DC

Output Current : 0 to 50A with shunt PSP & Set PSP : 0 to + 19.99 V DC

AC) Local control Mode : Following controls will be provided in local mode from local control panel.

1. Setting of Ref. PSP through Potentiometer

2. Setting of Output Voltage through Potentiometer.

3. Setting of output current limit through Potentiometer.

4. Auto/AVCC Mode Selection

5. START/STOP of Current Interrupter

AD) Remote Monitoring and control through PLC through RS 232C / RS 485 Serial Link : Following features will be provided by means of PLC and RS232C / RS 485 Serial Link with MODBUS RTU Protocol.

1. All Ref. Fail

2. TR unit in Auto mode

3. TR unit in AVCC mode

4. TR unit in Local mode

5. TR unit in Remote mode

1. TR unit Operation in AUTO mode

2. TR unit Operation in AVCC mode

1. Lowest/selected PSP value

2. Output DC voltage

3. Output DC current

1. Setting of PSP

2. Setting of DC output voltage

3. Setting of DC output Current

AE) Current Interruption : Current interruption facility will be provided by means of a built-in contactor & microprocessor based fully programmable and GPS enabled Synchronisable digital timer with real time clock & ON/OFF time display. The timer will have facility for adjusting the ON time & OFF time from 0 to 999 sec. by means of front panel keypad. Timer will have START, STOP & RESET facility thru local keypad or thru remote potential free contacts.

The Timer will have typical time accuracy of + 5 PPM

Facility for interconnection of an external timer shall also be provided.

A removable bypass link will be provided for bypassing the interrupter contactor contacts.

AF) Enclosure/Construction : Floor mounted Indoor type.
Fabricated from 1.5mm/2.0mm CRCA sheet.

Confirming to IP55 degree of protection.

Lockable doors shall be provided in the front and back.

AG) Cooling : Natural air cooled

AH) Painting : Baked epoxy paint/Powder Coating of shade RAL 7032 Siemens grey with proper pre-treatment and primer application as per standard Industrial Practice.

AI) Earthing : 2 Nos. M6 earthing bolts and 1 no. nickel plated copper earth bus bar shall be provided.

**9.8 Manufacturer's Technical Expertise & Experience**

The manufacturer should be a reputed and established manufacturer of CP Rectifier & CPPSM Units and should have experience in manufacturing of C.P. rectifiers & CPPSM units of similar specifications. The manufacturer will have to submit a list of C.P. Rectifier & CPPSM installations having similar specifications executed in the past 5 years, giving present working status of various units.

**9.9 Testing And Inspection**

The Manufacturer/Contractor shall provide all the necessary facilities to carry out full performance tests on the AC operated DC Output TR Units at his works.

**9.10 Guarantee**

The manufacturer/Contractor will have to guarantee the successful working of the units for a period of 12 months from date of Installation & commissioning.

## 10.0 REFERENCE ELECTRODE [CuCuSO4] PERMANENT TYPE

Permanent Copper / Copper Sulphate reference electrodes three (3) numbers at each CP Station .All the three reference electrodes shall be routed individually to TRU through test station. Reference Cell tail cable length shall be sufficient enough to reach the test station and further to the TRU without any splicing or jointing.
As per Owner or Owner's representative's direction, Permanent Copper Copper sulphate reference electrodes are to be installed for [P-S-P] Monitoring. One number CSE (Permanent type) at each ER Probe shall be installed.

## 11.0 TEST STATIONS [TLP]

**11.1** Test stations [TLP] shall be provided along the pipeline ROW for monitoring the performance of the cathodic protection system at intervals of 1000 meters unless otherwise specified. In addition to above, test stations of requisite type [A, B, C, D, E or Combination of any two of these Viz: DE] shall be provided at the following locations:

a. At both sides of major road crossings
b. At all insulating joints
c. At vulnerable locations with drastic changes in soil resistivity.
d. At connections of surge diverters, grounding cells and polarisation cells.
e. At HT AC/DC overhead line crossings and selected locations where HT overhead line is in the close vicinity of the pipeline.
f. At railway line crossings and running parallel to the pipeline.
g. At both sides of major river crossings.
h. At high voltage cable crossings or along routes where HV cables are running in parallel.
i. In the vicinity of DC net works or grounding system where interference problems are suspected.
j. At crossings/parallel running of other pipelines/ structures.
k. At both sides of cased crossings.
l. At any other locations considered vulnerable/locations where interference is expected.
m. At any other locations considered necessary by owner/ owner's representative.

Non Metallic [TLP] is to be installed at every 1Km. of Salt Pan Area. For Other Areas metallic [TLP] may be provided.

**11.2** Between the pipeline and foreign pipelines or structures that may exist in common ROW. Test stations for bonding shall be provided with shunt and resistor as a means to monitor and control current to ensure zero net flow of Current from one to the other.

**11.3** Test stations used for sacrificial anodes shall have shunt for measurement of individual anode current, and provision of resistance to limit & control the anode current output.

**11.4** Test station with current measuring facility shall be provided at each intermediate CP station drainage point ( to measure pipeline current on any one or both side of the pipeline from drainage point), at interference prone areas, on both sides of major river crossings and at least at two additional locations along the pipeline ROW between two CP stations.

**11.5** All test stations shall have weather proof enclosure, having degree of protection IP55 with hinged lockable shutter. Enclosure shall be made of sheet steel of at least 3 mm thickness and shall be suitable for M.S. post mounting. The test stations shall be designed with terminals required for both temporary [TCP] and permanent CP system [PCP] and shall be suitable for total life of permanent CP system.

**11.6** The test stations shall be installed with the front of the test station facing the pipeline. The name plate of test stations shall in minimum carry following information.

- Test station number
- Chainage in km
- Test station connection scheme type
- Distance from pipeline in meters
- Direction of product flow

**11.7** Terminal blocks and different scheme of wiring as required shall be provided in the test station as per the test station connection scheme sketch.

**11.8** The location of all the test stations shall be marked with their connection schemes and other relevant information on alignment sheets. A detailed test station schedule shall be prepared.

**11.9** Computerized test stations (CTSU) shall be provided at remote places. Minimum 1 number with 3 channel Computerised Test Stations shall be supplied along with reading units.

## 12.0 SURGE DIVERTER, GROUNDING CELL AND POLARISATION CELL

**12.1** At the crossing or parallel run of pipeline and overhead HT line of 66 KV and above, the pipeline shall be grounded through solid state polarisation cell/device. Alternatively, grounding could also be done with galvanic anodes [grounding cells] at the discretion of the owner. The grounding shall be done at regular intervals where transmission line run parallel within 25 m of the pipeline, to ground any surges in the pipeline potential that may appear in case of faults [phase to phase or phase to ground] in overhead transmission line.

Locations along pipeline where continuous induced over-voltage due to HT line etc. is expected &/or observed during commissioning, the pipeline shall be earthed through solid state polarisation cell/device to the HT tower earth system causing the voltage induction to ground or through a separate earthing system. Alternatively the pipeline shall be grounded with galvanic anodes [Grounding cells] at the discretion of the owner.

**12.2** The solid state polarisation cell/device shall be installed in a vandal proof steel housing by the contractor.

**12.3** Spark gap surge diverter shall be connected across each insulating joint to protect it from high voltage surges.

Alternatively, Zinc or Magnesium grounding cell may be provided across insulating joints along ROW where the pipelines on both sides of the insulating joint are Cathodically protected and difference of protection voltage is not more than 0.4 volts.

12.3.1 Surge diverter shall be provided for the protection of insulating joints located at the ends of the pipe line/at terminals & in between. Alternatively owner on his own discretion may permit use of Magnesium (Mg)/Zinc (Zn) galvanic anodes [grounding cells] appropriately sized for protection of insulating joints. Choice between Zn & Mg anodes will depend up on the potential values on either side of the insulating joint locations. These anodes shall be sized for the specified design life of permanent cathodic protection system [PCP].

12.3.2 The total system including cable, cable termination, anodes/surge diverters shall be suitable for the anticipated fault current magnitude at the location of its installation.

12.3.3 Unless otherwise specified the minimum rating of grounding cell, polarisation cell and surge diverter shall be as below:

i. Grounding Cell

| | | | |
|---|---|---|---|
| - | Type | : | 2 or 4 plate type |
| - | Current rating | : | Suitable to pass more than 10 kA surge |

**ii. Polarisation Cell**

| | | | |
|---|---|---|---|
| - | Type | : | *Solid state device* |
| - | Current rating | : | The rating shall be based on actual fault current expected at site. |

**iii. Surge Diverter**

| | | | |
|---|---|---|---|
| - | Type | : | Spark gap |
| - | Current 8/20 μs) | : | 100 kA |
| - | Spark over AC voltage | : | |
| - | 50 Hz | | 1 KV |
| - | Impulse ( 1.2/50 μs) | : | 2.2 KV |

**12.4** The grounding cell, surge diverter and the solid state polarisation cell/device system shall be sized for the design life of permanent CP system. The Zinc (Zn) or Magnesium (Mg) anodes meant for pipeline grounding shall also be sized for the life of the permanent CP system and the surge magnitude taking into account the current discharge from the anodes. The grounding system shall have minimum resistance to earth to restrict the pipeline voltage [PSP] as per NACE protection criteria.

## 13.0 CP AT CASED CROSSING

At all cased crossings the casing shall be coated using 2 pack epoxy, 750 micros thick, both on internal and external surface of the casing. The casing shall be protected additionally by independent [from carrier pipe protection system] sacrificial anode installations. The sacrificial anode installations shall be provided at both ends of casing. The anode installation shall be sized based on the permanent CP design parameters specified for the main pipeline.

The carrier pipe inside casing shall be protected by Zn or Mg ribbon anodes well connected to the outer surface of bottom of carrier pipe extending between hour hand positions of 4 and 8 o' clock. The anodes shall be placed at close intervals as per design calculations and sized based on the permanent CP design parameters. Casings upto 20 mts in length may not be provided additional cathodic protection to carrier pipe bottom inside casing. More than 20 mts length casing additional cathodic protection to carrier pipe bottom shall be provide.

The annulus between the casing and the carrier pipe shall be filled with graded sand/ betonite.

The HDD contractor will arrange an agency to check the coating condition of the casing pipe post erection of HDD so that requisite repairs(if required) are done to the damaged coat.

## 14.0 PAINTING

The sheet steel used for fabrication shall be thoroughly cleaned and degreased to remove mill scale, rust, grease and dirt. Fabricated structures shall be pickled and then rinsed to remove any trace of acid. The under surfaces shall be prepared by applying a coat of phosphate paint and a coat of yellow zinc chromate primer. The under surfaces shall be free from all imperfections before undertaking the finished coat. After preparation of the under surface, spray painting with two coats of final paint shall be done. The finished panel shall be dried in oven in dust free atmosphere. Panel finish shall be free from imperfections like pin holes, orange peels, run off paint etc.

All unpainted steel parts shall be cadmium plated to prevent rust formation.

## 15.0 CABLES

PVC sheathed FRLS. The size of the copper conductor shall be 6 sq mm for anode cable from anode to junction box, 10 mm2 from junction box to test station, 10 mm2 from test station to pipeline. The size of

the conductor shall be 4 mm2 for potential measurement and 25 mm2 for bonding, polarization cell / grounding cell and surge diverter connection purpose. The anode cable from anode to junction box shall be unarmored. The length of anode tail cable shall be sufficient enough to reach junction box (buried) in case of temporary CP anode and up to test station in case of permanent CP anodes.

## 16.0 INSTALLATION

### 16.1 Cable Laying

16.1.1 Cables shall be laid in accordance with approved layout drawings to be prepared by the contractor. No straight through joint shall be permitted in a single run of cable. Cable route shall be carefully measured and cables cut to required length.

16.1.2 All cables inside station/plant area shall be laid at a depth of 0.75 M. Cables outside station/plant area shall be laid at a depth of 1.5 m . Cables shall be laid in sand under brick cover back filled with normal soil. Out side the station/ plant area the routes shall be marked with polyethylene cable warning mats placed at a depth of 0.9 m from the finished grade.

16.1.3 All underground unarmoured cables forming part of permanent CP system shall run through PE sleeves. Cables along the pipeline shall be carried along the top of the pipe by securely strapping it with adhesive tape or equivalent as required.

16.1.4 RCC or GI pipes of proper size shall be provided for all underground cables for road crossings.

16.1.5 Cables shall be neatly arranged in trenches in such a manner that crisscrossing is avoided and final take off to equipment is facilitated.

16.1.6 Cable root markers shall be installed overground at suitable intervals.

16.1.7 In no case cables shall pass from below underground pipeline. All cables shall be placed above underground pipeline and tightened with tape.

### 16.2 Cable To Pipe Connections

All cable connections to the pipeline including charged foreign pipeline shall be made using an (owner) approved exothermic process e.g.: Pin Brazing.

The Pin Brazing to have

| | | |
|---|---|---|
| i. | extremely low Contact Resistance | $\leq 0.1\ \Omega$. |
| ii. | Low transition resistance | 7.5 to 14 □Ω per brazed joint |
| iii. | High mechanical strength | Binding strength 490 $N/mm^2$ |
| iv. | Shear Strength | 245 $N/mm^2$ |
| v. | Brazing Temperature | $650^0$ C |
| vi. | Time per Braze | 2 Seconds |
| vii. | Weather Effect | Suitable for all weather operation |
| viii. | Life | 40 Years + 1 |

### 16.3 Field Test

## 17.0 CIVIL WORKS

All civil works associated with the complete cathodic protection work shall be included in the scope of CP contractor. This shall include providing cable trenches, foundation for equipment and all test stations etc.

## 18.0 TESTING AND INSPECTION AT WORKS

**18.1** Owner/ Owner's representative shall visit the works during manufacture of various equipment [Anodes, Cables, Junction Boxes, Test Lead Points etc.] to assess the progress of work as well as to ascertain that only quality raw material and fabrication technology is used for the same. All necessary assistance during such inspections shall be provided by the contractor/fabricator to owner's representative.

**18.2** The minimum testing, inspection requirements for all components/ equipment shall conform to the requirements as defined in the relevant codes and standards. Detailed inspection and testing procedures

along with the acceptance criteria, including various stages where hold points, review etc shall be for owners inspection, shall be prepared by CONTRACTOR for Owner's approval.

**18.3** Test certificates including test records, performance curves etc. shall be furnished. All test certificates shall be endorsed with sufficient information to identify equipment to which the certificate refers to and must carry project title, owner's name and purchase order details etc.

**18.4** Owner reserves the right to ask for inspection of all or any item under the contract and witness all tests and carry out inspection or authorise his representative to witness test and carry out inspection. CONTRACTOR shall notify the Owner or Owner's representative at least 20 days in advance giving exact details of tests, dates and addresses of locations where the tests would be carried out.

## 19.0 PACKING AND TRANSPORT

All equipment/ material shall be protected for inland/ marine transport, carriage at site and outdoor storage during transit and at site. All packages shall be clearly, legibly and durably marked with uniform block letters giving the relevant equipment/ material details. Each package shall contain a packing list in a water proof envelope. Copies of the packing list, in triplicate, shall be forwarded to owner prior to despatch. All items of material shall be clearly marked for easy identification against the packing list.

## 20.0 SYSTEM TESTING, COMMISSIONING AND INTERFERENCE MITIGATION

### 20.1 System Testing At Site

Contractor shall furnish the detailed field testing and commissioning procedure for approval. Field tests as per the approved procedures shall be carried out on the equipment/ systems before being put into service. The acceptance of the complete installation shall be contingent upon inspection and field test results being satisfactory.

20.1.1 Before the CP facilities are placed in operation all necessary tests shall be carried out to establish that all equipment, devices, wiring and connection, etc. have been correctly installed, connected and are in good working condition as required for intended operation.

20.1.2 Owner/Owner's representative may witness all the tests. At least one week's notice shall be given before commencing the tests.

20.1.3 All tools, equipment and instruments required for testing shall be provided by C P CONTRACTOR.

20.1.4 Generally following tests shall be carried out and recorded in perform given in subsequent clauses.

Checking: Visual inspection, comparison with drawings and specifications.

Inspection: Detailed physical inspection & Dimensions measurement Testing:

Simulation tests of equipment to determine its operational fitness.

**i. Cables**

- Cable no.
- Voltage grade
- Conductor cross section
- Continuity check
- Voltage test
- Insulation resistance values between core and earth.
- All cables shall be tested by 500 V megger.

**ii. Insulating Joints**

Checking of insulating joint for leakage, before and after energisation of C.P.by means of insulating joint tester. Structure-to-electrolyte potential of both protected and non-protected sides of insulating joint shall be checked before and after energisation of CP system. Grounding cell/Surge diverter shall be connected thereafter.

iii **Polarisation cell**

- Location/ identification number
- Rating
- Check for continuity

- Check for wiring
- Check for standby current drain with CP energisation (current drain with respect to voltage across the device/cell shall be recorded).

**iv. Grounding Cell**

- Location
- Type (no. of anodes)
- Ratings

**v. Surge diverter**

- Location/ identification number
- Ratings
- Check for healthiness

vi **Anode ground beds**

- Location/ test station number
- Current Output of each Anode
- Current output of the ground bed

## 20.2 Commissioning

20.2.1 Natural pipe to soil potential [P-S-P] shall be measured at each test station [TLP] location prior to connecting anodes to pipeline. The pipe to soil potential observation shall be repeated after connecting the anodes and allowing sufficient time for polarisation. The current output of the anode installation shall also be measured to ensure that it does not exceed the output current capacity of the anodes. In case the anode output current exceeds the rated capacity it shall be controlled by insertion of resistance element in the anode circuit inside test station and the pipe to soil potential shall be rechecked for adequacy of protection. Additional anodes shall be provided where required to achieve desired level of protection [PSP].
Each anode installation shall become individually operational as above.

20.2.2 After connecting all the anode ground beds to pipe line, measurement of pipe to soil potentials shall be taken at each test station [TLP] to ensure adequate conformity to protection criteria.

20.2.3 In case of insufficient protection as per the NACE CP design criteria on any portion of the pipe line, CONTRACTOR shall carry out necessary additions/ modifications to the provided protection in consultation with the OWNER so that NACE criteria is met.

## 20.3 Interference Mitigation

Investigation shall be made by an expert agency with prior experience for stray current electrolysis of the pipeline. Interference due to high voltage DC lines, electric traction & installed CP System of existing underground utilities and make suitable Recommendations so that recommended D.C. Interference Mitigative measures could be installed.The C.P. Contractor to carry out Interference due to overhead AC lines and install suitable Mitigative measures for AC Interference.

Measurements including pipe to soil potential [PSP] and pipe line current etc. on the pipeline/ structure being CP protected shall be made to investigate the current discharge [into surrounding soil electrolyte] and collectionlocations. In case of fluctuating stray currents investigation shall be made continuously over a period of time and if required simultaneously at different locations to find out the stray current source. For long line measurements, data logges shall preferably be used.

Where foreign pipeline (unprotected or protected by independent CP system) runs in parallel to the pipeline in same trench or very near to the pipeline, and is not bonded to the pipeline then investigation shall be made for current pickup & discharge points on both the pipelines.

Mitigation measures shall be provided depending on type of interference. These shall include installation of bond with variable resistor and diodes, installation of galvanic anodes for auxiliary drainage of current, adjustment/ relocation (if possible) of offending interference source, provision of electrical shield etc. depending on the type of interference. Between an existing pipeline & upcoming pipeline a concrete raft [size to be approved by owner as per OISD] is to be provided as a barrier. The new pipeline will pass below the existing U/G Pipeline.

Bonding with foreign pipeline/ structure as a mitigation measure shall be provided where the owner of the pipeline/

structure has no objection, otherwise alternative mitigation measure shall be provided.
Wherever bonding is provided for mitigation the bonding resistor shall be adjusted for optimum value for minimum / no interference so that no net current flows from one to the other pipeline. Galvanic anodes installed as a mitigation measure shall be sized for the life specified for permanent CP.

## 21.0 SYSTEM MONITORING

**21.1** The temporary CP system provided shall be monitored at all test stations once in a month for healthiness/ adequacy

of protection till commissioning of permanent CP or for design life of temporary CP specified, whichever is less. During this period if any deficiency/ interference in protection system is noticed the same shall be rectified / augmented by additional anodes as required. The monitoring report shall be submitted regularly to owner for his review / information.

**21.2** PCP system after commissioning shall be monitored by the CP contractor for One Year once a month and During this period if any deficiency/ interference in protection system is noticed the same shall be rectified / augmented by additional fixtures as required.

## 22.0 INSTRUMENTS, TOOLS AND SPARES

**22.1** CONTRACTOR shall include a List of all instruments, tools and tackles necessary for proper operation and maintenance [O&M], Monitoring of complete Cathodic protection [TCP] [PCP] systems and associated equipment that are to be deployed at site, such as Corrosion Voltmeter, Multi-combination Meter, CPL Survey Data Logger, DCVG Meter, Holiday Detector, Pipe Locator, Elcometer for Coating thickness measurement, CAT survey, Soil resistivity meter etc. duly calibrated by an Owner Approved agency in last six (6) months.

**22.2** CONTRACTOR shall provide number of spares and consumables being provided for proper operation and maintenance of part of Cathodic protection [TCP] system to be integrated with permanent CP system [PCP] designed on the basis of permanent CP design parameters and associated equipment, for two (2) years un-interrupted operation of the system.

# DESIGN BASIS FOR CIVIL & STRUCTURAL WORKS

## CONTENTS

## 1 INTRODUCTION

M/s Haridwar Natural Gas Pvt. Ltd.is a joint venture of GAIL (India) Limited & BPCL Ltd. HNGPL has been set up to implement City Gas Distribution Networks at geographical areas in thecountry. Presently HNGPL is expanding the City Gas Distribution Networks to supply natural gas to various Domestic, Commercial, Industrial and Automobile Consumers in Geographical Area (GA) of Hyderabad.

This document presents the design criteria to be adopted for the various Civil / Structural facilities envisaged in construction. All the applicable statutory rules pertaining to factories act (as applicable for the State), Fire Safety Rules of Tariff Advisory Committee, Water Act for pollution control etc shall be complied with. Statutory clearance of respective OISD, CPWD/PWD, CCOE and norms of State Pollution Control Board shall be followed.

## 2 SCOPE

The scope of work to be performed under this contract shall include complete Civil and Structural works as per plans, equipment layout, drawings & technical specifications.

Following Civil & Structural work has been envisaged but not limited to

- Topographic and Soil Investigation Survey
- Process Area Development
- Skid foundations
- Valve Pit Chamber
- Pipe and Valve Support Foundation
- Valve Operating Platforms and Crossovers

All items in the Schedule of Rates shall be inclusive of all material, labour, constructional infrastructures like scaffolding/ staging, finishing, cleaning, cutting chases/holes etc. in brick work/ RCC work and making good the same and rectification of any damaged work shall be applicable for all heights and locations.

The procurement and supply of all materials, consumables and non-consumables, and hardware etc. including necessary tools and tackles required for satisfactory completion of the job shall be the responsibility of Contractor within the quoted rates.

## 3 DESIGN STANDARDS

Designs shall be based on the latest Indian Standard (IS) Specifications or Codes of Practice. The design standards adopted shall follow the best modern engineering practicein the field based on any other international standard or specialist literature. In case of any variation or contradiction between the provision of the IS Standards or Code and the specifications given with the submitted tender document, the provision as directed by Owner shall be followed.

All analysis work related with civil or structural design shall be carried out as per relevant Codes and Standards. Design of concrete structures shall be as per IS 456. Structuralsteel shall be designed based on elastic theory in conformation to IS 800. All connections shall be welded connection and it shall confirm to IS 808. Minimum thickness of weld shall be 6 mm for shop weld and 8 mm for field weld.

## 4 CODES & STANDARDS

The following Indian codes and standards shall be used for design of Civil and Structural works. In all cases, latest revisions with amendments, if any, shall be followed. Apart from the specific codes mentioned herein, all other relevant and related codes concerning the specific job under consideration and/or referred to in these codes and technical specifications shall be followed wherever applicable. (All codes shall be latest as on the date of issuing of tender/bid document).

| | |
|---|---|
| **LOADS & FORCES** | |
| IS:875(part I to V) | Code of Practice for Design loads (other than earthquake) forBuildings & Structures. |
| IS:1893 | Criteria for Earthquake resistant design of structure. |
| **FOUNDATION** | |
| IS:1080 | Code of Practice for Design and Construction of ShallowFoundations in Soils (other than raft, ring and shell). |
| IS:1904 | Code of Practice for Design and Construction of Foundationsin Soils- General Requirements. |
| IS:2911 (All Parts) | Code of Practice for Design and Construction of Pile Foundation. |
| IS:2974 | Code of Practice for Design & Construction of MachineFoundation |
| IS:6403 | Code of Practice for determination of Bearing Capacity ofShallow Foundations. |
| IS:8009 (Part-I) | Code of Practice for Settlement of Foundations. |
| **CONCRETE STRUCTURES** | |
| IS:456 | Code of Practice for Plain and Reinforced Concrete. |
| IS:432 | Specifications for Mild Steel and Medium Tensile Steel bars and Hard Drawn Steel Wires for Concrete Reinforcement (Grade-I) |
| IS:1566 | Hard drawn Steel Wire Fabric for Concrete Reinforcement. |
| IS:1786 | High Strength Deformed Steel bars and wires for Concrete Reinforcement. |
| IS:3370 | Code of Practice for Concrete Structures for Storage ofLiquids |
| IS:4326 | Earthquake Resistance Design and Construction of Buildings. |
| IS:13920 | Code of practice for ductile detailing of RCC structuressubjected to Seismic forces. |
| **MASONRY** | |
| IS:1905 | Code of Practice for Structural use of Un-Reinforced Masonry. |
| **STEEL STRUCTURES** | |
| IS:800 | Code of Practice for General Construction in Steel. |
| IS:808 | Dimensions for Hot rolled steel beams, Channel and anglesections |
| IS:806 | Code of Practice for use of Steel Tubes in general Building Construction. |
| IS: 811 | Cold formed light gauge structural steel sections |
| IS:2062 | Steel for general Structural Purposes. |

| | |
|---|---|
| IS:3502 | Steel Chequered Plates. |
| IS:1363 | Hexagonal head bolts, Screws and Nuts of Product Grade C |
| IS:1367 | Technical Supply conditions for Threaded Steel Fasteners. |
| IS:2062/5624 | Specification for Foundation Bolts. |
| IS:2016 | Plain Washers. |
| IS:277 | Galvanized Steel Sheet (Plain and Corrugated) |
| IS:1728 | Specification for Sheet Metal Rain Water Pipes, normal sizegutters, fittings and accessories. |
| IS:278-1978 | Specification for Galvanized Steel Barbed wire for fencing. |
| IS:2721-2003 | Galvanized Steel Chain Link fence (Fabrication Specification) |

## 5. ENGINEERING DESIGN DATA

Design will be based on the latest soil investigation report. Life of Structure shall be takenas 50 years for wind load calculation.

PLOT DEVELOPMENT

On finalization of the plot area, the location and its surroundings shall be surveyed and Geo-technical investigations shall be carried out for establishing contour plan, coordinates & design bearing capacity of soil for each location by the executing agency as required. Suitable approach roads and other services shall be ensured for the design work.

Finished Ground Level (FGL) shall match with existing finish ground level of customer premises. Top level of internal roads shall be 150 mm above FGL. Floor finish level of process area shall be 300 mm above internal road top level. Water from the proposed plot shall be drained to drain at a slope of 1 in 500 where applicable. The drain shall have a slope 1 in 750.

DESIGN OF FOUNDATIONS

Safe bearing pressure shall be based on settlement criteria for dead plus live load conditions. Maximum settlement for foundation for all types of equipment's , pipe racks, footings including raft, etc. shall be 25mm.

In case of wind or seismic forces, settlement is not the criteria and safe bearing capacity based on shear criteria shall be considered. While designing foundations at various levels, the bearing capacity at that particular level and also the effect of uplift/sub soil water table shall also be considered.

## 6. LOADS AND FORCES

Design loads shall comply with the requirements of IS: 875 and IS: 1893 as minimum, unless more stringent requirements are specified herein. All buildings, structures shall be ingeneral designed for the worst possible combination of the following loads.

1. Dead load (DL)
2. Live load (LL)
3. Wind load (WL)
4. Seismic load (SL)
5. Equipment Load (E)
6. Impact / Vibrating Load
7. Other Loads

DEAD LOAD (DL)

The dead load comprises of weights of all structural and architectural components and external loads pertaining to all permanent construction, including walls, floor, roofs, partitions, stairways, and equipment excluding their contents. Self-weight of material may be calculated on the basis of unit weights given in IS: 875 (Part I).

LIVE LOAD (LL)

Live loads shall comprise of all loads other than dead loads. This shall be in general as per IS: 875 (Part II).

WIND LOAD (WL)

Wind load shall be in accordance with IS: 875 (Part –III)

SEISMIC LOAD (SL)

Seismic forces shall be as per IS: 1893.The detailing of reinforcement shall be as per IS:13920.

EQUIPMENT LOAD (E)

Equipment loads shall be considered as follows:

Equipment Load for Empty Condition E (E)
It is the weight of equipment excluding fire proofing, piping all loose internals, platformssupported from the equipment.

Equipment Load for Test Condition E (T)
It is the weight of equipment including fire proofing, piping, all loose internals, insulation,platforms supported from the equipment and weight of water.

Equipment Load for Operating Condition E (O)
It is the weight of equipment including fire proofing, piping, all loose internals, insulation,platforms supported from the equipment and liquid/gas contents.

Equipment Load (B)
It is the weight of equipment to be considered for maintenance purpose.

IMPACT LOAD

The live loads shall be assumed to include adequate allowance for ordinary impact conditions. However, for structures carrying loads which induce impact or vibration, calculations shall provide for increase in the imposed load due to impact or vibration as perrequirement of IS:875 (Part-2)

OTHER LOADS

Surcharge Load shall be considered as 1 $t/m^2$

Earth pressure

| | | |
|---|---|---|
| Unit wt. of soil shall be taken(□) | = | As per latest soil report |
| Angle of repose (□) | = | As per latest soil report |

$K_a$ = As per latest soil report

## 7. ANALYSIS AND DESIGN METHODOLOGY

Limit state method as per IS: 456 shall be followed in the design for concrete structures except for liquid retaining structures. The design of liquid retaining structures shall be carried out using working stress method as per IS: 3370.

Steel structures shall be designed as per IS: 800.

Detailing of reinforcement shall be done according to IS: 4326, IS: 13920 and SP: 34.

Permissible stresses increase in materials shall be as per respective IS code and shall be considered under Wind/Seismic loading.

Appropriate load factor for Limit State Design shall be considered as per code provisions.

Architectural design of Porta Cabin shall fully meet the functional requirement, shall beadequately sized and provided with sufficient ventilation and natural lighting.

## 8. LOAD COMBINATION

The load combinations shall be generally as per IS: 875 (Part 5).In

general, all structures shall be designed for worst effect.

DL **±** Wind Load with no increase in allowable stress.

Underground structure shall be designed for the following load cases.

i) DL ± LL ± Equipment load
ii) DL ± LL ± Equipment load ± Seismic load.
iii) DL ± Seismic load.
iv) Combination I + Earth pressure + Surcharge pressure
v) Combination II + Earth pressure + Surcharge pressure

## 9. CONSTRUCTION MATERIALS

CONCRETE

Cement concrete used shall comply with provisions of IS: 456-2000 and as specified in the technical specification. All RCC works shall be in design mix concrete of grade M 25 with 20mm and down size aggregate & PCC Works shall be in nominal mix as specified on drawings.

CEMENT

Approved quality of Ordinary Portland Cement of Grade 43 / Grade 53 shall be used for reinforced concrete works; and Portland Pozzalano Cement may be used for non RCC works such as brick masonry and plaster etc. For all underground structure, Sulphate Resistant Cement (SRC) shall be used in accordance with Indian Standards based on detail soil investigation report.

AGGREGATE

Aggregates shall be from approved sources and shall comply with IS 383. Fine and coarse aggregates shall be considered separate ingredients. Both shall meet the grading requirements of IS 383.
Aggregates shall be clean, hard, durable, chemically inert and impermeable. They shall be free from adherent coatings, laminated particles or admixtures of materials likely to be deleterious to the concrete. Dune and beach sand shall not be used for fine aggregate.

The grading for Sand shall conform to IS: 383-1970 and shall be within the limit of Grading Zone-III. The maximum size of particle shall be 4.75mm and shall be graded down.

WATER

Water used for concrete shall be clean and free from oil, acid, alkali, organic matter or other harmful matter in such quantities as would affect the concrete in the plastic or hardened state. Potable water shall generally be considered satisfactory for mixing of concrete. Tests on water samples shall be carried out in accordance with IS: 3025 and theyshall fulfill the guidelines and requirements of IS: 456.

BRICKS

Bricks shall be locally available bricks minimum of class designation 5.0 conforming to IS: 1077.

**REINFORCEMENT STEEL**

**BLD.. STEEL REINFT-TMT-** Providing and placing steel reinforcement in position for RCC works including straightening, cutting, bending, placing in position and binding with 16 SWG black soft annealed binding wire at every intersection, supplying and placing appropriate cover block all complete.

Reinforcement bars for RCC will be High Yield Strength Deformed/TMT steel bars for Grade Fe 415 / Fe 500 D conforming to IS: 1786-2008 and MS bars of Grade I conforming to IS: 432 (Part-I).The maximum spacing of bars shall be as per IS: 456.

STRUCTURAL STEEL

Structural steel is to be used for general structural purposes shall be of grade Fe 415 MPa conforming to IS: 2062. The minimum yield strength of steel shall be 410 MPa. The minimum yield strength for steel structure shall be as follows:

| | |
|---|---|
| Thickness <20 mm | 250 MPa |
| Thickness 20-40 mm | 240 MPa |
| Thickness >40 mm | 230 MPa |

Equipment supports, Access / Operating platforms and crossover shall be fabricated from the structural steel as per requirement. All structural supports, operating platforms & cross over shall be protected with suitable paintings as specified.

Minimum thickness for various structural components shall be as follows:Stiffeners:

8mm
Base Plates: 10mm
Chequered Plate: 6mm
Grating: 3mm

ANCHOR BOLTS

Materials for anchor bolts shall be of mild steel conforming to IS: 226 and IS:432 grade-I. Materials such as MS bars, washers, nuts, pipe sleeves and plates etc. shall conforms to IS : 1363 & IS : 1364 of 1992.

GROUT

Approved quality Non Shrink (Premix Type), free flow grout shall be provided for all anchor bolts, sleeves, pockets, & spaces under column bases, shoe plate etc. with a crushing strength of 28 days minimum 40 MPa.

WELDING

Welding shall confirm to IS 814 -1963. Structural Steel shapes shall conform to IS: 808 (Hot Rolled Steel Beam, Column, Channel & angle Section).

## 10. SITE PREPARATION AND CHAIN LINK FENCING

Site preparation shall be conform to the requirement of the relevant section of this design basis and specification. Salient features of the plot to be developed. The layout and level ofplot shall be prepared and the benchmarks shall be set. Suitable provision of drainage system shall be made outside the plot to divert the natural storm water drainage into the nearest existing drainage system.

Chain link fencing of 1.8 m height made from 3.15 mm diameter GI wire with mesh size of 50x50 mm shall be provided.

## 11. ROADS, DRAINS AND CULVERTS

ROADS

Roads shall be of RCC and shall be designed for IRC loading.

Road width shall be 3 meter width within the plot area. The minimum radius of curvature of the turnings shall be 6.0m unless otherwise mentioned in the relevant drawings. Roads shall be constructed as per the specified drawings.

Approach road including culverts shall be of RCC and shall also be connected with nearest existing metallic road/approach road outside the customer plot for all stations. Carriageway for approach road shall be 4.5m wide or as per existing road.

Roads must be paved with 150 mm thick M25 concrete with nominal reinforcement of 8 diameter @ 200 c/c (both ways at top & bottom) laid over 75 mm P.C.C. (1:3:6). The PCC shall be laid over 200 mm thick compacted boulder layer with sand filling.

STORM WATER DRAIN

The design of storm water drainage shall be based on maximum hourly precipitation for storm deviation of 20 minutes. The drainage system shall be so designed so that the velocity of flow shall be within 1 m/sec to 2.5 m/sec.

Coefficient for design shall be as follows:

| | | |
|---|---|---|
| 1 | Open areas | 0.5 |
| 2 | Road and paved area parking area | 0.7 |
| 3 | Roof surface | 1.0 |

Storm water drain shall be constructed in brick masonry along the periphery of plot to carry storm water from plot area to nearby drain. The drain shall have slope of 1 in 1000 (minimum).

CULVERTS

RCC Hume pipe NP-3 class has been considered for crossing drains under the roads as per site conditions. Piping culverts under roads shall be of RCC box-shaped.6

## 12. PROCESS AREA

Process area consists of valves, equipment's, metering skid etc. Entire process area shall be paved with 150 mm thick M25 concrete pavement with nominal reinforcement of 8 diameter @ 200 C/c (both ways at bottom) laid over 75 mm P.C.C. (1:3:6). The PCC shall be laid over 200 mm sand filled over well compacted sub base. The paving shall be laid in panels and designed joints shall be provided with approved quality separators & joint sealant. Boulders soling to be provided in sub-base based on geotechnical investigation recommendation, if required.

EQUIPMENT FOUNDATION

Equipment foundation supporting lightweight equipment and coming within the processarea may be made an integral part of the paved area. However, heavy equipment's shall have isolated equipment foundation even if coming within process area.

Loose fills, expansive soil etc if found beneath the equipment foundation shall be removed and back filled either with PCC (1:3:6).

PIPE SUPPORT FOUNDATIONS

Pipe supports shall be provided as per mechanical layout drawings for piping. The pipe support may lie within the process area or at any other location. The pipe support foundations shall be designed to take care of the loads and it's fixing details as per standard drawings. Pipe support in process area shall be integral part of pavement. Isolated pipe supports shall however be provided outside the process area.

## 13. VALVE PIT

Valve Pit shall be constructed in reinforced concrete of grade M25. High density rubber padshall be wrapped around the pipe in contact with RCC. The valve pit shall be covered with precast concrete on top of pit with hook provision for lifting.

## 14. SIGN BOARDS

Signboards shall be provided at all sites as per direction of Owner.

Galvanized Iron Concertina:

Galvanized Iron Concertina Wire, Cross Razor Razor Type Material-Iron Surface Treatment-Galvanized Soil Flling (excavation by mechanical means (Hydraulic excavator) / manual means in foundation trenchesordrains)

ROOF. GI SHEET 20 GAUGE:

ROOF. GI SHEET 20 GAUGE -Supplying and fixing corrugated G.I. sheet roofing thick with G.I. 'J' or 'L' hooks 10 dia.; G.I. limpet and Bitumen washer complete excl. the cost of purlins; rafters trusses.

# SITE CLEARING, AREA GRADING EXCAVATION & EARTHWORK

## CONTENTS

## 1.0 INTRODUCTION

This specification deals with site clearing, earthwork and excavation, leveling, cutting and grading, area filling and backfilling for area designated in the drawings.

**EXC ORD SOIL UPTO 1.5 MEXCAVATION**-Excavation in all kinds of soil such as black cotton, silt, earth; murrum; gravel; kankar; boulders; etc. excluding soft and hard rock and carting away the excavated earth to unobjectionable place.

## 2.0 SETTING OUT

Before commencement of earthwork, block levels of existing ground shall be taken by the Contractor jointly with the Engineer. Excavation shall not be commenced until the initial ground levels have been recorded and accepted. Reference lines, bench marks and base lines shall be set out by the Contractor for control of earthwork operation.

Setting out shall be done with pegs, blocks, bamboo poles, marking boundaries or centre lines, as the case may be, and the same shall be maintained for reference and future checking.

Engineer shall be provided with necessary men, material and instruments for checking and approval. However, such checking and approval by the Engineer shall in no way absolve the Contractor of his responsibilities for carrying out the work to the true lines, levels and positions as per drawing and subsequent corrections, if any.

## 3.0 SITE CLEARANCE AND DEMOLITION

The site shall be cleared of all trees, stumps, roots, brush wood, bushes and other objectionable materials. Useful and saleable material, if any shall be the property of the owner and shall be stacked properly as directed by the Engineer.

The areas to be covered with embankments shall be stripped of top soil to required depths to expose acceptable founding strata. Top soil unsuitable for use in embankment construction and other fills shall be disposed off as directed. All combustible materials shall be stacked and burnt in locations sufficiently remote to eliminate all danger of fire hazards. All old concrete, brick works and drains which interfere with construction works shall be dismantled with the approval of the Engineer taking all necessary precautions prescribed in safety specification. Top soil which is suitable for use in construction work shall be stockpiled for later use. Other objectionable materials such as trash, debris, stones, brick, broken concrete,scrap metal etc., shall be disposed off as directed by the Engineer.

## 4.0 CLASSIFICATION OF SOIL

The Engineer will decide the class of any particular soil. Classification of soil shall be as under and the decision of the Engineer shall be binding on the Contractor:

ORDINARY SOIL

Soils which yield to ordinary application of pick and shovel, phawra rake or other ordinary digging implements (including earth moving equipment such as bulldozer, shovels without resorting to blasting) without offering much resistance, shall be classified as ordinary soil. This includes organic soil, turf, sand, gravel, loam clay, mud, peat, black cotton soil, soft shale and loose moorum etc.

HARD SOIL

This comprises of all soils that cannot reasonably be excavated by the above mentioned digging implements, but can be excavated with close application of pick axe or scarifiers or jumpers to loosen. This includes compact moorum, stiff clay, hard shale, cobble stone etc.,

SOFT /DECOMPOSED ROCK

This comprises of rock or boulders which may be quarried or split with crow bars, pavement breakers etc., This include lime stone, sand stone, weathered rocks and hard conglomerates etc .and existing structures embedded in earth and tarred macadam roads, pavements, met in the excavation.

HARD ROCK

This comprises of rocks which require blasting for excavation. Where blasting is prohibited, excavation has to be carried out by chiseling, wedging or any other agreed methods.

## 5.0 METHOD OF EXCAVATION

The Contractor may carry out excavations, filling and compaction by any method considered most suitable and befitting the site conditions subject to any stipulations contained in the contract and the specifications. All excavations shall be required to be kept completely free from water, from whatever source it may come during the construction. No foundation work shall be taken up until the surfaces are properly drained.

## 6.0 EXCAVATION OF SOILS OTHER THAN HARD ROCK

Excavation shall be carried out in the most expeditious and efficient manner to the lines and levels as indicated in drawings or as directed by Engineer. Prior approval of the Engineer shall be taken for the method to be adopted for excavation including dimensions, side slopes, dewatering, shoring etc. Approval shall not make the Engineer responsible for any consequent damage or loss caused.

All precautions shall be taken to preserve the material below and beyond line of excavation in soundest condition. All damages done beyond limits of excavation shall be made good by the Contractor at his own cost in a manner approved by the Engineer.

All excavated materials shall be removed to spoil heaps, dumping yards or transported for filling as may be necessary. When soil heaps are formed for future use, heaps shall be protected from washing away due to rain or surface run off. The sides of excavation shall be maintained in stable condition by adequate stepping and batter. To prevent entry of surface water and accumulation of subsoil water in excavated areas, suitable drainage arrangements as may be needed and directed by Engineer shall be provided and maintained. Pumped out water shall be drained off properly avoiding damage to other existing works. If any pipelines, cables or service lines are likely to be exposed, excavation around these services shall be carried out manually and all such services shall be adequately supported and protected at no extra cost.
Excavation shall be carried out in any material encountered including road surfaces, pavements, buried parts of old foundations, pits or other structures. Excavated materials shall be placed beyond 1.5 meters of the edge of the excavation pit/trench or half the depth of the pit/trench whichever is more or further away as directed by the Engineer. Sumps made for dewatering must be kept clear of the foundations.

In firm soil the sides of the trenches shall be kept vertical up to a depth of 2.0m from the bottom and for a greater depth, trench shall be widened by allowing steps of 50cm on either side after every 2.0m depth from the bottom, so as to give a vertical side slope of 1/4: 1. Where the soil is soft, loose or slushy, the width of the steps shall be suitably increased or sides suitably sloped or suitable shoring and strutting provided as directed by the Engineer. For trenches deeper than 2.0m, the Contractor shall obtain detailed instruction from the Engineer in writing regarding the stepping, sloping of sides or shoring and strutting to be done.For these bye-works, no extra cost will be paid to the Contractor.

## 7.0 EXCAVATION IN HARD ROCK

Where hard rock is met and blasting is considered necessary for its excavation, the Contractor shall intimate the Engineer in writing. Excavation in hard rock shall be done either by blasting or chiseling or by such other agreed methods as may be required. Levels of hard rock surface shall be taken and got approved by Engineer before start of excavation. Blasting shall be permitted only when proper precautions are taken for protection of persons, works and property. The Contractor shall obtain the necessary license for procuring, storing and using explosives.

Blasting operations shall be carried out by a licensed Blaster. The quality and quantity of explosives, size and spacing of holes depth of holes etc. shall be such that they will neither open seams nor damage/shatter the rock beyond the specified lines of excavation. A tolerance of 150 mm will however be allowed beyond the excavation lines. As excavation approaches final stages, the depth of holes and the amount of explosives used shall be reduced progressively to avoid over breakage or damage to founding strata. Any fissures, cracks and voids below prescribed depth of excavation shall be corrected by removing loose pieces, shattered or affected rock and replaced by lean concrete of M-7.5 grade in the case of foundations. Where excavated surface is to receive structural concrete, the surface shall be cleaned of dust and other objectionable materials.

In cases where blasting, though otherwise required is prohibited because of any reason, the excavation shall be carried out by chiseling, wedging or such other agreed methods. All materials excavated from blasting, chiseling or any such methods shall be stacked for measurement as directed by Engineer.

## 8.0 CUTTING AND FILLING FOR SITE LEVELING

Excavation and filling operations for site leveling shall be so planned and executed, that transportation and re-handling are minimized. The sides of excavation and fills shall be maintained in stable condition by adequate batters, stepping and dewatering. Materials not desirable shall be disposed off in area indicated by Engineer. When it is required to blend the material, it shall be done by selective excavation and filling operation. Wells, ponds, cesspools and water logged areas shall be emptied of water before filling. Filling shall be done in horizontal layers not exceeding 300mm in thickness as specified or as directed by the Engineer. All clods shall be broken before placing the fill. Earth moving equipment shall be allowed to ply over the fill to permit compaction. Adequate allowance shall be made for subsidence of fill material. Levels shall be taken and excess or shortfall shall be made good by appropriate cutting or filling.

## 9.0 EXCAVATIONS FOR FOUNDATIONS

Excavation for foundation shall be done to the lines and levels indicated in the drawings. Excavated material shall be transported and stored at convenient spots for reuse in back filling of foundations and other fills. Surplus material shall be transported, spread and leveled at dumping areas. Side slopes of excavation and/or shoring shall be adequate from consideration of stability and working space. When so required and authorized by Engineer, the sides of excavation shall be protected with proper shoring, strutting, sheeting and sand bags etc. These shall be removed only when work in the pit is completed with the approval ofthe Engineer. When it is felt that removal of supports may result in side collapse or settlementof adjoining ground or endanger adjoining structures and foundations, they shall be left permanently in position. The last 150 mm of excavation shall be done and the bottom trimmed to the required levels only when concreting is imminent. If at any point the natural ground is disturbed or loosened for any reason, it shall be consolidated by tamping or rolling or made up with concrete of M-7.5 grade cement concrete at no extra cost. Where the soil encountered at depths indicated in drawings is loose or weak, it shall be further excavated tolevels of firm strata as may be directed by the Engineer and filled with lean concrete of M-7.5grade cement concrete or sand as directed.

## 10.0 EXCESS EXCAVATION

All excavation done beyond the specified limits or directions of Engineer shall be considered as excess excavation. They shall be made good as prescribed below by the Contractor at his cost:

(i). Excess excavation in case of site leveling shall be made good by filling and compacting with material same as the surrounding material. Degree of compaction shall be at least the same as the surrounding material.

(ii). Excess excavation in case of foundation beyond required depths shall be made good by filling with lean concrete of M-7.5 grade cement concrete.

## 11.0 DISPOSAL

Excavated materials that are unsuitable for use in construction works or in excess of construction requirements shall be disposed off in dumping yards or in locations indicated by Engineer. Waste piles/heaps shall be located in such places where they will not interfere with natural flow of rain water access or transport or with the access to nearby structures. When required, they shall be leveled and trimmed to such lines and levels as indicated by Engineer

## 12.0 BACKFILLING

Backfilling of foundations shall be done using suitable soils from excavations. Soil shall be free from organic matter and other materials which would affect the stability of the fill and shallbe free from boulders, brick bats wood pieces and other injurious materials, lumps and clods.
Before commencement of backfilling of foundations all shoring and formwork, bits of timber, cement bags and all other rubbish shall be removed. Backfilling operation shall not commence without approval of Engineer. Backfilling shall be carried out in well compacted layers of 150 mm thickness. Each layer shall have near optimum moisture content. Layers will extend to the entire width of excavation and shall be sprinkled with water during compaction process. Ramming shall be done to achieve firm compaction. Backfill shall be trimmed and finished to levels indicated in the drawings and/or as directed by the Engineer. Mechanical equipment like vibratory roller, vibro earth rammer or vibratory compactor shall be used for compaction.

## 13.0 EARTH FILLING

Material for filling shall be selected earth obtained from excavations for site leveling, trenches and foundations or from selected borrow areas as may be required. Soil shall be of uniform quality and free from boulders, organic materials and other objectionable matter and shall not be expansive soils. Filling shall be done in well compacted layers not exceeding 150 mm in thickness. Each layer shall be compacted to 95% Standard Procter Density. Sufficient soaking shall be done before compaction. The entire area shall be finally dressed and trimmed to required levels. Mechanical equipment like vibratory roller, vibro earth rammer or vibratory compactor shall be used for compaction.

# PLAIN CEMENT CONCRETE & ALLIED WORKS

**TABLE OF CONTENTS**

## 1. INTRODUCTION

This specification covers the general requirements for concrete to be used on jobs using on-site production facilities including requirements in regard to the quality, handling, storage of ingredients, proportioning, batching, mixing and testing of concrete, and also requirements in regard to the quality, storage, bending and fixing of reinforcement. This also covers the transportation of concrete from the mixer to the place of final deposit and the placing, curing, protecting, repairing and finishing of concrete.

## 2. PLAIN CEMENT CONCRETE 1:3:6 OR AS SPECIFIED :

Plain cement concrete shall be in proportion of 1:3:6 or as specified. i. e. in volume by one part of cement, three part of coarse sand and six parts of black stone aggregate of size 40 mm size.

The building materials as stated above shall be mixed in dry condition with power driven concrete mixer. After materials are properly mixed, water shall be added and materials shall again be mixed in concrete mixer It should be watched that no excessive water is added so that permissible water cement ratio is maintained throughout during the progress of concrete work. Before the concreting work, necessary centering work if so necessary shallbe provided for which payment shall be done separately under respective items. All the materials shall be got tested for every lot from govt. approved Engineering testing laboratories as per I.S. code of practice and test certificates shall be submitted to Owner/site engineer .

The concrete so prepared shall be stacked in water tight platform .The concrete should not be thrown from height so that segregation may not take place. The concrete so placed shall be properly compacted with concrete vibrator machine to avoid voids .Moreover concrete shall be compacted in such a way that the surface is become smooth and no honey combing is observed.

After properly setting of concrete, curing shall be done for minimum period of seven days.

**FOUNDN. PCC WITH 20MM METAL** 1:3:6- FOUNDATION; PLINTH; SUPER STRUCTURE Providing & laying cement concrete at all height/depth using 20mm metal incl. necessary shutting form work &curing for a period of 14 days Removing of centering.

## 3. M-20 CEMENT CONCRETE :

The cement concrete shall be in proportion.(1:1.5:3) i.e. in volume by 1 part of cement,1.5 parts of coarse sand and 3 parts of black stone aggregate of size 20 mm size. The stone aggregate shall be of even size and black in color without any white spot. The aggregate shall be got approved from engineer in charge /Owner. The building materials as stated above shall be mixed in dry condition with power driven concrete mixer. After materials are properly mixed, water shall be added and materials shall again be mixed in concrete mixer. It should be watched that no excessive water is added so that permissible water cement ratio is maintained throughout during the progress of concrete work. Before concreting work, necessary centering work and reinforcement as per structural drawing shall be placed for which payment shall be done under respective items. All the materials shall be got tested for every lot from govt. approved Engineering testing laboratories as per I.S. code of practice and test certificates shall be submitted to Owner/Owners representative.

After setting of concrete, sufficient curing shall be done for minimum period of seven days. During concrete work, concrete cube of size 150m.m. x 150 m.m. x 150 m.m. shall be prepared and these concrete cubes shall be got tested for compressive strength from approved engineering testing laboratories and testing certificate should be submitted to Owner/Owners representative. The slump test shall also be carried out on site of work during every concrete work on site.

**FOUNDN. RCC 1:1.5:3 Mix FOUNDN.** RCC 1:1.5:3 Mix FOUNDATION; PLINTH; SUPER STRUCTURE Providing and laying reinforced cement concrete using reinforcement and 20mm metal incl. shuttering form work and curing for a period of 14 days. Removing of centering,

## 4. APPLICABLE CODES AND SPECIFICATIONS

The following specification, standards and codes shall form a part of this specification. All standards, tentative specifications, codes of practice, referred to herein, shall be the latest editions including all applicable official amendments and revisions.

In case of discrepancy, if any, between this specification and those referred to in the following, the latter shall be govern.

Applicable Specifications and Codes of Practices.

I.S. 269 - Specification for ordinary and low heat Portland cement.

I.S. 383 - Specification for coarse and fine aggregate from natural source for concrete.

I.S. 2386 - Method of test for aggregates for Concrete (Part I to VIII)

I.S. 516 - Method of test for strength of concrete

# CHAIN LINK FENCING

## CONTENTS

## 1.0 INTRODUCTION

This specification specifies the requirements of chain link fence for security purposes.

## 2.0 MATERIALS

Material for chain link fencing shall conform to IS: 2721 latest edition. Mesh for chain link fencing shall be of 3.15mm hot dip galvanized steel mesh wire, the diameter being measured over zinc coating. The diameter of mesh wire shall not vary from the specified diameter by more than 0.05mm. The material for mesh wire and line wire of chain link fencing shall conform to IS: 280-1978. Stretcher bar for erection of mesh shall consist of mild steel flats 25mmx4.75mm. The stirrup wire for securing the line wires to the intermediate post shall be of 2.5mm mild steel wire. Hairpin staples for fastening the bottom line wire to the foundation concrete shall be of 6mm mild steel wire with ends of staples bent outwards for adequate anchorage. The cleats for eyebolts shall be of mild steel plate 10mm thick.

Material for barbed wire shall conform to IS: 278 latest edition. Line wire for the barbed wire shall be made from two strands of galvanized steel wire of nominal diameter 2.5mm twisted together. Barbs shall be made of point wire of galvanized steel of nominal diameter 2.5mm in such a way that four points of the barbs are set and located or locked as far as possible at right angles to each other. The barbs shall have a length of not less than 13mm and not more than 18mm.Droppers for barbed wire shall be of mild steel flat 25mmx4.75mm with 38mmx4.85mm half round staples for fastening the barbed wire.

## 3.0 ERECTION

Straining posts shall be provided at all ends and corners of fences, at changes in direction or acute variations in level and at intervals not exceeding 60m on straight lengths of fence. Intermediate posts shall be spaced at regular intervals not exceeding 3m. Struts shall be fitted to all straining posts behind the chain link fabric in the direction of the line of fence.

There shall be four evenly spaced rows of line wire. The top wire shall be doubled, making five line wires in all. The bottom wire shall be close to the ground. Each line wire shall be strained lightly by means of eyebolt strainer at each straining point. The eyebolt strainer shall consist of bolt with welded eye. The bolt shall be sufficiently threaded and fitted with a nut and washer. Each line wire shall be secured to each of the intermediate posts by a wire stirrup passing through holes in the posts and secured to the line wire by three complete turns on each side of the post. Two-way eyebolt strainers shall have suitable ring nuts fitted after wires have been strained on one side.

The mesh shall be strained between each pair of straining posts and shall be secured to each straining post by means of a stretcher bar. One of the top line wires shall be threaded through the appropriate adjacent rows of mesh, care being taken that no meshes in the rows are by-passed by the line wire except where deviation is necessary at the straining posts. The second top line wire shall be strained in front of the fencing. The mesh shall be attached to top and bottom line wires by wire ties spaced 150mm apart and to other line wires by wire ties spaced 450mm apart. Bottom row of the mesh shall be threaded to the foundation concrete using staplesspaced 500mm apart and set in concrete to a depth of 150mm. The top of concrete shall be 50mm above G.L. and 50mm below the fencing.

**FENCING:** CHAINLINK WITH BW TO 1.8 M HIGFENCING. CHAINLINK WITH BW TO 1.8 M HIGFENCING/BOUNDARY WALL Supplying and erecting chain link fencing with 2nos. 4mm GI straining wire on the following heights of angle iron posts at approximately 2.5m centre to centre embedded in CC IN Y SHAPE to accommodate concertina coil at TOP for security( To be incorpoarted in cost). Proper angle/ Channel with cross at Bottom and Top with painting to be provided for stability (Only foundation Brick work to be paid separately and angle/ Channel with crossatBottomandTop)

# STRUCTURAL CONCRETE

## CONTENTS

## 1.0 INTRODUCTION

This specification covers the materials, workmanship, special requirements & regulations with which the contractor must comply to achieve dense workable concrete, having the specified characteristic strength.

The mixing, placing, compacting, curing and finishing of concrete shall be done according to IS: 456-2000 "Code of Practice for Plain and Reinforced Concrete".

## 2.0 MATERIALS FOR CONCRETE

AGGREGATES

Aggregates shall comply with the requirements of IS: 383-1970 "Coarse and Fine Aggregates for Concrete". They shall be hard, strong, dense, durable, clean and free from veins and adherent coating, vegetable matter and other deleterious substances; and shall be obtained from approved sources. Aggregates shall not contain any harmful material such as pyrites, coal, lignite, shale or similar laminated material, clay, alkali, soft fragments, sea shells and organic impurities in such quantity as to affect the strength or durability of concrete. Aggregates which are chemically reactive with alkalies of cement shall not be used. Aggregates which are not sufficiently clean shall be washed in clean fresh water to the satisfaction of the Engineer.

TESTING

All aggregates shall be subject to inspection and testing. The Contractor shall submit samples for testing as may be required by the Engineer. Sampling and testing shall be carried out in accordance with IS: 2386-1963 "Methods of Test for Aggregates for concrete".

GRADING

The Contractor shall ensure that the full range of aggregate used for making concrete is graded in such a way as to ensure a dense workable mix. The delivery of aggregates will commence only when the Engineer has approved the samples and the quality and grade shall be maintained consistent and equal to the approved sample. Before construction commences, the Contractor shall carry out a series of tests on the aggregates and on the concrete to determine the most suitable grading of the available aggregates. Once the most suitable grading has been found, the grading shall be adopted for the construction of the works and periodic tests shall be carried out to ensure that it is maintained.

SIZE AND GRADING OF FINE AGGREGATES

The grading shall conform to IS: 383 and shall be within the limits of Grading Zone-III. The maximum size of particle shall be 4.75mm and shall be graded down. Sand containing more than 10% of fine grains passing through 150 micron sieve or having the fineness modulus less than 2 shall not be used for concrete work.

SIZE AND GRADING OF COARSE AGGREGATES

The nominal maximum size of the aggregates for each mark of concrete or for each type of work shall depend upon the description of the particular item in the Schedule of Items and/or according to relevant clauses of IS: 456-2000. The aggregates shall be well graded and the grading shall conform to relevant requirements of IS: 383 depending upon the maximum nominal size as specified or as required.

TYPE OF COARSE AGGREGATES

The type of coarse aggregate viz., stone chips, gravel or broken brick shall be as described in the Schedule of Items. Unless otherwise specified in the Schedule of Items, stone chips shall be used as coarse aggregate.

- STONE CHIPS

It shall be crushed or broken from hard stone obtained from approved quarries of igneous or metamorphic origin. The stone chips shall be hard, strong, dense, durable and angular in shape. It shall be free from soft, friable, thin, flat, elongated or laminated and flaky pieces and free from dirt, clay lumps, and other deleterious materials like coal, lignites, silt, soft fragments, and other foreign materials which may affect adversely the strength & durability ofconcrete. The total amount of deleterious /foreign materials shall not exceed 5% by weight according to relevant clause of IS: 383.

- GRAVEL

It can be either river bed shingle or pit gravel. It shall be sound, hard, clean, and irregular in shape and suitably graded in size with or without some broken fragments. It shall be free from flat particles, powdered clay, silt, loam and other impurities. Before using, the gravel shall be screened and washed to the satisfaction of the Engineer. However, the foreign/deleterious materials shall not exceed 5% by weight.

- BROKEN BRICKS

These shall be obtained by breaking well burnt or over burnt dense brick bats. They shall be homogeneous in texture, well graded in size, roughly cubical in shape, clean and free from dirt, clay, silt or any other deleterious matter. Before use, these shall be screened.

FINE AGGREGATES

Unless specified otherwise it shall either be natural river sand or pit sand.

Sand shall be clean, sharp, strong, angular and composed of hard siliceous material. It shall not contain harmful organic impurities in such form or quantities as to affect adversely the strength and durability of concrete. Sand for reinforced concrete shall not contain any acidicor other impurities which are likely to attack steel reinforcement. The percentage of all deleterious materials including silt, clay etc., shall not exceed 5% by weight. If directed, sandshall be screened or washed before use to the satisfaction of Engineer.

CEMENT

Ordinary Portland cement / Portland slag cement complying with the requirements of IS:269-1989 and I.S. 455-1989 respectively shall be used for making plain and reinforced concrete, cement grout and mortar.

Other types of cement may be used depending upon the requirements of certain jobs with the approval of the Engineer. These shall conform to the following standards:

The Contractor shall supply a copy of the manufacturer's test certificate for each consignment of cement supplied by him and consignments shall be used on work in the order of delivery. The Contractor shall supply samples of cement to the Engineer as frequently as he may require for testing. The sampling of cement for testing shall be according to IS: 3535-1986. All tests shall be in accordance with the relevant clauses of IS: 4031 (Part-I to Part-15) 1988 to 1991 & IS: 4032-1985.

In order to ensure due progress, the Contractor shall at all times maintain on the site at least such stock of cement as the Engineer may from time to time consider necessary. No cement shall be used upon the works until it has been accepted as satisfactory by the Engineer.

The cement shall be stored in such manner as to permit easy access for proper inspection and in a suitable weather-tight, well ventilated building to protect it from dampness caused by ingress of moisture from any source. Different types of cement shall be stored separately. Cement bags shall be stacked at least 15 to 20 cm clear of the floor leaving a space of 60 cm around the exterior walls. The cement shall not be stacked more than 10 bags high. Each consignment of cement shall be stacked separately to permit easy access for inspection.

WATER

Water used for mixing concrete and mortar and for curing shall be clean and free from injurious amounts of oil, acid, alkali, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. The pH value of water shall generally be not less than '6'. Water has to meet the requirements mentioned in clause 4.3 of IS: 456-2000. Watershall be obtained from an approved source.

Where it is obtained from a source other than a supply main, it shall be tested to establish its suitability. Water for construction purpose shall be stored in proper storage tanks to prevent any organic impurities getting mixed up with it.

ADMIXTURE

Admixtures to concrete shall not be used without the written consent of the Engineer. When permitted, the Contractor shall furnish full details from the manufacturer and shall carry out such test as the Engineer may require before any admixture is used in the work.

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REINFORCEMENT STEEL

Reinforcing bars for concrete shall be round steel bars of the following types as may be shown on the drawing:

- Plain mild steel bars conforming to Grade-I of IS: 432-1982 "Mild Steel & Medium Tensile Steel for Concrete Reinforcement".
- "High strength deformed steel bars conforming to IS : 1786-2008 for Concrete Reinforcement".
- Reinforcement fabrics conforming to IS:1566-1982 "Hard Drawn Steel Wire Fabric for Concrete Reinforcement"

All reinforcement bars shall be of uniform cross sectional area and be free from loose mill scales, dust, loose rust, coats of paint, oil or other coatings which may destroy or reduce bond. Unit weight of reinforcement bars conforming to I.S. 1786-1985 is given below.

| **Nominal Size (Dia) (mm)** | **Mass Per Meter Run (Kg)** |
|---|---|
| 6 | 0.222 |
| 8 | 0.395 |
| 10 | 0.617 |
| 12 | 0.888 |
| 16 | 1.580 |
| 20 | 2.470 |
| 25 | 3.850 |
| 32 | 6.310 |

Binding wire for reinforcement shall be annealed steel wire 20 BWG conforming to IS : 280 - 1978 "Specification for Mild Steel Wire".

FOUNDATION BOLTS

Bolts to be embedded in concrete shall, unless otherwise detailed in drawings, conform to IS : 5624-1970 "Specification for Foundation Bolts". Material for bolts, shall, unless otherwise mentioned in drawings or the schedule of items, be of steel conforming to IS : 2062-1992.

Nuts and locknuts shall conform to IS : 1363 (Part 1 to 3) -1992 "Specification for Black Hexagon Bolts, Nuts and Lock Nuts (Diameter 6-39 mm) and Black Hexagon Screws "Specification for Hexagon Bolts and Nuts (M-42 to M-150)".

Plain washers shall conform to IS : 2016 -1967 "Specification for Plain Washers and spring washers shall conform to IS : 3063 -1972 "Spring Washers for Bolts, Nuts & Screws".

## 3.0 CONCRETE MIX PROPORTIONING

The mix proportion shall be selected to ensure adequate workability when handling and placing. On hardening, concrete shall have the required strength, durability and surface finish. The determination of the proportions of cement aggregates and water to attain the required strength shall be either:

- By determining the concrete mix; such concrete shall be called “Design Mix Concrete”, or
- By adopting nominal concrete mix; such concrete shall be called “Nominal Mix Concrete”.

Concrete of grade M20 and above shall be ‘Design Mix Concrete’ unless otherwise specified. In either case, the Contractor shall be solely responsible to ensure that the concrete has all the essential properties, i.e. characteristic compressive strength, and any additional properties that may be specified.

MIXES & MIXING

Concrete for construction shall be as detailed in the table of concrete mixes & as shown by test cube results as specified. This list may be extended by the addition of other mixes as required and to the approval of the Owner/Owner’s Representative.
The criteria stated in the table of concrete mixes are designed to produce concrete of the required strength & durability.
The specified characteristics strength is for concrete which has been cured at a temperature of 20°C ± 1°C. The term “characteristics strength” represents the value of the strength of concrete corresponding to the probability that, for a normal statistics distribution of the test results for determining the strengths by the compression tests, only 5% of the test result have a value lower than the one determined in this way.
The mixes shall be designed mean strengths that are greater than the specified characteristics cube strength by a margin of 1.64 times the standard deviation expected fromthe concrete batching plant, except that no standard deviation of less than 3.5N/mm² shall beused as a basis for designing a mix.
Mixes shall be designed with due regard for minimum workability necessary to allow the contractor to place & compact the concrete as specified with the equipment he proposes to use in any particular situation.

| TABLE OF CONCRETE MIXES | | | |
|---|---|---|---|
| **Concrete Grade** | **Minimum Qty of cement Kg/m³** | **Maximum free water-cement ratio** | **Characteristics strength150 mm Cube** |
| M20 | 300 | 0.55 | 20 |
| M25 | 300 | 0.5 | 25 |
| M30 | 320 | 0.45 | 30 |
| M35 | 340 | 0.45 | 35 |
| M40 | 360 | 0.4 | 40 |

Where air-entrainment is specified the average air content as measure in accordance with relevant Indian codes:

a. Concrete containing 40 mm max. size aggregate 4.0%±1.0%
b. Concrete containing 20 mm max. size aggregate 5.0%±1.0%

These air contents are applicable at the time of concrete placing.

Concrete for paving or non structural pre-cast units shall have minimum flexural beam strength of 3.5 N/mm² at 28 days.

DESIGN MIX CONCRETE

At least two weeks before commencement of concreting of a particular grade in permanent works, the Contractor shall have obtained the Owner/Owner's Representative's approval of the Design Mix for that particular grade.

TRIAL MIXES

STRUCTURAL CONCRETE

The mix(s) shall be designed mixes in accordance with IS SP23 Handbook on Concrete Mixes and IS 10262 and as specified in this document. The relative proportions of the fine and coarse aggregates, the workability and strengths of the mixes shall be determined byproduction equipment trial mixes. The trial mixes shall be carried out in order to produce a concrete which can be properly placed and compacted, so that a dense impermeable concrete can be produced which shall adequately resist the ingress of damaging salts. If an admixture is proposed it shall be used in the trial mixes. The required workability for large foundations will differ from that for tall thin sections of structural concrete cast above ground and the trial mixes shall allow for both cases.
When the proposed workability and proportion of the aggregates and admixture (if any) for each of the grades of concrete has been established, test concrete shall be produced for approval. The following tests shall be carried out for each grade of concrete:
Four separate test mixes shall be prepared and six test cubes shall be made from each test mix for each grade of concrete. The test cubes shall be made and cured in accordance with IS 516.Testing shall be made in threes or multiples of threes. Only 28-day result shall be considered and the mean strength and standard deviation established for each grade.
The test mixes shall be accepted provided that:
a) The mix proportions and workability are in accordance with this Specification.
b) The standard deviation for all the different grades shall be worked out as per clause 2.1 of IS: 10262-1982.
c) The acceptance criteria shall be in accordance with clause 16 of IS 456.

| **Maximum Water Cement Ratio in Cement Concrete to Ensure Durability under specified exposure** | | |
|---|---|---|
| **Condition of Exposure** | **Concrete** | |
| | **Plain** | **Reinforced** |
| **Moderate** | 0.6 | 0.50 |
| For Example Sheltered from heavy and wind driven rain and against freezing, whilst saturated with water, buried concrete in soil and concrete continuously under water | | |
| **Severe** | 0.5 | 0.45 |
| For Example Exposed to Sea water, alternate wetting and drying and to freezing while wet, subject to heavy condensate or corrosive fumes | | |

Based on the results of the preliminary test, the contractor shall select a final design mix for the trial mixes and shall furnish the same to the Owner/Owner's Representative. The contractor shall demonstrate that the proposed design mix will produce the grade and quality

of concrete required with adequate workability
A fresh mix design shall be arrived at each time there is a change in the quality or source of materials

| **Minimum Cement Content (Ref IS 456, Table 5)** | | |
|---|---|---|
| **Plain Concrete** | | |
| **Exposure** | **Min. Grade of Concrete** | **Min. Cement Content (kg/m3)** |
| Mild | - | 220 |
| Moderate | M15 | 240 |
| Severe | M20 | 250 |
| Very Severe | M20 | 260 |
| Extreme | M25 | 280 |
| | | |
| **Reinforced Concrete** | | |
| **Exposure** | **Min. Grade of Concrete** | **Min. Cement Content (kg/m3)** |
| Mild | M20 | 300 |
| Moderate | M25 | 300 |
| Severe | M30 | 320 |
| Very Severe | M35 | 340 |
| Extreme | M40 | 360 |

NOMINAL MIX CONCRETE

No mix design or preliminary tests are necessary for Nominal Mix Concrete. Nominal Mix Concrete shall be restricted to works of minor nature in which the strength of concrete is not critical as decided by the Engineer. The limit of chloride content of concrete shall be as follows:

| **Type or Use of Concrete** | **Max. Total Acid Soluble chloride content expressed as kg/m3 of concrete** |
|---|---|
| Concrete containing metal and steam cured at elevated temperature and pre-stressed concrete. | 0.4 |
| Reinforced or plain concrete containing embedded metal | 0.6 |
| Concrete not containing embedded metal | 3.0 |

BATCHING

In proportioning concrete, the quantity of both cement and aggregate shall be determined by weight. If fine aggregate is moist and volume batching is adopted, allowance shall be made for bulking in accordance with IS 2386 (Part III). All measuring devices shall be accurate to + 3% and shall be regularly checked.
The water-cement ratio shall be maintained constant at its correct value. To this end, determination of moisture content in both fine and coarse aggregate shall be made by the Contractor at no extra cost. The frequency of tests shall be determined by the Engineer according to weather conditions.

## 4.0 FORMWORK

The design and construction of the formwork shall be the responsibility of the Contractor. However, if instructed by the Engineer, the drawings and calculations for the design of the

formwork shall be submitted to the Engineer for approval. Design of formwork shall take account of safety and surface finish. The formwork shall be sufficiently rigid and tight to prevent loss of grout or mortar from the fresh concrete.

Formwork shall be designed to withstand the worst combination of self weight, reinforcement weight, wet concrete weight, concrete pressure, construction and wind loads together with dynamic effect caused by placing, vibrating and compacting the concrete. Forms shall be designed and constructed to maintain rigidity throughout the placing, ramming, vibration and setting of the concrete to the required shape, position and level and specified class of finish within the allowable tolerances. All joints shall be sufficiently tight to prevent leakage of grout. If movement or deflection of the formwork or loss of grout occurs, the damaged concrete supported by such formwork shall be removed and the concrete re-cast so that the required finish is obtained. Formwork and its supports should be designed to withstand the worst combinations of self-weight, reinforcement and wet concrete weights, concrete pressure, construction and wind loads. Due regard shall be taken to the type of mix when considering the design pressure on the formwork. The formwork shall be precambered by an amount equal to the expected maximum deflection shall be as shown on the drawings.

If timber forms are used they shall be of sound, well-seasoned timber free from loose knots. The forms shall be faced to give the specified class of finish for the structures. The formed surfaces of exposed concrete shall be smooth, true and free from all irregularities.

For below ground concrete except against existing structures, rough formwork, steel pans etc., provided all joints prevent the loss of grout.

The formwork shall be capable of being dismantled and removed from the cast concrete without shock, disturbance or damage. The arrangement shall be such that the soffit forms properly supported on props, can be retained in position for such period as may be required by maturing conditions or specifications.

CLEANING AND TREATMENT OF FORMS

All rubbish shall be removed from the interior of the forms before the concrete is placed. The faces of the forms in contact with the concrete shall be clean and treated with a suitable release agent, where applicable. Release agent shall be applied so as to provide a thin uniform coating to the forms without contaminating the reinforcement.

STRIKING OF FORM WORK

In normal circumstances where Ordinary Portland Cement is used, forms shall generally be removed after the expiry of the following periods:

| | |
|---|---|
| Walls, Columns and vertical faces of all structural members | 24 to 48 hours |
| Slabs (Props left Under) | 3 Days |
| Beam Soffits (Props left Under) | 7 Days |
| Removal of Props under Slabs: | |
| 1) Spanning upto 4.5m | 7 Days |
| 2) Spanning over 4.5m | 14 Days |
| Removal of Props under Beams and Arches: | |
| 1) Spanning upto 6.0m | 14 Days |
| 2) Spanning over 6.0m | 21 Days |

For other cements, the stripping time recommended for Ordinary Portland Cement shall be suitably modified. The number, size and position of props left under shall be such as to be able to safely carry the dead load of the slab, beam or arch, together with any live load likely to occur during curing or further construction.

Sleeves for through bolts shall not be provided in formwork for liquid retaining structures as they are potential hazard for leakage. Special devices shall be fabricated using two ordinary M20 nuts separated by two numbers 10 mm rounds welded to opposite flat side of the nuts. The faces of the nuts will have a compressible rubber bushing 20 mm thick. The overall dimension of the assembly shall be 50 mm less than the designed thickness of the concrete. Adjusting bolt shall pass through formwork and will lock into the nuts. While these bolts are tightened, the formwork will travel inwards.

Once the desired dimension is achieved, concrete will be poured. During removal of shuttering,

the bolts will be removed to loosen the shuttering plates. The depression will be sealed using suitable concrete sealant.

SURFACE FINISHES FROM FORMWORK

Generally formwork shall be specified as either wrought or unwrought depending on the required surface finish.

UNWROUGHT FORMWORK

Unwrought Formwork shall consist of sawn boards, brick or concrete block work, sheet metal or other suitable material to give adequate support to the concrete.
Appearance is not of primary importance for this class of formwork.
Surfaces to which plaster, granolithic or other finish is to be applied shall be roughened while the concrete is still green.

WROUGHT FORMWORK

Wrought formwork shall be provided for concrete surfaces that are required to be finished smooth.
Wrought formwork shall be lined with metal or plywood having smooth surfaces and edges. Formwork shall be furnished in largest practicable sizes to minimize the number of joints. Care shall be taken that there are no irregularities or roughness between successive sections of shuttering such that finished surfaces shall be free of board or shutter marks. Upon removal of formwork, surfaces of finished concrete shall be rubbed down with carborundum stone where necessary to obtain a uniform and smooth appearance.
The finish shall be such as to require no filling of surface pitting, butt fins, surface discoloration and other minor defects shall be remedied by approved methods.
Rendering of defective concrete as a means of making good will not be permitted except that, in case of minor porosity on the surface, approval may be given for the surface to be treated by rubbing down with a cement mortar of the same fine aggregate/cement ratio as the concrete. The treatment shall occur immediately after removing the formwork. Both cement and aggregate shall be from the same source as the concrete materials.
Concrete containing honeycombing, major air holes or similar defects shall be cut out and replaced as directed. No repair shall be executed without approval.

TIES

Where it is required to use internal ties and spacers, their type, spacing and use shall be approved. No part of any such tie or spacer remaining permanently embedded in the concrete shall be nearer than the specified cover to the finished surface of the concrete. Wire ties projecting through the concrete face shall not be permitted.

PERMANENT FORMWORK
Permanent formwork for elevated concrete floors in steel structures shall be profiled steel sheet. The sheet shall be of sufficient thickness to sustain all construction loads plus the weight of fresh concrete between supporting beams without excessive deflection. The underside of the sheet shall be coated with an approved corrosive resistant paint. The material shall conform to IS 513. The deflection shall be limited to span / 150. The sheet shallbe fixed on the supporting beams at every alternate valley by 10 mm dia fusion welding with 22 mm dia x 2.5 mm thick reinforcing washer. Minimum 100 mm overlap shall be provided. The deck sheet end resting on wall shall have a seating of 150 mm minimum. Side laps shallbe secured with tack welding to ensure that the slurry does not leak down. End laps shall always be on the supporting walls or on supporting beams. The overhang of the deck sheet shall be limited to 300 mm maximum. Temporary supports, where ever advised by the construction manager, shall be firm, and at the same level as the permanent supports and shall be in place till the concrete attains its full strength. While removing the temporary supports, care shall be taken that the slab is not disturbed.

FORMWORK FOR VIBRATED CONCRETE

If external vibrators are to be used for compaction of concrete, the type of vibrator, design of the formwork and the method of fixing the vibrators shall all be approved.

CLEANING AND TREATMENT OF FORMS

Before concreting is commencing the forms and previously cast concrete shall be thoroughly cleaned and free from all sawdust, tie wire, shavings, dust, dirt and other debris. Temporary openings shall be provided where necessary to drain away water and remove rubbish.
Release agents shall be applied and be compatible with the class of finish. Care shall be taken not to contaminate the reinforcement.

## 5.0 CONSTRUCTION JOINTS

The number of construction joints shall be kept to the minimum necessary for the execution of the work. Their location shall be carefully considered and approved by Engineer before concrete is placed. Construction joints shall normally be at right angles to the general direction of the member. The concrete at the joint shall be bonded with that subsequently placed against it, without provision for relative movement between the two. When the work has to beresumed on surface, which has hardened, such surface shall be roughened. It shall then be swept clean and thoroughly wetted. For vertical joint neat cement slurry shall be applied on the surface before it is dry. For horizontal joints the surface shall be covered with a layer of mortar about 10 to 15 mm thick composed of cement and sand in the same ratio as the cement and sand in concrete mix. This layer of cement slurry or mortar shall be freshly mixedand applied immediately before placing of the concrete.
Where the concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire brushes, care being taken to avoid dislodgement of particles of aggregate. The surface shall be thoroughly wetted and all free water removed. The surface shall then be coated with neat cement slurry. On this surface, a layer of concrete not exceeding 150 mm in the thickness shall first be placed and shall be rammed against old work, particular attention being paid to corners and close spots; work thereafter shall proceed in the normal way. The number, size and positions of props left under shall be able to carry safely the dead load of the slab, beam or arch together with any live load likely to occur during curing or further construction. Cambers and chamfers, wherever shown in drawing shall be provided accordingly.

EXPANSION JOINTS

Expansion joints and joints around equipment in concrete paving shall be as detailed in the drawing and shall be formed with an approved bitumen impregnated fibreboard. The upper 20 mm shall be sealed with an approved two part, Polysulphide, oil resistant sealant (H.C. grade) or hot applied bitumen sealing compound, applied strictly in accordance with the manufacturer’s instructions.
The joint filler shall be fixed firmly to the first placed concrete before the adjoining concrete is placed. The concrete must be thoroughly compacted on both sides of the joint. The location of expansion joints shall be shown on the engineering drawings.

CONTRACTION JOINTS

Contraction joints (either complete or partial) shall be located on the drawings and formed with a building paper membrane interface, or equivalent separating membrane and the upper 25 mm depth sealed. The steel reinforcement shall be continuous through partial contraction joints. The use of contraction joints should be kept to a minimum compatible with freedom from cracking.

JOINT FILLERS

Joint fillers and sealing compounds shall comply to IS 1834, IS 1838 and IS 11433.

## 6.0 REINFORCEMENT

Reinforcement shall comply with IS 1786 or IS 432. Different types of reinforcement may be used in the same structural member. Reinforcement shall be cut and bent in accordance with approved bar bending schedules.

CUTTING AND BENDING

Reinforcement shall be cut and/or bent in accordance with IS 2502. It is essential that reinforcement shall not be subjected to mechanical damage prior to embedment. In general, reinforcement shall be bent cold.
Bends in reinforcement shall have a substantially constant curvature.
It is permissible to bend mild steel reinforcement projecting from concrete provided that care is taken to ensure that radius of bend is not less than that specified in IS 2502. Grade Fe.415 bars shall not be re-bent or straightened without the Engineer's approval.

FIXING

Reinforcement shall be secured against displacement outside the specified limits. Actual concrete cover shall be not less than the required nominal cover minus 5 mm or two third the nominal cover whichever is more. In slabs, the actual concrete cover shall be not more than the required nominal cover plus.
**5** mm on bars up to and including 12 mm size
10 mm on bars over 12 mm and up to 25 mm
15 mm on bars over 25 mm
Spacers and chairs shall be used to maintain the specified nominal cover to the steel reinforcement. Spacers or chairs shall be placed at a maximum spacing of 1 meter. Wherever reinforcing bars are intended to be in contact, they shall be securely bound together with 18 gauge annealed soft iron wire.
The mix used for spacer blocks made from cement, sand and fine aggregates shall be comparable in strength, durability and appearance to the surrounding concrete.
The position of reinforcement shall be checked before and during concreting, particular attention being directed to ensure that the nominal cover is maintained within the limits, given, especially in the case of cantilever sections.

SURFACE CONDITIONS

Concrete shall not be placed around reinforcement unless the reinforcement is free from mud, oil, paint, loose rust, grease or any other substance which can be shown to adversely effect the steel or concrete chemically or reduce the bond.

LAPS AND JOINTS

Laps and joints shall be made only by the methods specified and at the positions shown on the drawings or as agreed by the Engineer.

WELDING

Welding on site shall be avoided if possible, but may be permitted where suitable safeguards and techniques are employed. Generally, however, all welding shall be carried out in a workshop. The competence of the welder shall be demonstrated prior to and periodically during welding operations. Welding of mild steel bars shall be carried out in accordance with IS 2751. Welding of high strength deformed bars shall be in accordance with IS 9417. The carbon content of high yield strength deformed bars conforming to IS 1786 shall not be more than 0.25%. If carbon content exceeds the limits specified herein, specifically written down welding and testing procedure shall be followed.

TOLERANCES ON PLACING

Reinforcement shall be placed within the following tolerances:
1. For effective depth 200 mm or less + 10 mm
2. For effective depth more than 200 mm + 15 mm.

TYING OF REINFORCEMENT

Bars crossing each other, where required shall be secured by binding wire (annealed) conforming to IS 280. Every compression bar will be tied at least in two perpendicular directions.

## 7.0 TRANSPORTING, PLACING, COMPACTING AND CURING OF CONCRETE

TRANSPORTING

Concrete shall be transported from the mixer to the formwork as rapidly as possible by methods that will prevent the segregation, loss of any ingredients or ingress of foreign matter or water and will maintain the required workability. The concrete shall be deposited as close as possible to its final position to avoid handling or moving the concrete horizontally by vibrating. The addition of water at point of discharge is prohibited.

PLACING AND COMPACTING CONCRETE

All placing and compacting shall be carried out under suitable supervision and as soon after mixing as is practicable. Placing of concrete shall commence only after embedment in the concrete is securely fixed in position. Care shall be taken to avoid displacing reinforcement and damage to the faces of formwork, particularly when the concrete is allowed to fall freely through the depth of lift. The concrete shall not be dropped from a height of over 1.5 meters unless it is dropped by a tremie or chute. The bonding medium shall have the same cement-sand content as the concrete to be placed on it. Bonding planes shall generally be horizontal. No concrete shall be placed in flowing water. Under water, concrete shall be placed in position by tremies or by pipeline from the mixer and never allowed to fall freely through the water.
Concrete shall be placed in successive horizontal layers in thicknesses not exceeding 500 mm. Concrete shall be thoroughly compacted by vibration or other means during placing and worked around the reinforcement, embedded fixtures and into corners of the formwork to form a solid void free mass having the required surface finish. When vibrators are used, vibration shall be applied continuously during the placing of each batch of concrete until the expulsion of air has practically ceased and in a manner that does not promote segregation. Over vibration shall be avoided to minimize the risk of forming a weak surface layer.
When internal or immersion type vibrators are used they shall have frequency of 7000 RPM. They shall be inserted in a vertical position at an interval of about 600 mm. Vibrators shall not be used to transport concrete inside the formwork. When external vibration is used, the design of formwork and disposition of vibration shall be such as to ensure efficient compaction and to avoid surface blemishes.
The Contractor shall keep a complete record of the work of concreting showing the time and date of placing. This record shall be available for inspection at any time by the Engineer. Structural concreting against open excavation will not be permitted.

CURING

Curing is the process of preventing the loss of moisture from the concrete while maintaining a satisfactory temperature. The prevention of moisture loss from the concrete is particularly important if the water/cement ratio is low.
Curing and protection shall start immediately after the compaction of the concrete to prevent it from:
Prematurely drying out, particularly by solar radiation and wind,
Leaching out by rain and flowing water.

Where members are of considerable bulk or length, the cement content of the concrete is high, the surface finish is critical; the method of curing shall be specified in detail.

Surfaces shall normally be cured for at least for 7 days. The most common methods of curing are:

- Covering the surface with a damp absorbent material like sacking and keeping the material constantly wet.
- By ponding top surface with water (sea water not permitted) for slabs and the like.
- By continuous or frequent applications of water to the surface, avoiding alternate wetting and drying and the application of cold water to warm concrete surfaces.
- Spraying the surface with an efficient curing membrane.

The curing compound shall conform to relevant Indian Standards and shall be applied in accordance with the manufacturer's instructions to provide a water loss not greater than 0.55 kg/ m2 in 72 hours. Curing compound shall be used where conventional curing by water cannot be accomplished, following approval of construction manager.

## 8.0 CONCRETING IN HOT WEATHER

In hot weather (above 40 deg C) special precautions shall be necessary to avoid the loss of moisture and/or rapid stiffening of the concrete, which prevents its proper compaction, can cause thermal and plastic cracking and a reduction in strength and durability.
During hot weather, the concreting shall be done as per the procedure set out in IS 7861 Part 1. At the time of placing, no part of the concrete shall have a temperature exceeding 35 deg C. The temperature of concrete can be reduced by cooling the water and aggregate.
During hot dry weather at the point of placement the fresh concrete shall be protected from drying winds and solar radiation by the provision of PVC or similar tented shelter, which shall remain to avoid exposure to the sun. Suitable method to shelter the surface shall be adopted such that finishing operations can be carried out whilst it is in place. To prevent early drying and cracking, the relative humidity shall be kept high and the concrete surfaces kept moist by spraying with clean water and covered with wet hessian.

Note: To avoid de hydration of concrete use OPC 43 grade cement.

## 9.0 CONCRETING IN ADVERSE WEATHER

Concreting shall not be permitted when storm or rain appears to be imminent. In the event that the rain storms or other severe weather conditions occur unexpectedly, concreting shall be stopped and appropriate temporary stop ends, vee grooves etc., placed as necessary. To meet such circumstances the contractor shall always have in readiness on site approved framed sheeting or tarpaulins for protection of newly placed concrete. Under water concreting shall be permitted only with the approval of construction manager. Concrete placed under water may be lowered in bottom opening skips or may be fed continuously through an approved tremie pipe. Unless otherwise agreed with the construction manager, the cement content of any concrete mix to be placed under water shall be increased by 20%.

## 10.0 SAMPLING AND STRENGTH OF CONCRETE

Samples from fresh concrete which is to be used in the works shall be taken as per IS 1199 and cubes shall be made, cured and tested at 28 days in accordance with IS 516.
Facilities required for testing materials and concrete in the field such as testing machine with an operator shall be made available at the Engineer's request.

Frequency of sampling and acceptance criteria for strength tests shall be as per clauses 15 and 16 of IS 456. Concrete test cubes may be cured by accelerated methods as described in IS 9013. Cubes may also be optionally tested at 7 days or at the time of striking the formwork. However, in all cases, the 28 days compressive strength specified in IS 456 shall be the criterion for acceptance or rejection of the concrete.

For pre casting work additional cubes shall be taken and tested at 3 days or prior to lifting. Higher rate of sampling will be required at the beginning of the Construction period in order to establish the level of quality control or where there are critical elements. All samples shall be clearly marked with their identification and accurate records shall be maintained.

The concrete will be deemed to comply with the specified design strength provided the acceptance criteria in IS 456 are met.

If any test results fail to comply with the above then the quantity of concrete represented by the results shall be at risk, and may be required to be removed and replaced. The 28 days cube crushing results shall be grouped consecutively in different groups and each group shall have standard deviation as specified IS 456

If the standard deviation is greater than this, the concrete production shall be reviewed. 7-Day Tests (In situ Concrete)

- Tests shall be carried out at 7 days to establish a relationship between the 7-day and 28 day strengths. The relationship shall be used to interpret further test results in order to predict the probable value of the corresponding 28-day strengths.
- Notice shall be given without delay of any 7 day test results which indicates that the corresponding 28 day test results are likely to fail to meet the specified strength, so that necessary action can be taken to minimize the effect of such possible failure.
- 3 Day Tests (Pre-cast Concrete)
- For pre-cast concrete tests shall be carried out at 3 and 7 days to establish the relationship with the 28 day results.

There shall be no production tests on blinding concrete.

## 11.0 INSPECTION

All materials, workmanship and finished construction shall be subject to the continuous inspection and approval of the Engineer. All materials supplied by the Contractor and all construction performed by the Contractor, rejected as not in conformity with the specifications and drawings shall be immediately replaced by the contractor at no cost to the Owner.

## 12.0 CLEAN UP

Upon the completion of concrete work, all debris, scraps of wood, etc., resulting from the work shall be removed and the premises left clean.

## 13.0 WORKABILITY

The concrete mix shall be designed by varying the relative proportion of fine and coarse aggregates to ensure adequate workability for working it into corners and angles of the formwork and around the reinforcement without segregation of the materials or bleeding of the free water at the surface. On striking the formwork, the concrete shall present a face, which is uniform, free from honeycombing, surface crazing or excessive dusting. To confirm the workability of the designed mix for each grade of concrete, a series of workability tests shall be carried out on the preliminary trial mixes, unless acceptable data exists.

## 14.0 INITIAL SETTING TIME

The initial setting time shall be not less than ½ hour after the production concrete isdischarged into the forms and with a maximum time between mixing and completion of placingconcrete shall not exceed 1 hour. The total time between mixing and initial set shall be a minimum of 1 hour. There shall be a maximum setting time of 6 hours.
When trial mixes are made to determine the workability of the concrete, the initial setting time of the cement paste shall be determined as per IS 8142.

## 15.0 SLUMP

The slump of the structural concrete mixes shall be such that the concrete can be transported, placed into the forms, and compacted without segregation. Slump for pumpable concrete shall be determined by site trials and shall at least be 100 mm on site of pouring.

## 16.0 PRECAST CONCRETE

The requirements of this Specification relating to concrete and reinforcement shall be observed so far as they are applicable to reinforced concrete. In addition the following requirements specifically relating to pre-cast work should be met.

RECASTING YARD

The yard in which pre casting work is to be undertaken shall be cleaned and have firm level beds preferably of concrete with drainage channels between the beds. The beds shall have a surface of suitable quality to give the pre-cast units the required class of finish.
Where pre-cast units have projecting reinforcement the moulds shall, if necessary, be raised on stools above the general level of the pre casting yard.

MOULDS FOR PRE-CAST CONCRETE

The moulds shall be strongly constructed, closely jointed and true to the required shape with edges, corners and surfaces which comply with the relevant class of finish. Moulds are to be so designed that they can be readily taken apart and reassembled.

MARKING

All units shall be marked on the face which will not be exposed in the permanent works, with the date of manufacture and such distinguishing letters or numbers required for erection identification.

CURING, MATURING AND STACKING

The production schedules shall allow for proper curing and maturing of pre-cast concrete and shall be carried out as approved. The sides of the moulds may be removed after not less than 12 hours provided that the concrete has thoroughly set. All concrete surfaces shall be kept covered with thoroughly wetted hessian for at least 7 days.
Slinging, transporting and stacking may take place when designed handling stresses have been attained, but building or setting in the works shall not be permitted until the 28 days cube strength has been reached.
The time periods required for gain of strength of concrete may be reduced where approved special techniques are adopted such as vacuum or pressed concrete, steam curing or when a rapid hardening cement is used. No methods of accelerated curing shall be used without prior approval.

CEMENT/SAND MORTAR

Cement/sand mortar for bedding and jointing pre-cast members shall be of equivalentstrength, quality and color to that of the concrete member being bedded or jointed. Cement/sand mortar shall be mixed in small quantities and used immediately. Particular attention shall be paid to compacting the cement/sand mortar to prevent the formation of voidsand air pockets. The mortar mix shall be determined from tests following the recommendations of Indian Standard, alternatively grouting may be considered.

SURFACES FOR STRUCTURAL CONNECTIONS (MARINE STRUCTURES)

The surfaces of pre-cast concrete slabs and other units, which are to be in contact with in situ concrete, shall be prepared to achieve a good bond between the concrete unit and the adjoining concrete. The CONTRACTOR shall submit to the Owner/Owner’s Representative his proposals for preparation of a suitable surface.

## 17.0 GROUTING

Where equipment manufacturer's drawings define a grouting procedure, said procedure shall be followed, subject to the approval of Owner/Owner's Representative. All recommendation and instructions of the grout manufacturer shall be followed by contractor.No grout shall be placed when the outside temperature is below 5 °C unless special approval provisions are made against freezing. The minimum compressive strength of grout shall be at least equal to the parent concrete.

MATERIAL

Sand cement dry pack shall be proportioned at the site, but all non-shrink grouts shall consist of only pre-measured, pre-packaged material supplied by the grout manufacturer, except water. Water to be used for mixing Portland cement grout shall be clean, potable and free from all deleterious materials such as oils, acids, alkalis and organic materials.

GROUT TYPES

SAND CEMENT DRY PACK AND ORDINARY MORTAR GROUT

Cement shall be Portland cement and shall conform to the requirements of IS 269. Sand shall be mixed at two to one ratio by weight with the cement with a ramming consistency and shall have a minimum compressive strength of 15 N/mm2 at 7 days.

NON-SHRINK CEMENT BASED GROUT
Non-shrink cement based grout must have a full range of consistencies, including dry pack, plastic and flowable state to be suitable for used in a variety of applications. Grout should be capable of being pumped flowable without segregation. Vibration only when expressly stated by manufacturer. Grout working time shall be minimum of 60 minutes regardless of application consistency used. The grout shall contain no metallic substances (catalyzed or non catalyzed), aluminum powder, water reducing agents, fluidizers, accelerators, super plasticizers, or other materials known to increase drying shrinkage and/ or compromise long term durability. Non-shrink cement based grout shall have a minimum compressive strength of50 N/mm2 at 7 days.

NON-SHRINK EPOXY GROUT

Grout shall be 100 % solids system with the ability to be placed in flowable state. Non-shrink epoxy shall have a minimum allowable compressive strength of 60 N/mm2 at 7 days.

GROUT TYPE SELECTION

When the application is an unobstructed bearing plate or void which is not subject to impact or vibrations and allows the easy placement of grout without undue man-hour expenditure, used a sand cement dry pack or an ordinary mortar grout.
If one of the criteria cited above is not met (i.e. obstructed bearing plate or void or subject to impact or vibration) then use a pre-packaged, pre-measured, non-shrink, cement based grout.

STORAGE

Non-shrink cement based grout and epoxy grout aggregates shall be prepared by contractor in sound, dry bags and epoxy grout liquid components in sealed hardener and resin containers. Contractor shall be responsible for storing the grout in a dry, weatherproof area and within a temperature range of 4 °C to 32 °C.
Any material which becomes damp or otherwise defective shall be immediately removed from the site by contractor at his own expense.

SURFACE PREPARATION

All surfaces to be grouted shall be entirely free of oil, grease, dirt, wax, laitance, curing

compounds and other foreign substances that may interfere with complete bearing or bonding. When removing laitance, a hand held pneumatic chipping hammer shall be of the largest tool, contractor shall take the utmost care to prevent any possible structural damage that could be caused by improperly or negligently removing the laitance.
When any cement based grouts are used, concrete surfaces shall be saturated with water for 24 hours prior to grout placement. Excess water shall be removed just prior to grouting.
When epoxy grouts are used, all surfaces shall be made completely dry prior to grouting.

## LEVELLING AND ALIGNMENT

Prior to commencing grouting equipment bases, column bases or anchor bolts, leveling and alignment shall be performed to place and maintain said items in their final position during grouting. A minimum grout space of 25 mm shall be provided unless specified otherwise on the drawing. All metal surfaces which are to be in direct contact with the grout shall be thoroughly cleaned and made free of all grease, oil, dirt, wax or other foreign substance.
Leveling shims shall be removed when they would prevent uniform bearing under the base support such as tower bases rings. Removal of the shim shall be delayed long enough to ensure against disturbing the grout. Voids where shims have been removed shall be completely packed with grout before finishing.

## MIXING

Grout types shall be mixed according to manufacturer's recommended procedures. Epoxy grout component ratio shall not be changed from that recommended by the manufacturers. No solvent or thinners shall be added to the mix. The amount of water added to a non-shrink cement based grout will determine its consistency. The lowest water/ grout ratio need to get the grout in place should be used.

## PLACEMENT

Grout placement shall proceed in a manner that assures the filling of all voids and the intimate contact of grouting materials with surfaces to be grouted. The placement of grout shall be rapid and continuous so as to avoid cold joints under any base plate. All grouting shall be done in one direction only, placing grout on one side and working it to the other. Placement will be such as to provide full and uniform bearing under all foundation bearing surfaces. All exposed grout shall be provided with a 25 mm, chamfer, unless otherwise directed by purchaser's Owner/Owner's Representative.

## CURING

Grout shall be cured according to manufacturer's recommendations. Forms shall remain in place with a minimum of 24 hours regardless of whether grout is cement based or epoxy. Cement based grout shall be protected from extreme drying conditions. Epoxy grout shall not be wet cured. The temperature of the base plate, concrete foundations and grout shall be maintained between 4°C and 32 °C during grouting and for a minimum of 24 hours thereafter.

# BRICK MASONRY WORK

## CONTENTS

## 1.0 INTRODUCTION

This specification deals with masonry and allied works in foundation, plinth and superstructure.

**Providing n laying in building, Brick masonary work** in CM 1:6 in superstructure using best quality, locally available bricks with a compressive strength of min.75Kg/Sqcm including scaffolding where ever required, curing, disposal of surplus, Including plaster for above NGL of 19 MM Thick Including curing

## 2.0 MATERIALS

Bricks for masonry in foundations, walls and other locations shall be common burnt clay building bricks having minimum crushing strength of 5 N/sq.mm. or such other strength as may be described in the Schedule of Items, when tested in accordance with IS : 1077-1992 "Common Burnt Clay Building Bricks". They shall be sound, hard and thoroughly well burnt, with uniform size having rectangular faces with parallel sides and sharp straight right angled edges and be of uniform colour with fine compact uniform texture. Bricks shall be of uniform deep red cherry or copper colour. They shall be free from flaws, cracks and nodules of free lime. Water absorption after 24 hours immersion in cold water shall be not more than 20% by weight. They shall not absorb more than 10% by weight of water after immersion for six hours. They shall emit a clear metallic ringing sound when struck by a mallet and shall not break when dropped on their face, from a height of 60 cm.

Fractured surface shall show homogeneous, fine grained uniform texture, free from cracks, air holes, laminations, grits, lumps of lime, efflorescence or any other defect which may impair their strength, durability, appearance and usefulness for the purpose intended. Underburnt or vitrified bricks shall not be used.

Samples of bricks brought to the site shall be tested periodically for compression and other tests according to IS: 3495 (Parts-1 to 4) -1992 "Method of Test for Burnt Clay Building Bricks". Where the size of bricks is not specifically mentioned, it shall be taken to mean conventional sizes as is commonly available in the area. In case modular bricks are to be used, it shall be accordingly specified in Schedule of Items. The bricks shall be classified on the basis of average compressive strength as given in Table 1 of IS: 1077-1992.

Bricks shall be unloaded by hand and carefully stacked and all broken bricks shall be removed from the site.

## 3.0 SAMPLES AND INSPECTION

Representative samples shall be submitted by the contractor and approved samples retained by the Engineer for comparison and future reference. Bricks shall be obtained fromapproved manufacturer. All bricks shall be subject to inspection on the site and shall be to the approval of the Engineer who may reject such consignment as are considered by him tobe inferior to the quality specified. The Contractor shall provide all labour required for inspection and conduct such test as shall be required by the Engineer without additional charges.

## 4.0 SELECTION OF MORTARS

Mortar for masonry shall conform generally to IS: 2250-1981 "Code of Practice for Preparation and Use of Masonry Mortars", and proportion shall be as specified in the drawing or in the Schedule of Items.

Cement mortar shall be prepared by mixing cement and sand in specified proportion. It is convenient to take unit of measurement for cement as a bag of cement weighing 50 Kg equivalent to 0.035 cubic meters. Sand is measured in boxes of suitable size (say of 40 x 35 x 25 cm). It shall be measured on the basis of dry volume. In case of damp sand, the quantity shall be increased suitably to allow for bulkage in accordance with IS:2386-1963 (part-III) or by any approved method.

The mixing of the mortar shall be done preferably in a mechanical mixer. This condition may be relaxed by the engineer taking into account the nature, magnitude and location of the work. If mixed in the mixer, cement and sand in the specified proportion shall be fed in the

mixer and mixed dry thoroughly, water shall be then added gradually and wet mixing continued for at least 3 minutes. In case of hand mixing also after mixing dry on a water-tight masonry platform, water shall be added and the mortar turned over and over, backward and forward several times.

Fresh mixed mortar, in case becoming stiff due to evaporation of water may be re-tempered by adding water as frequently as needed to restore the requirement of the consistency but this shall be permitted only upto a maximum of 2 hours from the time of addition of cement in the mortar.

## 5.0 STORAGE AND HANDLING

Bricks shall not be dumped at site. They shall be carefully handled and carefully stacked in regular tiers to avoid breakage and defacement of bricks and prevent contamination by mud or other materials. Bricks selected for different situations of work shall be stacked separately.

## 6.0 SOAKING & CLEANING

Bricks required for masonry shall be cleaned to be free from dirt, dust and sand and fully soaked in clean water by submerging in vats before use, till air bubbling ceases. The bricks shall not be too wet at the time of use. After soaking they shall be removed from the tank sufficiently early so that at the time of laying they are skin dry and stacked on a clean space.

## 7.0 LAYING

Brickwork in general shall be as per IS 2212-1991. Bricks shall be laid in English bond, unless otherwise specified, with frogs upward over a full bed of evenly laid mortar, and slightly pressed and tapped into final position to the lines levels and shape as shown in the drawing fully embedded in mortar. All joints including inside faces shall be flushed and packed. Not more than 8 courses shall generally be laid in a day. The first course itself shallbe made horizontal by providing enough mortar in the bed joint to fill up any undulations. The horizontality of courses and the verticality of wall shall be checked very often with spirit level and plumb bob respectively.

Horizontal joints shall be truly horizontal and vertical joints shall line up in every alternate course. The joints shall not exceed 10 mm in thickness and shall be well finished and neatly struck. The joints shall be kept uniform throughout the brick work. All the brick joints of the face works shall be neatly raked out to a minimum depth of 15 mm with the help of raking tools and the faces of brick wall cleaned with wire brush to remove any splashes of mortar before the close of the day's work, while the mortar is still green and the last brick layer shall be cleaned with wire brush and the frogs free from mortar.

Walls coming in contact with R.C.C. structures shall perfectly be bonded with M.S. inserts or lugs where shown on drawings and the sides butting against the R.C.C structures neatly and efficiently flashed and packed with rich mortar & cement slurry at no extra cost. Where such lugs are not required to be provided, brick work shall be built tightly against columns, slabs or other structural parts, around door and window frames with proper distance to permit caulked joint. Where drawings indicate structural steel column or beam to be partly or wholly covered with brick work, bricks shall be built closely against all flanges and webs, with all spaces between steel and brick work filled solid with mortar not less than 10 mm thick.

Damaged or broken brick or brick bats shall not be used in brick work. Cut bricks may be used to complete bond or as closers or around irregular openings.

Bricks shall not be thrown from heights to the ground, but shall be handled carefully and put gently in position to avoid damaging the edges. Selected bricks of regular shape and dimension shall be used for face work.

Making of grooves, sleeves and chases shall be done, during the construction, to the lines, levels and position as shown in the drawing or as instructed by the Engineer. Such sleeves shall slope outward in external walls so that their surface cannot form channels for the easy passage of water inside.

Fixtures, plugs, frames, pipes, inserts etc., if any, shall be built in at the right places to the lines & levels as shown in the drawings while laying the course and not later by disturbing the brick work already laid.

Brick walls of one brick thick or less shall have one selected face in true plane and walls more than one brick thick shall have both the faces of wall in true plane.

All connected brick wo rk shall be carried out simultaneously with uniform heights throughout the work, and in exceptional cases, with the approval of the Engineer, the brick work built in any part of the work may be lower than another adjoining wall/connected wall by a maximum of one meter and the difference in height of adjoining wall/connecting wall shall be raked back according to bond by stepping at an angle not steeper than 45 degree, without sacrificing the necessary bond, horizontality of layers, verticality of joints and the wall.

## 8.0 PROTECTION OF BRICK WORK

The brick wall shall be protected and covered with gunny bags or water proof sheets from the effects of inclement weather, rain, frost, etc. during the construction and until the mortar sets. Care shall be taken during construction that the edges of jambs, sills and soffits of openings are not damaged.

## 9.0 CURING

Masonry in cement or composite mortar shall be kept continuously moist on all faces for a minimum period of 7 days by means approved by the Engineer.

## 10.0 SCAFFOLDING

Necessary and suitable scaffolding shall be provided at all heights to facilitate the construction of brick wall. Scaffolding shall be sound, strong and all supports and other members shall be sufficiently strong and rigid, stiffened with necessary bracings and shall be firmly connected to the walls securing them against swing or sway. Planks shall be laid over the scaffolding at required levels. Scaffolding shall preferably be of tubular steel, although the Engineer may permit other material, depending upon the circumstances.

Scaffolding shall be double, having two sets of vertical supports, particularly for the face wall and all exposed brick work. Single scaffolding may be used for buildings upto two storeys high or at other locations, if permitted by the Engineer. In such case the inner ends of horizontal members shall rest in holes provided in header course only. Such holes shall not be allowed in pillars under one meter in width, or immediately near the skew backs or arches. The holes thus left in masonry shall be filled with bricks set in rich mortar and the surface made good on removal of scaffolding.

If for any reason the Contractor is required to erect scaffolding in property other than that belonging to the Owner, including municipal corporation or local bodies, necessary permission shall be obtained by the Contractor from the appropriate authorities and necessary licensing fees if any shall have to be borne by him.

All scaffoldings once erected shall be allowed to remain in position, efficiently maintained by the Contractor, till all the finishing works required to be done are completed and shall not be removed without the approval of the Engineer. The Contractor shall allow workmen of other trades to make reasonable use of the scaffolding without any extra cost.

# PLASTERING & POINTING

**TABLE OF CONTENTS**

## 1.0 INTRODUCTION

This specification covers the material and workmanship requirements for the Plastering works as applicable.

## 2.0 MATERIALS

CEMENT

Ordinary Portland cement / Portland slag cement complying with the requirements of IS: 269-1989 and I.S. 455-1989 respectively shall be used.

SAND

Sand for plaster and pointing shall conform to IS: 1542. Sand shall be hard, durable, clean and free from adherent coatings and organic matter and shall not contain any appreciable amount of silt, day bails or pellets. Sand shall not contain harmful impurities such as iron pyrites, coal particles, lignite, mica shale etc.
Sand whose grading falls outside the limits of IS: 460 due to excess or deficiency of coarse or fine particles shall be processed to comply with the standards.
Fine sand shall be obtained from river beds not affected by tidal water of the sea and shall be clean, sharp and free from excessive deleterious matter. The sand shall not contain more than 8 per cent of mud and silt as determined by field test with a measuring cylinder.

WATER

Water used for mixing concrete and mortar and for curing shall be clean and free from injurious amounts of oil, acid, alkali, salts, sugar, organic materials or other substances that may be deleterious. The pH value of water shall generally be not less than '6'. Water has to meet the requirements mentioned in clause 4.3 of IS: 456-2000. Water shall be obtained from an approved source.

CEMENT MORTAR

Cement mortar shall be prepared by mixing cement and sand in specified proportion. It is convenient to take unit of measurement for cement as a bag of cement weighing 50 Kg equivalent to 0.035 cubic meters. Sand is measured in boxes of suitable size (say of 40 x 35 x 25 cm). It shall be measured on the basis of dry volume. In case of damp sand, the quantity shall be increased suitably to allow for bulkage in accordance with IS:2386-1963 (part-III) or by any approved method.

The mixing of the mortar shall be done preferably in a mechanical mixer. This condition may be relaxed by the engineer taking into account the nature, magnitude and location of the work. If mixed in the mixer, cement and sand in the specified proportion shall be fed in the mixer and mixed dry thoroughly, water shall be then added gradually and wet mixing continued for at least 3 minutes. In case of hand mixing also after mixing dry on a water-tight masonry platform, water shall be added and the mortar turned over and over, backward and forward several times.

Fresh mixed mortar, in case becoming stiff due to evaporation of water may be re-tempered by adding water as frequently as needed to restore the requirement of the consistency but this shall be permitted only up to a maximum of 2 hours from the time of addition of cement in the mortar.

CEMENT MORTAR WITH WATERPROOFING COMPOUND

Waterproof compound shall conform to IS: 2645 of approved make. The compound shall be well mixed with dry cement in the proportion of 3% by weight or as recommended by manufacturer.

## 3.0 WORKMANSHIP

PREPARATION OF BACKGROUND SURFACE

The surface shall be cleaned of all dust, loose mortar droppings, traces of algae, efflorescence and other foreign matter by water or by brushing. Smooth surfaces shall be roughened by wire brushing or hacking for non-hard and hard surfaces respectively. Projections on surfaces shall be trimmed wherever necessary to get even surfaces. In case of brick/stone masonry, raking of joints shall be carried out wherever necessary. The masonry shall be allowed to dry out for sufficient period before carrying out the plaster work. The masonry shall not be soaked but only damped evenly thereafter before applying the plaster.
In case of concrete work, projecting blurs of mortar formed due to the gaps of joints in shuttering shall be removed. Such surface shall be scrubbed clean with wire brushes. The surface shall be pock marked with a pointed tool at spacing of not more than 50 mm centers, the pocks being made not less than 3 mm deep to ensure a proper key for the plaster. The surface shall be washed off and cleaned of all oil, grease etc. and well wetted before the plaster is applied.

SEQUENCE OF OPERATIONS

For external plaster, the plastering operations shall be started from the top floor level and carried downwards. For internal plaster, the plastering may be started wherever the building frame, roofing and brick work are ready.
The surfaces to be plastered shall first be prepared as described in ‘Preparation of background surface. The first layer shall then be applied to ceilings. After the ceiling plaster is complete and scaffolding for the same removed, plastering on wall shall be started. After a suitable time interval as detailed under various types of plaster in subsequent paras, depending upon the type of mortar, the secondary layers if required shall be applied. After a further suitable time interval as detailed under various type of plaster in subsequent paras, the finishing coat shall be applied first to the ceiling and then to the walls.
Plastering of cornices, decorative features, etc. shall be completed before the finishing coat is applied. Unless otherwise specified corners and edges shall be rounded off to a radius of 25 mm, such rounding off shall be complete along with the finishing coat to prevent any joint marks showing out later.

SCAFFOLDING

Refer specification for structural concrete

DAMAGE RECTIFICATION

Any cracks, damages, any part of work which sound hollow when tapped or found damaged or defective otherwise shall be cut out in rectangular shape and redone as directed by Owner/Owner’s Representative.

## 4.0 APPLICATION OF PLASTER

ONE LAYER PLASTER WORK

To ensure even, specified thickness, plaster of 150 mm x 150 mm shall be first applied horizontally and vertically at not more than 2 meter interval over the entire surface to serve as gauges. The surface of these gauged areas shall be truly in the plane of the finished plaster surface. The mortar shall be brought to true surface by working with a wooden straight edge reaching across the gauges with small upward and sideways movements at atime. Finally the surface shall be finished off true with a trowel or wooden float to obtain a smooth texture. Excessive trowelling or overworking the float shall be avoided. All corners, arises, angles and junctions shall be truly vertical/horizontal and shall be carefully finished. Rounding or chamfering of corners, arises, junctions etc. shall be carried out with proper templates to the size required.
In suspending the work, the plaster shall be left, cut clean to line, both horizontally and vertically. When recommencing the plastering the edge of the old work shall be scrapped clean and wetted before plastering the adjoining area. Plastering work shall be closed on the border of the wall and nearer than 150 mm to any corners or arises and shall not be closed on the body of the features such as plaster bands, cornices nor at the corners or arises.

TWO LAYER PLASTER WORK

FIRST OR UNDER LAYER

The first or under layer of the specified thickness shall be applied as described above or mentioned in drawing. Before the first coat hardens, surface of it shall be beaten up by edges of wooden tapers and close dents shall be made on the surface. The subsequent coatshall be applied after this coat has been allowed to set for 3 to 5 days depending upon weather conditions. The surface shall not be allowed to dry during this period.

SECOND OR FINISHING LAYER

The second layer shall be complete to the specified thickness in the same manner as for first layer.

CURING

Curing shall be started 24 hours after finishing the plaster. The plaster shall be kept wet for a period of 7 days. During this period the plaster shall be suitably protected from all damages at the Contractor’s expense by such means as approved by the Owner/Owner’s Representative. The date of execution of plastering shall be marked on the plastering to ensure the proper duration of curing.

## 5.0 POINTING

Pointing shall be of the type specified such as flush, cut or weather struck, raised and cut etc.

PREPARATION OF BASE SURFACE

The joints shall be raked to such a depth that the minimum depth of the new mortar measured from either the sunk surface of the finished pointing or from the edge of the brick shall be less than 20 mm.

MORTAR

Mortar shall be in accordance with the specifications of cement mortar as described above.

APPLICATION OF MORTAR AND FINISHING

The mortar shall be pressed into the raked out joints with a pointing trowel according to the type of pointing specified. The mortar shall be spread over the corner edges or surfaces of the masonry. The pointing shall then be finished with the pointed tool. The superfluous mortar shall be cut off from the edges.

FLUSH POINTING

The mortar shall be pressed into joints and shall be finished off flush and leveled. The edges shall be neatly trimmed with trowel and straight edges.

CUT OR WEATHER STRUCK POINTING

The mortar shall first be pressed into joints. The top of the horizontal joints shall then be neatly pressed back by about 15 mm with the pointing tool so that the joint is sloping from top to bottom. The vertical joint shall also be similarly pointed. The junctions of vertical joints with the horizontal joints shall be at true right angles in case of brick and coursed rubble masonry.

RAISED AND CUT POINTING

This type of pointing shall project from the wall facing with its edges cut parallel so as to have a uniformly raised band about 6 mm and width 10 mm more as directed. The pointing shall be finished to a smooth but hard surface.

# STRUCTURAL STEEL WORKS

## CONTENTS

## 1.0 INTRODUCTION

This Specification defines the requirements for the supply, fabrication and erection of structural steel work, design of connections and preparation of fabrication drawings for buildings, plant and equipment supports, stairways, access platforms, steel flooring, ladders and the like. This Specification does not include the requirements of protective treatment like painting, fireproofing, jetty and other marine structures.

## 2.0 MATERIALS

All materials used in the Works shall be new, first quality steel of Indian manufacture free from laminations, seams, blisters and other harmful defects and shall comply with the appropriate Indian Standards.
Manufacturer or Laboratory test certificates in accordance with the requirements of the relevant Indian Standards shall be supplied to the Engineer-In-Charge in respect of all materials to be used in the Works, prior to commencement of fabrication.

### STRUCTURAL STEEL

Unless specified otherwise, structural steel used in the Works shall comply with the requirements of IS 2062 and be of Grade Fe 410WB specified therein. Hot rolled sections shall be Indian Standard Sections in accordance with IS 808. The thickness tolerance for plates and flats shall be as specified in IS 1852. The deviation over or under the nominal thickness shall be equal to half the total thickness tolerance. Steel shall be marked in accordance with IS 2062. Members in steel grades other than Grade A shall have additional marks of a form and in positions to be agreed with the Engineer-In-Charge. When design drawing do not specify grade of steel intended for connections and fittings, IS 2062 Grade Fe410 WB or BS EN 10025 Grade 430 B shall be used. Steel for cold rolled sections shall be as per IS 801. Hollow rectangular / square sections shall conform to IS 4923. Steel Tubes shall conform to IS 1161.

### BOLTS, NUTS AND WASHERS

Bolts and nuts shall comply with IS 1363, IS 1367, IS 3757 and IS 6639 as appropriate. Nuts shall be of at least the strength grade appropriate to the grade of bolts or other threaded elements with which they are used.
Plain washers for use with ordinary bolts and nuts shall comply with IS 5369. Tapered washers shall comply with IS 5372 or IS 5374 as applicable.
High tensile bolts of strength grade 8.8 shall comply with requirements of IS 3757 or BS 3692. Dimensional requirements to comply with IS 3757. Bolt shall be of product grade C to IS 1367 part 2 and mechanical properties to IS 1367 part 3.
Nuts shall be heavy hex Grade 4 conforming to IS: 1363 Part 3 and 1367 Part 2 for ordinary strength bolts and heavy hex Grade 8 conforming to IS: 6623 for high tensile bolts.
All Bolts, Nuts and Washers shall be hot-dip galvanized in accordance with IS 1367 (part 13) or in accordance with BS 4921.

### WELDING CONSUMABLES

Welding consumables, used for metal arc welding of steels complying with IS 2062, shall comply with IS 814. Welding consumables and procedures shall be such that the mechanical properties of deposited weld metal are not less than the respective minimum values for the parent metal being welded.

### STEEL GRATING AND STAIR TREADS

Steel grating and stair treads shall be open grid rectangular pattern complying with Standard drawings.

## 3.0 CONNECTION DESIGN AND FABRICATION DRAWINGS

Before commencing of job, all related detailed engineering documents shall be approved. Structural steel work shall be designed in accordance with IS 800. The design of ladders, platforms, handrails, stairways and the like shall be in accordance with Standard Drawings.

DESIGN DETAILS

Connections made in the shop shall be either bolted or welded. Connections made on site shall generally be bolted. Welded site connections shall be permitted only when specified on design drawings or with prior permission of the Engineer-In-Charge. Bolted connections shall contain a minimum of two bolts each. Bolts smaller than M16 shall not be used without prior approval of the Engineer-In-Charge. Tapered washers shall be used for bolts passing through tapered sections.
The thickness of gusset plates and welded end plates shall be not less than 8 mm. Connections shall not generally project above the level of the top of steel work. In the case of pipe racks the top of steel work shall be free from projections within the width of the rack.
All grating floor panels shall be fixed to supporting steel work by means of positive non-slip flooring grips and all panels shall be side-bolted together with two 6 mm diameter galvanised bolts per side.
The design drawing shall show the position on the structure where temporary bracing or restraints are to be provided until walls / floors and other non steel structures are built.

## 4.0 FABRICATION

Fabrication shall be carried out in accordance with the requirements of IS 800. Fabricated structural steel work shall be within the tolerances specified in IS 7215. The radius of re-entrant flame cuts shall be as large as possible but not less than 20mm, except in small members where this is impracticable.
Ends of columns shall generally be gas flame cut and ground where steelwork fabrication is carried out on site. For critical and highly stressed structures fabricated in off-site workshops, ends of columns shall be sawn square and base plate surface machined prior to welding, as called for on the design drawings. Joint assembly of column and base plate shall be jigged.
Frames, platforms, stairs and handrails shall be shop assembled in the largest units suitable for handling and transportation. All fabricated frames shall be suitably braced to prevent distortion during transit.
Where fillet welds to very thick column base plates are called for on the design drawings, preheating of the plate may be required to retard cooling rate and reduce shrinkage stresses and shall be incorporated in the welding procedures.

IDENTIFICATION

At all stages of fabrication, structural steel members shall be positively identified by a suitable marking scheme.
For the purposes of marking for erection, every part shall be marked with a durable and distinguishing mark in such a way as not to damage the material. For small members which are delivered in bundles or crates, the required marking shall be done on small metal tags securely tied to the bundle.

STRAIGHTENING

All materials shall be straight and, if necessary before being worked shall be straightened and/or flattened (unless required to be of curvilinear form) and shall be free from twists.
Rolled Sections and plates shall be clean, free from kinks, bends or twists, and straight within the tolerances allowed by IS 1852 “Specification for Rolling and Cutting Tolerances for Hot Rolled Steel Products”.
Where straightening is necessary, it may be carried out by mechanical means or by the application of a limited amount of localized heat. The temperature of heated areas, measured by methods approved by the Engineer-In-Charge shall not exceed 600°C
Rolled sections and plates with major defects shall be returned to Supplier for replacement.

CLEARANCES

The erection clearance for ends of members with web cleats or end plates shall be not greater

than 2 mm at each end. The erection clearance at ends of beams without web cleats and end plates shall be not more than 3 mm at each end but where for practical reasons, greater clearance is necessary, suitably designed seating approved by the Engineer-In-Charge shall be provided.

CUTTING

Prior to cutting, all members shall be properly marked showing the requisite cut length/width, connection provisions e.g. location and dimensions of holes, welds, cleats, etc. Marking for cutting shall be done judiciously so as to avoid wastages or joints as far as possible.
Cutting shall be by sawing, shearing, cropping or machine or hand flame cutting. Hand flame cutting shall be used only where it is impractical to use machine flame cutting and for notching, or for the completion of the formation of slotted holes. Electric metal arc cutting shallnot be permitted.
Cut edges shall be true to profile and be free from major notches and sharp edges and shall be dressed immediately by grinding.
Where members are notched to fit other members the notches shall be as small as practicable and chamfered at re-entrant corners with a minimum radius of 6 mm.

HOLES

All holes for fasteners or pins shall be drilled except as permitted otherwise herein. All matching holes for fasteners or pins shall register with each other so that fasteners can be inserted freely through the assembled members in a direction at right angles to the faces in contact.
Holes for ordinary bolts of property class below 8.8 in light roof members or other light framing and in connecting angles and plates other than splices, may be punched full size through material not thicker than the diameter of the hole, provided that the punching does not unduly distort the material.
Slotted holes shall either be punched in one operation or formed by drilling two holes and completed by cutting, grinding or filing the surface smooth.
Burrs shall be removed from holes before assembly except that where holes are drilled in one operation through parts clamped together which would not otherwise be separated after drilling, they need not be separated to remove the burrs.
For bolts not exceeding 24 mm diameter, holes shall be not more than 1.5 mm greater in diameter than the bolt and for bolts over 24 mm diameter, holes shall be not more than 2 mm greater in diameter than the bolts, except in steel base plates and where otherwise specified on the Drawings.
All matching holes for fasteners or pins shall register with each other so that fasteners can be inserted without undue force through the assembled members in a direction at right angles to the faces in contact. Drifts may be used but holes shall not be distorted. All unused drilled holes shall be plugged by welding.

JOINTS IN COMPRESSION

Abutting surfaces dependent on contact for the transmission of load shall be within the specified tolerances.

SPLICING

Splicing of built up/compound/latticed sections shall be done in such a fashion that each component of the section is jointed in staggered manner.
Where no butt weld is used for splicing, the meeting ends of two pieces of joint/channel/built up section shall be ground flush for bearing on each other and suitable flange and web splice plates shall be designed and provided for the full strength of the flange/web of the section and bolts/welds designed accordingly.
Where full strength butt weld is used for splicing (after proper edge preparation of the web and flange plates) of members fabricated out of joist/channel/built up section, additional flange and web plates shall be provided over and above the full strength butt welds, to have 40% strength of the flange and web.
Where a cover plate is used over a joist/channel/section the splicing of the cover plate and channel/joist section shall be staggered by minimum 500 mm. Extra splice plate shall be used for the cover plate and joist/channel section.

## 5.0 ERECTION

Prior to erection, the Contractor shall carry out an inspection of the location and level of the prepared foundations and anchor bolts, and advise the Engineer-In-Charge of his findings.
Erection shall be carried out in accordance with the requirements of IS 800.
All components shall be erected within the specified tolerances and in such a manner so that they are not bent, twisted or otherwise damaged and the specified cambers are provided when required. Drifting to align holes shall not enlarge the holes or distort the metal. Holes which cannot be aligned without distortion shall be a cause for rejection unless enlargement by reaming is specifically approved by the Engineer-In-Charge. Holes shall not be made by gas cutting. Throughout the erection of the structure, the steel work shall be securely bolted or fastened in order to ensure that it can adequately withstand all loadings liable to be encountered during erection, including where necessary, those from erection plant and its operation. Any temporary bracing or temporary restraint shall be left in position until such time as erection is sufficiently advanced so as to allow its safe removal.
All connections for temporary bracings, members, etc. to be provided for erection purposes shall be so made that they do not weaken the permanent structure or impair serviceability.
No permanent bolting or welding shall take place until the steel work has been properly aligned and the erection has been approved by the Engineer-In-Charge.
Connected parts shall be firmly drawn together. If there is a gap remaining which may affect the integrity of the joint, the joint shall be remade after insertion of a suitable pack. Where parts cannot be brought together by drifting without distorting the steelwork, rectification may be made by reaming, provided the design of the connection will allow for larger diameter holesand bolts, and is approved by the design Engineer-In-Charge.

### WELDING

Welding of structural steel shall be in accordance with IS 9595 and IS 816.For welded parts, all mating surfaces shall be sealed by welding against the ingress of moisture. Welding shall be carried out by suitably qualified welders who have satisfactorily completed the appropriate tests laid down in IS 7310. All welding shall be carried out under the direction of a competent Welding Technologist. The minimum size of fillet weld shall be 6 mm. The Contractor shall make necessary arrangement for providing sufficient number of welding sets of the required capacity, all consumables, cutting and grinding equipment with requisite accessories/auxiliaries, equipment and materials required for carrying out various tests such as dye penetration, magnetic particle, ultrasonic and the like. Adequate protection against rain and strong winds shall be provided to the welding personnel and the structural members during welding operation. Welding shall not be carried out in the absence of such protection.
It shall be the responsibility of the Contractor to ensure that all welding is carried out in accordance with this specification and relevant IS Codes. The Contractor shall provide all the supervision to fulfill this requirement.

### PREPARATION OF MEMBER FOR WELDING

#### EDGE PREPARATION

Edge preparation/leveling of the fusion faces for welding shall be done strictly in accordance with the dimensions shown in the drawings.
In case, the same are not indicated, edges shall be prepared (depending on the type of weld indicated in the drawing) in accordance with the details given in IS 9595. Leveling of fusion faces shall be approved by the Engineer. The tolerance on limits of gap, root face and included angle shall be as stipulated in IS 9595.

#### CLEANING

Welding edges and the adjacent areas of the members (extending up to 20 mm) shall be thoroughly cleaned of all oil, grease, scale and rust and made completely dry. Gaps between the members to be welded shall be kept free from all foreign matter.

#### PREHEATING

Preheating of members shall be carried out as per IS 9595 when the base metal temperature is below the requisite temperature for the welding process being used. Preheating shall be done in such a manner that the parts, on which the weld metal is being deposited, are above the specified minimum temperature for a distance of not less than 75 mm on each side of the weld line. The temperature shall be measured on the face opposite to that being heated. However, when there is access to only one face, the heat source shall be removed to allow the temperature equalization (1 minute for each 25 mm of plate thickness) before measuring the temperature.

GRINDING

Column splices and butt joints of struts and compression members (depending on contact for load transmission) shall be accurately ground and close-butt end over the whole section with a tolerance not exceeding 0.2 mm locally at any place. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc. shall be accurately ground so that the parts connected butt over minimum 90% surface of contact. In case of connecting angles or channels, care shall be taken so that these are fixed with such accuracy that they are not reduced in thickness by grinding by more than 2 mm. Ends of all bearing stiffeners shall be ground to fit tightly at both top and bottom. Similarly bottom of the knife edge supports along with the top surface of column brackets shall be accurately ground to provide effective bearing with a tolerance not exceeding 0.22 mm locally at any place.
Slab bases and caps shall be accurately ground over the bearing surfaces and shall have effective contact with the ends of stanchions. Bearing faces which are to be grouted need not be ground if such faces are true and parallel to the upper faces.

WELDING PROCESSES

Welding of various materials under this specification shall be carried out using one or more of the following processes.

- Manual Metal Arc Welding Process (MMAW)
- Submerged ARC Welding Process (SAW)
- Gas Metal Arc Welding Process (GMAW)
- Flux Cored Arc Welding Process (FCAW)

The welding procedure adopted and consumables used shall be specifically approved by the Engineer.

NON DESTRUCTIVE TESTING OF WELDS

Visual inspection shall be made in accordance with guidance given in IS 822 or BS 5289 after completion of all welding over the full length of the weld. All NDT shall be performed by personnel qualified to a recognized national or international standard (e.g. PCN, ASNT Level II, etc.) Magnetic particle inspection (MPI) shall be in accordance with the recommendations given in IS 5334 or BS 6072.Dye penetrant inspection (DPI) may be used in accordance with the recommendations given in IS 3658 or BS 6443. The test results shall be recorded and be available for inspection by the Engineer in charge. Where ultrasonic examination is required, it shall be made in accordance with IS 4260 or BS 3923 Part 1, level 2

BOLTING

Bolts of property class 4.6 shall generally be used for all connections including bracing and column splices. However, for connections resisting large moments and forces, bolts of property class 8.8 shall be used with the prior approval of the Engineer-In-Charge.
Where necessary the connected parts shall be firmly drawn together. Steel packing plates shall be provided where necessary to ensure that the total remaining gap between adjacent surfaces does not exceed 2 mm.
The length of bolt shall be such that at least one clear thread shows above the nut after tightening and at least one thread plus the thread run out is clear between the nut and the unthreaded shank of the bolt. The threaded length shall be clear of the joint mating surfaces.
Washers shall be provided under the element (nut or bolt head) turned during tightening.
Nuts used on connections subject to vibration shall be secured to prevent loosening. Self-locking nuts shall be used or else the nuts shall be secured by the use of locknuts or upsetting

of the threads of the bolts after assembly and tightening.
Bolts, nuts and washers used to connect metal sprayed or galvanized steel work shall be spun galvanized.
Where slotted holes are provided for movement connections, the joint shall be free to move.
Areas of steel which will form the mating faces of a high strength friction grip joint or are to be concrete cased shall be unpainted and maintained in a clean condition and free from loose rust, oil, loose scale and other deleterious matter.
High tensile bolts to IS 1367 property class 8.8 shall be tightened in accordance with the manufacturer's recommendations using a torque wrench which shall be calibrated at least once each working day.
The combination of bolts and nuts shall be not less than the following:
4.6 bolts with grade 4 nuts (IS-1363, IS-1367/BS 4190)
8.8 bolts with grade 8 nuts (IS-3757, IS-6623/BS 3692)
Any bolt assemblies which seize when being tightened shall be replaced.
Grade 4.6 and grade 8.8 bolts of the same diameter shall not be used in the same structure, except for holding down bolts.
The bolt length shall be chosen such that at least one thread plus the thread run-out will be clear between the nut and unthreaded shank of the bolt after tightening and at least one clear thread shall show above nut.When the members being connected have surface protective treatment, a washer shall be placed under the nut or bolt head being rotated. A suitable plate washer shall be used under the head and nut when bolts are used to assemble components with oversize or slotted holes.
When the bolt head or unit is in contact with a surface which is inclined at more than 30 from a plane at right angles to the bolt axis, a taper washer shall be placed to achieve satisfactory bearing.
Galvanized Nuts – Nuts shall be checked after being galvanized for free running on the bolt and re-tapped if necessary to ensure a satisfactory tightening performance.
Ordinarily bolts Grade 4.6 to IS1367 shall be tightened to a "snug tight" fit. "Snug tight" is defined as tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench.
High tensile bolts Grade 8.8 to IS 3757 shall be tightened to a torque of approximately 85% of the proof load of the bolt, by means of a power or hand operated torque wrench. Bolts shall be tightened to the torques given in the following table.

| Bolt Diameter | Torque to be Applied (Nm) For Bolt Class 8.8 of IS 3757 |
|---|---|
| M20 | 476 |
| M24 | 822 |
| M30 | 1630 |
| M35 | 2850 |

PROTECTIVE TREATMENT

Steel shall be pre-treated and painted or galvanized .The protective treatment shall be carried out after fabrication is complete. No welding, holing or other work which may damage the protective treatment shall be carried out following painting.

EQUIPMENT

All equipment used in erection shall be provided by the Contractor, and shall be suitable for its purpose and of adequate capacity.
Equipment to be used shall include staging, ladders, and plant including temporary structures necessary to complete the erection.

ALIGNMENT

Each part of the structure shall be aligned as soon as practicable after it has been erected Packs, shims and other supporting devices shall be flat, of adequate strength and rigidity and not larger than necessary. Where packings are to be left in position and subsequently grouted, they shall be placed such that they are totally enclosed by the grout.

CLEARANCE
The Contractor shall periodically clean up as required by the Engineer-In-Charge to maintain a safe working environment and on completion of the work remove all rubbish, plant and surplus

materials from the site of work, storage areas, to the satisfaction of the Engineer-In-Charge.

SAFETY AND SECURITY DURING ERECTION

The Contractor shall comply with IS 7205 for necessary safety and adhere to safe erection practice and guard against hazardous as well as unsafe working conditions during all stages of erection.
During erection, the steel work shall be securely bolted or otherwise fastened and when necessary, temporarily braced/guyed to provide for all loads including those due to the wind, erection equipment and its operation to be carried by the structure till the completion of erection.
No permanent bolting or welding shall be done until proper alignment has been achieved.
Proper accesses, platforms and safety arrangements shall be provided for working and inspection whenever required.

## 6.0 INSPECTION

Prior to inspection, all slag, loose scale, dirt, grit, weld spatter, paint, oil or other foreign matter shall be removed from the steel work. Welded connections shall not be painted prior to inspection.

The Contractor shall carry out non-destructive testing of welds at his own cost in the presence of the Engineer's Inspector. All welds shall be visually inspected along 100% of their length.
NDT testing of welds for general steel structures is not required. For critical structures where connections are highly stressed, NDT inspection shall be performed.

## 7.0 STORAGE AND HANDLING

Fabricated parts shall be handled and stacked in such a way that permanent damage is not caused to the components. Means shall be provided to avoid damage to the protective treatment on the steel work.
All work shall be protected from damage in transit. Particular care shall be taken to stiffen free ends, prevent permanent distortion and protect all machined surfaces adequately.

## 8.0 PAINTING

Steelwork shall be prepared, primed and painted in accordance with the project Specification for painting. Steelwork to be galvanized shall be in accordance with IS 4759. Paint shall be excluded from areas within 50mm of joints to be field welded. In order to minimize coating damage, all reasonable care shall be taken: 1) when handling steelwork between stages in painting, and 2) when slinging and loading steelwork which has received its final coat.
No material shall be shipped until the final shop coat of paint is thoroughly dry and clearly colour coded. Adequate packing, crating, blocking and/or bracing shall be provided to prevent damage to the fabricated material while loading, in transit and while unloading.

After complete erection, surfaces, areas damaged subsequent to shop painting shall be repaired in accordance with the Painting Specification. Any damage caused, during delivery and/or erection, to galvanized steel surfaces shall be repaired in accordance with Paint Specification.

PAINT WW.CEMENT PAINT 2 COATSPAINT WW. CEMENT PAINT 2 COATSWHITE WASHING/ PAINTING: Preparing surface and painting with cement paint of Snowcemor approved make, shade and quality, in all heights of walls, ceiling, sun shades fins etc. incl. providing materails complete

**ROOF STEEL. SECTIONSROOF STEEL. SECTIONS ROOFING** Supply/fabricating/erecting the Steel Section and in rolled steel sections like R.S.J.; angles; Tees; channels etc and plates; square or rectangular rods. TATA or SAIL make

# ROAD WORK & CONCRETE PAVEMENTS

## CONTENTS



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## 1.0 INTRODUCTION

This specification establishes the requirements of material, laying and finishing of concrete pavements.

## 2.0 MATERIALS

WATER

Water used for cement concrete, mortar, plaster, grout, curing etc. shall be clear and free from injurious amounts of oils, acids, alkalis, organic matters or other harmful substances. Only natural water suitable for drinking shall be used. It shall conform to IS: 456.

AGGREGATE FOR CONCRETE

The aggregate for concrete shall comply in all respects with IS: 383 and IS: 456. This should be furnished in at least two separate sizes with separation at 20mm IS sieve when combined material graded from 5 to 38 mm is specified and at 25mm IS sieve when combined material graded from 20 to 50 mm is specified. This shall be obtained from a source approved by Owner/Owner's Representative and shall be chemically inert, strong, hard, durable and of limited porosity. This shall be of the gauge specified in the schedule of rates and approximately cubical in shape. It shall be free from soft or decayed pieces, dirt, clay, leaves or any organic matter. The aggregate shall not have any injurious effect when mixed with cement nor shall it corrode the reinforcement, nor otherwise impair the strength and durability of the concrete. The size of coarse aggregate mentioned in this specification denotes maximum size of aggregate and the same shall be grade downward as per IS: 383.

SAND FOR CONCRETE AND MORTAR

Fine aggregate shall preferably be natural sands. In case of crushed sand the very fine natural sand amount passing IS: 383. Sand shall consist of clean, hard, strong, sharp, durable uncoated particles free from any mix of clay, dust, vegetable matter, mica, iron pyrites, shells, soft or flaky and elongated particles, alkali organic matter, salts, loam and other impurities which may be considered by the Owner/Owner's Representative as harmful. Sulphate content should not exceed 1%. Total content of all deleterious matter should not exceed 5%. This source of sand shall be approved by the Owner/Owner's Representative. Sand obtained from river bed subject to tidal effect will not be allowed in works. All sand shall be washed before being brought to site.

STORAGE OF AGGREGATES

The contractor shall at all time maintain at the site of work such quantities of aggregates as are considered by the Owner/Owner's Representative to be sufficient to ensure continuity of work. Each type and grade of aggregates shall be stored separately. This ground on which the aggregates are stored shall be firm and have sufficient slope to ensure adequate drainage of rain water.
Any aggregate delivered to site wet shall be placed in storage for atleast 24 hours to ensure adequate drainage before it is used for concreting.
Sand heaps shall be covered with bricks or such other materials to prevent blowing off and to assist in good house keeping.

CEMENT

The cement used shall be ordinary Portland cement, conforming to IS: 8112, unless otherwise specified. The cement issued to the contractor shall be stored in a suitable weather tight building and in such a manner as to permit easy access for proper inspection. All cement storedat site by the contractor shall be arranged in batches and used in the same order as received from owner. Contractor shall maintain a cement register in which all entries shall be completedday-to-day showing quantities received, date of receipt and daily cement consumption.

REJECTION OF CEMENT

The Owner/Owner's Representative may reject cement which has deteriorated after issue to the contractor owing to inadequate protection against moisture or other causes or in any other case where the cement is not to his satisfaction.

ADMIXTURE

No admixture shall be normally permitted for concrete or mortar. Water proofing compound to be used in concrete, plaster, damp proof course etc. where specified, shall be of approved make. It shall be mixed as per manufacturer's specifications and as approved and directed by the Owner/Owner's Representative.
Joint sealing in pavements and around equipment's structural columns shall be approved compound conforming to IS: 1834 TYPE 'b' (SHALITEX or approved equivalent).

## 3.0 GRADES AND PROPORTIONING

The grades indicated in drawings and schedules shall conform to IS: 456, the strengths being indicated below.

Min. Crushing Strength of 15 cm. Cube in Kg/cm² at 28 days

| Grade | Compressive Strength |
|---|---|
| M- 10 | 100 |
| M-15 | 150 |
| M-20 | 200 |
| M-25 | 250 |
| M-30 | 300 |

The water cement ratio aggregates and grading for each mix shall be predetermined from the results of cube tests of trial mixes. The mix proportions determined thus shall be followed at site and shall in no way relieve the contractor of his responsibility as regards the prescribed strength of mix. The mix proportions, however, shall be revised if the results of the cube tests during the construction show consistently lower or higher strength than the prescribed one. Noclaim to alter the rates of concrete work will be entertained due to such changes in mix designs, as the contractor will be responsible to produce the concrete of required grade. The slump of concrete mix for pavements compacted by vibrations should not be more than 25 mm and thatfor manual compaction not more than 50 mm.
All concrete shall be controlled concrete conforming to IS: 456. For mud-mat and filling purpose ordinary concrete of 1:4:8 mix proportions may be used or as indicated in drawings.

## 4.0 EQUIPMENT

All equipment like weighting devices, measuring boxes, mixers, sub-grade templates, hand tempers, vibrating screens, internal vibrators, longitudinal floats, bridges, belts, push brooms, straight edges, edging tools etc. shall be on the worksite in first class working condition and shall have been inspected by the Owner/Owner's Representative before paving operations are permitted to start. Throughout the construction period the contractor shall maintain adequate equipment in first class working conditions to ensure the proper execution of the work.

## 5.0 PREPARATION OF SUB GRADE

The sub grade or sub base for laying of the concrete slabs shall comply with the following requirements:

I. No soft spots are present in the sub grade or sub base.
II. The uniformly compacted sub grade or sub base extends at least 300mm on either side of the width to be concreted.
III. The sub grade is properly drained.
IV. The minimum modulus of sub grade reaction obtained with a plate bearing test shall be 5.54 Kg/cm².
V. Sub grade shall be prepared to the lines and grades shown on the drawings.

VI. No concrete shall be placed around manholes or other structure until they have been brought to required grade and alignment.
VII. The sub grade shall be in moist condition at time of concrete placement.

**6.0 FORMWORK**

All side forms shall be of mild steel unless uses of wooden sections are specially permitted. The steel forms shall be MS channel sections and their depth shall be equal to thickness of the pavement. The sections shall have a length of atleast 3.0m except on curves, where shorter sections may be used. These forms should be provided with ample bracing and supports to prevent the springing of the forms under the concrete pressure or thrust of machinery operating nearby.

The forms should be in sufficient number and they should not be removed until concrete is hardened sufficiently.
In case wooden forms are permitted, these shall have minimum base width of 100mm for 200mm slabs and 150mm for more than 200mm thickness.

**7.0 REINFORCEMENT**

All reinforcement work shall confirm to IS: 456. Reinforcing steel shall be free from dirt scale or other foreign matter and rust. The number, size, form and position of all the reinforcement shall unless otherwise directed or authorised by Owner/Owner's Representative be strictly as per drawings. The placing of reinforcement shall be such that when properly placed into the work,

extreme longitudinal bars will be located not less than 50mm nor more than 100mm from the edges of the slab except for dummy joints, the length of reinforcement will keep clear of transverse joints by not less than 50mm nor more than 100mm as measured from the centre of the joint to the ends of longitudinal bars.
While overlapping the bars in either direction the overlap shall be atleast equal to spacing between bars in the respective direction.
To prevent displacement before or during concreting, the bars shall be secured to one another with 16 SWG black soft annealed binding wire. Wooden planks provided for labour to move shall be supported independent of reinforcement and the cage shall never be permitted to sag or get displaced during concreting. Concrete blocks shall be used to ensure correct cover of concrete over bars as shown in drawings.
Dowels if used as load transferring device shall be checked for exact position before concreting. Dowels shall be parallel to the surface and perpendicular to the joint and shall not place any restraint on the movement of the joint.

**8.0 MIXING**

Mixing should be carried out in mechanical mixers. Drum of the mixer shall rotate at a peripheral speed of 60RPM (Rotation per minute). Hand mixing can, however, be permitted by Owner/Owner's Representative in special cases. Water cement ratio shall be rigidly controlled during mixing. Mixers shall be fitted with automatic devices to discharge measured quantity of water directly into the mixing pan. The water shall be introduced into the drum within first 15 seconds of mixing, but not until all the cement and aggregate constituting the batch are thoroughly mixed. Mixing shall continue until the concrete is uniform in colour and for not less than 2 minutes after all the materials and water are in the drum. The entire content of the drum shall be discharged before any materials are placed therein for the succeeding batch.

Correction for Bulking**-** In volume batching suitable allowance shall be made for the bulking of fine aggregates due to presence of water. For this purpose the bulking shall be determined as directed by Owner/Owner's Representative.

**9.0 PLACING**

The place where concrete is to be poured should be clean and free from all loose dirt, standing

water etc.

Walking on reinforcement layers is not permissible. Walkways of wooden planks or similar material can be placed with removable supports and should be independent of the reinforcement. The reinforcement position should not be disturbed nor should at sag during carriage and placement of concrete.
Placing and vibration should not take totally more than 20 minutes from time of mixing. Method of placing should be got approved by Owner/Owner's Representative. Segregation during carriage and placement should be avoided. If during carriage concrete segregates, it should be remixed before placement.

Concrete should not be dropped from a height of over 1.5m.

To ensure bond and water tightness between old concrete surface and fresh concrete to be placed, the surface should be cleaned and roughened by "initial green cut" by wire brushing or chipping. The initial green may be done by wire brush after 6 hours of placing concrete in order to facilitate the work. Chipping can be done only after 48 hours. A layer of cement slurry with 1:1 mix (1 cement: 1 sand) should be poured to obtain a uniform coating on old concrete. Immediately thereafter, the fresh concrete should be poured.

Concrete shall be mixed in quantities required for immediate use and shall be deposited on the sub-grade in a single operation to the required depth and width of the pavement. Spreading shall be as uniform as possible to avoid re-handling of concrete. Where however, a certain amount of redistribution is necessary it shall be done with shovels and not with rakes. Concrete shall be vibrated with internal vibrators. Concrete shall be placed continuously until completion of the part of the work between construction joints or as directed by Owner/Owner's Representative continuously until completion of the part of the work between construction joints or as directed by Owner/Owner's Representative.

All precautions shall be taken for concreting in extreme weather in accordance with the relevant clauses of IS: 456. Due protection shall be provided to prevent cement being blown away while proportioning and mixing during windy weather. No concreting shall be carried out in continuous heavy rains. Necessary arrangements to cover the freshly poured concrete shall be provided, to protect it from the direct rays of the sun and from drying winds.

All concreting placement should be co-ordinated with placement of conduits, inserts, embedded parts etc. executed either by same agency or separately.

Concrete in standing water shall be executed strictly as per IS: 456. This shall be paid as a separate item where applicable.

The concrete shall be laid in panels not exceeding 4m x4m as shown in layout drawing or as directed by Owner/Owner's Representative.

## 10.0 COMPACTION

The surface of the pavement shall be compacted either by means of power driven finish machine or a vibrating hand screed. For areas where width of the slab is very small as the corner of street junction etc. hand consolidation and finishing shall be done as follows:

I. Concrete as soon as placed, shall be struck off uniformly and screeded to the crown and cross-section shown on the plans and to such level above the base that when compacted and finished, the pavement shall conform to the grade and cross section indicated by the plans. The entire surface shall then be tamped until a close knit dense surface is obtained.

II. The tamper shall rest on the side forms and shall be drawn ahead with a swing motion in combination with a series of lifts and drops alternating with lateral shifts, theaim of this operation being compaction and screeding to the approximate level required. Subsequent tamping should advance 75mm at a time in the direction in which the

work is proceeding and in final stages the tamping should be closer about12mm at a time until a level and dense surface is obtained.

III. If so directed by Owner/Owner's Representative, hand operated vibrating tamper consisting of normal type of hand tamper attached to a pneumatic or electric vibrating unit shall be used for compaction.

IV. Segregated particles of coarse aggregate which collect in front of the tamper shall be thrown outside the forms or thoroughly mixed by hand with a mass; of concrete already on the base.

V. Compaction by tamping shall be carried on till the mortar in the mix just works upto the surface. The surface shall be examined after compaction correction, if needed, shall be made by adding or removing concrete followed by further compaction and finishing.

## 11.0 FINISHING

FLOATING

As soon as practicable, after concrete has been struck off and compacted, it shall be further smoothened and compacted by means of a longitudinal float 1200 mm long and 75mm wide operated from a foot bridge.

STRAIGHT EDGING

After floating is completed and excess water removed but while concrete is still plastic the slab surface shall be tested for trueness with a straight edge and rectified, if necessary.

BELTING

Just before the concrete becomes non-plastic, the surface shall be belted with a two ply canvas belt not less than 200mm wide and atleast 1.0M longer than the width of the slab. Hand belts shall have suitable handles to permit controlled uniform manipulation. The belt shall beoperated with short strokes transverse to the carriage way centreline and a rapid advance parallel to the centre line.

BROOMING

After belting and as soon as surplus water has risen to the surface the pavement shall be given a broom finish to produce corrugations of uniform appearance of not more than 1/16 inch in depth.

EDGING

Before the concrete has its initial set the edges shall be carefully finished with an edger of the radius required and pavement edge shall be left smooth and true to line.

## 12.0 CURING

INITIAL CURING

Immediately, after the completion of the finishing operations, the surface of pavement shall be entirely covered with wetted burlap, cotton or jute mats.

FINAL CURING

Upon the removal of the mats, the slab shall be thoroughly wetted and covered by the following method:
Curing with wet earth- A system of transverse and longitudinal dykes of clay about 50mm high

shall be laid over the slab. These dykes shall be blanketed with sandy soils free from stones to prevent drying up. The rest of the slab shall be covered with sufficient sandy soil so as to produce a blanket of earth not less than 37mm depth after wetting. This earth shall be kept thoroughly wet till the concrete has attained the required strength but not less than 14 days.

## 13.0 JOINTS

Wherever called for on the drawings expansion joints, dummy joints and longitudinal joints shall be provided as per details indicated in the drawing and as directed by Owner/Owner's Representative.

After the curing, the temporary seal or other intruded materials of all expansion and contraction joints shall be removed completely and the slots filled with approved joint sealing compound. The edges of the joints shall thoroughly cleaned and primed with a thin bituminous paint which shall be allowed to dry before the sealing compound is applied.

The primer shall be applied with a brush. The composition of primer shall be as follows:

| **Name of Material** | **Percent by weight** |
|---|---|
| 200 – Penetration Bitumen | 66% |
| Light creosote oil | 14% |
| Solvent Naphtha | 20% |

The bitumen shall be melted and fluxed with oil. When cold, solvent Naphtha shall be added. Bituminous emulsion shall not be used as primers. Care shall be taken to ensure that the sealing compound is not heated above $200^0$C and the temperature does not exceed $180^0$C forlong periods.
Sealing compound shall be poured into the joint opening in such a manner that the material will not be spilled on the exposed surface of the concrete. When required to prevent pick up under traffic, the exposed surface of the sealing compound shall be dusted with hydrated lime.

## 14.0 OPENING TO TRAFFIC

Traffic shall not be allowed for a period of 28 days after laying of concrete.
Before opening the roads to traffic all joints shall be filled and trimmed or topped out as required.

**DRIVWAY PAVER**

DRIVWAY PAVER BL 80 MM TKDWAY . PAVER BL 80 MM TKROAD WORK Supplying & laying CC paver blocks 80mm thick usingminimum M 35 grade laid on 50mm avg thickness sand bedding

DRIVWAY WBM 150 MM THICKDWAY . WBM 150 MM THICKROAD WORK-Supplying and spreading stone aggregate of required size asper our specification in 2 layers to achieve the required thickness.

# DISMANTLING AND DEMOLITION

## CONTENTS

## 1.0 INTRODUCTION

This specification deals with the procedures to be adopted while demolishing/dismantling of existing concrete, steel and masonry structures.

While the intent is not to specify each and every details of the dismantling activity, the contractor shall take every possible care while executing the works and as per directions of the Owner/Owner's Representative.

## 2.0 SAFETY AND SECURITY

Safety and security of the structures, site or the field personnel shall be solely the responsibility of the Contractor. The Contractor shall take all necessary safety measures to prevent mishaps or accidents during dismantling work.

For important structure/buildings as directed by the Owner/Owner's Representative, an advanced / improved demolition / dismantling technique / control demolition technique shall be adopted after carrying out collapse analysis as and when required. This shall be done such that the ground vibrations caused during demolishing/dismantling shall not unduly disturb/ damage the adjacent / neighbouring buildings/structures.

As for as possible for dismantling, core cutting techniques that uses cutting tools which produces less vibration/noise shall be used. Wherever applicable, approval of statutory body/concerned environmental agencies shall be obtained before starting of the dismantling/demolishing work.

## 3.0 WORKMANSHIP

Before taking up any dismantling/demolishing activity, a clear and detailed method statement indicating the detailed procedure adopted shall be prepared and submitted to the Owner/Owner's Representative for approval. The documents approved by the Owner/Owner's Representative do not absolve or dilute the Contractor's responsibilities towards safety precautions. Any liabilities/injuries/accidents arising due to defective safety practices of the Contractor shall be solely to the Contractor's accounts.

All materials obtained from dismantling/demolishing operations shall be the owner property, unless otherwise specified and shall be kept in the safe custody until handed over to the Owner/Owner's Representative

Where it becomes necessary to disconnect any existing service lines such as Electrical, Piping etc. during dismantling/demolishing operation and where so required by the Owner/Owner's Representative suitable alternate arrangement shall be made by the Contractor to maintain the continuity and proper functioning of the affected service linkage.

Dismantling activity implies carefully taking up or down and removing without damage. The articles shall be passed by hand where necessary, and lowered to the ground, and not thrown. Where nails, screws, bolts etc. fix these, these shall be taken out with proper tools and not by tearing or ripping off. Demolition activity implies taking up or down or breaking up. This shall consist of demolishing whole or part of work including all relevant items as specified or shown in the drawings.

Prior to commencement of activity, the structures to be dismantled shall be studied carefully and the works procedure planned out. The permission to dismantle shall be obtained in writing from the Owner/Owner's Representative. Adequate warning/sign posts shall be provided at locations. The entire area shall be cordoned off after prior intimation. Where the plant is in operation, the operating staff of the plant shall be informed of the dismantling activity.

The demolition shall always be planned before hand and shall be done in reverse order of the one in which the structure was constructed. The scheme of demolition shall be got approved from the Owner/Owner's Representative before starting the work. Necessary propping, shoring and under pinning shall be provided for the safety of the adjoining work or property, which is to be left intact before demolition is taken up and the work shall be carried out in such a way that no damage is caused to the adjoining properties. Necessary precaution shall be taken to keep the dust nuisance down as and where necessary. The dismantling shall be commenced in a systematic manner- Chipping of concrete shall proceed taking adequate care as not to cause damage to the existing structures. Use of sledgehammer shall be limited so as not to cause damage to adjacent structures/equipment. Floor slabs shall be chiseled around the perimeter to enable removal of slabs in units. The area identified for chiseling shall be suitably assessed so as not to cause any damage to floor below, if any. The reinforcement shall be subsequently cut and the debris shall then be moved to the location identified by the Owner/Owner's Representative and as per his instructions. Masonry units shall be dismantled in such a way so that collapse of entire units is avoided. The bricks shall be removed in units. These shall be then moved to a location us directed by Owner/Owner's Representative, Adequate supports wherever necessary shall be provided to the area adjacent to the dismantling activity so as to protect any damage or collapse, Shuttering shall be provided below the slabs where chipping is envisaged. If necessary, blinds shall be erected to avoid dust and flying of the chipped particles.

Any serviceable material obtained during dismantling or demolition shall be separated out and stacked properly as directed by Owner/Owner's Representative within a lead of 100 meters. All unserviceable materials rubbish etc. shall be disposed off as directed by Owner/Owner's Representative.

Where structural steel platforms are to be dismantled, these shall be either carefully cut or if it is a bolted structure such as platforms, be dismantled to enable reuse of these units for a different location.

After the dismantling or demolishing work is complete, all loose debris etc. shall be removed and the area swept clean or washed with water.

# STANDARD FIELD QUALITY PLAN

| Sl. No | Component Operation & Description of Test | Sampling Plan with basis | Ref. Document & acceptance norms | Testing Agency | Remarks | Check |
|---|---|---|---|---|---|---|
| 1 | **CHECKING OF FOUNDATION MATERIALS** | | | | | |
| A. | **CEMENT** | One sample per lot of 100 MT or part thereof from each source for MTCs and one sample per lot of 200 MT or part thereof from each source for site testing. | IS:456, IS:269, IS:8112, IS:12269, IS: 4489 & Specification | Manufacturer approved lab | Review of manufacturers test certificates (MTCS) and laboratory test results by | β |
| i | Initial & final setting time | | | | | |
| ii | Soundness | | | | | |
| iii | Heat of Hydration for low heat cement ( Not Applicable for OPC & PCC) | | | | | |
| iv | Fineness | | | | | |
| v | Compressive Strength | | | | | |
| vi | Chemical Composition of Cement | One sample per lot of 100 MT or part thereof from each source fro MTCs. | IS:456, IS:269, IS:8112, IS:12269, IS: 4489 & Specification | Manufacturer | Review of manufacturers test certificates by | β |
| B. | **COARSE AGGREGATES** | | | | | |
| i. | Determination of Particle size (Sieve Analysis) | One sample per lot of 100 cubic meter or part thereof from each source for each source for each size | IS: 383, IS: 2386 and specification | approved lab. However, Moisture content test for design mix concrete shall be done on all days of concreting at site. | Each source to be approved by . Review and acceptance of test result by | B |
| ii | Flakiness Index | | | | | |
| iii | Crushing Value | | | | | |
| iv | Specific Gravity | | | | | |
| v | Bulk Density | | | | | |
| vi | Absorption Valve | | | | | |
| vii | Moisture Content | | | | | |
| viii | Soundness of Aggregate | | | | | |
| ix | Presence of detections materials | | | | | |

| Sl. No | Component Operation & Description of Test | Sampling Plan with basis | Ref. Document & acceptance norms | Testing Agency | Remarks | Check |
|---|---|---|---|---|---|---|
| **C** | **FINE AGGREGATE** | | | | | |
| i | Gradation/Determination of Particle size( Sieve Analysis) | One sample per lot of 100 cubic meter of part thereof from each source | IS:383, IS:2386, IS:456 and specification | approved lab. However, Moisture content test for design mix concrete shall be done on all days of concreting at site. | Each source to by approved by . Review and acceptance of test result by | β |
| ii | Specific Gravity and density. | | | | | |
| iii | Moisture content* | | | | | |
| iv | Absorption Value* | | | | | |
| v | Bulking | | | | | |
| vi | Silt Content Test | | | | | |
| vii | Presence of deleterious materials | | | | | |
| **D** | **BRICKS** | | | | | |
| i. | Dimensional tolerance | As per enclosed Annexure-II | CPWD & specification | approved Lab. | Approved by | β |
| ii | Compressible Strength | | | | | |
| iii | Water Absorption | | | | | |
| iv | Efflorescence | | | | | |
| **E** | **WATER** | | | | | |
| i | Cleanliness (Visual Check) | Random | IS: 456, IS: 3025 and specification. The water used for mixing concrete shall be fresh, clean and free from oil, acids and alkalis, organic materials, or other deleterious materials. | Contractor | Each source to be approved by | β |
| ii | Chemical and physical properties of water for checking its suitability for construction purposes | One sample per source | IS:456, IS:3025 and specification | Contractor/ approved lab. | Approved by | β |

| Sl. No | Component Operation & Description of Test | Sampling Plan with basis | Ref. Document & acceptance norms | Testing Agency | Remarks | Check |
|---|---|---|---|---|---|---|
| **2** | **Reinforcement Steel** | | | | | |
| i. | Identification & size | Random | IS:432, IS:1139, IS:1786 & specification | Contractor | Approved by | β |
| ii. | Chemical Analysis Test | One sample per heat | IS:432, IS:1139, IS:1786 & specification | Manufacturer | Review of manufacturers test certificates by | β |
| iii | Tensile Test | One sample per lot of 40 MT or part thereof for each size of steel conforming to IS:1139 and 5 MT or part thereof for HDS wire for each size of steel as per IS:432. For steel as per IS:1786 under 10mm 1 sample for each 35 MT or part thereof. Over 16m , 1 sample for each 45 MT or part thereof. | IS:432, IS:1139, IS:1786 & specification | Manufacturers / approved Lab | Review of manufacturers test certificates as well as lab test result by | β |
| iv | Yield stress/ proof stress | | | | | |
| v | Percentage Elongation | | | | | |
| vi | Bend/Rebend Test | One sample per lot of 20 MT or part thereof for each size of steel as per IS:432, IS:1139. For steel as per IS:1786 under 10mm-16mm, 1 sample for each 25 MT or part thereof 10mm-16mm 1 sample for each 45 MT or part thereof. | IS:432, IS:1139, IS:1786 & specification | Manufacturers / approved Lab | Review of manufacturers test certificates as well as lab test result by | β |

| Sl. No | Component Operation & Description of Test | Sampling Plan with basis | Ref. Document & acceptance norms | Testing Agency | Remarks | Check |
|---|---|---|---|---|---|---|
| vii | Reverse Bend Test for HDS wire. | One sample per lot of 5 MT or part thereof for each size | IS:432, specification | Manufacturer/ approved lab. | Review of manufacturers test certificates as well as lab test result by | β |
| **3** | **Structural Steel Used In Cable Trenches & Foundations** | | | | | |
| i. | Dimensional Check | Random | specification & approved drawing | Contractor | Checklist to be prepared and signed jointly. | β |
| ii | Visual Check for damages, resting, pitting etc. | 100% | specification & approved drawing | Contractor | Checklist to be prepared and signed jointly. | Y |
| iii | Visual Check for welding, defects, primer coating and painting/ galvanizing as applicable | Sample per lot of 40 MT or part thereof for tensile tests and 1 sample per lot of 20 MT or part thereof for bend test for each size. | IS:2062, Specification & approved drawings | Manufacturer/ approved lab | Review of Mtgs test certificates as well as lab test results by | Y |
| iv | Physical properties of structural steel | One sample per lot of 40 T or part thereof for tensile tests and 1 sample per lot of 20 T or part thereof for bend test. | IS 2062 , Specifications and approved drawings | Manufacturer/ approved lab | Review of Mtgs test certificates as well as lab test results by | β |
| **4** | **EQUIPMENT FOUNDATION/ CABLE TRENCH** | | | | | |
| A | **BEFORE EXCAVATION** | | | | | |
| i | Checking of pegs condition as per line and alignment | 100% on each location | IS:4091, IS:3764 & approved drawing/ specification | Contractor | Approved by | Y |

| Sl. No | Component Operation & Description of Test | Sampling Plan with basis | Ref. Document & acceptance norms | Testing Agency | Remarks | Check |
|---|---|---|---|---|---|---|
| ii. | Checking of pit making as per drawing & RL. | 100% on each location | IS:4091, IS:3764 & approved drawing/ specification. | Contractor | Approved by | Y |
| B | **EXCAVATION** | | | | | |
| i | Dimensional conformity | Each location | IS:4091, IS:3764 & approved drawing/ specification. | Contractor | Approved by | β |
| ii | Verticality/slopes & Square ness of each pit | Each location | IS:4091, IS:3764 & approved drawing/ specification. | Contractor | Approved by | β |
| iii | Vertification & classification of foundation wherever application. | Each location | IS:4091, IS:3764 & approved drawing/ specification. | Contractor | Approved by | β |
| **C** | **FOUNDATION BOLTS/ MATALLIC INSERTS** | | | | | |
| i | Check for proper identification foundation bolts w.r.t. type of foundation | 100% | specification & approved drawings | Contractor | Checklist to be prepared & signed jointly. | Y |
| ii | Visual check for mechanical damage and galvanizing/ painting it applicable for metallic insert | 100% | specification & approved drawings | Contractor | Checklist to be prepared & signed jointly. | Y |
| iii | Alignment & Level | 100% | specification & approved drawings | Contractor | Checklist to be prepared & signed jointly. | β |

| Sl. No | Component Operation & Description of Test | Sampling Plan with basis | Ref. Document & acceptance norms | Testing Agency | Remarks | Check |
|---|---|---|---|---|---|---|
| iv | Grouting/ Underpinning of foundation base plate. | 100% | specification & approved drawings | Contractor | Checklist to be prepared & signed jointly. | Y |
| D | **P.C.C. PADDING** | For all locations | IS:456 and approved foundation drawings & Specification | Joint Inspection by and Contractor. | Approval by | β |
| E | **SHUTTERING (Formwork)** | | | | | |
| i. | Check for materials, breakage or damage. | 100% | IS: 456, specification / approved drawings. | Joint Inspection by and contractor | Approval by | Y |
| ii | Check for plumb, alignment parallelism, squareness and equidistance from stub. | 100% casting | IS:456, Specification/ approved drawings. | Joint Inspection by and contractor. | Approval by | β |
| iii | Dimensional check | 100% before casting | Specification/ approved drawings | Joint Inspection by and contractor | Approval by | β |
| iv | Check for level & height. | 100% before casting | Specification/ approved drawings | Joint Inspection by and contractor | Approval by | β |

| Sl. No | Component Operation & Description of Test | Sampling Plan with basis | Ref. Document & acceptance norms | Testing Agency | Remarks | Check |
|---|---|---|---|---|---|---|
| v | Check for rigidity of frame/ tightness | 100% | Specification/ approved drawings | Joint Inspection by and contractor | Approval by | β |
| vi | Cleaning and oiling | 100% | Specification/ approved drawings | Joint Inspection by and contractor | Approval by | β |
| vii | Diagonal bracing if required as per drawings/ site conditions | 100% | Specification/ approved drawings | Joint Inspection by and contractor | Approval by | Y |
| viii | Checking of joints to avoid undue loss of cement slurry. | 100% | Specification/ approved drawings | Joint Inspection by and contractor | Approval by | Y |
| F | **Placement of Reinforcement Steel** | | | | | |
| i | Check the steel bars for rust, cracks, surface flaws, laminate etc. (Visual check) | 100% | IS:456 and Specification/ approved drawings | Joint Inspection by and contractor | Approval by | Y |
| ii | Check as per the bar bending schedule before placement of concrete. | For all locations | IS:456 IS:2502 and Specification/ approved drawings | Joint Inspection by and contractor | Approval by | Y |
| iii | Checking cutting tolerance for bars as per check list/ drawings, check whether all the bent bars and lap lengths are as per | For all locations | IS:456 , IS:2502 and Specification/ approved drawings | Joint Inspection by and contractor | Approval by | β |

| Sl. No | Component Operation & Description of Test | Sampling Plan with basis | Ref. Document & acceptance norms | Testing Agency | Remarks | Check |
|---|---|---|---|---|---|---|
| | approved bar bending schedule. | | | | | |
| iv | Check whether all joints & crossing of bars are tied properly with right guage & annealed wire as per specification | 100% | IS:456 , and Specification/ approved drawings | Joint Inspection by and contractor | Approval by | Y |
| v | Check for proper cover distance spacing of bars, spacers & chairs after the reinforcement cage has been put inside the formwork. | 100% | IS:456 , and Specification/ approved drawings | Joint Inspection by and contractor | Approval by | Y |
| vi | Check whether tapping of bars are tied properly with right guage and annealed wire as per specification. | 100% | IS:456 , and Specification/ approved drawings | Joint Inspection by and contractor. | Approval by | β |
| vii | Anchor bolts if applicable | | | | | |
| a | Level, center-to-center distance of bolts. | 100% on each location | approvedpile foundation drawings/ specification. | Joint Inspection by and contractor. | Checklist to be prepared and signed jointly. | β |
| b | Visual check for galvanizing. | 100% on each location | approvedpile foundation drawings/ specification. | Joint Inspection by and contractor. | Checklist to be prepared and signed jointly. | β |

| Sl. No | Component Operation & Description of Test | Sampling Plan with basis | Ref. Document & acceptance norms | Testing Agency | Remarks | Check |
|---|---|---|---|---|---|---|
| **5** | **CONCRETING** | | | | | |
| a | APPROVAL OF MIX DESIGN | Each mix | IS: 456 & drawings/ specification. | approved by Lab | Approval by | á |
| b | BATCHING, MIXING & PLACING OF CONCRETE AND COMPACTING. | 100% | IS:456 & approved pile foundation drawings/ specification | Joint Inspection by and contractor. | Approval by | β |
| c | PLACING CONCRETE AND COMPACTING. | 100% | IS:456 & approved pile foundation drawings/ specification | Joint Inspection by and contractor. | Min gap between boxes and reinforcement bars should be maintained. Approved by . | β |
| **D** | **Concrete testing** | | | | | |
| i | Slump Test | One sample per casting | IS:456, IS 516, IS: 1199 and specification. | Contractor | Approved by | β |
| ii | Check for quantities for cement, fine aggregate, coarse aggregate and water while batching | 100% on all locations | IS:456, IS 516, IS: 1199 and specification. | Contractor | Checklist to be prepared and signed jointly. | β |
| e | **Concrete Cube Testing** | | | | | |
| i | Compressive Strength | One sample for every 20 Cum of concreting or part thereof for each days concreting ( one sample consists of min. 3 test cubes for 28 days strength) | IS:456, IS 516, IS: 1199 and specification. | approved lab | Approval by Cubes must be testedwithin a week after 28 days curing period and test resultsshould be approved. | á |

| Sl. No | Component Operation & Description of Test | Sampling Plan with basis | Ref. Document & acceptance norms | Testing Agency | Remarks | Check |
|---|---|---|---|---|---|---|
| f | CHECK FINISHING, DIMENSIONAL CONFORMITY AND WORKMANSHIP BEFORE & AFTER BOX REMOVAL. | 100% | IS:456, IS 516, IA: 1199 and specification. | Contractor | Approval by | β |
| **6** | **BACKFILLING** | | | | | |
| i | Check for thickness of layer & watering | 100% | specification and approved drawings. | Contractor | Approved by | Y |
| ii | Visual check for correction/ ramming. | 100% | specification and approved drawings. | Contractor | Approved by | Y |
| iii | Compaction test ( percentage of max. dry density) | Samples for each pit. Equipment & other foundation 20% at random | Specification | approved lab | Review of lab test results by . Elevation for testing to be decided by . | β |
| **6** | **BRICK-WORK & TILING WORK** | | | | | |
| i. | Mortar mix/ proportion | Random | IS:2250, specification & CPWD specification. | Contractor | Approval by | β |
| ii | Plumb & Alignment | Random | specification & CPWD Specification | Contractor | Approval by | β |
| iii | Joints | Random | specification & CPWD Specification | Contractor | Approval by | β |

| Sl. No | Component Operation & Description of Test | Sampling Plan with basis | Ref. Document & acceptance norms | Testing Agency | Remarks | Check |
|---|---|---|---|---|---|---|
| iv | Water absorption Test | Random | specification & CPWD Specification | Contractor | Approval by | β |
| **7** | **PLASTERING** | | | | | |
| i | Plastering thickness and evenness | Random | specification & CPWD Specification | Contractor | Approval by | β |
| ii | Mortar mix./ proportion | Random | specification & CPWD Specification | Contractor | Approval by | β |
| 8 | SITE SURFACING | | | | | |
| i | Levelling | 100% | specification & CPWD Specification | Contractor | Checklist to be prepared and signed jointly | B |

**Section:** **GENERAL GUIDELINES FOR IMPLEMENTATION**

1. Details of categories of check codes á, β & Y including accepting and deviation dispositioning authorities are indicated at Annexure-1.

2. specification shall mean technical specification, approved drawings/ data sheets and LOA provisions applicable for the specific contract.

3. Accepting criteria and permissible limits for certain tests are indicated at Annexure-II. For balance tests, site to verify the same with respect to specification, relevant Indian Standards and/or prevalent code of practice.

4. It is clarified that the tests indicated at column 2 of this F.Q.P. i.e. against column “Component Operation & Description of Test,” are only generally required to be conducted. However, reserves the right to carryout any additional tests at any stage if the situation so warrants.

5. site representative shall witness all the tests conducted by the contractor as mentioned inthis F.Q.P. However, in case of tests conducted in the approved lab, it is preferred to witness the tests in the lab itself, if possible.

6. shall approve testing laboratory before accepting the test results from the lab.

7. shall approve the sources for cement, coarse aggregate, fine aggregate & water before actual utilization.

8. All the testing & measuring equipment used by the contractor for testing are required to be calibrated. A copy of valid calibration report shall be retained by as records.

9. Classification of foundations shall be approved by based on the Joint Inspection Report &Soil investigation reports.

10. Curing of concrete work should be continued for a minimum period of 10 days.

11. ZONE-IV FINE AGGREGATE.

a. Zone-IV line aggregate shall be used for nominal mix. Reinforced cement concreting work.

b. Zone-IV line aggregate shall be avoided for design mix. Reinforced cement concreting work unless tests have been done to ascertain the suitability of proposed mix proportion with the prior approval site.

12. Bricks shall be free from cracks, flaws and modules of free lime. They should have smooth rectangular faces with sharp corners and should be uniform in colour.

13. CEMENT

a. In case supply of cement is in the scope of the contractor, the same shall be procured from sources approved by site and got tested at site on sample basis for specified acceptancetests as specified in the F.Q.P. at a reputed Third Party Lab approved by site.

b. The samples of cement for site testing shall be taken within three weeks of the delivery and all the tests shall be commenced within one week of sampling, if the cement remains in store for a period of more than six month. All the site tests are required to be repeated before usage.

14. REINFORCEMENT STEEL & STRUCTURAL STEEL USED IN CABLE TRENCHES AND FOUNDATIONS.

a. In case supply of steel is in the scope of the contractor, the same shall be procured from the main producers i.e. SAIL, TISCO, IISCO or Rashitriya Ispat Nigam Ltd. The steel shall be got tested at site on sample basis of specified acceptance tests as specified in this F.Q.P. at a reputed Third Party Lab approved by site.

b. The results of the testing of cement and reinforcement steel referred to in 13.a and 14.a above shall be got approved from site before cement and reinforcement steel are put to use. However, in exceptional cases due to exigencies of work. site may authorize the contractor to use Cement and Reinforcement Steel even before the test results are received. However, in all such cases, if the test results subsequently received are found to be not complying with the specified acceptance criteria, the contractor shall have to dismantle and recast all such foundations cast with such non-conforming materials at his own cost. Confirmation to this effect shall be obtained from the contractor by the Project authorities beforehand in all such cases.

15. The contractor shall submit welding procedure specification (WPS) including the type of electrode used for approval of site before starting the welding work.

16. Approval/ acceptance of individual test results by in the course of execution of contract will not relieve the contractor of his contractual obligations and responsibilities, nor does it limitthe Owner's right under the contract.

17. In case, requirement of special items like Super Sulphated Cement, Corrosive Resistant Reinforcement Steel (CRRS) etc arise due to site conditions, the specific approved of may be obtained before using the same and all the tests as per relevant standards shall be carried out.

All the materials shall be stored by the contractor in a manner affording convenient access for identification and inspection at all times. Storage of material shall be in accordance with IS:

4032 (Latest Edition).

ACCEPTANCE CRITERIA AND PERMISSIBLE LIMITS FOR FOUNDATION MATERIALS & CONCRETE

**A. CEMENT**

| **Description of the Test** | **33 Grade OPC as per IS:269** | **43 Grade cement as per IS:8112** | **PPC as per IS:1489** | **Low Heat Cement** |
|---|---|---|---|---|
| i) Fineness (min) | 225 $m^2$/Kg | 225 $m^2$/Kg | 300 $m^2$/Kg | 225 $m^2$/Kg |
| ii) Compressive Strength (min)<br>72 □ 1 hours<br>168 □ 2 hours<br>672 □ 4 hours | <br>160 kgf/$cm^2$<br>220 kgf/$cm^2$<br>- | <br>23 MPa<br>33 MPa<br>43 MPa | <br>16 Mpa<br>22 Mpa<br>33 Mpa | <br>100 kgf/$cm^2$<br>160 kgf/$cm^2$<br>350 kgf/$cm^2$ |
| iii) Initial Setting Time (Min) | 30 Minutes | 30 Minutes | 30 Minutes | 30 Minutes |
| iv) Final Setting Time (Max.) | 600 Minutes | 600 Minutes | 600 Minutes | 600 Minutes |
| v) Soundness ( Le chatelier Method) | Max 10 mm expansion | Max 10 mm expansion | Max 10 mm expansion | Max 10 mm expansion |
| vi) Heat of hydration (Max.) | - | - | - | Max. 65 cal/gm for 7 days cal/gm for 28 days |
| vii) Chemical Composition | As per IS | As per IS | As per IS | As per IS |

**B. COARSE AGGREGATE**

(i) Sieve Analysis

| **IS SIEVE Designation** | **Percentage passing for Graded aggregate of nominal size** | | **Percentage passing for single sized aggregate of nominal size** | |
|---|---|---|---|---|
| | 40 mm | 20 mm | 40 mm | 20 mm |
| 63 mm | - | - | 100 | - |
| 40 mm | 95 to 100 | 100 | 85-100 | 100 |

| **IS SIEVE Designation** | **Percentage passing for Graded aggregate of nominal size** | | **Percentage passing for single sized aggregate of nominal size** | |
|---|---|---|---|---|
| 20 mm | 30 to 70 | 95 to 100 | 0-20 | 85-100 |
| 10 mm | 10 to 35 | 25 to 55 | 0-5 | 0-20 |
| 4.75 mm | 0 to 5 | 0 to 10 | - | 0-5 |

(ii) Flakiness Index Not to exceed 25%

(iii) Crushing Value Not exceed 45%

| | | |
|---|---|---|
| (vi) | Soundness of aggregate applicable for concrete works subject to froast action | Loss of weight after 5 cycle to exceed 12% when tested with Sodium sulphate and 18% when tested with magnesium sulphate. |

(v) Deleterious material — Not to exceed 5% of the weight of aggregate when tested as per IS:2386 Part-II (1963)

**C. FINE AGGREGATE**

(i) Sieve Analysis — Shall confirm to Zone II or Zone III.

| **IS Sieve designation** | **Percentage Passing for** | | | |
|---|---|---|---|---|
| | Grading zone-I | Grading zone-II | Grading zone-III | Grading zone-IV |
| 10 mm | 100 | 100 | 100 | 100 |
| 4.75 mm | 90-100 | 90-100 | 90-100 | 95-100 |
| 2.35 mm | 60-95 | 75-100 | 85-100 | 95-100 |
| 1.18 mm | 30-70 | 55 – 90 | 75 – 100 | 90- 100 |
| 600 Micron | 15-34 | 35-59 | 60-79 | 60-100 |
| 300 Micron | 15-20 | 8-30 | 12-40 | 15-50 |
| 150 Micron | 0-10 | 0-10 | 0-10 | 0-15 |

(ii) For guidance of adjusting sound in mix of concrete, the following table may be used.

| **Moisture Content %** | **Building % by volume** |
|---|---|
| 2 | 15 |
| 3 | 20 |
| 4 | 25 |
| 5 | 30 |

(iii) Silt Content Test: Shall not exceed 4% when tested for building work and shall not exceed 10% as per procedure specified CPWD specification when tested.

(iv) Deleterious Materials: Total deleterious material shall not be more than 5% by weight.

(D) REINFORCEMENT STEEL: As per relevant Indian Standards.

(E) CONCRETE CUBE TEST

For nominal (volumetric) concrete mixes, compressive strength for M20 (1:1½:3 (cement: sand: Coarse aggregate) concrete shall be 265 kg/ $cm^2$ for 28 days.

(F) ACCEPTANCE CRITERIA BASED ON 28 DAYS COMPRESSIVE STRENGTH FOR NOMINAL MIX CONCRETE.

(a) The average of the strength of three specimen be accepted as the compressive strength of the concrete, provided the strength of any individual cube shall neither be less than 70%, nor higher than 130% of the specified strength.

(b) If the actual average strength of accepted sample exceeds specified strength by more than 30%, the Owner/Owner's Representative, if he so desires, may further investigate the matter. However, if the strength of any individual cube exceeds more than 30% of

specified strength, it will be restricted to 30% only for computation of strength.

(c) If the actual average strength of accepted sample is equal to or higher than specified strength upto 30%, than strength of the concrete shall be considered in order and the concrete shall be accepted at full rates.

(d) If the actual average strength of accepted sample is less than specified strength but not less than 70% of the specified strength, the concrete may be accepted at reduced rate at the discretion of Owner/Owner's Representative.

(e) If the actual average strength of accepted sample is less than 70% of specified strength, the Owner/Owner's Representative shall reject the defective portion of work represented by sample and nothing shall be paid for the rejected work. Remedial measures necessary to retain the structure shall be taken at the risk and cost of contractor. If, however, the Owner/Owner's Representative so desires, he may order addition to tests to be carried out to ascertain if the structure can be retained. Al the charges in connection with these additional tests shall be borne by the Contractor.

(G) ACCEPTANCE CRITERIA FOR DESIGN MIX CONCRETE SHALL BE AS PER IS: 456.

(H) SAMPLING PLAN FOR BRICK- WORK

Scale of sampling and permissible number of defectives for visual and dimensional characteristics.

| **No of bricks in the lot** | **For Characteristics specified for individual bricks** | | **For dimensional characteristics for group of 20 bricks. No. of bricks to be selected.** |
|---|---|---|---|
| 2001-10000 | 20 | 1 | 40 |
| 1001-35000 | 32 | 2 | 60 |
| 35001-50000 | 50 | 3 | 60 |

**Note:** In case the lot contains 2000 or less bricks the sampling shall be as per decision of the Owner/Owner's Representative.

ii) Scale of sampling for physical characteristics

| **Lot size** | **Sampling size for compressive strength water absorption and efflorescence** | **Permissible No. of defectives for efflorescence** |
|---|---|---|
| 2001-10000 | 5 | 0 |
| 10001-35000 | 10 | 0 |
| 35001-50000 | 15 | 1 |

**Note:** In case the lot contains 2000 or less bricks, the sampling shall be as per decision of Owner/Owner's Representative.

iii) Water absorption Test.
Water absorption after 24 hours immersion shall not exceed more than 22 percent by weight.

# TOPOGRAPHICAL SURVEY

## CONTENTS

## 1.0 INTRODUCTION

This specification deals with the Topographical Survey work for development of terminals. The intent of the survey for the proposed sites is to obtain sufficient topographical data for finalizing all engineering works and establishment of Reference levels and plot extremities forreference during construction of the project.

## 2.0 SCOPE OF WORK

The terminals/plots along with approaches to the plots which are to be surveyed shall be clarified by the Engineer in charge during execution of work.

The Survey agency shall carry out detail survey of the area along with showing:-

- Physical features, spot levels, invert levels of existing drains and culverts in terms of RL with their cross sections, transmission/telephone lines, service lines etc. land survey by triangulation or other suitable method.
- Topographical survey indicating existing permanent and temporary structures including levels & limits.
- Drawing of terrain.
- Detailed levels and coordinates of existing roads and other units.
- Preparation of survey drawings with descriptive note on terrain.
- Setting of reference grid lines and temporary bench marks.
- True North
- Grids at 5m internal shall be established parallel to true north. Working reference point "A" to be fixed at site with reference to some permanent bench mark.
- Check the co-ordinations of existing roads and other units with reference to the details
- Survey of 5m length beyond the periphery of the proposed plot all around the proposed site.
- Establish the HFL while indicating its source of information.
- To identify storm water disposal point with it's levels as per existing site condition.
- Plot plan to show all test locations w.r.to plot corner pegs as well as their Reduced Level.

## 3.0 LEVELING WORK

The leveling work shall be based on the bench marks available in the vicinity or any permanent existing features. Vertical control based on existing bench marks shall be established based on closed level network.

Suitable instruments shall be used for establishing the bench marks and for doing the general leveling work. All survey points, reference grid /corner pillars (of wooden pegs), shall be protected in such a way so that they are not disturbed during the construction period. The size of pegs shall be minimum 100mm diameter of Wooden balli which shall be embedded in ground. Reference point for the grid system shall be nearest to the existing permanent features.

## 4.0 SURVEY DETAILS

It shall be general survey work to be used for engineering purposes. The survey shall be

oriented towards furnishing information for project planning and detailed engineering work. The survey shall show all the existing features along with levels and important dimensions. Existing features such as roads, railway tracks, buildings, drains, manholes, overhead & underground service lines, communication and supply lines, and similar permanent and temporary structures shall be shown. Each survey drawing shall show sets of perpendicular grid lines parallel to actual North, South and East, West with reference to reference point. These are needed for the purpose of orienting and matching the survey drawings with layout of the unit. Ground levels shall be shown on rectangular grid pattern at intervals of 10 meters. Additional levels to show sudden change of levels shall also be indicated. Contours are to be drawn at 0.20 m intervals. Inverts levels of existing drains at regular intervals shall be taken. Top levels of man-holes shall also be taken. Existing levels at regular intervals and at all junctions for roads, top levels, width, curvature at turning points shall be shown. Any other important detail shall also be shown. Bench marks, reference points, triangulation stations, any existing boreholes, oil wells trial pits etc. used shall be clearly identified in the drawing indicating their values/co-ordinates. Co-ordinates mentioned above shall be surveyed with respect to the reference axes N-S and E-W.

All survey data collected during the day shall be plotted on the drawing sheet on the same day. These drawings shall be used for following, day to-day progress of work and for quick reference, if needed.

## 5.0 SURVEY DRAWING AND SCALE

All survey drawings shall be made in metric units.

Survey drawings that are to be submitted to the Owner shall be in colour on white paper.

Four copies each of drawings shall be submitted to the Owner along with 2 editable copy on a DVD. .

A descriptive note regarding the site conditions and special features shall also be submitted in field reports. These notes will compliment the drawing and will contain information which could not be covered in the survey drawings. The entire survey report shall also be submitted in soft copy on DVD in 2 sets.

The scale of the drawings shall be 1:100. Generally, A-1 size sheets shall be used for drawings.

## 6.0 INSTRUMENTS, TOOLS AND TACKLES

The use of proper instruments is an important factor in survey work. The Contractor shall arrange his own instruments, accessories, tools and tackles, camping equipment and transport necessary for conducting the survey as per precision required.

Experienced and qualified engineers, surveyors and draughtsmen shall be engaged to carry out the work.

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Survey team shall have at least the following survey instruments and accessories.

- Total Station
- Precision Automatic levels with precision leveling staff
- Precision Measuring Tapes

# GEOTECHNICAL SURVEY

## CONTENTS

## 1.0 INTRODUCTION

This specification deals with the Geotechnical Survey work for development of terminals. The plan for Geo-technical Survey is drawn with a view to obtain sufficient data regarding the engineering properties of soil supporting the foundation for equipment and structures and to plan the various facilities.

## 2.0 SCOPE OF WORK

The scope of services of the contractor for undertaking soil investigation work shall cover all the work connected with soil exploration program at the proposed terminal including the setting out of locations of the various exploration points from reference point, conducting all field investigations at site, collection of soil and water samples, field and laboratory tests and submission of final reports. All field investigation, laboratory tests and reports etc. shall be done in accordance with the latest relevant Indian Standard Codes.

## 3.0 FIELD INVESTIGATION

This specification deals with Field Investigation/ tests and laboratory tests involved in ascertaining soil stratification & engineering properties of the soil at proposed project site. The field investigations/ tests comprise of the following:-

EXPLORATORY BORE HOLES

There shall be one borehole at specified Terminal / plot. The location of these shall be indicated by Engineer before commencement of field activities. The location and number of these boreholes can be altered at site, if found necessary. All boreholes shall be of 150 mm diameter and shall be sunk into soil to a depth of 10m or up to refusal strata, whichever is earlier. The exploratory work at site shall be carried out by using shell and auger equipment. Disturbed samples for boring shall be collected every 1.5m or change in stratum and representative samples placed systematically for proper logging of the strata. The existing ground level shall be marked in terms of RL. Proper logging shall be done with description of different strata encountered with their reduced levels. All boreholes after completion of work shall immediately be filled in with a mixture of bentonite slurry and clay-sand mixture.

UNDISTURBED SAMPLING

In cohesive and semi-cohesive soils, undisturbed samples conforming to IS:2132 shall be taken using open tube samples with an area ratio of less than 15% so as to obtain a core of samples of 100mm diameters and 450mm long at every change in stratum or at intervals of 1.5m whichever is less. The tubes shall be marked and the ends of the sample tube shall be sealed properly with wax of thickness not less than 25mm and capped properly immediately after the sample is recovered from the boreholes to ensure no loss of moisture with time while retained in the tube. Sample tubes shall be immediately shifted to the laboratory for testing.

STANDARD PENETRATION TEST (SPT)

Standard Penetration Test shall be performed at the base of boreholes as per IS: 2131 with the first test at a depth of 0.5 m and thereafter at every change in stratum or at intervals of 1.5 meter whichever is less in both cohesive and non-cohesive soil. The S.P.T. shall also be conducted at termination depth of Borehole. Test may also be required to be carried out in compact sand which in normal terminology will be refusal strata. No. of blows required to penetrate every 150mm shall be recorded in case of normal sand, silt or clay as per IS:2131.

In case of dense/ hard stratum, the penetration (in mm) for every 20 blows per test shall be recorded. All these field records are to be submitted along with bore logs. Bent rods and damaged/ defective nipples shall not be used for the test and shall be replaced immediately by proper ones. Centering spacers shall be used at every 6 meters or at smaller intervals in depths to reduce the effect of whipping of rods. Samples collected in process of conducting S.P.T. shall be preserved as disturbed sample. Graphs shall be drawn for each penetration test. Collection of undisturbed samples and conducting S.P.T. tests will be done alternatively.

DISTURBED SAMPLES

Representative disturbed samples obtained from boring at every 1.5 meter interval in depth or change in stratum shall be placed in suitable jars labeled properly for onward transmission to the laboratory. These samples shall be sent to the laboratory immediately after the boring is complete. All S.P.T. samples shall also be similarly preserved.

STANDING GROUND WATER LEVEL

Records shall be maintained of the level at which water is struck and the level of any rapid in flow shall also be recorded. On reaching such level the borehole shall be left open for a period of two hours to observe the rise of water in the casing. Boreholes can be continued thereafter, upto the end of the day. The level of the water in the casing at the end of the day and at the beginning of the next day shall be recorded properly. For studying the ground water table no drilling mud will be permitted for stabilizing the hole.

## 4.0 LABORATORY TESTS

Laboratory tests shall be conducted on selected samples collected from site to establish the physical and chemical properties of soil. Following tests shall be done as appropriate in accordance with latest relevant Indian code of Practice.

(i) Natural moisture content
(ii) Void ratio
(iii) Liquid plastic and shrinkage limits
(iv) Specific gravity
(v) Dry density and bulk density
(vi) Direct Shear test
(vii) Consolidation/ swelling test
(viii) Particle size analysis
(ix) Chemical properties of the soil

ATTERBERG LIMITS

Liquid and plastic limit tests shall be conducted on all cohesive soils for classificationpurposes and for predicting engineering properties. The results of limit tests shall be plotted on the plasticity chart of A. Cassagrande. Shrinkage limit shall also be determined for a few soil samples.

PARTICLE SIZE ANALYSIS

Particle size analysis shall be done on all clayey and sandy samples. Both sieve and hydrometric analysis shall be conducted and gradation curves shall be plotted to show the particle size distribution.

SHEAR TESTS

Shear tests shall be conducted on the undisturbed samples. A few unconfined compression tests shall be conducted on clayey samples but the majority of clayey samples in un-drained condition shall be subjected to tri-axial tests. The cohesion values and angle of internal friction are to be determined either by Mohr's circle or by any other method. Particular attention shall be paid for conducting tri-axial tests, each of which shall be done on a minimum of 3 specimens. Specimens shall be prepared by trimming and not by pushing small tube in a large tube.

CONSOLIDATION TESTS

A few consolidation tests shall be carried out on undisturbed samples of clayey soil, to estimate the settlement of foundation from "e-log p" curves, compression index - Cc and co- efficient of consolidation – Cu. Consolidation test shall be done in manner that will not allow the sample to swell.

SWELLING TEST

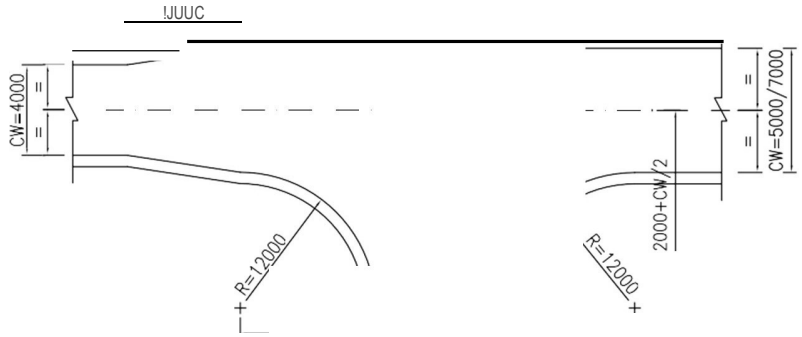
For soils of expansive nature, swelling tests on a few samples shall be selected for conducting swelling test to determine swelling pressure and magnitude.

SPECIFIC GRAVITY AND BULK DENSITY

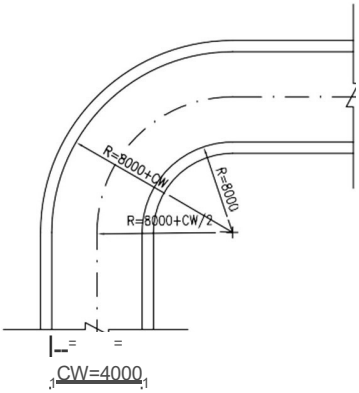
These shall be determined as per the standard procedures. CHEMICAL

ANALYSIS OF SOIL

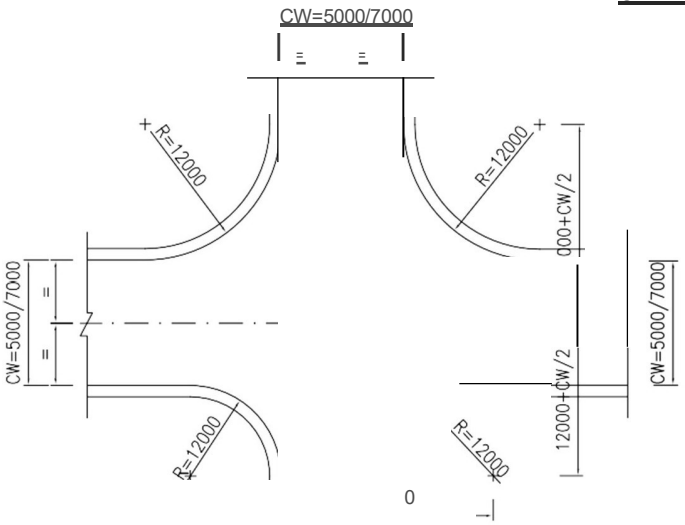
Water samples from a few bore holes shall be taken and chemical analysis shall be done for sulphate, chloride content and pH value, particularly to determine the aggressiveness to concrete, steel and GI pipes. Care shall be taken to ensure that they are not diluted with rain or surface water during recovery from the boreholes. Similarly, a few soil samples shall be chemically tested to determine the sulphate contents, chloride content and pH values and other aggressive components as per IS - 2720.



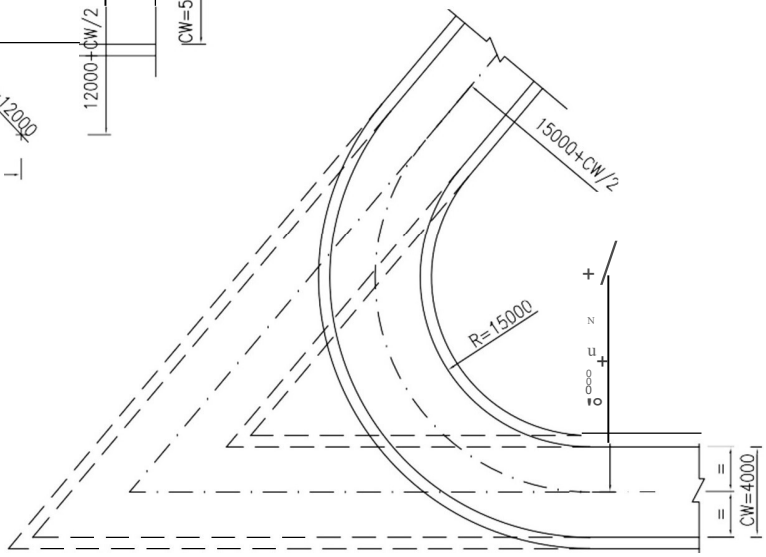

CASE - I




CASE - III




CASE - II

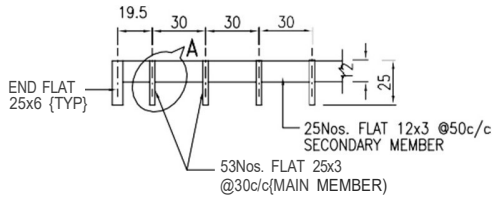



CASE - IV

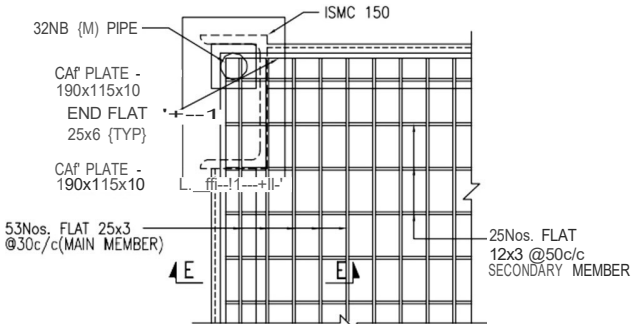
NOTES:-

1. ALL DIMENSIONS ARE IN MM. UNLESS OTHERWISE MENTIONED.
2. MINIMUM RADIUS OF CURVES FOR ROADS WITH CW=4.0m
3. MINIMU RAOIU'.::OF CURVES FOR ROADS WITH CW>4.0m SHALL t,t 1:*Im.*
4. RADIUS OF CURVES FOR APPROACH ROADS TO BUILDINGS AND OTHERS AREAS MAY BE REDUCED AS PER SERVICES REQUIRMENTS.
5. rOk ROALJ CURVI:.'.:: WIIH ACUII:. ANGLI:. IURNING. THE MINIMU RADIUS SHALL BE 1Srr ANC ANGLE NOT LESS THAN SO·.
6. RADIUS :JF CURVES ANC ;;ROSSING WHI:.N LJIr f I:.RI:.N I rROM IHOS!:. GIVEt\ IN THIS STANDARD TO MEET ANY SPECIAL REQUIRMENT SHALL BE SO MARKED IN THE AREA DRAWINGS.

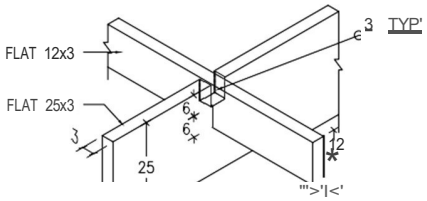
| | | | |
|---|---|---|---|
| | **STANDARD FOR DETAIL OF ROAD CURVES AND CROSSINGS** | **DRAWING NUMBER** | **REV** |




SECTION E - E




DETAIL AT B




DETAIL AT A

1500

A

L1J -200x200x12 THK.
BASE PLATE

[E - 1SMC 150

r100x100x12 THK.
BASE PLATE

50NB {M} PIPE JL_..1 _.J - 20¢ M.S.RUNGS @250c/c

B

A

SECTION C - C

(P L **A N)**

B - 1500

-1SMC 100

ISMC 100

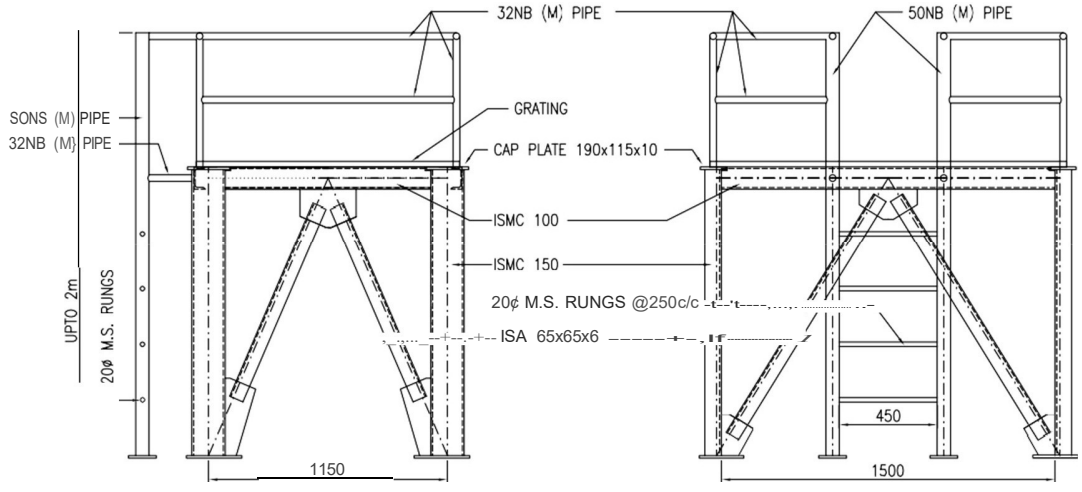
ISMC 150

II32NB PIPE

SONB PIPE_/ I 450 ) 20¢ M.S.RUNGS @250c/c

SECTION D - D

(P L **A N)**

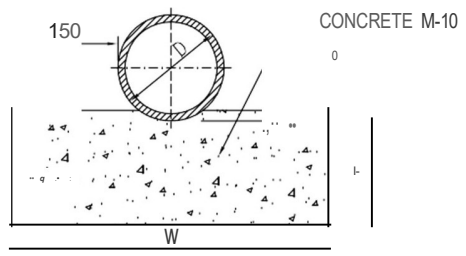



VIEW **A - A**

VIEW B - B

| | | | |
|---|---|---|---|
| | **STANDARD FOR PLATFORM DETAILS** | **DRAWING NUMBER** | **REV** |
| | | | |
| | | | |

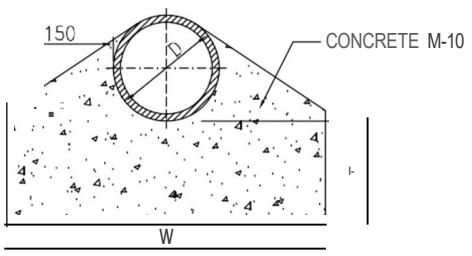
TYPE-I




SECTION ELEVATION OF BEDDING

(FOR C.S PIPE SEWER WHERE SUPPORT IS REQUIRED)

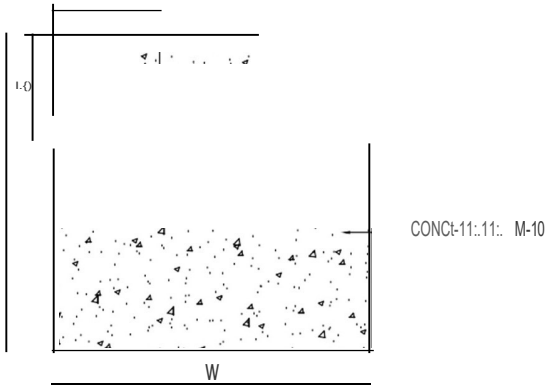
TYPE-II




SECTION ELEVATION OF HAUNCHING

(FOR HOPE, SW PIPE SEWERS)

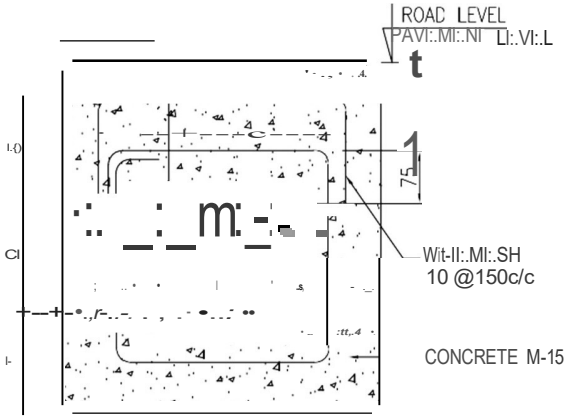
TYPE-IIIA




SECTION ELEVATION SURROUND OR ENCASING

(FOR SEWERS UNDER ROADS COVER>6D0mm)

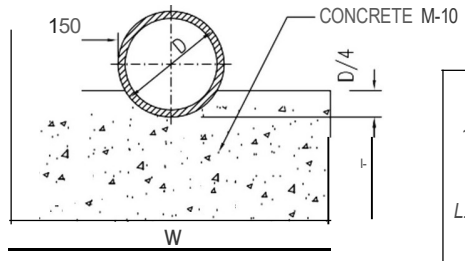
TYPE-IIIB




SECTION ELEVATION SURROUND OR ENCASING

(FOR SLEEVES/PIPES CULVERTS UNDER ROADS FOR COVER<60Dmm)

TYPE-IV




**SECTION ELEVATION CONCRETE GRADE BEDDING**

(FOR SEWERS - CONCRETE PIPE)

LEGEND

D = EXTERNAL DIA OF PIPE
W = 0+300
T = 100 FOR PIPES UNDER 150 NOMINAL DIA.
T = 150 FOR PIPES OF 150 NOMINAL DIA AND ABOVE.

**NOTES:-**

1. BEDDING:- WHER BEDDING IS USED, THE CONCRFTF SHALL BE BROUGHT Uf' 10 AILI:.ASI I() THE INVI:.1-11 LI:.VI:.L Or THE Pin 10 rOI-IM A CI-IAIJLI:. & TO AVOID LINE CONIACI BETWEEN THE PIPE AND BED.

*L*. HAUNCHING:- THE rULL WIIJIh Or THE tll:.IJ SHALL tll:. CAt-11-111:.1) I() THE LEVEL OF THE HORIZONTAL DIAMETER OF THE PIPE AND SPLAYS FROM IHIS LEVI:.L CAt-11-111:.D ON tlOH· SIDES Or THE PIPI:. 10 MI:.1:.1 THE PIPI:. tlAt-11-11:.L TANGENTIALLY.

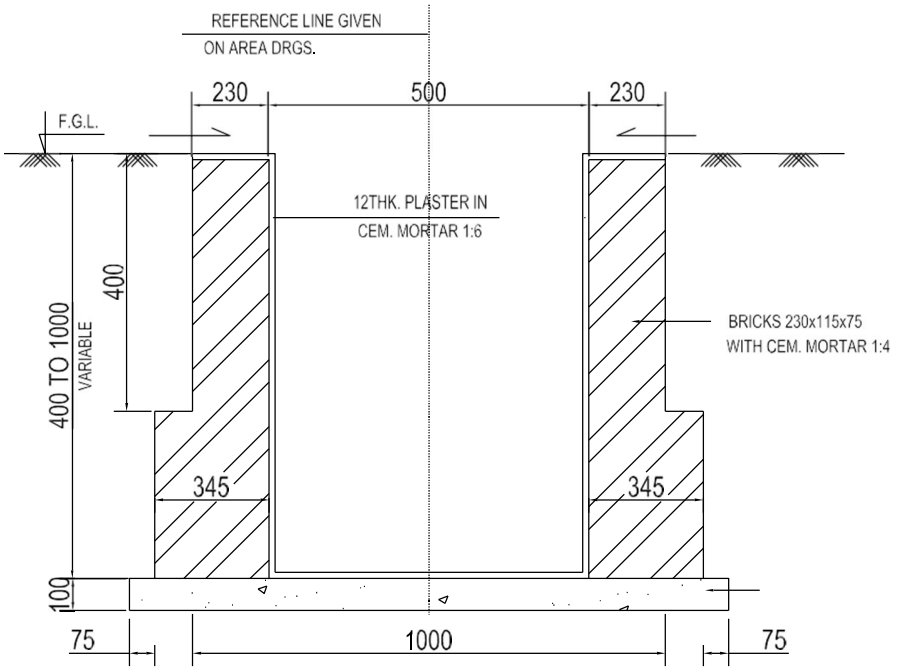
-5. SURROUNDED OR 1:.NCASING IYPI:.-IIIA:- THE SUI-II-IOUNIJ 01-< 1:.NCASING SHALL BE SIMILAR TC HAUNCHING UP TC THE HORIZONTAL , DIA OF THE Pin & THE POt-11101\ OVI:.1-< I HI':. SHALL tll:. rINISHI:.IJ IN A SEMI-CIRCULAR FORM TO GIVE A UNIFORM ENCASING FOR THE TOF HALF OF THE PIPE.

IYPI:.-IIItl:- IT IS SIMILA!-< 10 IYPI:.-IIIA AtlOVI:. 1:.XCI:.PI IHAI THE IOf' POI-IIION OVER THIS SHALL BE FINISHED RECTANGULAR AS SHOWI\ ANC THE SECTION PI-IOVIIJI:.IJ WIIH REINFORCEMENT A':. Pt.I-I REQUIRMENTS.

3. CONCRETE CI-IAIJLI:. tll:.IJIJING:- IS THE METHOC OF BEDDING PIPES IN WHICH THE LOWER PART OF THE PIPE EXTERIOR IS BEDDEC IN CRADLE CONSTRUCTION Or CONCt-11:.11:. WIIr IJIMI:.NSIOI\ A':. SHOWN.

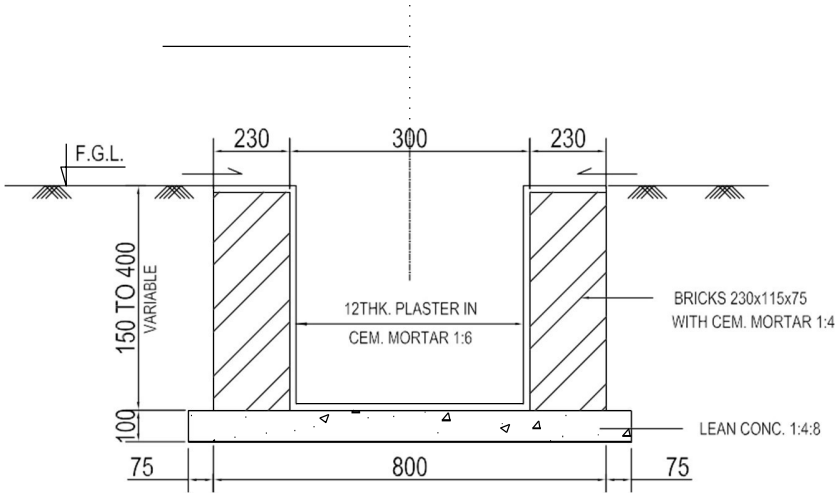
4. CONCRETE WORK SHALL BE CONFOR TO IS: 456.

| | | | |
|---|---|---|---|
| | **STANDARD FOR CONCRETE BEDDING AND ENCASEMENT FOR PIPES** | **DRAWING NUMBER** | **REV** |




RECTANGULAR DRAIN

(TYPE-1)

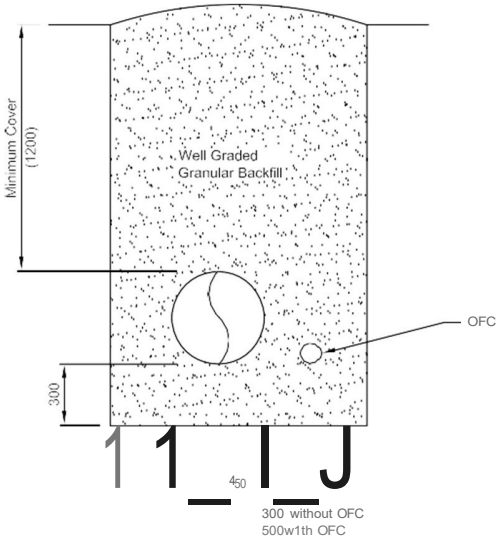



RECTANGULAR DRAIN

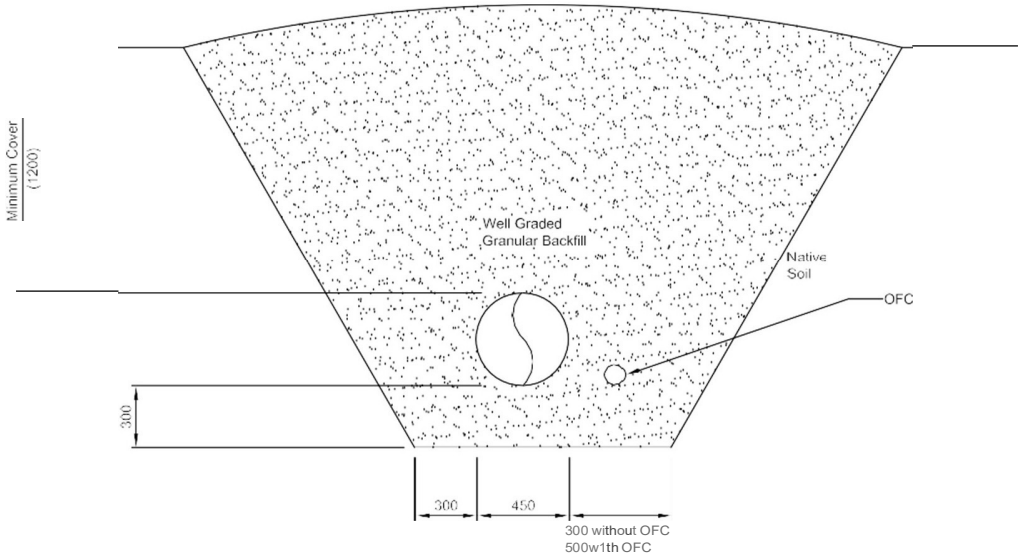
(TYPE-2)

| | | | |
|---|---|---|---|
| | **STANDARD FOR STORM WATER DRAIN (OPEN)** | **DRAWING NUMBER** | **REV** |
| | | **ENG-STD-CV-DWG-TP-005** | **0** |
| | | **SHEET 1 OF 1** | |

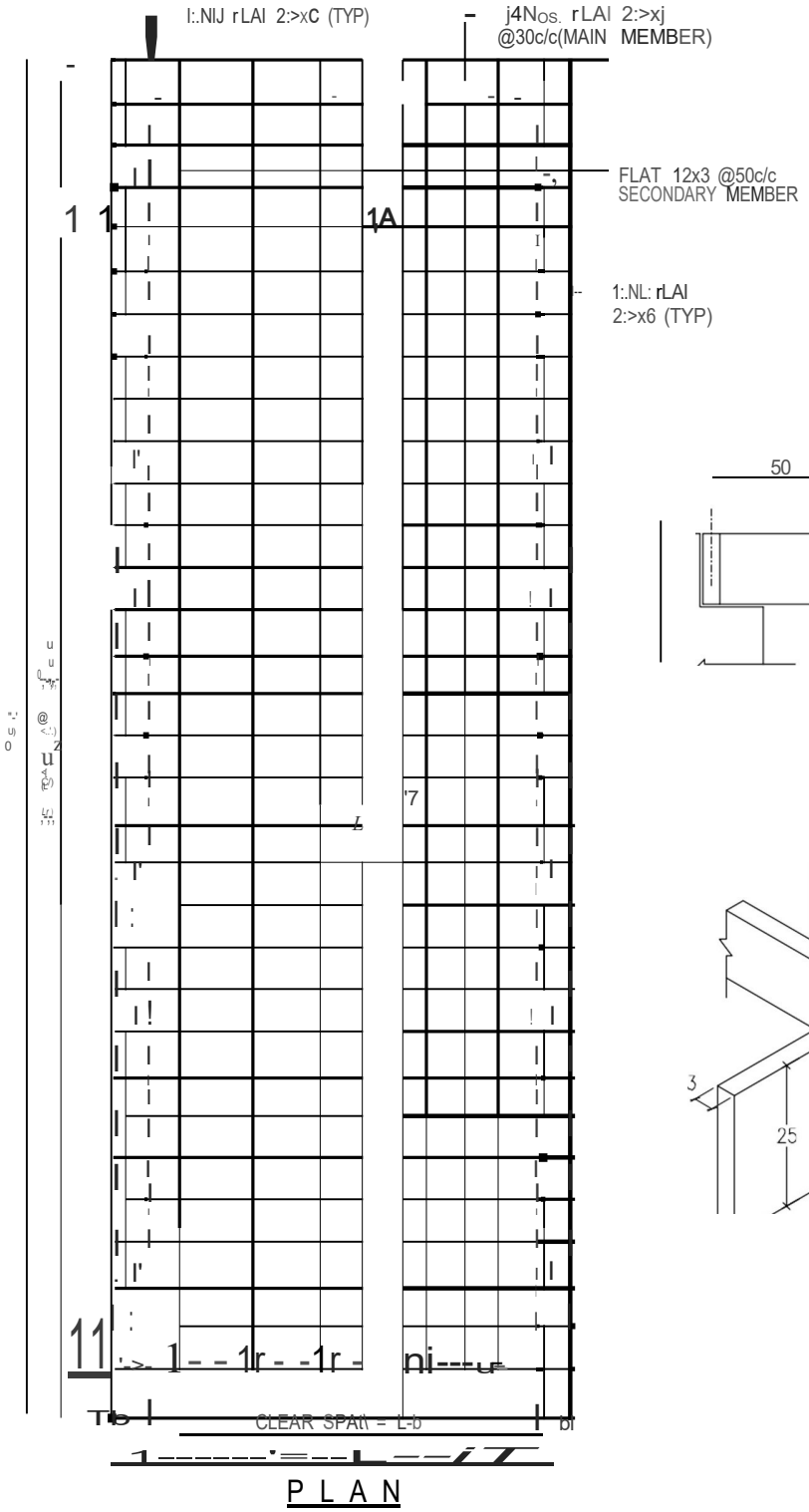
For Rocky Strata / Gravel Area :



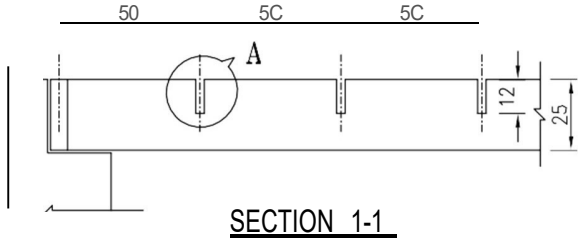

For Clay Soil :



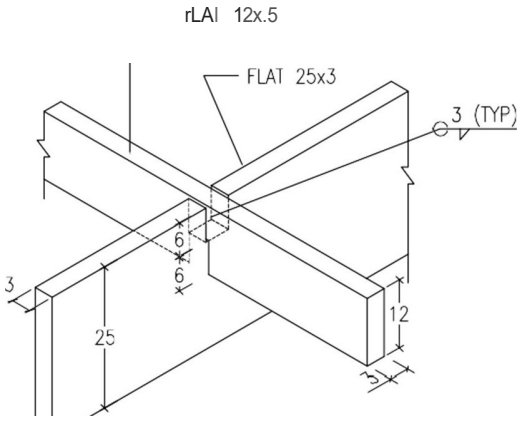

| | STANDARD FOR TRENCH SAND BEDDING | DRAWING NUMBER | REV |
|---|---|---|---|
| | | | |




P L A N




SECTION 1-1

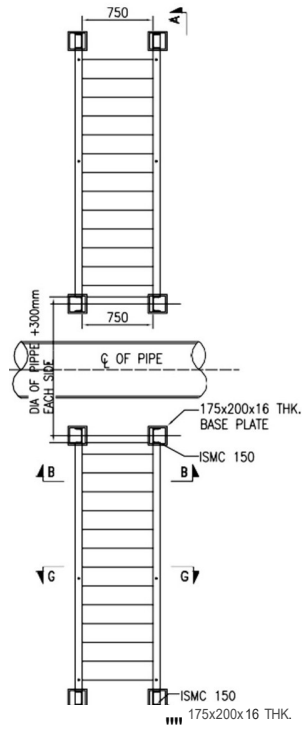



DETAIL AT A

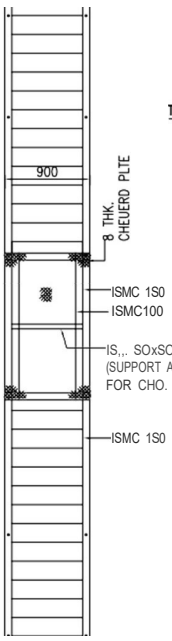
NET SAFE WORKING LOADS FOR GRATING

| PROPERTIES | | | TYPE-I | L | 500 | 600 | 100 | 800 | 900 | 100C | 110C | 12!:>C | 140C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 6d | 2.5 | 3.o | 3.5 | 4.o | 4.5 | 5.0 | 5.5 | 6.0 | 6.0 |
| Lxx(cm4 | Zxx(err 3 | MR(kgm | | W | > 2000 | | | | 1 .' | 110 | 830 | 540 | 345 |
| 14.tl4 | 11.tl/ | 19!:>.94 | | p | 1471 | 1221 | 105Q | 915 | I:l'O | 670 | 550 | 400 | 275 |

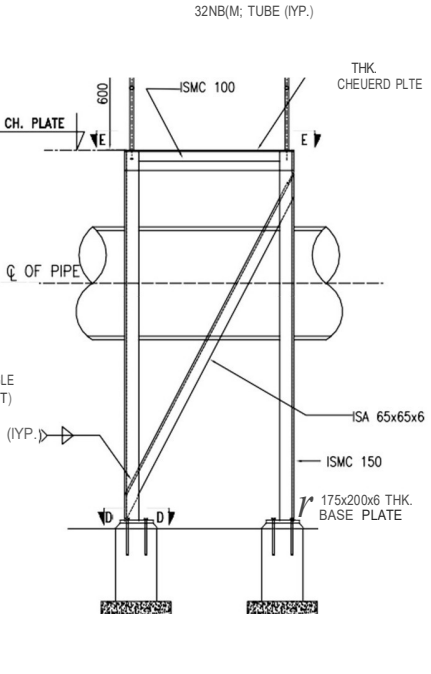
| | STANDARD FOR GRATING DETAIL | DRAWING NUMBER | REV |
|---|---|---|---|
| | | | |



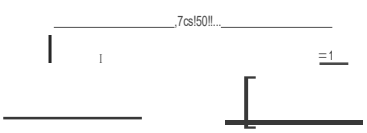

PLAN AT FOUNDATION LEVEL



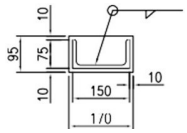

VIEW E-E



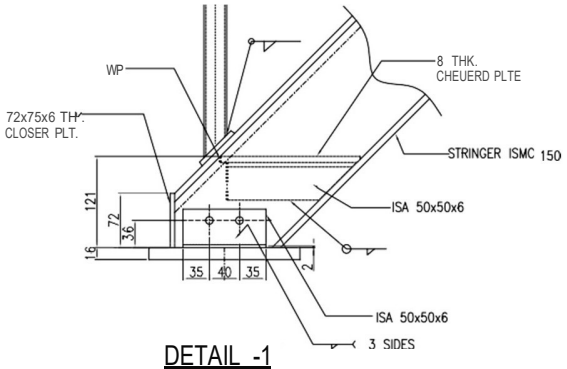

VIEW B- B




SECTION G-G
(BOTTO PLATE)

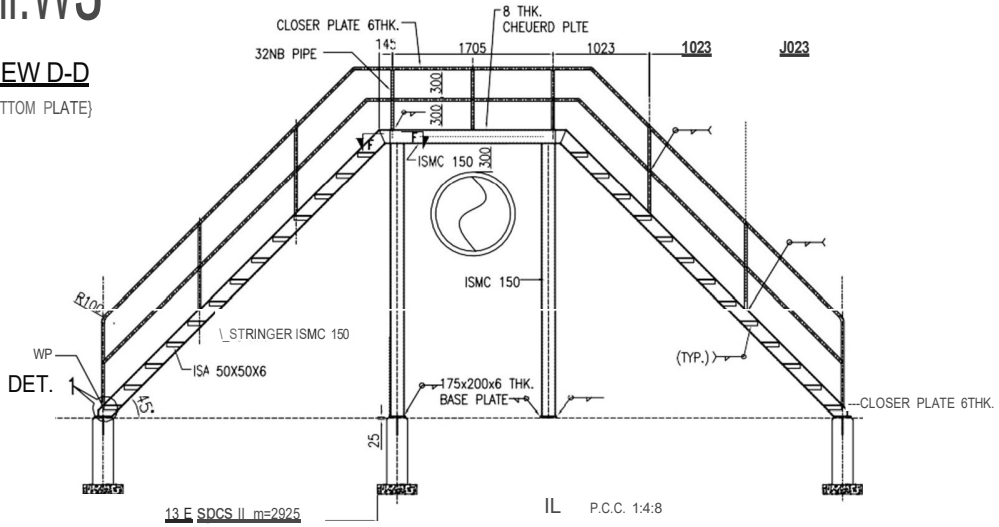



VIEW F-F
TOP PLATE



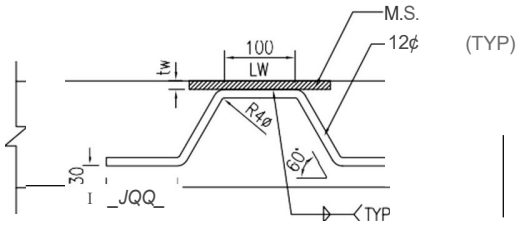

DETAIL -1

VIEW D-D
(BOTTOM PLATE}

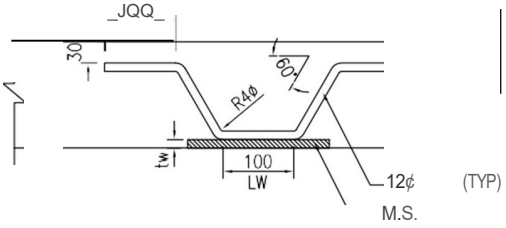



VIEW A-A

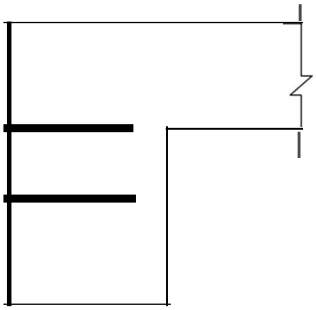
| | | | |
|---|---|---|---|
| | **STANDARD FOR TYPICAL DETAIL OF CROSS-OVER** | **DRAWING NUMBER** | **REV** |



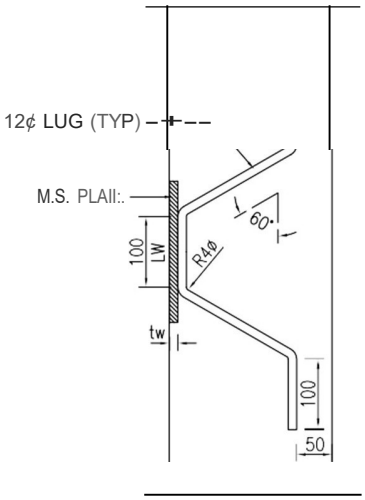

INSERT PLATE DETAIL ON TOP OF SLAB



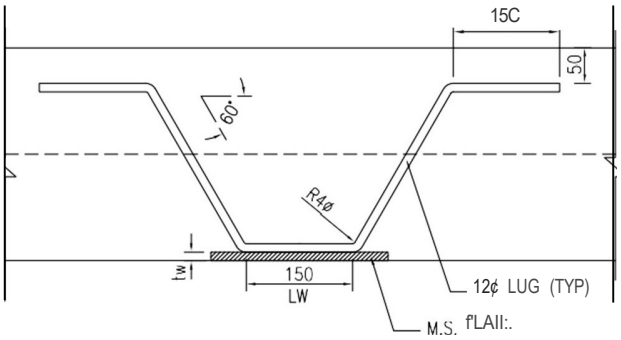

INSERT PLATE DETAIL ON BOTTOM OF SLAB



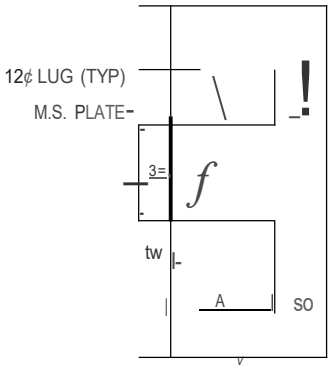
INSERT PLATE DETAIL ON SIDE OF BEAM




PLAN AT 1-1



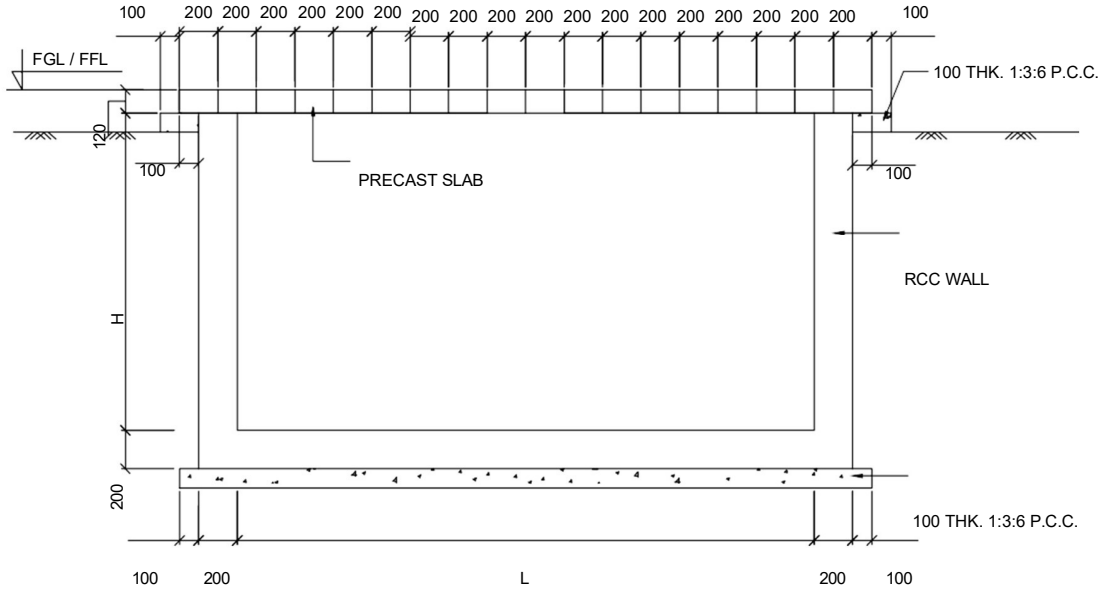

INSERT PLATE DETAIL ON BOTTOM OF BEAM



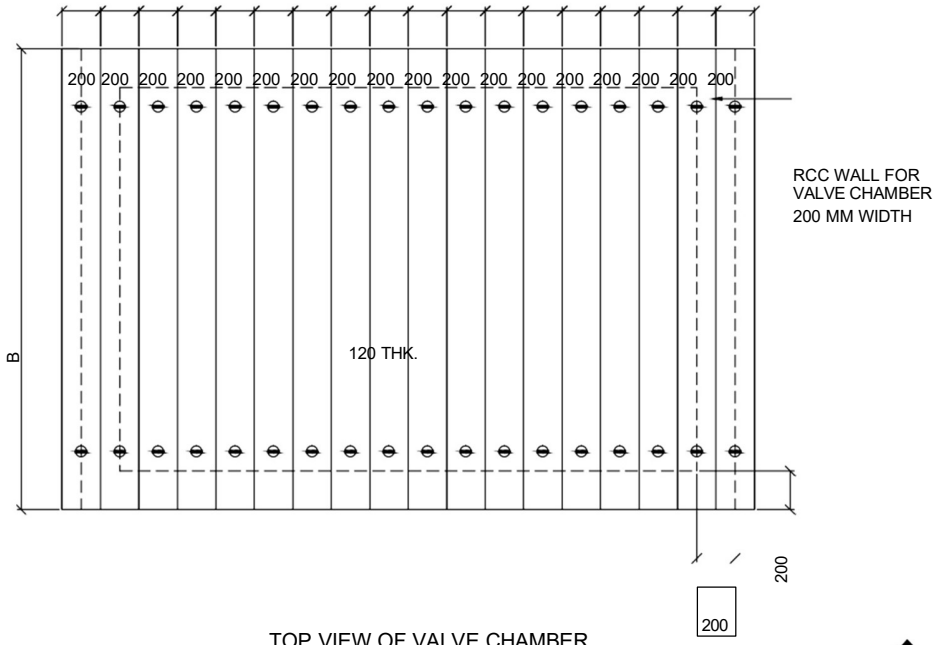

INSERT PLATE DETAIL ON COLUMNS

LW = Wt.LU LtNGIH AVAILAI:ILI:.
tw = IHICKNI:.SS Ot M.S. I'LAII:.
A+B = LUG MBEOMENT REQUIREC

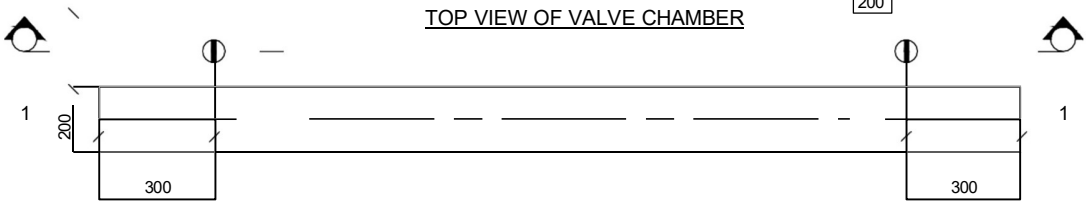
| | | | |
|---|---|---|---|
| | **STANDARD FOR INSERT PLATE DETAILS (LUG BENDING DETAILS)** | **DRAWING NUMBER** | **REV** |



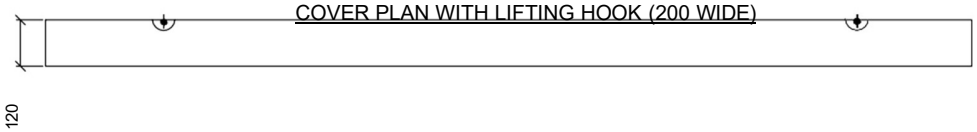

DETAIL OF VALVE CHAMBER




TOP VIEW OF VALVE CHAMBER

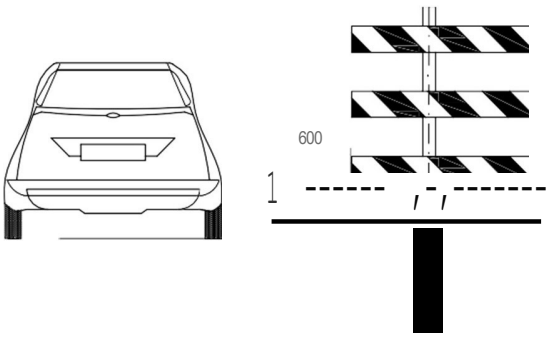



COVER PLAN WITH LIFTING HOOK (200 WIDE)



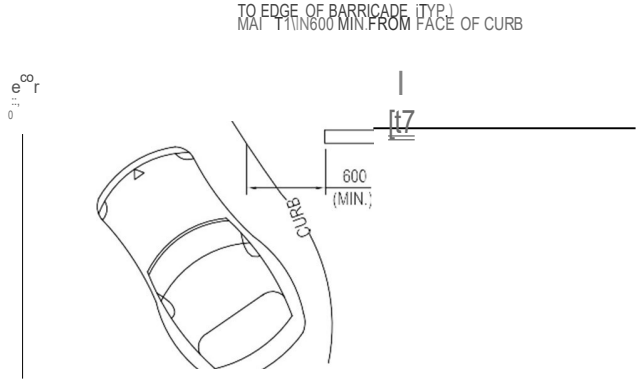

SECTION 1-1

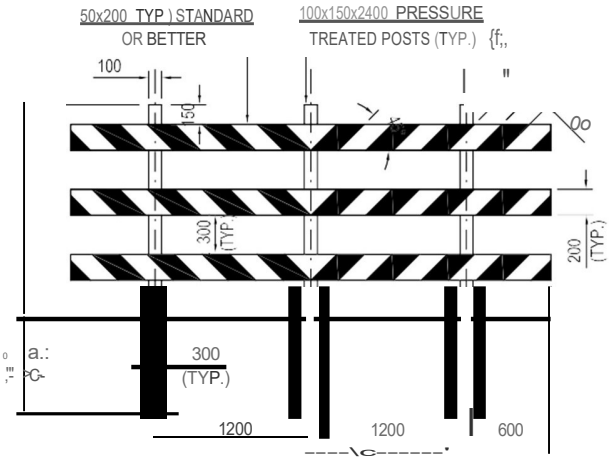
| | | | |
|---|---|---|---|
| | **STANDARD FOR G.A. OF VALVE PIT** | **DRAWING NUMBER** | **REV** |
| | | | |




TYPICAL NARROWING OF DRIVING AREA BARRICADE (USWDIMENSIONS BELOW)
ORIENT DIAGOINAL BARS TO CHANNEL TRAFIC AS SHOWN

## NARROWING OF DRIVING AREA

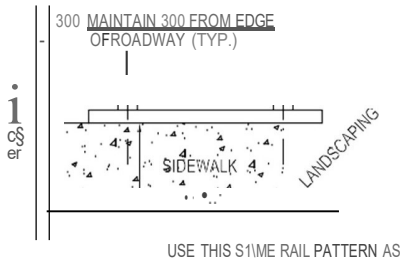



BACKFILLAND COMPACTED WITH
3/4"-0" CRUSHED STONE (TYP.)

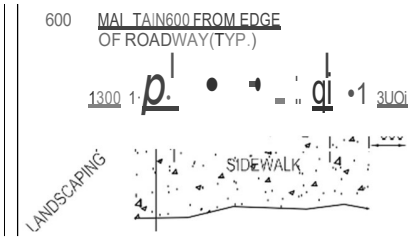
## END OF ROAD BARRICADE

(TYPICAL DIMENSIONS AND LAYOUT)



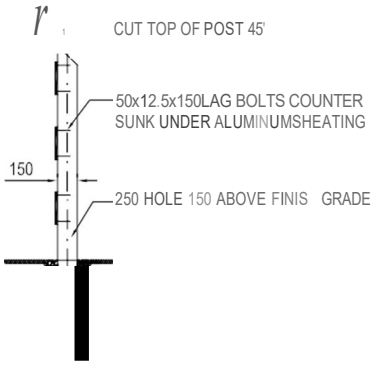

USE THIS S1\ME RAIL PATTERN AS
THE "END OF ROAD" BARRICADE

## END OF SIDEWALK ('TYPE B')




USE THIS SAMER1\ILPATTERNAS
THE"ENDOFROAD" BARRICADE

## END OF SIDEWALK ('TYPE A')




## SECTION

NOTES:-

ALL WOOD SHALL BE PAINTED WHITE.

ALTERNATINGRED & WHITEHIGH INTENSITYPRISMATIC 0.80 ALUMINUM SHEATING SHALL BE SCREWED TO THE HORIZONTAL RAILS

ALL FASTENERSTO BE STAINLESS STEEL OR RUST PROOF HEAVT GALVANIZED

FOR STREET BARRICADES HORIZONTAL RAIL LENGTH SHALL EQUAL THE DISTANCE BETWEEN THE FACEOF CURB PLUS 600. (EG. 1000 CURB 1600RAILS).

| | STANDARD FOR BARRICADES | DRAWING NUMBER | REV |
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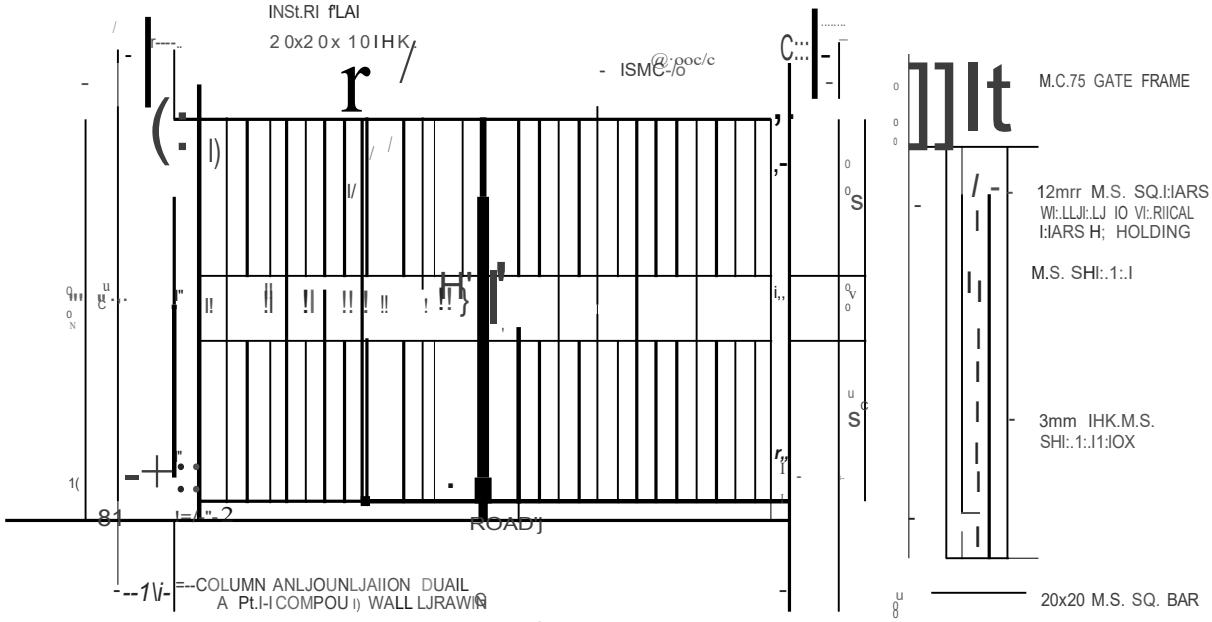


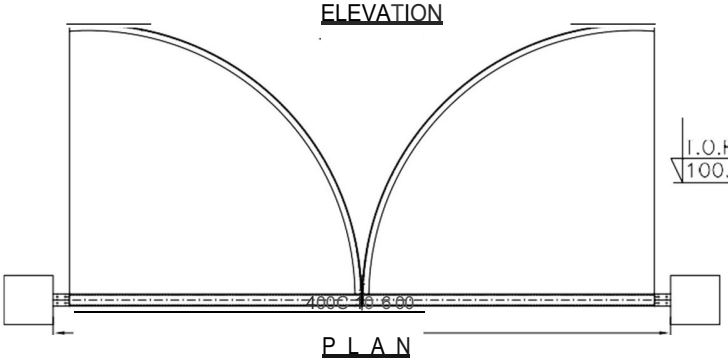


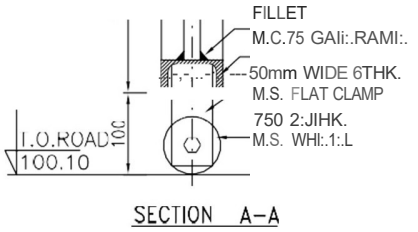


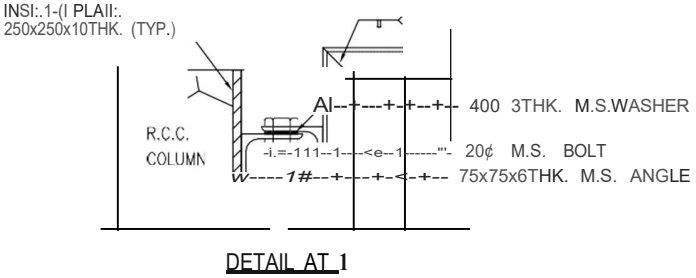


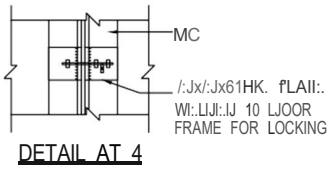


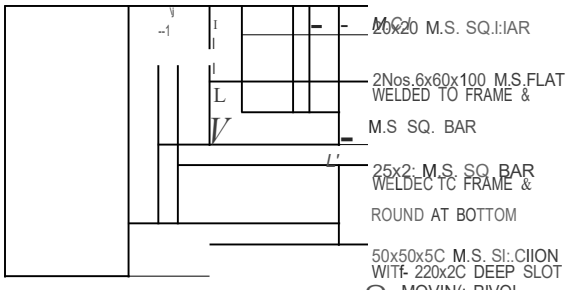


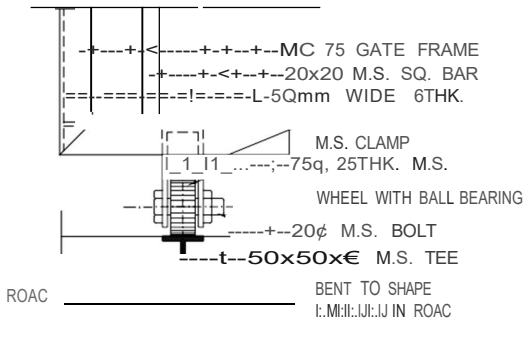


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| | **STANDARD FOR GATE** | **DRAWING NUMBER** | **REV** |
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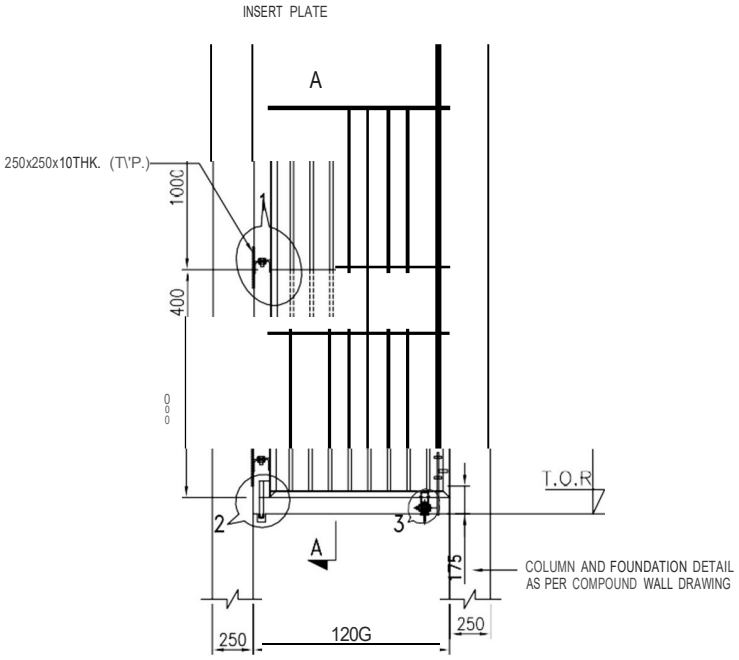
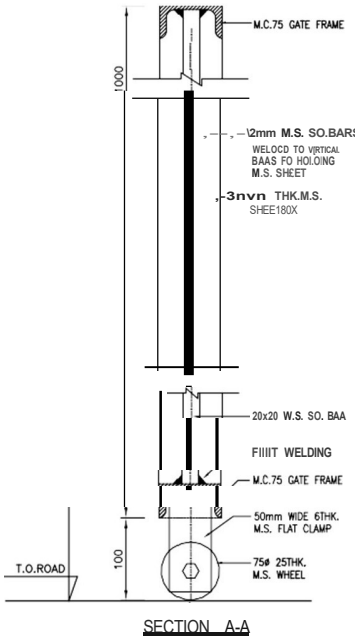
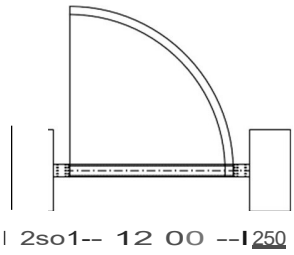
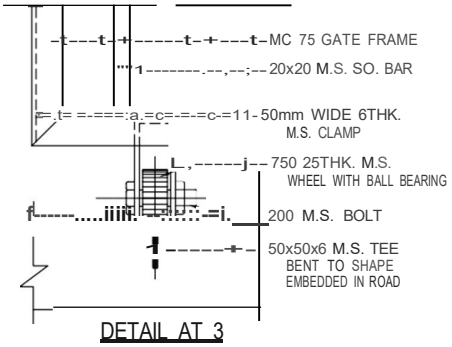



ELEVATION

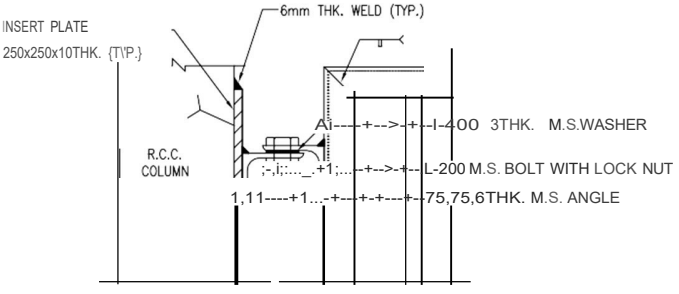



SECTION A-A




DETAIL AT 3

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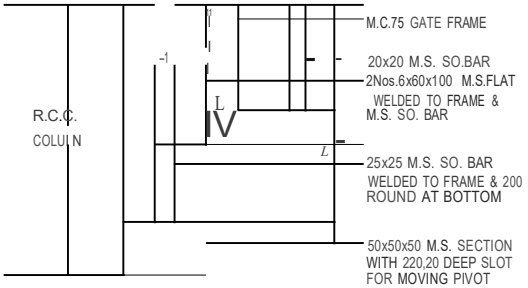


DETAIL AT 2

| | STANDARD FOR GATE | DRAWING NUMBER | REV |
|---|---|---|---|
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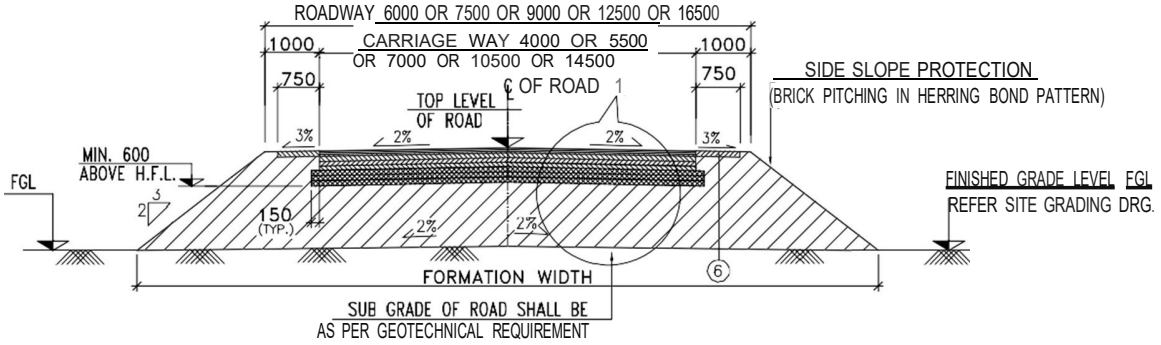
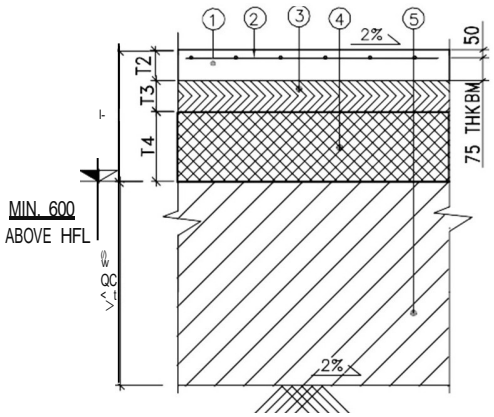



CROSS SECTION OF ROAD




DETAIL - 1

LEGEND :-

(D R.C.C. M-25 150 **MM** THK. (T2)

8 ili 150

BASE COURSE (T3)
MINIMUM2 LAYERS (EACH 75mm THICK) or WATER BOUND
(WBM) WITH GRADE-II (63mm TO 45mm) REFER

SUB BASE COURSE (T4)
MINIMUM 2 LAYERS (EACH 100mm THICK)
(WBM) WITH GRADE-I AGGREGATE TO 45mm) REFER

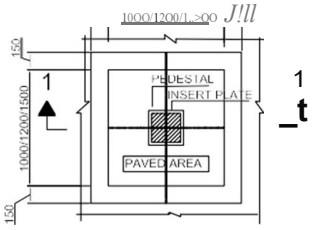
RECOMMENDATION.

(TOTAL CRUST THICKNESS) T = T2+T3+T4
(TI- PREMIX CARPET IS ONLY A WEARING COURSE AND
IS NOT CONSIDERED IN TOTAL CRUST THICKNESS)

GEOTECHNICAL RECOMMENDATION SHALL BE FOLLOWED FOR ROAD SUBGRADE AND EMBANKMENT PREPARATION.

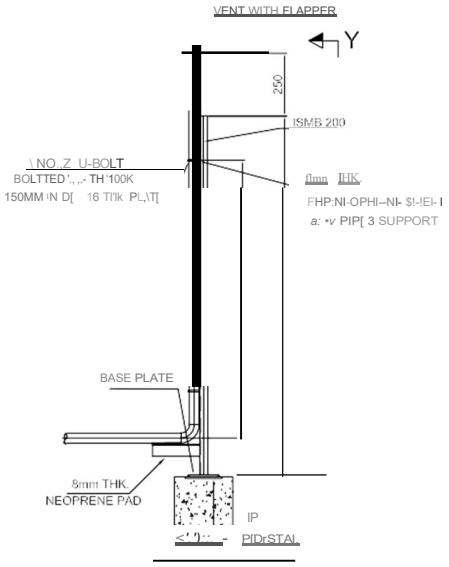
NOTES:-

| | | | |
|---|---|---|---|
| | **STANDARD FOR CROSS SECTION OF ROAD ( RCC)** | **DRAWING NUMBER** | **REV** |

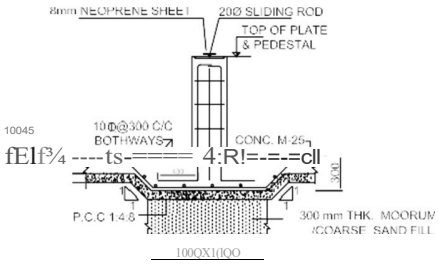



FOUNDATION PLAN

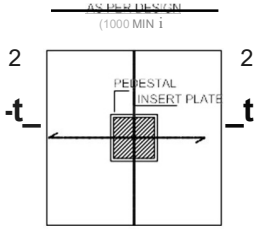
(FOUNDATION LOAD LESS THAN 8 KN/M2)




DETAIL OF VENT SUPPORT

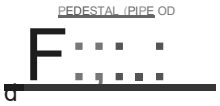



SECTION 1-1

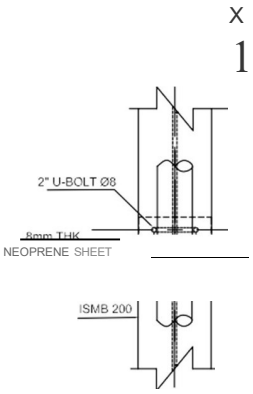



FOUNDATION PLAN

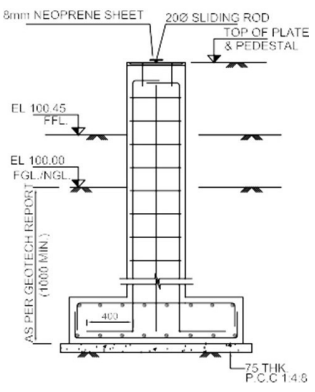
(FOUNDATION LOAD GREATER THAN 8 KN/M2)



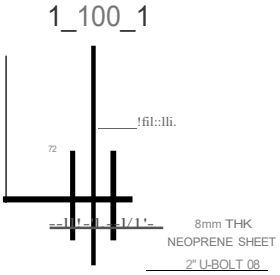

PEDESTAL PLAN



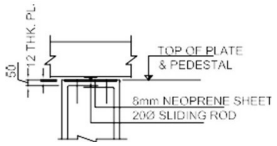

VIEW Y-Y




SECTION 2-2




VIEW X-X




TYP. DETAIL OF PIPE SUPPORT

| | STANDARD FOR RCC PIPE SUPPORT | DRAWING NUMBER | REV |
|---|---|---|---|
| | | | |

# TECHNICAL SPECIFICATION FOR PRESSURE GAUGES

## TABLE OF CONTENTS

## 1.0 GENERAL

The technical requirements for Pressure Gauges, Differential pressure gauges and Vacuum gauges are specified in this document. This is to be read together with corresponding datasheet(s).

### 1.1 Codes And Standards

The related standards referred to herein and mentioned below shall be of the latest editions prior to the date of the purchaser's enquiry:

| | |
|---|---|
| ASME B 1.20.1 | Pipe Threads General Purpose (Inch) |
| ASME B 16.5 | Pipe Flanges and Flanged Fittings NPS'A through NPS24 |
| ASME B 16.20 | Metallic Gaskets for Pipe Flanges, Ring Joint, Spiral wound and Jacketed. |
| EN10204 | Inspection Documents For Metallic Products |
| IEC-60529 | Degree of Protection Provided by Enclosures (IP Code) |
| IS-13947 | Specification for Low Voltage Switchgears and Control gears. |
| IS-3624 | Specification for Pressure and Vacuum Gauges. |

### 1.2 Conflicting Requirement

In the event of any conflict between this standard specification, job specification, datasheets, statutory regulations, related standards, codes etc. the following order of priority shall govern:

i) Statutory Regulations
ii) Data Sheets
iii) Standard Specification
iv) Codes and Standards

### 1.3 Additional Responsibility of Vendor

In addition to compliance to purchaser's specifications in totality, vendor's extent of responsibility shall include the following:

a) Data sheets indicate the minimum acceptable material of construction for pressure element, movement etc. Alternate superior material of construction shall also be acceptable provided vendor assumes complete responsibility for the selected materials for their compatibility with the specified fluid and its operating conditions.

b) Data sheets specify the type of pressure element. Unless specifically indicated otherwise, alternate type of pressure elements shall also be acceptable provided all the functional and performance requirements specified in the respective data sheets are guaranteed by the vendor.

### 1.4 Drawing and Data

1.4.1 Detailed drawings, data, catalogues and manuals required from the vendor are indicated by the purchaser in vendor data requirement sheets. The required number of reproducible, prints and soft copies shall be dispatched to the address mentioned, adhering to the time limits indicated.

1.4.2 Final documentation consisting of design data, installation manual, operation and maintenance manual etc., submitted by the vendor after placement of purchase, order shall include the following, as a minimum:

a) Specification sheet

b) Certified drawings sheets for each equipment and accessories, which shall provide dimensional details, internal constructional details, end connection details and materials of construction.

c) Copy of type test certificates.

d) Installation procedure for each gauge and its accessories.

e) Calibration and maintenance procedures including replacement of internal parts wherever applicable.

## 2.0 GENERAL TECHNICAL REQUIREMENTS

### 2.1 Performance Requirements

Unless otherwise specified, the accuracy which is inclusive of repeatability and hysteresis of pressure gauges / differential pressure gauges shall meet the following performance requirements:

a) Direct pressure gauge : ±1% of full scale

b) Chemical seal type pressure gauge : ±2% of full scale

c) Differential pressure gauges : ±2% of full scale

### 2.2 Cases and Dials

2.2.1 Unless specified otherwise, the gauges shall be weather proof to IP 65 as per IEC 60529 / IS 13947, as a minimum.

2.2.2 In general, dial markings and dial colour shall be as per IS 3624.

2.2.3 The gauge dial shall be made of a suitable metallic materials so that the finished dial shall be capable of withstanding a dry heat of 85°C for 10 hours and immersion in water-at 85°C for 1 hour without cracking, blistering, warping or discoloring of the dial or paint on the dial.

2.2.4 The pointer stops shall be provided at both ends of the scale to restrict the pointer motion beyond 5% above the maximum of scale and less than 5% below the minimum of the scale.

2.2.5 The dial cover shall be made out of shatter proof glass sheet of thickness 1.5 to 3mm for gauges with dial size less than 100mm while minimum 3.0mm for gauges with dial size 100mm or greater.

2.2.6 All gauges shall be provided with a blow-out device i.e. blow out disc of aperture not less than 25mm for gauges with dial size 100mm and above, while 20mm for gauges with dial size less than 100mm.

2.2.7 When safety type solid front type of gauges is specified, they shall consist of a solid partition isolating the pressure element from the dial. In such gauges the total solid partition disc area shall not be less than 75% of the cross sectional area of the inside of the case surrounding the pressure element.

2.2.8 The bezel ring shall be screwed or Bayonet type made out of SS316 material.

### 2.3 Pressure Elements, Gauge Movement and Socket

2.3.1 The pressure element shall be an elastic element like bourdon tube made from stainless steel

(SS316L) and the gauge socket shall be made out of stainless steel (SS316) unless specified otherwise.

2.3.2 In case of bourdon type of gauges, the size of the bourdon tube shall not be less than 75% of the nominal diameter of the dial size.

2.3.3 Gauge construction shall ensure no leakage of process fluid from the sensor elements to atmosphere and between the high pressure and low-pressure side (in case of differential pressure gauges) under normal condition.

2.3.4 The gauge socket shall be in one piece and shall also serve as element anchorage in case of bourdon tube type element, which shall be directly connected to the socket, without any capillary or tube in between.

2.3.5 Any joint in the process wetted system including joint between the element and the anchorage/socket shall be welded type only.

2.3.6 Unless specified otherwise, the pressure gauges shall have an over-range protection of at least 130% of maximum working pressure, as a minimum.

2.3.7 Data sheet indicates the minimum requirement of material of construction. Alternate materials as specified in Annexure 1 to this specification shall also be acceptable subject to meeting process conditions.

2.3.8 The gauge movement material shall be of stainless steel unless specified otherwise in the data sheet. It shall be adjustable for calibration without dismantling the sensor unit. The use of'S' link for calibration of span is not permitted.

2.3.9 Vendor shall ensure that the operating pressure falls in the middle 30% of the full working range i.e. operating pressure shall fall between 35% and 65% of the range offered.

2.3.10 Pressure gauges with range as 0 to 100 kg/cm$^2$g and above shall have safety type solid front case. All gauges in oxygen and chlorine service shall be thoroughly degreased using reagents like tri-chloro-ethylene or carbon tetrachloride. All connections shall be plugged after degreasing process in order to avoid entrance of grease or oil particles.

2.3.11 The casing of the pressure gauge shall be filled with suitable fluid to provide better protection and dampen the effect of pulsation and pressure spikes.

### 2.4 End Connection

Unless specified otherwise, the following shall govern-

a) Threaded end connections shall be NPT as per ANSI / ASME B. 1.20.1.
b) Flanged end connection shall be as per ANSI / ASME B. 16.5
c) Ring joint flanges shall have octagonal grooves as per ANSI / ASME B16.20.
d) Flange face shall be as per clauses 6.4.4.1, 6.4.4.2 and 6.4.4.3 of ANSI / ASME B16.5.
The face finish as specified in the data sheet shall be as follows;

125AARH : 125 to 250 AARH
63 AARH : 32 to 63 AARH

### 2.5 Accessories

2.5.1 Gauges shall be supplied with all accessories as specified in the data sheets pre-installed.

2.5.2 Over Range Protector (OPV):

a) Whenever the maximum pressure specified in the data sheet exceeds the over range protection pressure, over range protector shall be supplied.

b) In case of pressure gauges with diaphragm seal, the over-range protector shall be installed between the seal and the gauge.
c) The material of construction of over range protector shall be same as socket material, as a material.

2.5.3 Snubber:

a) Whenever the service specified is pulsating type, snubber shall be supplied.
b) The material of construction of snubber shall be same as socket material, as a minimum.

## 3.0 NAME PLATE

Each gauge shall have a stainless steel nameplate attached firmly to it at a visible place either by riveting or screwed to the case, furnishing the following information:

a) Tag number as per data sheets.
b) Vendor's name
c) Model number and manufacturer's serial number.
d) Range of the instrument.
e) MAWP and maximum vacuum rating of element

## 4.0 INSPECTION AND TESTING

Unless otherwise specified, purchaser reserves the right to test and inspect all the items at the vendor's workshop in line with the inspection test plan for pressure, differential pressure and vacuum gauges.

### 4.1 Test reports

Vendor shall submit following test certificates and test reports for purchaser's review:

a) Material test report as per EN10204 clause 2.2 for wetted parts like gauge socket and sensing element and as per clause 3.IB for flanges and spacer rings of diaphragm seal type pressure gauges.
b) Type test report for enclosure.
c) Dimensional test report for all gauges.
d) Performance test reports for all gauges including accuracy, repeatability, over pressure and vacuum test (as applicable)
e) Type test reports for shock test and endurance test as per IS-3624 for each type / model.
f) Type test report for influence of temperature for each type/model.

### 4.2 Witness Inspection

4.2.1 All pressure, differential pressure and vacuum gauges shall be offered for pre dispatch inspection for following as a minimum:

a) Physical dimensions verification and workmanship.
b) Performance test including accuracy and repeatability, on representative samples of each type/model number before and after over-pressure and vacuum test.
c) Over-pressure and vacuum test (as applicable) shall be carried out on representative samples of each type / model number without loss of their elastic characteristics.
d) Review of all certificates and test reports as indicated in clause 4.1 of this specification.

4.2.2 In the event when the witness inspection is not carried out by purchaser, vendor shall anyway complete the tests and the test documents for the same shall be submitted to purchaser for scrutiny.

# SPECIFICATION FOR HEALTH, SAFETY AND ENVIRONMENT (HSE) MANAGEMENT AT CONSTRUCTION SITES

## 1.0 SCOPE

This specification establishes the health, Safety and environment (HSE) management requirement to be complied by Contractors during construction.

Requirements stipulated in this specification shall supplement the requirements of HSE management given in relevant Act (s)/legislations, General Conditions of Contract (GCC), Special Conditions of Contract (SCC) and Job (Technical) Specifications. Where different documents stipulate different requirements, the most stringent shall apply.

## 2.0 REFERENCES

The document should be read in conjunction with following:

- General Conditions of Contract (GCC)
  Special Conditions of Contract (SCC)
  Building and other construction workers (regulation of employment and condition of service) Act,1996
  Job (Technical) specifications
  Relevant IS Codes
  Statutory requirements

## 3.0 REQUIREMENTS OF HEALTH, SAFETY & ENVIRONMENT (HSE) MANAGEMENT SYSTEM TO BE COMPLIED BY BIDDERS

### 3.1 MANAGEMENT RESPONSIBILITY

#### 3.1.1 HSE Policy & Objectives

The Contractor should have a documented HSE policy & objectives to demonstrate commitment of their organization to ensure health, safety and environment aspects in their line of operations.

#### 3.1.2 Management System

The HSE management system of the Contractor shall cover the HSE requirements including but not limited to what is specified under para 1.0 and para 2.0 above.

#### 3.1.3 Indemnification

Contractor shall indemnify & hold harmless Owner/Consultant & their representatives free from any and all liabilities arising out of non-fulfilment of HSE requirements.

#### 3.1.4 Personnel deployment

Contractor as a minimum requirement shall designate/deploy the following persons at site:

| | | | |
|---|---|---|---|
| a) | Up to 250 persons deployed by him at site | - | Designate one safety supervisor |
| b) | For 251 to 500 persons | - | Deploy one qualified & |

| | | | |
|---|---|---|---|
| | | | \Experienced safety Engineer/Office in addition to the Safety Supervisor as described in (a) above. |
| c) | For more than 500 persons | - | Deploy an additional Safety Engineer/ Officer for every 500 Persons or part deployed by him at site thereof, in addition to (b) above. |

Deployed by him at site

No work will be started at site until above safety personnel are mobilized at site. The contractor shall submit a safety organogram clearly indicating the lines of responsibility, reporting system and furnish Bio-Data/Resume/Curriculum Vitae with contact details of the safety personnel he intends to mobilize, at least 1 moth before the intended mobilization.

### 3.1.5 Implementation & Monitoring

Contactor shall be fully responsible for planning, implementing and monitoring all HSE requirements and compliance of all laws & statutory requirements. The Contractor shall also ensure that the HSE requirements are clearly understood & faithfully implemented at all levels at site.

### 3.1.6 Awareness

The Contractor shall promote and develop consciousness about Health, Safety and Environment among all personnel working for the Contractor. Regular awareness programs and fabrication shop/work site meetings shall be arranged on HSE activities to cover hazards involved in various operations during construction.

### 3.1.7 Fire prevention & First-aid

The contractor shall arrange suitable first aid measures such as First Aid Box, trained personnel to administer First Aid, stand-by ambulance or vehicle and install fire protection measures such as: adequate number of steel buckets with sand & water and adequate number of appropriate fire extinguishers to the satisfaction of OWNER/CONSULTANT.

### 3.1.8 Documentation

The contractor shall evolve a comprehensive, planned and documented system for implementation and monitoring of the HSE requirements. This shall be submitted to OWNER/CONSULTANT for approval. The monitoring for implementation shall be done by regular inspections and compliance to the observations thereof. The Contractor shall get similar HSE requirements implemented at his sub-contractor(s) work site/office. However, compliance of HSE requirements shall be the responsibility of the Contractor. Any review/approval by OWNER/CONSULTANT shall not absolve contractor of his responsibility/liability in relation to all HSE requirements.

### 3.1.9 Audit

Non-Conformances on HSE by Contractor (including his sub-contractors) as brought out during review/audit by his internal audit team as well as OWNER/Consultant's representative shall be resolved forthwith by Contractor. Compliance report shall be submitted to OWNER/CONSULTANT.

### 3.1.10 Meetings

The Contractor shall ensure participation of his top most executive at site (viz. Resident Engineer/Site-in-Charge) in Safety committee/HSE Committee meetings arranged by OWNER/CONSULTANT. The compliance of any observations during the meeting shall be arranged urgently. He shall assist OWNER/CONSULTANT to achieve the targets set by them on HSE during the project implementation.

3.1.11 The Contractor shall adhere consistently to all provisions of HSE requirements. In case of non-compliance or repeated failure in implementation of any of the HSE provisions; OWNER/CONSULTANT may impose stoppage of work without any cost & time implication to the Owner and/or impose a suitable penalty, up to a cumulative limit of 1.0% (one percent) of the contract value with a ceiling of Rs.10 lacs (Rupees Ten Lacs only). This penalty shall be in addition to all other penalties specified elsewhere in the contract. The decision of imposing stoppage work, its extent and penalty shall rest with OWNER/CONSULTANT. The same shall be binding on the Contractor. The penalty does not make the contractor eligible to continue the work in unsafe manner.

## 3.2 HOUSE KEEPING

3.2.1 Contractor shall ensure that a high degree of house keeping is maintained and shall ensure interalia; the following:

All surplus earth and debris are removed/disposed off from the working areas to identified location(s). Unused/surplus cables, steel items and steel scrap lying scattered at different places within the working areas are removed to identified location(s).
All wooden scrap, empty wooden cable drums and other combustible packing materials, shall be removed from work place to identified location(s).
Roads shall be kept clear and materials like pipes, steel, sand, boulders, concrete, chips and bricks etc. shall not be allowed on the roads to obstruct free movement of men & machines.
Fabricated steel structural, pipes & piping materials shall be stacked properly for erection.Water logging on roads shall not be allowed.
No parking of trucks/trolleys, cranes and trailors etc. shall be allowed on roads, which may obstruct the traffic movement.
Utmost care shall be taken to ensure over all cleanliness and proper upkeep of the working areas.
Trucks carrying sand, earth and pulverized materials etc. shall be covered while moving within the plant area/or these materials shall be transported with top surface wet.
The contractor shall ensure that the atmosphere in plant area and on roads is free fromparticulate matter like dust, sand, etc. by keeping the top surface wet for ease in breathing.
At least two exits for any unit area shall be assured at all times.

## 3.3 HSE MEASURES

### 3.3.1 Construction Hazards

Contractor shall ensure that during the performance of the work, all hazards have been identified, assessed and eliminated.

A list of construction hazards along with their effects & preventive measures is given in the Annexure-V.

### 3.3.2 Accessibility

The Contractor shall provide safe means of access to any working place including provisions of suitable and sufficient scaffolding at various stages during all operations of the work for the safety of his workmen and OWNER/CONSULTANT.

### 3.3.3 Personal Protective equipment's (PPEs)

The contractor shall ensure that all their staff and workers including their sub-contractor(s)'s have been issued & wear appropriate PPEs like safety helmets, safety shoes, safety belt, full body harness, protective goggles, gloves etc. All these gadgets shall conform to applicable IS Specifications/CE or other applicable international standards.

For shot blasting, the usage of protective helmets (approved by the competent authority), gauntlet and protective clothing is mandatory.

For offshore contracts, contractor shall provide PPEs (new) to CONSULTANT & Owner's personnel at his (contractor's) cost. All personnel shall wear life jacket at all time.

### 3.3.4 Working at height

The contractor shall issue height permit for working above 3 meters height after verifying and certifying the checkpoints as specified in the attached permit. He shall also undertake to ensure compliance to the conditions of the permit during the currency of the permit including adherence to personal protective equipment's .

The permit shall be issued initially for one week or expected duration of an activity and extended further for the balance duration. This permit shall be applicable in areas where specific clearance from Owner's operation Department/Safety Department is not applicable. CONSULTANT field Engineers/Safety Officers/Area Coordinators may verify and sign this permit during the execution of the job.

In case work is undertaken without taking sufficient precautions as given in the permit, CONSULTANT Engineers may cancel the permit and strop the work till satisfactory compliance is arranged. Contractors are expected to maintain a register for issuance of permit and extensions thereof including preserving the used permits for verification during audits etc.

Contractor shall arrange (at his cost) and ensure sue of Fall Arrester Systems by his workers. Fall arresters are to be used while climbing tall structures. These arresters should lock automatically against the anchorage line, restricting free fall of the user. The device is to be provided with a double security opening system to ensure safe attachment or release of the userat any point of rope. In order to avoid shock, the system should be capable of keeping the person in vertical position in case of a fall.

Contractor shall ensure that Life Lines are used by all personnel while working at height. One end of the life line shall be firmly tied with the worker and the other end with a fixed and rigid structure. The life line should be strong enough to take the load of the worker in case of a fall.

Contractor shall provide Roof Top Walk ladders for carrying out activities on sloping roofs in order to reduce the changes of slippages.

Contractor shall ensure that a proper Safety Net System is used wherever the hazard of fallfrom height is present. The safety net shall be located not more than 9.0 meters below the working surface extending on either side up to sufficient margin to arrest or to reduce the consequences of a possible fall of persons working at different heights.

### 3.3.5 Electrical installations

The contractor shall ensure that electrical systems and equipment including tools and tackles are properly selected, installed, used and maintained.

The contractor shall deploy qualified and licensed electricians for proper and safe installation and for regular inspection of construction power distribution lines/points including their earthing. A copy of the license shall be submitted to CONSULTANT for records.

### 3.3.6 Welding/Gas cutting

Contractor shall ensure that flash back arresters conforming to BS: 6158 or equivalent are installed on all gas cylinders while in use. All cylinders shall be mounted on trolleys. All welding machines shall have effective earthing. To eliminate radiation hazard, Tungsten electrodes used for Gas Tungsten Arc Welding shall not contain Thorium.

### 3.3.7 Ergonomics and tools & tackles

The Contractor shall assign to his workmen, tasks commensurate with their qualification, experience and state of health. All lifting tools, tackles, equipment, accessories including cranes shall be tested periodically by statutory/competent authority for their condition and load carrying capacity. Valid test and fitness certificates from the authority shall be submitted to Owner/CONSULTANT for their review/acceptance before the lifting tools, tackles, equipment, accessories and cranes are used.

Contractor shall ensure installation of Safe Load Indicator (SLI) on all cranes (while in use) to minimize overload risk. SLI shall have capability to continuously monitor and display the load on the hook, and automatically compare it with the rated crane capacity at the operating condition of the crane. The system shall also provide visual and audible warnings at set capacity levels to alert the operator in case of violations.

### 3.3.8 Occupational Health

The contractor shall identify all operations that can adversely affect the health of its workers and issue and implement mitigation measures. For surface cleaning operations, sand blasting shall not be permitted even if not explicitly stated elsewhere in the contract.

### 3.3.9 Hazardous substances

Hazardous and/or toxic materials such as solvent coating or thinners shall be stored in appropriate containers, which shall be labeled with the name of the materials, the hazards associated with its use and necessary precautions to be taken.

Where contact or exposure of hazardous materials/Noise pollution exceeds the specified limit or otherwise have harmful affects, appropriate personal protective equipment's such as gloves, earmuffs, goggles, aprons, chemical resistant clothing, respirator, etc. shall be used.

### 3.3.10 Spills

Chemical and other spills shall be contained and cleaned up immediately to prevent further contamination.

### 3.3.11 Radiation exposure

a) All personnel exposed to physical agents such as non-ionizing radiation, ultraviolet rays or similar other physical agents shall be provided with adequate shielding or protection commensurate with the type of exposure involved.
b) For ionizing radiation, requirements of Bhabha Atomic Research Centre (BARC) shall be followed.

### 3.3.12 Road Safety

The contractor shall ensure adequately planned road transport safety management system. The vehicles shall be fitted with reverse warning alarms. The contractor shall also ensure a separate pedestrian route for safety of the workers and comply with all traffic rules and regulations.

For pipeline jobs, the contractor shall submit a comprehensive plan covering transportation of pipes, movement of side booms, movement of vehicles on the ROW, etc.

### 3.3.13 Welfare measures

Contractor shall at the minimum, ensure the following facilities at work sites :

A crèche where 10 or more female workers are having children below the age of 6 years.

Reasonable canteen facilities at appropriate location depending upon site conditions.

Rest rooms (separate for male workers and female workers)
Toilets, drinking water, adequate lighting at site and labour camps, commensurate with applicable Laws/Legislation.

### 3.3.14 Environment Protection

Contractor shall ensure proper storage and utilization methodology of materials that are detrimental to the environment. Where required, contractor shall ensure that only the environment friendly materials are selected and emphasize on recycling of waste materials such as metals, plastics, glass, paper, oil and solvents.

For pipeline jobs, top soil shall be stacked separately while making ROW through fields. This fertile soil shall be placed back on top after backfilling.

### 3.3.15 Rules & Regulations

All persons deployed at site shall be knowledgeable of and comply with the environmental laws, rules and regulations relating to the hazardous materials, substances and wastes.

Contractor shall not dump, release or otherwise discharge or dispose off any such materials without the express authorization of OWNER/CONSULTANT.

## 3.4 TOOL BOX MEETING (TBM)

Contractor shall conduct daily TBM with workers prior to start of work and shall maintain proper record of the meeting. A suggested format is given below. The TBM is to be conducted by the immediate supervisor of the workers.

| **TOOL BOX MEETING RECORDING SHEET** | | |
|---|---|---|
| Date & Time | | |
| Subject | | |
| Presenter | | |
| Hazards Involved | | |
| Precautions to be taken | | |
| Worker's Name | Signature | Section |
| | | |
| Remarks, if any | | |

The topics during TBM shall include:

Hazards related to work assigned on that day and precautions to be taken.
Any forthcoming HSE hazards/events/instruction/orders, etc.

The above record can be kept in local language, which workers can read. These records shallbe made available to OWNER/CONSULTANT whenever demanded.

## 3.5 TRAINING

Contractor shall ensure that all his personnel possess appropriate training to carryout the assigned job safely. The training should be imparted in a language understood by them and should specifically be trained about.

Potential hazards to which hey may be exposed at their workplace
Measures available for prevention, recurrence and elimination of these hazards

The topics during training shall cover, at the minimum:

Education about hazardous jobs and precautions required
Emergency and evacuation plan
HSE requirements
Fire fighting and First-Aid
Use of PPEs

Records of the training shall be kept and submitted to OWNER/CONSULTANT whenever demanded.

For off-shore and jetty jobs, contractor shall ensure that all personnel deployed have undergone structured training on swimming, use of lifeboats, basket landing, etc.

### 3.6 INSPECTION/AUDIT

The contractor shall carry out daily HSE inspection and record observations at a centrallocation. These inspection records shall be freely accessible to Owner/CONSULTANT representatives. He shall also carry out internal HSE audits as well as cooperate during HSE audits by Owner/CONSULTANT, which will be at least two times during the project executionperiod.

## 4.0 DETAILS OF HSE MANAGEMENT SYSTEM BY CONTRACTOR

### 4.1 ON AWARD OF CONTRACT

The Contractor shall submit a comprehensive Health, Safety and Environment manual or procedure and HSE Plans for approval by OWNER/CONSULTANT prior to start of work. The Contractor shall participate in the pre-start meeting with OWNER/CONSULTANT to finalize HSE Plans including the following:

Job procedure to be followed by Contractor for activities covering handling of equipment's , scaffolding, electric installations, etc. describing the risks involved, actions to be taken and methodology for monitoring each activity.
OWNER/CONSULTANT review/audit requirement.
Organization structure along with responsibility and authority, records/reports etc. on HSE activities.
Procedures for reporting and investigation of accidents and near misses
HSE Training programmes.
Reference to Rules, Regulations and Statutory requirements.
HSE reports.

### 4.2 DURING JOB EXECUTION

4.2.1 Contractor shall implement approved Health, Safety and Environment management procedure/plan/manual including but not limited to as brought out under Para 3.0. Contractor shall also ensure :

to arrange workmen compensation insurance, registration under ESI Act, third party liability insurance etc., as applicable

to arrange all HSE permits before start of activities (as applicable), like permits for hot work, confined space, working at heights, storage of chemical/explosive materials and its use and implement all precautions mentioned therein. In this regard, requirements of Oil industry Safety Directorate Standard No. Std-105 "Work Permit Systems" shall be complied with while working in existing plants.

to submit, timely, the completed checklist on HSE activities Monthly HSE report, accident reports, investigation reports etc. as per OWNER/CONSULTANT requirements. Compliance of instructions on HSE shall be done by Contractor and informed urgently to OWNER/CONSULTANT.

That his top most executive at site attends all the Safety Committee/HSE meetings arranged by OWNER/CONSULTANT. Only in case of his absence from site that a second senior most

person shall be nominated by him, in advance, and communicated to OWNER/CONSULTANT.

Display at site office and work locations caution boards, list of hospitals, emergency services available, etc.

Provide posters, banners for safe working to promote safety consciousness.
Assess, analyze and mitigate the construction hazards.
Carryout audits/inspection at his works as well as sub contractor works as per approved HSE document and submit the reports for OWNER/CONSULTANT review.
Assistance and cooperation during HSE audits by OWNER/CONSULTANT, and submit compliance report.
Generation and submission of HSE records/report as per HSE Plan. And this specification.
Apprise OWNER/CONSULTANT on HSE activities at site.
Carryout all dismantling activities safely, with prior approval of OWNER/CONSULTANT representative.

## 1.0 RECORDS

The contractor shall maintain/submit HSE records in the following reporting formats:

1. Monthly HSE checklist cum compliance report Accident/Fire report
   Supplementary Accident & Investigation report
2. Monthly HSE report
3. Permit for working above 3 mete height
4. HSE Plan

**IS – CODES FOR HSE**

| | |
|---|---|
| SP:53 | Safety code for the use, Care and protection of hand operated tools. |
| IS: 816 | Code of practice for safety and health requirements in electric and gas welding and cutting operations |
| IS: 1179 | Eye and Face precautions during welding, equipment etc. |
| IS: 1860 | Safety requirements for use, care and protection of abrasive grinding wheels. |
| IS: 1989(Part–I & II) | Leather safety boots and shoes |
| IS: 2925 | Industrial Safety Helmets |
| IS: 3016 | Code of practice for fire safety precautions in welding and cutting operations. |
| IS: 3043 | Code of practice for earthing. |
| IS: 3521 | Industrial Safety belts and harness. |
| IS: 3738 | Rubber boots. |
| IS: 3996 | Safety Code of scaffolds and ladders. |
| IS: 4770 | Rubber gloves for electrical purposes |
| IS: 5216 (Part-I | Recommendations on Safety procedures and practices in electrical works |
| IS: 5557 | Industrial and Safety rubber lined boots. |
| IS: 5983 | Eye protectors |
| IS:6519 | Selection, care and repair of Safety footwear |
| IS: 6994 (Part-I) | Industrial Safety Gloves (Leather & Cotton Gloves) |

| | |
|---|---|
| IS: 7293 | Safety Code for working with construction Machinery |
| IS: 9167 | Ear protectors |
| IS: 11006 | Flash back arrestor (Flame arrestor) |
| IS:11016 | General and safety requirements for machine tools and their operation |
| IS: 11226 | Leather safety footwear having direct moulded rubber sole |
| IS: 11972 | Code of practice for safety precaution to be taken when entering a sewerage system |
| IS: 13367 | Code of practice-safe use of cranes |
| IS: 13416 | Recommendations for preventive measures against hazards at working place |

## ANNEXURE - II

### DETAILS OF FIRST AID BOX

| SL.NO. | DESCRIPTION | *QUANTITY* |
|---|---|---|
| 1. | Small size Roller Bandages, 1 inch wide (Finger Dressing small) | 6 Pcs. |
| 2. | Medium size Roller Bandages, 2 inch wide (Hand and Foot Dressing) | 6 Pcs. |
| 3. | Large size Roller Bandages, 4 inch wide (Body Dressing Large) | 6 Pcs. |
| 4. | Large size Burn Dressing (Bun Dressing Large) | 4 Pkts. |
| 5. | Cotton wool (20 gms packing) | 4 Pkts. |
| 6. | Antiseptic Solution Dettol (100 ml.) or Savalon | 1 Bottle |
| 7. | Mercurochrome Solution (100 ml.) 2% in water | 1 Bottle |
| 8. | Sal-volatile (20 ml. Ammonia) | 1 Bottle |
| 9. | A Pair of Scissor | 1 Piece |
| 10. | Adhesive Plaster (1.25 cm x 5 m) | 1Spool |
| 11. | Eye pads in Separate Sealed Packet | 4 Pcs. |
| 12. | Tourniquet | 1 No. |
| 13. | Safety Pins | 1 Dozen |
| 14. | Tine IODINE (100 ml.) | 1 Bottles |
| 15. | Ointment for burns (Burnol 20 gms.) | 1 Bottole |
| 16. | Polythene Wash cup for washing eyes | 1 No. |
| 17. | Potassium Permanganate (20 gms.) | 1 Pkt. |
| 18. | Tinc. Benzoine (100 ml.) | 1 Bottole |
| 19. | Triangular Bandages | 2 Nos. |
| 20. | Band Aid Dressing | 5 Pcs. |
| 21. | Iodex (25 gms.) | 1 Bottole |
| 22. | Tongue Depressor | 1 No. |
| 23. | Boric Acid Powder (20 gms.) | 2 Pkt. |
| 24. | Sodium Bicarbonate (20 gms.) | 1 Pkt. |
| 25. | Dressing Powder (Nebasulf) (10 gms.) | 1 Bottole |
| 26. | Medicinal Glass | 1 No. |
| 27. | Duster | 1 No. |
| 28. | Booklet (English & Local Language) | 1 No. each |
| 29. | Soap | 1 No. |
| 30. | Toothache Solution | 1 No. |
| 31. | Eye Ointment | 1 Bottle |
| 32. | Vicks (22 gms.) | 1 Bottle |
| 33. | Forceps | 1 No. |
| 34. | Cottom Buds (5 nos.) | 1 Pkt. |
| 35. | Note Book | 1 No. |
| 36. | Splints | 4 Nos. |
| 37. | Lock | 1 Piece |
| 38. | Life Saving/Emergency/Over-the Counter Drugs | As decided at site |
| | NOTE : Type of Box<br>Size | Aluminum<br>14” x 12” x 4” |

**Annexure-III**

**TYPES OF FIRE EXTINGUISHERS AND THEIR APPLICATION**

| | **CARBON DIOXIDE** | **DRY CHEMICAL** | | | | **WATER TYPE** | | | | **FOAM** |
|---|---|---|---|---|---|---|---|---|---|---|
| | | SODIUM POTASSIUM BICARBONATE | | MULTI PURPOSE A B C | | | | | | |
| | CO2 | CARTRIDGE OPERATED | STORED PRESURE | STORED PRESSURE | CARTRIDGE OPERATED | STORED PRESSURE | CARTRIDGE OPERATED | WATER PUMP TANK | SODA ACID | FOAM |
| CLASS A FIRES WOOD PAPER TRASH HAVING GLOWING EMBERS | x | X | x | _/ | _/ | _/ | _/ | _/ | _/ | _/ |
| | (BUT CAN CONTROL MINOR SURFACE FIRES) | | | | | | | | | |
| CLASS B FIRES FLAMMABLE LIQUIDS GASOLINE OIL PAIN GRASE ETC. | _/ | _/ | _/ | _/ | _/ | X | X | X | X | _/ |
| CLASS C FIRES ELECTRICAL EQUIPMENT | _/ | _/ | _/ | _/ | _/ | X | X | X | X | X |

LEGEND : _/ : CAN BE USED

X : NOT TO BE USED

***ANNEXURE-14***

## *INDICATIVE LIST OF STATUTORY ACTS & RULES*

Indian Explosives Act, 1984
The Motor Vehicles Act, 1988
The Factories Act, 1949
The Petroleum Act, 2002
Workmen Compensation 'act
Static/Mobile Pressure Vessel Act
Indian Electricity Act
Indian Boiler Act, 1923
Water (Prevention & Control Pollution) Act, 1974
Water (Prevention & Control of Pollution) Cess Act-1977
The Mines & Minerals (Regulation & Development) Act-1947
The Air (Prevention & control of Pollution) Act-1981
The Atomic Energy Act-1962
The Radiation Protection Rules-1971
The Indian Fisheries Act-1954
The Indian Forest Act-1927
The Wild Life (Protection) Act-1972
The Environment (Protection) Act-1986
The Environment (Protection) Rules-1986
The Hazardous Wastes (Management & Handling) Rules-1989
The Manufacture, Storage & Import of Hazardous Chemicals Rules-1989
The Central Motor Vehicles Rules-1989
The Building and Other Construction Workers (Regulation of Employment and Condition of Service) Act, 1996

## ANNEXURE-V

### *CONSTRUCTION HAZARDS, THEIR EFFECTS & PREVENTIVE MEASURES*

| ***ACTIVITY*** | ***TYPE OF HAZARD*** | **EFFECT OF HAZARD** | **PREVENTIVE MEASURES** |
|---|---|---|---|
| (A) EXCAVATION<br>• Pif Excavation up to 3.0m | ➢ Falling into pit | ➢ Personal injury | ➢ Provide guard rails/barricade with warning signal.<br>➢ Provide at least two entries/exits.<br>➢ Provide escape ladders. |
| | ➢ Earth Collapse | ➢ Suffocation/ Breathlessness<br>➢ Buried | ➢ Provide suitable size of shoring and strutting, if required.<br>➢ Keep soil heaps away from the edge equivalent to 1.5m or depth of pit whichever is more.<br>➢ Don't allow vehicles to operate too close to excavated areas. Maintain at least 2m distance from edge of cut.<br>➢ Maintain sufficient angle of repose. Provide slope not less than 1:1 and suitable bench of 0.5m width at every 1.5m depth of excavation in all soils except hard rock.<br>➢ Battering/benching the sides. |
| | ➢ Contact with buried electric cables<br>➢ Gas/Oil Pipelines | ➢ Electrocution<br>➢ Explosion | ➢ Obtain permission from competent authorities, prior to excavation, if required.<br>➢ Locate the position of buried utilities by referring to plant drawings.<br>➢ Start digging manually to locate the exact position of buried utilities and thereafter use mechanical means. |
| • Pit Excavation beyond 3.0m | ➢ Same as above plus<br>➢ Flooding due to excessive | ➢ Can cause drowning situation | ➢ Prevent ingress of water<br>➢ Provide ring buoys<br>➢ Identify and provide suitable size dewatering pump or well point system |

| ACTIVITY | TYPE OF HAZARD | EFFECT OF HAZARD | PREVENTIVE MEASURES |
|---|---|---|---|
| | rain/ underground water | | |
| | ➢ Digging in the vicinity of existing Building/ Structure | ➢ Building/Structure may collapse<br>➢ Loss of health & wealth | ➢ Obtain prior approval of excavation method from local authorities<br>➢ Use under-piping method<br>➢ Construct retaining wall side by side |
| | ➢ Movement of vehicles/ equipments close to the edge of cut. | ➢ May cause cave-in or slides<br>➢ Persons may get buried | ➢ Barricade the excavated area with proper lighting arrangements<br>➢ Maintain at least 2m distance from edge of cut<br>➢ Strengthen shoring and strutting |
| • Narrow deep excavations for pipelines, etc. | ➢ Same as above plus<br>➢ Frequent cave-in or slides | ➢ May cause severe injuriesor prove fatal | ➢ Battering/benching of sides<br>➢ Provide escape ladders |
| | ➢ Flooding due to Hydro testing | ➢ May arise drowning situation | ➢ Same as above plus<br>➢ Bail out accumulated water<br>➢ Maintain adequate ventilation |
| • Rock excavation by blasting | ➢ Improper handling of explosives | ➢ May prove fatal | ➢ Ensure proper storage, handling & carrying of explosives by trained personnel.<br>➢ Comply with the applicable explosive acts & rules. |
| | ➢ Uncontrolled explosion | ➢ May cause severe injuriesor prove fatal | ➢ Allow only authorized persons to perform blasting operations.<br>➢ Smoking and open flames are to be strictly prohibited. |
| | ➢ Scattering of stone pieces in atmosphere | ➢ Can hurt people | ➢ Use PPE like goggles, face mask, helmets etc. |
| • Rock excavating by blasting (Contd) | ➢ Entrapping of persons/animals. | ➢ May cause severe injuriesor prove fatal | ➢ Barricade the area with red flags and blow siren before blasting. |
| | ➢ Misfire | ➢ May explode suddenly | ➢ Do not return to site for at least 20 minutes or unless announced safe by |

| ***ACTIVITY*** | ***TYPE OF HAZARD*** | **EFFECT OF HAZARD** | **PREVENTIVE MEASURES** |
|---|---|---|---|
| | | | designated person. |
| • Piling Work | ➢ Failure of pile-driving equipment | ➢ Can hurt people | ➢ Inspect Piling rigs and pulley blocks before the beginning of each shift. |
| | ➢ Noise pollution | ➢ Can cause deafness and psychological imbalance. | ➢ Use personal protective equipment's like ear plugs, muffs, etc. |
| | ➢ Extruding rods/casing | ➢ Can hurt people | ➢ Barricade the area an install sign boards<br>➢ Provide first-aid |
| | ➢ Working in the vicinity of 'Live-Electricity' | ➢ Can cause electrocution / asphyxiation | ➢ Keep sufficient distance from Live-Electricity as per IS code.<br>➢ Shut off the supply, if possible<br>➢ Provide artificial/rescue breathing to he injured. |
| (B) CONCRETING | ➢ Air pollution by cement | ➢ May affect Respiratory System | ➢ Wear respirators or cover mouth and nose with wet cloth. |
| | ➢ Handling of ingredients | ➢ Hands may get injured | ➢ Use gloves and other PPE. |
| | ➢ Protruding reinforcement rods. | ➢ Feet may get injured | ➢ Use Safety shoes.<br>➢ Provide platform above reinforcement for movement of workers. |
| | ➢ Earthing of electrical mixers, vibrators, etc. not done | ➢ Can cause electrocution / asphyxiation | ➢ Ensure earthing of equipment's and proper functioning of electrical circuit before commencement of work. |
| | ➢ Falling of materials from height | ➢ Persons may get injured | ➢ Use hard hats<br>➢ Remove surplus material immediately from workplace<br>➢ Ensure lighting arrangements during night hours. |
| | ➢ Continuous pouring by same gang | ➢ Cause tiredness of workers and may lead to | ➢ Insist on shift pattern<br>➢ Provide adequate rest to workers between subsequent pours. |

| ***ACTIVITY*** | ***TYPE OF HAZARD*** | **EFFECT OF HAZARD** | **PREVENTIVE MEASURES** |
|---|---|---|---|
| | | accident. | |
| | ➢ Revolving or concrete mixer/ vibrators | ➢ Parts of body or clothes may get entrapped. | ➢ Allow only mixers with hopper<br>➢ Provide safety cages around moving motors<br>➢ Ensure proper mechanical locking of vibrator |
| • Super-structure | ➢ Same as above plus<br>➢ Deflection in props or shuttering material | ➢ Shuttering/p rops ma collapse and prove fatal | ➢ Avoid excessive stacking on shuttering material<br>➢ Check the design and strength of shuttering material before commencement of work<br>➢ Rectify immediately the deflection noted during concreting |
| | ➢ Passage to work place | ➢ Improperly tied and designed props/planks may collapse | ➢ Ensure the stability and strength of passage before commencement of work<br>➢ Do not overload and stand under the passage |
| (C) REINFORCEME NT | ➢ Curtailme nt and binding of rods | ➢ Persons may get injured | ➢ Use PPE like gloves, shoes, helmets, etc.<br>➢ Avoid usage of shift tools |
| | ➢ Carrying of rods for short distance/at heights | ➢ Workers may get injured their hands and shoulders. | ➢ Provide suitable pads on shoulders and use safety gloves<br>➢ Tie up rods in easily liftable bundles<br>➢ Ensure proper staging. |
| | ➢ Checking of clear distance/c over with hands | ➢ Rods maycut or injure the finger | ➢ Use measuring devices like tape, measuring rods, etc. |
| | ➢ Hitting projected rods and standing on cantilever rods | ➢ Persons may get injured and fell down | ➢ Use safety shoes and avoid standing unnecessarily on cantilever rods<br>➢ Avoid wearing of loose clothes |
| | ➢ Falling of material from height | ➢ May prove fatal | ➢ Use helmets<br>➢ Provide safety nets |
| | ➢ Transport | ➢ Protruded | ➢ Use red flags/lights at the |

| ***ACTIVITY*** | ***TYPE OF HAZARD*** | **EFFECT OF HAZARD** | **PREVENTIVE MEASURES** |
|---|---|---|---|
| | ation of rods by trucks | rods may hit the persons | ends<br>➢ Do not protrude the rods in front of or by the side of driver's cabin.<br>➢ Do not extend the rods 1/rd of deck length or 1.5 m which is less |
| (D) WELDING AND GAS CUTTING | ➢ Welding radiates invisible ultraviolet and infrared rays | ➢ Radiation can damage eyes and skin. | ➢ Use specified shielding devices and other PPE of correct specifications<br>➢ Avoid throated tungsten electrodes for GTAW |
| | ➢ Improper placement of oxygen and acetylene cylinders | ➢ Explosion may occur | ➢ Move out any leaking cylinder<br>➢ Keep cylinder in vertical position<br>➢ Use trolley for transportation of cylinders and chain them<br>➢ Use flash back arrestors |
| | ➢ Leakage/cuts in hoses | ➢ May cause fire | ➢ Purge regulators immediately and then turn off<br>➢ Never use grease or oil on oxygen line connections and copper fittings on acetylene lines<br>➢ Inspect regularly gas carrying hoses<br>➢ Use the current for which the cable is designed<br>➢ Always use red hose for acetylene and other fuel gases and black for oxygen |
| | ➢ Opening-up of cylinder | ➢ Cylinder may burst | ➢ Always stand back from the regulator while opening the cylinder<br>➢ Turn valve slowly to avoid bursting<br>➢ Cover the lug terminals to prevent short circuiting. |
| | ➢ Welding of tanks, container or pipes storing | ➢ Explosion may occur | ➢ Empty them before welding<br>➢ Never attach the ground cable to tanks, container or pipe storing flammable liquids |

| ***ACTIVITY*** | ***TYPE OF HAZARD*** | **EFFECT OF HAZARD** | **PREVENTIVE MEASURES** |
|---|---|---|---|
| | flammable liquids | | ➢ Never use LPG for gas cutting |
| (E) RADIOGRAPHY | ➢ Ionizing radiation | ➢ Radiations may react with the skin and can cause cancer, skin irritation, dermatitis, etc. | ➢ Ensure safety regulations as per BARC before commencement of job.<br>➢ Cordon off the area and install Radiation warning symbols<br>➢ Restrict the entry of unauthorized persons<br>➢ Wear appropriate PPE and film bagdges issued by BARC |
| | ➢ Transportation and Storage of Radiography source | ➢ Same as above | ➢ Never touch or handle radiography source with hands<br>➢ Store radiography source inside a pit in an exclusive isolated storage room with lock and key arrangement. The pit should be approved by BARC<br>➢ Radiography source should never be carried either in passenger bus or in a passenger compartment of trains.<br>➢ BARC have to be informed before source movement.<br>➢ Permission from Director General of Civil Aviation is required for booking radio isotopes with airlines. |
| | ➢ Loss of Radio isotope | ➢ Same as above | ➢ Try to locate with the help of Survey Meter<br>➢ Inform BARC(*) |
| (F) ELECTRICAL INSTALLATION AND USAGE | ➢ Short circuiting | ➢ Can Cause Electrocution or Fire | ➢ Use rubberized hand gloves and other PPE<br>➢ Don't lay wires under carpets, mats or door ways.<br>➢ Allow only licensed electricians to perform on electrical facilities<br>➢ Use one socket for one appliance<br>➢ Ensure usage of only fully insulated wires or cables<br>➢ Don't place bare wire ends in a socket |

| ***ACTIVITY*** | ***TYPE OF HAZARD*** | **EFFECT OF HAZARD** | **PREVENTIVE MEASURES** |
|---|---|---|---|
| | | | ➢ Ensure earthing of machineries and equipment's<br>➢ Do not use damaged cords and avoid temporary connections<br>➢ Use spark-proof/flame proof type field distribution boxes.<br>➢ Do not allow open/bare connections<br>➢ Provide all connections through ELCB<br>➢ Protect electrical cables/equipment's from water and naked flames<br>➢ Check all connections before energizing |
| | ➢ Overloading of Electrical System | ➢ Bursting of system can occur which leads to fire | ➢ Display voltage and current ratings prominently with 'Danger' sings.<br>➢ Ensure approved cable size, voltage grade and type<br>➢ Switch off the electrical utilities when not in use<br>➢ Do not allow an unauthorized connections<br>➢ Ensure proper grid wise distribution of Power. |
| | ➢ Improper laying of overhead and underground transmission lines/cables | ➢ Can cause electrocution and prove fatal | ➢ Do not lay unarmored cable directly on ground, wall,roof of trees<br>➢ Maintain at least 3m distance from HT cables<br>➢ All temporary cables should be laid at least 750 mm below ground on 100 mm fine sand overlying by brick soling<br>➢ Provide proper sleeves at crossings/intersections<br>➢ Provide cable route markers indicating the type anddepth of cables at intervals not exceeding 30m and at the diversions/termination. |
| (G) FIRE PREVENTION AND PROTECTION | ➢ Small fires can become big ones | ➢ Cause burn injuries and may prove fatal | ➢ In case a fire breaks out, press fire alarm system and shout "Fire, Fire"<br>➢ Keep buckets full of sand & |

| ***ACTIVITY*** | ***TYPE OF HAZARD*** | **EFFECT OF HAZARD** | **PREVENTIVE MEASURES** |
|---|---|---|---|
| | and may spread to the surroundi ng areas | | water/fire extinguishing equipment near hazardous locations<br>➢ Confine smoking to 'Smoking Zones' only<br>➢ Train people for using specific type of fire equipment's under different classes of fire<br>➢ Keep fire doors/ shutters, passages and exit doors unobstructed<br>➢ Maintain good housekeeping and first-aid boxes (for detail refer Annex-2)<br>➢ Don't obstruct assess to f<br>➢ Fire extinguishers<br>➢ Do not use elevators for evacuation during fire<br>➢ Maintain lightening arrestors for elevated structures |
| | ➢ Improper selection of Fire extinguish ers | ➢ It may not extinguish the fire | ➢ Ensure usage of correct fire extinguisher meant for the specified fire (for details refer Annexure-III)<br>➢ Do not attempt to extinguish Oil and electric fires with water. Use foam cylinders/CO2/sand or earth. |
| | ➢ Improper storage of highly inflamma ble substances | ➢ Same as above | ➢ Maintain safe distance of flammable substances from source of ignition<br>➢ Restrict the distribution of flammable materials to only min. necessary amount<br>➢ Construct specifically designed fuel storage facilities<br>➢ Keep chemicals in cool and dry place away from hat. Ensure adequate ventilation<br>➢ Before welding operation, remove or shield the flammable material properly<br>➢ Store flammable materials in stable racks, correctly labelled |

| ***ACTIVITY*** | ***TYPE OF HAZARD*** | **EFFECT OF HAZARD** | **PREVENTIVE MEASURES** |
|---|---|---|---|
| | | | ➢ Wipe off the spills immediately |
| | ➢ Short circuiting of electrical system | ➢ Same as above<br>➢ Can cause Electrocution | ➢ Don't lay wires under carpets, mats or door ways<br>➢ Use one socket for one appliance<br>➢ Use only fully insulated wires or cables<br>➢ Do not allow open/bare connections<br>➢ Provide all connections through ELCB<br>➢ Ensure earthing of machineries and equipment's |
| (H) VEHICULAR MOVEMENT | ➢ Crossing the Speed Limits (Rash driving) | ➢ Personal injury | ➢ Obey speed limits and traffic rules strictly<br>➢ Always expect the unexpected and be a defensive drive<br>➢ Use sat belts/helmets<br>➢ Blow horn at intersections and during overtaking operations.<br>➢ Maintain the vehicle in good condition<br>➢ Do not overtake on curves, bridges and slopes |
| | ➢ Adverse weather condition | ➢ Same as above | ➢ Read the road ahead and ride to the left<br>➢ Keep the wind screen and lights clean<br>➢ Do not turn at speed<br>➢ Recognize the hazard, understand the defense and act correctly in time. |
| | ➢ Consuming alcohol before and during the driving operation | ➢ Same as above | ➢ Alcohol and driving do not mix well. Either choose alcohol or driving.<br>➢ If you have a choice between hitting a fixedobject or an on-coming vehicle, hit the fixed object<br>➢ Quit the steering at once and become a passenger. Otherwise take sufficient rest and then drive.<br>➢ Do not force the driver to drive fast and round theclock |

| ***ACTIVITY*** | ***TYPE OF HAZARD*** | **EFFECT OF HAZARD** | **PREVENTIVE MEASURES** |
|---|---|---|---|
| | | | ➢ Do not day dram while driving |
| | ➢ Falling objects/ Mechanic al failure | ➢ May prove fatal | ➢ Ensure effective braking system, adequate visibility for the drives, reverse warning alarm<br>➢ Proper maintenance of the vehicle as per manufacturer instructions |
| (I) PROOF TESTING (HYDROSTAT IC/ PNEUMATIC TESTING | ➢ Bursting of piping<br>➢ Collapse of tanks<br>➢ Tanks flying off | ➢ May cause injury and prove fatal | ➢ Prepare test procedure & obtain CONSULTANT/ Owner's approval<br>➢ Provide separate gauge for pressurizing pump and piping/equipment<br>➢ Check the calibration status of all pressure gauges, dead weight testers and temperature recorders<br>➢ Take dial readings atsuitable defined intervals and ensure most of them fall between 40-60% of the gauge scale range<br>➢ Provide safety relief valve (set at pressure slightly higher than test pressure) while testing with air/nitrogen<br>➢ Ensure necessary precautions, stepwise increase in pressure, tightening of bolts/ nuts, grouting, etc. before and during testing<br>➢ Keep the vents open before opening any valve while draining out of water usedfor hydro testing of tanks<br>➢ Pneumatic testing involves the hazard of released energy shored in compressed gas. Specific care must therefore be taken to minimize the chance of brittle failure during a pneumatic leak test. Test temperature is important in this regard and must be |

| ***ACTIVITY*** | ***TYPE OF HAZARD*** | **EFFECT OF HAZARD** | **PREVENTIVE MEASURES** |
|---|---|---|---|
| | | | considered when the designer chooses thematerial of construction<br>➢ A pressure relief device shall be provided, having a set pressure not higher than the test pressure plus the lesser of 345 KPa (50 psi) or 10% of he test pressure. |
| (J) WORKING AT HEIGHTS | ➢ Person can fall down | ➢ May sustain severe injuries or prove fatal | ➢ Provide guard rails/barricade at the work place<br>➢ Use PPE like safety belts,full body harness, life line, helmets, safety shoes, etc.<br>➢ Obtain a permit before starting the work at height above 3 meters<br>➢ Fall arrest systems likesafety nets, etc. must be installed<br>➢ Provide adequate working space (min. 0.6 m)<br>➢ Tie/weld working platform with fixed support<br>➢ Use roof top walk ladder while working on a slopping roofs<br>➢ Avoid movement on beams |
| | ➢ | ➢ May hit the scrap/ material stacked at the ground or in between | ➢ Keep the work place neat and clean<br>➢ Remove the scrap immediately |
| | ➢ Material can fall down | ➢ May hit the workers working at lower levels and provide fatal | ➢ Same as above plus<br>➢ Do not throw or drop material or equipment from height<br>➢ All tools to be carried in a tool-kit bags or on working uniform<br>➢ Remove scrap from the planks<br>➢ Ensure wearing of helmet by the workers at low level |
| (K) CONFINED | ➢ Suffocatio n/ | ➢ Unconscious ness, death | ➢ Use respiratory devices, if required |

| ***ACTIVITY*** | ***TYPE OF HAZARD*** | **EFFECT OF HAZARD** | **PREVENTIVE MEASURES** |
|---|---|---|---|
| SPACES | drowning | | ➢ Avoid over crowding inside a confined space<br>➢ Provide Exhaust Fans for ventilation<br>➢ Do not weal loose clothes, neck ties, etc.<br>➢ Check for presence of hydrocarbons, O2 level<br>➢ Obtain work permit before entering a confined space<br>➢ Ensure that the connected piping of the equipment which is to be opened is pressure free, fluid has been drained, vents are open and piping is positively isolated by a blind flange |
| | ➢ Presence of foul smell and toxic substances | ➢ Inhalation can pose threat to life | ➢ Same as above plus<br>➢ Check for hydrocarbon and Aromatic compounds before entering a confined space<br>➢ Depute one person outside the confined space for continuous monitoring and for extending help in case of an emergency |
| | ➢ Ignition/flame can cause fire | ➢ Person may sustain burn injuries or explosion may occur | ➢ Keep fire extinguishers at a hand distance<br>➢ Remove surplus material and scrap immediately<br>➢ Do not smoke inside a confined space<br>➢ Do not allow gas cylinders inside a confined space<br>➢ Use low voltage (24V)lamps for lighting<br>➢ Use tools with air motors or electric tools with max. voltage of 24V<br>➢ Remove all equipment's at the end of the day |
| (L) HANDLING AND LIFTING EQUPMENTS | ➢ Failure of load lifting and moving equipments | ➢ Can cause accident and prove fatal | ➢ Avoid standing under the lifted load and within the operating radius of cranes<br>➢ Check periodically oil, brakes, gears, horns and tyre pressure of all moving machinery<br>➢ Check quality, size and |

| ***ACTIVITY*** | ***TYPE OF HAZARD*** | **EFFECT OF HAZARD** | **PREVENTIVE MEASURES** |
|---|---|---|---|
| | | | condition of all chain pulley blocks, slings, U-clamps, D-shackles, wire ropes, etc.<br>➢ Allow crane to move onlyon hard, firm and levelled ground<br>➢ Allow lifting slings as short as possible and check gunny packing at the friction points<br>➢ Do not allow crane to tilt its boom while moving<br>➢ Install Safe Load Indicator |
| | ➢ Overloading of lifting equipments | ➢ Same as above | ➢ Safe lifting capacity of derricks and wincheswritten on them shall be got verified.<br>➢ The max safe working load shall be marked on all lifting equipment's<br>➢ Check the weight of columns and other heavy items painted on them and accordingly decide about eh crane capacity, boom and angle of erection<br>➢ Allow only trained operators and riggers during crane operation |
| | ➢ Overhead electrical wires | ➢ Can cause electrocution and fire | ➢ Do not allow boom or other parts of crane to come within 3 m reach of overhead HT cables<br>➢ Hook and load being lifted shall preferably remain in full visibility of crane operator. |
| (M) SCAFFOLDING, FORMWORK AND LADDERS | ➢ Person can fall down | ➢ Person may sustain severe injuries and prove fatal | ➢ Provide guard rails for working at height<br>➢ Face ladder while climbing and use both hands<br>➢ Ladders shall extend about 1m above landing for easy access and tying up purpose<br>➢ Do not place ladders against movable objects and maintain base at ¼ unit of the working length of the ladder |

| ***ACTIVITY*** | ***TYPE OF HAZARD*** | **EFFECT OF HAZARD** | **PREVENTIVE MEASURES** |
|---|---|---|---|
| | | | ➢ Suspended scaffolds shallnot be less than 500 mm wide and tied properly with ropes<br>➢ No loose planks shall be allowed<br>➢ Use PPE, like helmets,safety shoes, etc. |
| | ➢ Failure of scaffoldin g material | ➢ Same as above | ➢ Inspect visually all scaffolding materials for stability and anchoring with permanent structures.<br>➢ Design scaffolding for max. load carrying capacity<br>➢ Scaffolding planks shall not be less than 50x250 mm full thickness lumber or equivalent. These shall be cleared or secured and must extend over the end supports by at least 150mm and not more that 300 mm<br>➢ Don't overload the scaffolds<br>➢ Do not splice short ladders to make a longer one. Vertical ladders shall not exceed 6m. |
| | ➢ Material can fall down | ➢ Persons working at lower level gets injured | ➢ Remove excess material and scrap immediately<br>➢ Carry the tools in a tool-kit bag only<br>➢ Provide safety nets |
| (N) STRUCTURAL WORKS | ➢ Personal Negligence and danger of fall | ➢ Can cause injury or casualty | ➢ Do not take rest inside rooms built for welding machines or electrical distribution system<br>➢ Avoid walking on beams at height<br>➢ Wear helmet with chin strap and safety belts when working at height<br>➢ Use hand gloves andgoggles during grinding operations<br>➢ Cover or mark the sharp and projected edges<br>➢ Do not stand within the operating radius of cranes |
| | ➢ Lifting/sli- | ➢ Same as | ➢ Do not stand under the lifted |

| ***ACTIVITY*** | ***TYPE OF HAZARD*** | **EFFECT OF HAZARD** | **PREVENTIVE MEASURES** |
|---|---|---|---|
| | pping of material | above | load<br>➢ Stack properly all the materials. Avoid slippage during handling<br>➢ Control longer pieces lifted up by cranes from both ends<br>➢ Remove loose materials from height<br>➢ Ensure tightening of all nuts and bolts |
| (O) PIPELINE WORKS | ➢ Erection/ lowering failure | ➢ Can cause injury | ➢ Do not stand under the lifted load<br>➢ Do not allow any person to come within the radii of the side boom handling pipes<br>➢ Check the load carrying capacity of the lifting tools and tackles<br>➢ Use safe Load Indicators<br>➢ Use appropriate PPEs |
| | ➢ Other | ➢ Same as above | ➢ Wear gum boots in marshy areas<br>➢ Allow only one person to perform signalling operations while loweringof pipes<br>➢ Provide night caps on pipes<br>➢ Provide end covers on pipes for stoppage of pigs while testing/cleaning operations |

## ELECTRICAL

Electrical power is the mainstay of any construction activity, at the same time it requires utmost care in it's utilization to avoid accidents due to electrical shock, fire incidents or electric short circuits. Exposure of electrical installation to adverse environmental conditions increase the risk of such accidents. Hence it is necessary to take extra precautions for such installations to ensure safety of personnel and equipment. This standard addresses the safety measures required to be adopted for the electrical installations by all contractors during construction phase.

All electrical connections/work for electrical installations shall be carried out as per provisions of the latest revision of the following codes and standards in addition to the requirements of statutory authorities and ie rules :
Oisd-std-173 : fire prevention and protection system for electrical installations.
Sp-30 (bis) : national electric code.
The installation shall have approval from concerned statutory authorities.

1. All electrical connections shall be done by an electrician with valid licence and to the satisfaction of engineer-in-charge.
2. One competent licenced electrician shall be made available by contractor at site round the clock to attend to the normal/emergency jobs.
3. All switch boards/welding machines shall be kept in well ventilated and covered shed. The shed shall be elevated to avoid water logging. No flammable materials shall be used for constructing the shed. Also flammable materials shall not be stored in and around electrical equipment/switchboard. Adequate clearances and operational space shall be provided around the equipment.
4. Fire extinguishers and insulting mats shall be provided in all power distribution centres.
5. Temporary electrical equipment shall not be employed in hazardous areas without obtaining safety permit.
6. Proper housekeeping shall be done around the electrical installations.
7. All temporary installations shall be tested before engineering, to ensure proper earthing, bonding, suitability of protection system, adequacy of feeders/cables etc.
8. All welders shall use hand gloves irrespective or holder voltage.
9. Multilingual (English, Hindi and local language) caution boards, shock treatment charts and instruction plate containing location of isolation point for incoming supply, name and telephone number(s) of contact person in emergency shall be provided in substations and near all distribution boards/local panels.
10. Operation of earth leakage device shall be checked regularly by temporarily connecting series test lamp (2 bulbs of equal rating connected in series) between phase and earth.
11. The following design features shall be ensured for all electrical installations during construction phase.

12.1 Each installation shall have a main switch with a protective device, installed in an enclosure adjacent to the metering point. The operating height of the main switch shall not exceed 1.5 m. The main switch shall be connected to the point of supply by means of armoured cable.

12.2 The outgoing feeders shall be double or triple pole switches with fuses/mcbs. Loads in a three phase circuit shall be balanced as far as possible and load on neutral should not exceed 20% of load in the phase.

12.3 The installation shall be adequately protected against overload, short circuit and earth leakage by the use of suitable protective devices. Fuses wherever used shall be hrc type. Use of rewirable fuses shall be strictly prohibited. The earth leakage device shall have an operating current not exceeding 30 ma.

12.4 All connections to the handtools/welding receptacles shall be taken through proper switches, sockets and plugs.

12.5 All single phase sockets shall be 3 pin type only. All unused sockets shall be provided with socket caps.

12.6 Only 3 core (p+n+e) overall sheathed flexible cables with minimum conductor size of 1.5 mm2 copper shall be used for all hand tools.

12.7 Only metallic distribution boxes with double earthing shall be used at site. No wooden boxes shall be used.

12.8 All power cables shall be terminated with compression type cable glands. Tinned copper lugs shall be used for multistrand wires/cables.

12.9 Cables shall be free from any insulation damage.

12.10 Cables shall be laid underground at a minimum depth of 900 mm, covered with sand, brick and soil for ensuring mechanical protection. Cables shall not be laid in water logged area as far as practicable. Cable route markers shall be provided at every 25 m of buried trench route. When laid above ground, cables shall be properly cleated or supported on rigid poles of at least 2 m high. Minimum head clearance of 6 meters shall be provided at road crossings.

12.11 Under ground road crossings for cables shall be avoided to the extent feasible. In any case no under ground power cable shall be allowed to cross the roads without pipe sleeve.

12.12 All cable joints shall be done with proper jointing kit. No taped/temporary joints shall be used.

12.13 An independent earthing facility should preferably be established within the temporary installation premises. All appliances and equipment shall be adequately earthed. In case armoured cables are used, the armour shall be bonded to the earthing system.

12.14 All cables and wire rope used for earth connections shall be terminated through tinned copper lugs.

12.15 In case of local earthing, earth electrodes shall be buried near the supply point and earth continuity wire shall be connected to local earth plate for further distribution to various appliances. All insulated wires for earth connection shall have insulation of green colour.

12.16 Separate core shall be provided for neutral earth/structures shall not be used as a neutral in any case.

12.17 On/off position of all switches shall be clearly designated/ painted for easy isolation in emergency.

12.18 All insulations shall be inspected by engineer-in-charge atleast once in a month.

## LIST OF SUPPLIERS OF MAJOR BOUGHT-OUT ITEMS

## 1. (MECHANICAL & FIRE FIGHTING EQUIPMENT)

### A). MAINLINE & MECHANICAL

#### i) Pipe Carbon Steel To Indian Standards

1. A.S.T. Pipes Pvt. Ltd. (AST Group)
2. Advance Steel Tube Ltd.
3. Apl Apollo Tubes Ltd. (Er. Bihar Tubes Ltd.)
4. Asian Mills Pvt. Ltd.
5. Asrani Tubes Limited
6. Dadu Pipes (P) Ltd.
7. Essar Steel Limited(Er Hazira Pipes Mill)
8. Gaurang Products Pvt Ltd. (Ast Group)
9. Goodluck Steel Tubes Ltd.
10. HiǴTech Pipes Limited
11. Indus Tube Limited
12. Jindal Industries Ltd
13. Jindal Pipes Ltd.
14. Jindal Saw Ltd (Kosi Works)
15. Jotindra Steel & Tube Ltd
16. ALLit Pipes and Pipes Ltd.
17. Maharashtra Seamless Ltd.
18. Man Industries (India) Ltd. – Pithampur
19. Man Industries (India) Ltd. Anjar
20. Mukat Tanks & Vessels Ltd.
21. Nezone Tubes Limited
22. North Eastern Tubes Limited
23. Pratibha Industries Limited
24. Pratibha Pipes & Structural Ltd.
25. Psl Ltd (Chennai)
26. Psl Ltd (V1, V2 & Nc)
27. Rama Steel Tubes Ltd.
28. Ratnamani Metals and Tubes Ltd.
29. Ravindra Tubes Limited
30. Samshi Pipe Industries Limited
31. Surya Roshni Ltd.
32. Swastik Pipes Ltd.
33. Utkarsh Tubes & Pipes Ltd. (Formly Bmw)

34. Welspun Corp. Limited (Dahej)
35. Zenith Birla (India) Limited

## ii) Pipe & Tubulars To A.P.I. Standards

1. Arcelormittal Tubular Products Roman Sa, Romania
2. Bhel (Trichy),India
3. Dalmine Spa (Enquiry To Tenaris),UAE
4. Eewkorea Co. Ltd (Germany), Korea
5. Eew Korea Co. Ltd. (Korea), Korea
6. Eisenbau Kramer Gmbh, Germany
7. Hyundai Rb Co. Ltd. South Korea
8. Ilva Lamiere E Tubi Srl (Enq To Ilva Spa, Italy
9. Inox Tech. Spa, Italy
10. Ismt Ltd. Ahmedngr, India
11. Ismt Ltd. Baramati, India
12. Jindal Pipes Ltd., India
13. Jindal Saw Ltd. (Kosi Works), India
14. Jindal Saw Ltd. (Nashik Works), India
15. ALLit Pipes and Pipes Ltd. India
16. Maharashtra Seamless Ltd., India
17. Man Industries (I) Ltd. (Pithampur), India
18. Mukat Tanks & Vessels Ltd., India
19. Pratibha Industries Limited, India
20. Ratnamani Metals and Tubes Ltd., India
21. Siderca S.A.I.C (Enquiry Totenaris), UAE
22. Sumitomo Metal Ind. Ltd., India
23. Surya Roshni Ltd., India
24. Swastik Pipes Ltd, India
25. Tata Steel Uk Limited (Formerly C702)
26. Tubos De Acero De Mexico Sa (Enq. Tenaris), UAE
27. Tubos Reunidos Sa Spain
28. Umran Steel Pipe Inc (Turkey), Turkey
29. Valcovny Trub Chomutov, Czech Republic
30. Vallourec and Mannesmann Tubes, France
31. Welspun Corp Limited (Dahej), India

## iii) Pipe/Tube CS (Seamless) To ASTM STDs

1. Arcelormittal Tubular Products Roman Sa, Romania
2. Bhel (Trichy), India
3. Changshu Seamless Steel Tube Co. Ltd., China
4. Dalmine Spa (Enquiry To Tenaris, UAE

5. Heavy Metals & Tubes Limited (Mehsana), India
6. Ismt Ltd. Ahmedngr, India
7. Ismt Ltd. Baramati India
8. Jfe Steel Corporation, UAE
9. Jindal Sdaw Ltd (Nashik Works) India
10. Klt Automotive and Tubular Products Ltd., India
11. Mahalaxmi Seamless Limited, India
12. Maharashtra Seamless Ltd, India
13. Products Tubulares S.A.U, Spain
14. Ratnadeep Metal Tubes Ltd., India
15. Staineest Tubes Pvt Ltd., India
16. Sumitomo Metal Ind. Ltd., India
17. Tubos Reunidos Sa Spain
18. Valcovny Trub Chomutov, Czech Republic
19. Vallourec Andmannesmann Tubes France
20. Yangzhou Chengde Steel Pipe Co. Ltd Dubai (UAE)

**iv) Pipe Carbon Steel (Welded) To ASTM STDs**

1. Eew Korea Co. Ltd. (Germany), Korea
2. Eew Korea Co. Ltd. (Korea), Korea
3. Eisenbau Kramer Gmbh, Germany
4. Hyundai Rb Co. Ltd., South Korea
5. Inox Tech. Spa, Italy
6. Jindal Saw Ltd (Kosi Works), India
7. ALLit Pipes and Pipes Ltd., India
8. Man Industeries (I) Ltd.(Pithampur), India
9. Man Industries (India) Ltd. Anjar, India
10. Mukat Tanks & Vessels Ltd., India
11. Ratnamani Metals And Tubes Ltd., India
12. Sumitomo Metal India Ltd., India
13. Tata Steel Uk Limited

**v) Valve**

**a) Globe Valves**

1) M/S BDK (New Delhi)
2) M/S Datre Corpn (Calcutta)
3) M/S KSB Pumps (New Delhi)
4) M/S L&T (New Delhi)
5) M/S Neco Schuber & Salzer Ltd. (New Delhi)

6) M/S Niton Valve (Mumbai)

7) M/S Ornate Valves (Mumbai)

8) M/S Panchavati Valves (Mumbai)

9) AV Valves Ltd.

10) BHEL (Trichy), India

11) Econo Valves Pvt Ltd, India

12) Fouress Engg (I) Ltd (Aurangabad)

13) Guru Industrial Valves Pvt Ltd

14) Leader Valves Ltd, India

15) NSSL Ltd. (Neco Schubert & Salzerltd)

16) Oswal Industries Ltd, India

17) Petrochemical Engineering Enterprises, India

18) Sakhi Engineers Pvt Ltd

19) Shalimar Valves Pvt Ltd

20) Steel Strong Valves India Pvt Ltd, India

21) Petro Valves Pvt. Limited, Ahmedabad

## b) Check Valves

1. M/s Advance Valves Pvt. Ltd., Noida
2. M/s Aksons & Mechanical Enterprises, Mumbai
3. M/s Larsen & Toubro Limited (M/s Audco India Limited, Chennai)
4. M/s AV valves Ltd., Agra
5. M/s BDK engineering India Ltd., Hubli
6. M/s BHEL,OFE &OE Group, New Delhi
7. M/s Datre Coroportion Limited, Calcutta
8. M/s Leader Valves Ltd., Jalandhar
9. M/s Neco schubert &Salzer Ltd., New Delhi
10. M/s Niton Valves Industries (P) Ltd., Mumbai
11. M/s Precision Engg.Co., Mumbai
12. Econo Valves Pvt Ltd, India
13. Fouress Engg (I) Ltd (Aurangabad)
14. KSB Pumps Ltd (Coimbatore), India
15. NSSL Ltd. (Neco Schubert & Salzerltd)
16. Oswal Industries Ltd, India
17. Panchvati Valves & Flanges Pvt Ltd, India
18. Petrochemical Engineering Enterprises, India
19. Sakhi Engineers Pvt Ltd
20. Shalimar Valves Pvt Ltd
21. Steel Strong Valves India Pvt Ltd, India

## c) Plug Valves

1. M/s Breda Energia Sesto Industrial Spa, Italy
2. M/s Fisher Sanmar Ltd., Chennai
3. M/s Larsen & Toubro Ltd., New Delhi
4. M/s Nordstrom Valves, USA
5. M/s Serck Audco Valves, UK
6. M/s Sumitomo Corporation India Pvt. Ltd., New Delhi
7. M/s Z Corporation, Korea
8. M/s Hawa Valves (India) Pvt. Ltd., Mumbai
9. M/s Steel Strong Valves India Pvt. Ltd., Navi Mumbai
10. M/s Econo Valves
11. M/s Flow-Serve PTE (Mfr. SERCK), India

### d) Ball Valves

1. M/s Hawa Valves (India) Pvt. Ltd, Navi Mumbai
2. M/s Larsen & Toubro, Delhi
3. M/s Microfinish Valves Pvt. Ltd., Noida
4. M/s Oswal Industries Ltd., Gandhi nagar
5. M/s Virgo Engineers Ltd., Delhi
6. M/s Boteli Valve Group Co. Ltd., China
7. M/s Cameron (Malaysia) SDN BHD, Malaysia
8. M/s Dafram S.P.A., Italy
9. M/s Fangyuan Valve Group Co. Ltd., China
10. M/s Franz Schuck GmbH, Germany
11. O.M.S. Saleri (Italy)
12. Pibi Viesse S.P.A (Italy)
13. Nuovo Pignone (Italy)
14. Perar S.P.A (Italy)
15. Pietro Fiorentini (Italy)
16. Cooper Cameron Valv Italy SRL-FRM, Itly
17. Petrol Valves SRL
18. Tormene Gas Technology S.P.A (VALVITALIA)
19. AB Industries, Ahmedabad
20. Norflow Controls, Ahmedabad,

21. Niton Valves Inds. Pvt. Ltd., Mumbai
22. Steel Strong Valves (I) Pvt Ltd., Navi Mumbai,
23. Dembla Valves Ltd, Gurugram
24. Hawa Engineers Ltd, Ahmedabad
25. Micon Engineers(hubli) Pvt Ltd, Dharwad
26. V A Valves, Jalandhar,
27. PHBB Valves Pvt Ltd, Maharashtra
28. * Or as per attached Technical Criteria.

**vi) Split Tee**

1) M/s Ipsco, Canada
2) M/s TD Willamsons, USA
3) M/s Pipefit Engineers
4) M/s Sawan Engineers
5) M/s Furmanite International Ltd.
6) M/s VKVC
7) M/s Bhotika
8) M/s Huwelco Inc.
9) M/s Plant-Tech

**vii) Flow Tee**

1) M/s Coprosider SPA, Italy
2) M/s GEA Energy System India Limited, Chennai
3) M/s Multitex Filteration
4) M/s Pipeline Engineering, UK
5) M/s Scomark Engg. Limited (U.K.)
6) M/s Skeltonhall Limited, Engaland(U.K.)
7) M/s Technospecial SPA, Italy
8) M/s Tectubi SPA, Italy
9) M/s RMA Germany

10) M/s Pipefit Engineers Pvt. Ltd

11) M/s Sawan Engineers Pvt Ltd

12) M/s United Forge Industries

13) * Or as per attached Technical Criteria.

**viii) Flanges**

1. M/s Aditya Forge Ltd., Vadodara
2. M/s Amforge Industries Ltd., Mumbai
3. M/s CD Engineering Co., Ghaziabad
4. M/s Echjay Forgings Pvt. Ltd. (Bombay), Mumbai
5. M/s Echjay Industries Ltd., Rajkot
6. M/s Forge & Forge Pvt. Ltd., Rajkot
7. M/s Golden Iron & Steel Works, New Delhi
8. M/s JK Forgings, New Delhi
9. M/s Metal Forgings Pvt. Ltd., Mumbai
10. M/s Perfect Marketings Pvt. Ltd., New Delhi
11. M/s Sky Forge, Faridabad
12. M/s S&G, Faridabad
13. Chaudhry Hammer Works Ltd, India
14. JAV Forgings (P) Ltd, India
15. Kunj Forgings Pvt Ltd, India
16. MS Fittings
17. R.N. Gupta & Co. Ltd, India
18. R.P. Engineering Pvt Ltd, India
19. Sanghvi Forgings & Engineering Ltd
20. Shri Ganesh Forgings Ltd., India
21. Uma Shankar Khandelwal & Co., India
22. Sawan Engineers, Baroda
23. Stewarts & Lloyds of India Ltd., Kolkata
24. Engineering Services Enterprises

25. Pipefit Engineers Pvt. Ltd.
26. Utsah Engineering Pvt Ltd
27. Vivial Forge Pvt Ltd
28. Norma (India) Ltd
29. United Forge Industries
30. * Or as per attached Technical Criteria.

**ix) Fittings**

1. M/s Commercial Supplying Agency, Mumbai
2. M/s Dee Development Engineers Ltd.
3. M/s Eby Industries, Mumbai
4. M/s Flash Forge Pvt. Ltd., Vishakhapatnam
5. M/s Gujarat Infra Pipes Pvt. Ltd., Vadodara
6. M/s M.S. Fittings Mfg. Co. Pvt. Ltd., Kolkata
7. M/s Stewarts & Lloyds of India Ltd., Kolkata
8. M/s Teekay Tubes Pvt. Ltd., Mumbai
9. M/s Pipe Fit, Baroda
10. M/s Sky Forge, Faridabad
11. M/s S&G, Faridabad
12. M/s Sawan Engineers, Baroda
13. Eby Fasteners, India
14. Leader Valves Ltd, India
15. R.N. Gupta & Co. Ltd, India
16. Exten Engg Pvt Ltd
17. Sivananda Pipe & Fittings Ltd
18. Vivial Forge Pvt Ltd
19. Janta Engineers & Company (Iron)
20. United Forge Industries
21. * Or as per attached Technical Criteria.

## x) Gaskets

1. IGP Engineers (P) Ltd., Madras
2. Madras Industrial Products, Madras
3. Dikson & Company, Bombay
4. Banco Products (P) Ltd., Vadodara
5. Goodrich Gaskets Pvt Ltd
6. Starflex Sealing India Pvt Ltd, India
7. Teekay Meta Flex Pvt Ltd
8. UNIKLINGER Ltd
9. HEM Engg. Corp.
10. Unique Industrial Packing Pvt. Ltd.

## xi) Fasteners

1. Nireka Engg. Co. (P) Ltd., Calcutta
2. Precision Taps & Dies, Bombay
3. AEP Company, Vithal Udyog Nagar
4. Fix Fit Fasteners, Calcutta
5. Precision Engg. Industries, Baroda
6. Echjay Forgings Pvt. Ltd., Bombay
7. Capital Industries, Bombay
8. Boltmaster India Pvt Ltd, India
9. Deepak Fasteners Limited, India
10. Fasteners & Allied Products Pvt Ltd, India
11. Hardwin Fasteners Pvt Ltd, India
12. J.J. Industries, India
13. Multi Fasteners Pvt Ltd, India
14. Nexo Industries, India
15. Pacific Forging & Fasteners Pvt Ltd, India
16. Pioneer Nuts & Bolts Pvt Ltd, India
17. Precision Auto Engineers, India
18. President Engineering Works, India
19. Sandeep Engineering Works, India
20. Syndicate Engineering Industries, India

## xii) Welding Electrodes

For Mainline - Root: Lincoln, and Other passes: Lincoln.
For Piping- Root: Lincoln, Other passes: Lincoln, D&H or equivalent make.

## xiii) Fire Fighting

**equipment's**

### a) Fire

### Extinguishes

1. Avon Services (Production & Agencies) Pvt. Ltd., Bombay
2. Kooverji Devshi & Co., Bombay
3. Zenith Fire Services, Bombay
4. Safex Fire Services, Bombay
5. Reliable (Fire Protection) India Ltd., Bombay
6. Brij Basi Hi
7. Tech Udyog
8. Bharat Engg Works, India
9. Gunnebo India Ltd
10. Nitin Fire Protection Industries Ltd, India
11. Supremex equipment's , India
12. Vimal Fire Controls Pvt Ltd., India

### b) Fire Hydrants, Monitors, Deluge Valve, Nozzles

1. Zenith
2. Minimax
3. Newage
4. HD Fire
5. Vijay Fire
6. Asco Strumech Pvt Ltd, India
7. Brij Basi Hi
8. Tech Udyog
9. Gunnebo India Ltd
10. Nitin Fire Protection Pvt Ltd
11. Shah BhogiALL Jethamal & Brothers
12. Venus Pumps & Engineering Works

### c) RRL Hose

1. Jayshree
2. Newage

### d) Hoses

1. Ashit Sales Corporation, Bombay
2. Royal India Corporation, Bombay

3. Gayatri Industrial Corporation
4. Simplex Rubber Products Ltd., Ahmedabad
5. Zaverchand Marketing Pvt. Ltd., Baroda
6. Presidency Rubber Mill, Calcutta
7. The Cosmopolite, Calcutta
8. Simplex Rubber Products, Thane

### e) Hose Delivery

1. Chhatarya Rubber & Chemical Industries,
2. Nitin Fire Protection Industries Ltd, India

### f) Fire Hose Accessories

1. Asco Strumech Pvt Ltd
2. Brij Basi Hi-tech Udyog
3. Gunnebo India Ltd
4. Shah BhogiALL Jethamal & Brothers
5. Vimal Fire Controls Pvt Ltd., India

### g) Heat Shrinkable Sleeves

1. Covalence Raychem (Berry Plastics Corporation)
2. Canussa – CPS
3. CYJ Changtong New Material company

### h) Cold Applied Tapes

1. Denso GmBH
2. Polyken (Berry Plastics Corporation)

### i) PUR Coating

1. Powercrete (Berry Plastics Corporation)

### j) Casing End Closure

1. Raci, Italy
2. Raychem RPG Limited

### k) Casing Insulators

1. Raci, Italy
2. Raychem RPG Limited

### l) Rockshield

1. Raychem RPG Limited

### m) Warning Tape /Mesh

1. Sparco Multiplast Pvt. Ltd., Ahmedabad
2. M/s Raychem RPG Limited
3. Singhal Industries Private Limited

### n) High Build Epoxy Coating

1. Berry Plastics – Powercrete
2. Specialty Polymer Canada
3. Denso Protal, Canada

### o) Casing Insulators

1. Raci, Italy
2. Raychem RPG Limited
3. Veekay Vikram

## xiv) DRY GAS FILTER & FILTER SEPERATOR

1. Grand Prix Fab (Pvt.) Ltd.(New Delhi)
2. Perry Equipment, USA
3. Faudi Filter, Germany
4. Forain S.r.l., Italy
5. ABB, Faridabad
6. Burgess Manning, USA
7. Multitex Filtration Engineers India
8. Triveni Plenty Engg. Ltd. (New Delhi)
9. Siirtec International Contractor S.P.A (Italy)
10. Flashpoint, Pune india
11. Filteration Engineers (I) Pvt Ltd, India
12. Gujarat Otofilt, India
13. Tormene Gas Technology
14. Ultrafilter (India) Pvt Ltd, India
15. Ravi Techno Systems Pvt Ltd, India
16. Siirtec Nigi S.P.A
17. Filtan Filter Anlagenbau Gmbh
18. Fairley Arlon BV

19. PECO Facet
20. EPE Epenstenner GMBH
21. Filtrex srl
22. Petromar Engineered Soln
23. Plenty Filter
24. Eurofiltec
25. PTI Technologies Inc

**xv) FILTER ELEMENT**

1. Peco – Facet
2. Velcon
3. Pall – Filterite
4. Burgress Manning

**xvi) NDT Agency**

1. NDT Services, Ahmedabad
2. GEECY Industrial Services Pvt. Ltd., Mumbai
3. Corrosion Control Services, Mumbai
4. Perfect Metal Testing & Inspection Agency, Calcutta
5. Inter Ocean Shipping Co., New Delhi
6. RTD, Mumbai
7. Sievert, Mumbai
8. X-Tech, Vizag

#Note:– If NDT services not provided by above recommended agency, Thencontractor will engage the other NDT agency shall be accepted subjected to the valid applicable license (BARC) and Satisfactory performance.

**xvii) Long Radius Bends**

1. M/s BHEL, Trichy, Tamilnadu
2. M/s Jindal SAW Limited, (Koshi Works), U.P.
3. M/s PSL Limited, Gandhidham, Gujarat
4. M/s Welspun, Gujarat
5. M/s Fabricon, Belgium
6. M/s Sawan Engineers Pvt Ltd

7. M/s Gujarat Infra
8. M/s P K Tubes
9. M/s DEE Development
10. Pipefit Engineers Pvt. Ltd.
11. United Forge Industries
12. * Or as per attached Technical Criteria.

**xviii) PIG LAUNCHERS/ RECEIVERS/ PIG SIGNALERS**

1. Bassi Luigi Fittings B.V., Holland
2. BRAUN STAHL PIPE TEC, GERMANY
3. FORAIN, ITALY
4. Fluidel SRL, ITALY
5. RMA Maschinen- und, GERMANY
6. Siiritec Nigi, Itlay
7. SCHUCK ARMATUREN, GERMANY
8. T.D. Williamson Inc., USA
9. Tectubi SPA, Italy
10. Taylor Forge Engineering System INC, USA
11. Tormene Americana S.A. (Argentina)
12. Tormene Gas Technology S.p.A., Italy
13. PIPELINE ENGINEERING, UNITED KINGDOM
14. Krohne, Oil & Gas BV, Drive Houston,
15. Multitex Filtration Engrs. Ltd, New Delhi
16. BGR ENERGY SYSTEMS LIMITED New Delhi
17. Glapwell Contracting Services Ltd. UK
18. FULGOSI GIOVANNI S.n.c di Corrado & C, ITALY
19. VEEKAY VIKRAM & CO, GUJARAT
20. GBM S.R.L, ITALY

21. Multitex Filtration Engineers Ltd., India
22. Cardew Ltd., Alexeander
23. Forain S.R.L.
24. GD Engineering, India
25. Pipeline Engineering, UK
26. Bliss Anand Pvt Ltd
27. Control Plus Oil and Gas Solutions Pvt Ltd
28. Grand Prix Engineering Pvt Ltd
29. VEE Kay Vikram & Co. LLP
30. Oswal Infrastructure Pvt Ltd
31. * Or as per attached Technical Criteria.

**xix) HOT TAPPING VENDERS**

1. Furmanite International Ltd.
2. Huwelco Inc.
3. Unique Hydrographics
4. Conmate Energy
5. Propipe SL
6. Plant-Tech
7. TDW

**xx) INSULATING JOINTS**

1. IGP Engineers Pvt Ltd
2. Advance Electronic Systems
3. * Or as per attached Technical Criteria.

## 2. LIST OF MATERIALS OF RECOMMENDED BRAND AND/ OR MANUFACTURE

**B. (CIVIL & STRUCTURE)**

Unless otherwise specifically mentioned in the Schedule of Items, Contractor has to use materials as listed below, of only these brand names/Company's names, which are mentioned in the approved list for civil,water supply and sanitary items thereon.

**CIVIL**

| Sr. No. | Items/ Name of Products | Make/ Brands/ Manufactures |
|---|---|---|
| 1. | Reinforcement Steel | TATA,SAIL,RINL,IISCO,RATHI |
| 2. | Cement | Ambuja, ACC, JK, Grasim, Ultratech, Birla, L&T, Or Approved Equivalent Cement make |
| 3. | Structural Steel | TATA,SAIL,RINL,IISCO,ESSAR, ISPAT |
| 4. | Pre- engineered building (PEB) firms | Kirby Building system India ltd ,Interach Building Product limited, Tata blue scope steel ,Lloyd Insulation India ltd, Everest Industries. Ltd. Modern Prefab System Pvt Ltd,Aster Building Solution Pvt.Ltd, Octamec Engineering Ltd,Jindal Mectec Pvt Ltd,Fedders Lioyd Corporation Ltd. |
| 5. | Structural Steel Tubes ISI Marked | TATA, JINDAL , SURYA , SWASTIK |
| 6. | (a) Zincalume colour coated steel sheet(COIL)<br>(b) Profile of Sheet(as per tender specification) | (a)Tata Blue scope, Dongbu Steel ,Union Steel,JSW STEEL Ltd.<br><br>Kirby Building system India ltd ,Interach Building Product limited, Tata blue scope steel ,Lloyd Insulation India ltd, Everest Industries. Ltd. ModernPrefab System Pvt Ltd,Aster Building Solution Pvt.Ltd, Octamec Engineering Ltd,Jindal Mectec |
| 7. | Polycarbonate Sheet | Sabic Innovative Plastic , Everest |
| 8. | Mineral wool for thermal insulation of ceilings ( Under deck insulation) | Rock wool (india) Ltd. Minwool Rock Fibres Ltd., Lloyd Insulation, |
| 9. | Rolling shutters(ISI marked) | Swastic, Hercules, Shubdwar, M/s Bharat Rolling Shutters Industries Agra, Bengal RollingShutter Rama Rolling Shutter Works, Gandhi Entrance Automations Private |

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|---|---|---|
| 10. | Wind driven air Ventilators | Apurva Enterprises (Mumbai), SVS Wind Driven Turbo Ventilator(Ahmadnagar),Real Green Engineers Pvt.Ltd. Bangalore;Sun Green Ventilation system |
| | | Mumbai, Multi colour, Anchit Ispat PvtLtd. (Faridabad), |
| 11. | Synthetic Enamel Paint (1st quality only) | ICI Paint (Dulux), Asian Paint (Apcolite), Berger Paints (Luxol). Goodlass Nerolac Paints (Nerolac), Jenson & Nicholson Paints Ltd (Borolac), Shalimar, |
| 12. | G.I SHEET | ESSAR,JSW,,SAIL |
| 13. | Sheeting Screw | Corroshield, Buildex, |
| 14. | Chemical for Antitermite treatment | DE- NOCIL Bombay, Pest Control of India, Trishul |
| 15. | Factory made Panelled Door shutter | M/s Goel Brothers Raipur New Industrial Area Raipur (CG)<br>M/s Hindustan Housing factory Ltd- New Delhi M/s Delhi Construction Eqpt Sadar Bazar DelhiM/s Joinery manufacturing Co Calcutta<br>M/s Goyal Industries Faridabad<br>M/s Surbhi Metal (India) Ltd, Jodhpur |
| 16. | Flush doors IS-2191, 2202 | M/s Mysore Wood Products<br>M/s Laxmi Doors, Faizabad Road, Chinhat, Lucknow<br>M/s Merino flush doors<br>M/s Poineer Timber Products, Chandigarh, M/S Goyal Industries Faridabad |
| 17. | Fly proof doors (Made out of solid block marine grade) | M/S Laxmi Doors, Faizabad Road, Chinhat, Lucknow, Northern doors Kanpur |
| 18. | Natural Fibre Thermo Composite door/window shutter & frames, roofing sheets etc | Durosam |
| 19. | PVC Panel Door (Solid Core) | Rajshri Plastiwood Limited, Sintex, Hindopan, Marino |
| 20. | Pressed steel door frames/ cupboard and window frames (manufacturers) | M/s SAIL, M/s TATA |

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|---|---|---|
| 21. | Pressed steel door frames/ cupboard and window frames (fabricators) | M/s Loyal safe works Mayapuri, N/DelhiM/s Multiwyn Industrial Corpn Calcutta M/s Metal Window Corpn N/Delhi M/s Chhabra Steel Udyog, 260 Sadar Bazar, MeerutCantt M/s Delite safe works, Rani Jhansi Road, N/Delhi M/sIshwar Industries, 175/A Bombay Bazar, Meerut CanttM/s Chandni Industries, J-142, Patel Nagar 1st, Ghaziabad. |
| 22. | Steel Windows, Ventilators(as per IS- 1038 of 1983) & frames pressed steel door/window | M/S Multiwyn Industrial Corpn Calcutta M/S Metal Window Corp N/ Delhi Govind Enterprises, Delhi M/S Chhabra Steel Udyog 260, Sadar Bazar, Meerut Cantt, Agent steel MFG Pvt Ltd, Ahmedabad, Godrej, M/SChandni Industries, J-142, Patel |
| 23. | Al Section for Al Door/ Window/ Partitions | Hindalco, Indal, Ajit India, Jindal |
| 24. | AluminumI Door/ Window/ Glazing Fabricated and Anodized | M/s Ahlcon M/s Alumilite Pvt Ltd, M/s Ajit India Pvt Ltd, M/s RamnikALL S Raste Agra, Argent Industries, M/s Aluminium Tech Industries, I-2249 DSIDC Narela, Delhi, |
| 25. | Aluminium door and windows Fittings | M/s Elite Enterprises C/6 Shalimar Hardware 133, Jarg Mahal, Dhobitalao Mumbai 400002. M/s MohanMetal Industries 178/2-A, Bhole Nath Nagar, Shahadara, Delhi 110032. |
| 26. | Automatic Glass Door | Ditec (Gandhi) |
| 27. | Aluminium Grill | Alu Grill, Arihant Aluminium Corporation, Decogrille |
| 28. | Door Closer | Everite, Golden, Gandhi |
| 29. | Floor Spring | Prabhat,Everite |
| 30. | Builders Hardware | M/s Golden Industries Pvt. Ltd., Everite, Solo, Hardwyn |
| 31. | Plywood for general purpose (IS-303) | National Plywood Inds Pvt Ltd, S Fancy lane, 8th floor Calcutta-700001, |
| 32. | Pre laminated Particle board | Kitply, Bhutan board, Ecoboard, Novapan, Archidply, Merinova, Merino |
| 33. | Laminated Sheets | Formica, Merino Lam, Greenlam, National |
| 34. | Modular Partitions | Godrej, Blowplast |

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| 37. | Aluminium False Ceiling | Lloyds,Armstrong,Luxlon,Trac |
| 38. | Flooring Tiles ( Mosaic / Terrazzo / PCC ) (1st quality only) | M/S Mehtab Tiles, NITCO, Royal Tiles, Gem Tiles, Hindustan Tiles, M/S National Tiles & Industries,Ultra Tiles |
| 39. | Glazed Ceramic Tiles, Non-Skid (Floor/Wall), (1stquality only) | Kajaria, Somany, NITCO. Murudeshwar Ceramic Ltd ( Navin Diamond tile ), Johnson ( Marbonite ), Marbito, Somany, Orient, Asian |
| 40. | Vitrified/ Designer Vitrified Tiles (1st quality only) | Asian, Marbonite (Johnson), Kerrogres (Kajaria), NITCO, Orient |
| 41. | PVC Tiles/Flooring (IS 3461) (1st quality only) | Marblex Tiles, Krishna Tiles, Polyfin, Armstrong, Wonder floor. |
| 42. | False Flooring | Godrej or equivalent |
| 43. | Glass Mosaic Tiles (1st quality only) | Paladio, Coral, Accura, Bisazza, Italia, Mridul. |
| 44. | Designer Paver Tiles/ Interlocking tiles ISI marked/ Grass-jointed Tiles | Pavit, Ultra, Hindustan, Eurocon, Vyara, NationalTiles, Gem, Unistone, Konkrete, Unitile |
| 45. | Glass reinforced Paver block | Unistone or equivalent |
| 46. | Wall care Putty for Base preparation (1st quality only) | Birla Wall care putty, Berger, Jenson & Nicholson, JK White |
| 47. | White Cement (1st quality only) | Birla, JK |
| 48. | Cement based Paints (1st quality only) | Super Snowcem, Duracem, Super Acrocem. |
| 49. | Dry Distemper / Oil bound Distemper (1st quality only) | Goodlass Nerolac Paint, Shalimar Paint, Jenson & Nicholson, Asian Paint, Berger. ICI |
| 50. | Acrylic Washable Distemper (1st quality only) | Asian, Berger, ICI Dulux, Jenson & Nicholson, Nerolac,Shalimar,Garware& Goodlass |
| 51. | Plastic Emulsion Paint (1st quality only) | Asian, Berger, ICI, Nerolac, Jenson & Nicholson, Shalimar,Garware & Goodlass |
| 52. | Exterior Acrylic Emulsion (1st quality only) | ICI (Weathercoat), Excel (Nerolac), Apex (Asian), Berger, Jenson & Nicholson, Shalimar,Garware & Goodlass |
| 53. | Polymer based Paint | STP,CICO |
| 54. | Textured Paint / Wall Tile (1st quality only) | Unitile, Heritage, Spectrum, Iokos, Acropaints, Asian |

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|---|---|---|
| 55. | Flexible board for Expansion joint | STP or equivalent |
| 56. | Grout | Shrinkomp,Fosroc,Fairmate |
| 57. | Integral water proofing compound | STP, Pidilite, Fosroc, CICO, Sika. |
| 58. | Concrete Admixture | Pidilite, Fosroc, CICO, Sika. |
| 59. | Water proofing for cementitions surface IS-2645 | Acrocrete & Acrocote, CICO, Fosroc, STP |
| 60. | Bituminous Product | M/s Faridabad Spinning & Woolen Mills PvtLtd, 837, SP Mukherjee Marg Delhi, M/s STP Ltd (Formerly Shalimar Tar Products) M/s Bitufelt Pvt Ltd 123/377 Fazalm Ganj Kanpur 208012, Texas, Texas India Ltd, |
| 61. | Hardeners | Ironite, Ferrok, Hardonate |
| 62. | Construction Chemicals | Choksey, CICO, Forsroc, Sika |
| 63. | Non Metalic Surface Hardners | CICO, Fosroc, STP, Sika |
| 64. | Corrugated, Semi Corrugated & AC Sheets (IS-459-1970,IS-2098) | M/s Everest Bldg Products Ltd Jata Sankar Bosa Marg Muland (west) Bombay 400080, M/s Ramco AC Sheets “SWASTIK”, M/s Eternit Everest Ltd, UP Asbestos Ltd |
| 65. | GI Sheet ISI Marked | Multicolor, TATA, Bluescope, JSW, Colour Plus, Interarch, Lloyds, Jindal, |
| 66. | Sheet Glass /Structural Glazing | Hindustan Pilkington Glass Works, Saint Gobain, Modi |
| 67. | Multiell / Multiwall Polycarbonates Panel | M/s Coxwell Domes Engineering , Delhi, M/s Lexan , M/s Gallina India Pvt. Ltd. |
| 68. | Stainless Steel Cladding | Jindal |
| 69. | Punch Tape Concertina Coil | Global Technocrat, S.G.Engineers Delhi |

| | | |
|---|---|---|
| 70. | Punch Tape In Plastic Spool | Global Technocrat, S.G.Engineers Delhi |
| 71. | Stainless Steel Railing | Jindal |
| 72. | FRP/ HDPE Garbage Bins | Sintex, Swift, Nutech, Sheetal |
| 73. | Thermoplastic Road Marking Paint | Shalimark (STP) |
| 74. | Bollard | STP |
| 75. | Cateye | TATA, STP |
| | Readymade Speed Sanitary ware | STP Neycer Kermag (standard), Hindustan |
| 77. 79. | Fountain | Ripples, Green Evolutions, Agritech Services, Parryware Sanitary Ware (Ist quality), Parryware (superfine), Cera (Ist quality), Classica (Ist / |
| 78. | Multi-Vent | Multicolor |
| 80. | WC seat cover ISI Marked | Parryware, Neycer Kermag (standard), Hindustan Sanitary Ware (Ist quality), Cera (Ist quality), Classica (Ist / standard) |
| 81. | PVC Flushing Cistern IS: 774-1984 (ISI Certified) | Parryware, Hindustan Sanitary Wares, Cera. |
| 82. | Faucets & Taps, Stop Valves & Pillar Taps, Surgical basin mixer, Shower rose etc. | Gem, Parko, Parryware, HSW, Jaquar,Orient |
| 83. | Kitchen Stainless Steel Sink | Diamond, Nirali, Neel Kanth, Jayna |
| 84. | Looking Mirror | Saint Gobain, Modi Float, Triveni Float Glass, Crown, Atul,Ashai |
| 85. | Ready-made Bathroom Cabinets | Commander Gratings (I) Pvt Ltd, Gratolite Cabinet, A-4 Sector Viii Noida-202701, Alpina, Cera. |
| 86. | Float Valve | Leader, Bombay Metal & Alloy Co, Bombay superflow. |
| 87. | SGSW Pipes (IS-651) ISI Marked | Perfect Agra, Devraj Ind Gaziabad, Buran, RK, Prince, |
| 88. | CI (Centrifugally Cast) Pipes for sewage disposalISI marked | NICCO, SRIF, A-1 Singhal Casting Co Agra, JindalSaw, Kesoram, NECO |
| 89. | PVC rain water/sewage pipes (IS-4985) | Reliance, Finolex, Supreme, Kisan, Prince,Hindustan Plastic & machine corporation,Polypack industries (P) Ltd. |
| 90. | HDPE Water storage Tanks (Rotational Moulded) | Sintex, Swift, Nutech, Sheetal |

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| 91. | Cast Iron Pipes and Fittings | Hindustan Engineering Products Company Calcutta, S..L.C., Standard approved manufacturers ofany other brand of fittings |
| 92. | RCC Pipes | Indian Hume Pipe Company, Delhi / Allahabad / Chandigarh / Lucknow; Hindustan PressurePipes, Kolhapur; Dhere Concrete Products, Pune or any other approved manufacturer conforming B.I.S. |
| 93. | Brass Fittings | Leader Engineering Works, Jalandhar; L & K Mathura; Luster Sanitary, Jalandhar; Annapurna Metal Works, Calcutta; Neta Metal Works, Jalandhar; Honey Industrial |
| 94. | C.P. Fittings | Ego Metal Works, Ballabhgarh; Jaquar Industries, Delhi; Soma Plumbing Fixtures Limited, Calcutta; Gem Sanitary Appliances Pvt. Ltd.,Delhi; EsscoSanitations, Delhi; Bilmet, |
| 95. | Stone Ware (Salt-Glazed) Pipes | Hind Ceramics Limited, Orissa; Ceramic Industries Limited, Sambalpur; Shrikamakshi Agencies, Madras; Binary Udyog Pvt. Limited, Howrah; Tirumati Moulds Limited, Nagpur; Kiran Potteries, Hyderabad;Perfect Sanitary |
| 96. | Asbestos Cement Pipes and Fittings | Ganga Asbestos Limited, U.P.; Hyderabad Asbestos Cement Products Limited; J.K. Super PipeIndustries, Nanded; Konark Cement and Asbestos Limited, Orissa; Maharashtra Asbestos Limited, Bombay; Poddar Industrial Corporation, Patna; |
| 97. | HDPE pipes and fittings | ORI-PLAST,HASTI |

## STRUCTURE

| Sl. No. | Items/Name of Products | Makes/Brands/Manufactures |
|---|---|---|
| 1 | Structural Steel | SAIL / TATA / RINL / IISCO / ESSAR / ISPAT |
| 2 | Structural Steel Tubes ISI Marked | TATA / JINDAL / SURYA / SWASTIK |
| 3 | Synthetic Enamel Paint Ist Quality only | ICI Paint (Deluxe), Asian Paint (Apcolite), Shalimar Paint (Superlac), Goodlass,Nerolac Paint(Nerolac), Berger Paints |

Any materials not fully specified in these specification and which may be offered for use in the works shall be subject to approval of Engineer, without which it shall not be used anywhere in the construction works.

## 3. LIST OF RECOMMENDED SUPPLIERS OF MAJOR BOUGHT-OUT ITEMS

### C. (ELECTRICAL)

#### i) Air Conditioner

1. O General
2. Daikin
3. Hitachi

#### ii) Batteries (Lead Acid)

1. Amco Batteries Ltd.
2. Exide Industries Ltd.
3. HBLNIFE Power System Ltd.
4. Amara Raja Batteries Ltd.

#### iii) Batteries (Nickel Cadmium)

1. Amco Batteries Ltd.
2. HBLNIFE Power Systems Ltd.

#### iv) Batteries Charger/DC-DC Converter

1. Amara Raja Power System (P) Ltd.
2. BCH.
3. Chhabi Electricals Pvt. Ltd.
4. Caldyne Automatics Limited
5. Dubas
6. HBL Nife Power Systems Ltd.
7. Universal Industries Products

8. Universal Instrument Mfg Co Pvt Ltd

**v)** **Cable – Fire Alarm & Communication Cables**

1. Cords Cable Industries Ltd.
2. CMI
3. Delton cables Ltd.
4. ELKAY Telelinks
5. KEI Industries Ltd.
6. Reliance Engineers Ltd.

**vi)** **Cable – HT (XLPE)**

1. Universal Cable Ltd.
2. KEI Industries Ltd.
3. Industrial Cables
4. NICCO Corporation Ltd.
5. Uniflex
6. Polycab.
7. Torrent cables Ltd.

**vii)** **Cable – LT Power and Control**

1. Cords Cable Industries Ltd.
2. Universal Cable Ltd.
3. KEI Industries Ltd.
4. Havells.
5. Delton
6. Elkay Telelinks
7. Evershine Electricals
8. Ecko
9. Ravin
10. Rallison.
11. Suyog
12. Netco
13. Uniflex

14. Paramount
15. Gloster
16. Associated cables Pvt Ltd.
17. CMI
18. Gemscab
19. Industrial cables
20. NICCO
21. Polycab
22. Torrent

**viii)** **Cable – Gland**

1. .Baliga
2. .Comet
3. Flexpro
4. Flameproof
5. FCG
6. Electro Werke
7. Dowels
8. CCI

**ix)** **Cable – Lugs**

1. Dowels
2. Jainson
3. Ismal

**x)** **Cable – Tray**

1. Ercon Composites
2. Yamuna Power & Infrastructure Ltd.

**xi)** **Cable Termination and Jointing Kit**

1. CCI
2. Raychem
3. M-Seal

**xii)** **Ceiling/Exhaust/Pedestal Fans & Circulators**

1. Bajaj Electricals Ltd.
2. Crompton Greaves Ltd.
3. Khaitan Electricals Ltd.
4. Havell's

**xiii)** **Contractors – AC Power**

1. Andrew Yule
2. ABB
3. BHEL
4. C&S
5. Havell's
6. L&T
7. Schneider
8. Siemens Ltd.
9. Telemechanique

**xiv)** **Control Transformer**

1. AE
2. Indushree
3. Intra Vidyut
4. Kalpa Electricals
5. Transpower Industries Ltd.
6. Siemens

**xv)** **DG Set**

1. Sterling and Wilson.
2. GD ankalesaria.
3. Deev Genset.
4. Jackson
5. Sudheer Gensets.
6. Power Engineering(India) Pvt Ltd.

**xvi)** **Earthing Materials**

1. Rukmani Electrical & Components Pvt Ltd.
2. Indiana Grating Pvt Ltd.
3. Jef Techno Solutions Pvt Ltd

Flame proof LDB's/ JB,s/Control Station/ switches

7. FCG
8. Sudhir
9. Prompt Engineering Works
10. Flame Proof equipment's pvt. Ltd.
11. Baliga Lighting equipment's Pvt. Ltd.
12. Flexpro Electricals Pvt. Ltd.

#Note:- If material is not supplied by above recommended manufacture list, Then material of other make shall be accepted on MTC basis.

**xvii)** **High Mast**

1. Bajaj Electricals Limited
2. Crompton Greaves Limited.
3. Philips India Limited
4. Surya Roshani

**xviii)** **High Voltage PCC/ MCC panels**

1. BHEL
2. Control and Switchgear

3. Siemens
4. Tricolite Electrical Industries
5. Schneider
6. CGL
7. L&T

**xix) Indicating Lamps**

1. Alstom Ltd.
2. BCH
3. L&T Ltd.
4. Siemens Ltd.
5. Vaishno Electricals

**xx) Indicating Meters**

1. ABB
2. AMCO
3. AE
4. Alstom Ltd. (EE)
5. Conzerv/Schneider
6. Elecon Measurement Pvt. Ltd.
7. HPL Electric & Power Pvt. Ltd.
8. MECO Instruments Ltd.
9. Minilec
10. Rishabh Instruments Pvt. Ltd.
11. Trinity energy system
12. kaycee
13. Salzer

**xxi) Lighting Fixtures**

1. GE Lighting Pvt. Ltd.
2. Bajaj Electricals Ltd.
3. Crompton Greaves Ltd.

4. Philips India Ltd.

**xxii)** **Lighting Fixtures – Flameproof**

1. Bajaj Electricals Ltd.
2. Baliga Lighting Equipment Pvt. Ltd.
3. Crompton Greaves Ltd.
4. CEAG Flameproof Controlgear Pvt. Ltd.
5. Flexpro Electricals Pvt. Ltd.
6. Philips India Ltd.
7. Sudhir Switchgears Pvt. Ltd.
8. FCG.

**xxiii)** **Miniature Circuit Breakers (MCBs) and Lighting DB**

1. ABB
2. Hagger
3. Havell's India Ltd.
4. Indo Asian Fusegear Ltd.
5. Legrand
6. MDS Switchgear Ltd.
7. Schneider
8. Siemens Ltd.
9. HPL

**xxiv)** **Moulded Case Circuit Breaker (MCCBs)**

1. ABB
2. Andrew yule
3. Larsen & Toubro
4. Schneider
5. Siemens
6. Control and Switchgear

**xxv)** **Protection Relays – Thermal**

1. BCH
2. L&T Ltd.
3. Siemens Ltd.
4. Telemenchanique & Controls (India) Ltd.

**xxvi)** **Low Voltage Power Control Center (PCC)/ MCC/ PDB/ MLDB/ LDB**

1. ABB
2. BCH
3. C & S
4. Elecmech Switchgear & Instrumentation
5. KMG ATOZ
6. L&T
7. Pyrotech Electronics Pvt. Ltd.
8. Risha control Engineers Pvt. Ltd.
9. Siemens
10. Tricolite Electrical Industries
11. Unilec Engineers ltd.
12. Vidyut Control India Pvt. Ltd.
13. Control and Schematic
14. Zenith Engineering

**xxvii)** **Push Buttons**

1. BCH
2. Alstom Ltd.
3. L&T
4. Siemens Ltd.
5. Telemenchanique & Controls (India) Ltd.
6. Vaishno Electricals

**xxviii)** **Switches - Control**

1. BCH
2. Easum Reyrolle Relays & Devices Ltd.

3. Alstom
4. Kaycee Industries Ltd.
5. L&T
6. Siemens Ltd.

**xxix)** **Switches – 5/15A Piano/ Plate, Switch Socket**

1. Anchor Electronics & Electricals Pvt. Ltd.
2. Kingal Electricals Pvt. Ltd.
3. North-West Switchgear Ltd.

**xxx)** **Switch Socket Outlets (Industrial)**

1. Alstom Ltd.
2. Best & Cromption Engineering Ltd.
3. BCH
4. Crompton Greaves Ltd.
5. Essen Engineering Company Pvt. Ltd.

**xxxi)** **Solar Modules**

1. Tata BP Solar (I) Ltd.
2. REIL, Jaipur.
3. CEIL, Sahibabad.
4. HBL Power

**xxxii)** **Solar Street Lighting**

1. Tata BP Solar (I) Ltd.
2. REIL, Jaipur.
3. CEIL, Sahibabad.
4. HBL.

**xxxiii) <u>Terminals Blocks</u>**

1. Connectwell
2. Controls & Switchgear Co. Ltd.
3. Elmex Controls Pvt. Ltd.
4. Essen Engineering Co. Pvt. Ltd.

**xxxiv) <u>Tranformers</u>**

1. ABB
2. Andrew Yule
3. Areva
4. BHEL
5. Bharat Bijlee
6. Crompton Greaves
7. EMCO Ltd.
8. Intra Vidyut
9. Indushree
10. Indcoil
11. Kirloskar
12. Skippers Electricals
13. Transformers & Rectifiers (I) Ltd.
14. Voltamp

**xxxv) <u>UPS System and Inverter</u>**

1. DB Power
2. Aplab

3. Keltron
4. Hi-Rel
5. Dubas
6. Toshiba Corporation
7. Fuzi Electric Co Ltd

**xxxvi) GI-Octogonal Pole**

1. Bajaj
2. Transrail
3. Wipro

**xxxvii) List Of Recommended Manufacturers for Heater**

1. Escorts Limited, Faridabad, Haryana
2. Spherehot / Kanti ALL Chuni ALL & Sons Appliances Pvt Ltd.Surat
3. Kerone, Bhayander(E), Thane - 401105
4. Excel Heaters, Andheri (West), Mumbai - 400 053, India
5. Nirmal Industrial Controls Pvt. Ltd. , Mulund(W), Mumbai - 400 080

**NOTE: -** Item/Vendor, which are not listed above, shall be subject to prior approval from Client/Consultant.

## 4. LIST OF MATERIALS OF RECOMMENDED BRAND AND/ OR MANUFACTURE

### D. (INSTRUMENTATION)

### I. OFC JOINT CLOSURE

Manufacture/Procurement, Testing and supply of suitable OFC Joint closures including all necessary accessories of any of the following make:

1. Raychem
2. 3M
3. Siemens
4. Any other make from the approved vendor list of client with supporting

paper

**II. PRESSURE GAUGES**

1. AN Instruments Pvt Ltd
2. Badotherm Process Instruments
3. Baumer Bourdon Haenni S.A.S
4. British Rototherm Co Ltd
5. Budenberg Gauge Co Ltd
6. Dresser Inc
7. Forbes Marshall (Hyd) Pvt Ltd
8. General Instrument Consortium
9. H. Guru Instruments (South India) Pvt Ltd
10. Manometer (India) Pvt Ltd
11. Nagano Keiki Seisakusho Ltd
12. Hirlekar Precision, India
13. Waaree Instruments Ltd
14. Walchandnagar Industries Ltd (Tiwac Divn)
15. Wika Alexander Wiegand & Co GmbH
16. Wika Instruments India Pvt Ltd
17. Ashcroft India Pvt Ltd.

**III. TEMPERATURE GAUGES**

1. AN Instruments Pvt Ltd.
2. Badotherm Process Instruments B.V.
3. Bourdon Haenni S.A.
4. Dresser Inc.

5. General Instruments Consortium

6. H. Guru Instruments (South India) Pvt. Ltd

7. Nagano Keiki Seisakusho Ltd

6. Sbeletro Mechanicals

8. TRAC

**IV. FIELD INSTRUMENTS (P, DP, F, L, T)**

1. ABB Ltd
2. Honeywell
3. Fuji Electric Instruments Co Ltd
4. Yokogawa
5. Invensys India Pvt.Ltd

**V. <u>FLOW COMPUTERS</u>**

1. Emerson
2. Instromet International (Belgium)
3. FMC Measurement Solutions (UK)
4. RMG (Germany)
5. OMNI Flow Computers Inc.
6. Thermo Fisher, USA

**VI. <u>PRESSURE REGULATOR AND SLAM SHUT VALVE</u>**

1. Pietro Fiorentini S.P.A. (Italy)
2. Emerson
3. RMG-Regel Messtechnik (Germany
4. Mokveld Valves BV (Netherlands)
5. Schlumberger (USA)

6. Gorter Controls B V (Netherlands)
7. Instromet International NV
8. Nirmal Industrial Controls Pvt Ltd. (up to 6" size only)
9. ESME Valves Ltd
10. Kaye & Macdonald Inc.
11. Nuovo Pignone S.P.A (Italy) (GE Oil Co.)
12. Richards Industries (Formerly Treloar)
13. Samson AG Mess-und Regeltechnik
14. Tormene Gas Technology
15. Dresser Inc, USA (upto 8" size, 300# class only)

## VII. PRESSURE SAFETY VALVES

1. Keystone Valves (India) Pvt. Ltd.
2. Larson & Toubro Ltd.
3. Lesser GmbH & Co KG
4. Mekaster Engg Ltd..
5. Tyco Sanmar Ltd. (New Delhi)
6. Anderson Greenwood Crosby
7. BHEL (Trichy)
8. Curtiss Wright Flow Control Corporation
9. Dresser Inc.
10. Fukui Seisakusho Co. Ltd
11. Nakakita Seisakusho Co Ltd
12. Nuovo Pignone S.P.A (Italy) (GE Oil co)
13. Parcol S.P.A
14. Safety Systems UK Ltd
15. Tai Milano S.P.A
16. Weir Valves & Controls France

17. Bliss Anand Pvt Ltd.

## VIII. FLOW CONTROL VALVES

1. Fouress Engg. (New Delhi)
2. Fisher Xomox (New Delhi)
3. MIL Control Ltd. (Noida)
4. KOSO India Pvt ltd
5. Samson Control (Thane)
6. Dresser Valves India Pvt Ltd.
7. Fisher Controls
8. Valvitalia Italy
9. CCI Valve technology
10. Flowserve Pvt Ltd.
11. Metso Singapore Pvt Ltd.
12. Instrumentation Ltd Palghat
13. Dresser Inc. USA

## IX. CONTROL PANEL & ACCESSORIES

1. Keltron Controls Ltd., Kerala
2. Elechmec Corporation Ltd., Mumbai
3. Industrial Controls & Appliances Pvt. Ltd.,
4. Alstom System Ltd., Noida
5. Emerson Process Management (I) Pvt. Ltd.
6. ABB Instruments Ltd., New Delhi
7. Larsen & Toubro Ltd.
8. Control & Automation, New Delhi
9. GE Fanuc Systems Pvt. Ltd., New Delhi

10. Rockwell Automation (I) Ltd., Ghaziabad
11. Honeywell Automation Ltd.
12. Rittal
13. Pyrotech Elcronics Pvt Ltd.
14. Positronics Pvt Ltd.
15. Electronics Corporation of India Ltd.

## X. JUNCTION BOXES AND CABLES GLANDS

1. Ex-Protecta
2. Flameproof Control Gears
3. Baliga
4. Flexpro Electricals

## XI. CONTROL AND SIGNAL CABLES

1. Associated Cables
2. Brook
3. Associated Flexibles & Wires (Pvt) Ltd
4. Universal Cables Ltd,India
5. Delton Cables Ltd, India
6. KEI Industries Ltd INDIA
7. CMI Limited
8. Cords Cable Industries Ltd, India
9. Elkay Telelinks (P) Ltd., India

10. Udey Pyrocables Pvt Ltd, India
11. Goyolene Fibres (I) Pvt Ltd, India
12. Netco Cable Industries Pvt Ltd, India
13. Nicco Corporation Ltd, India
14. Paramount Communications Ltd, India
15. Polycab Wires Pvt Ltd, India
16. Radiant Cables Pvt Ltd, India
17. Reliance Engineers Ltd., India
18. Suyog Electricals Ltd, India
19. Thermo Cables Ltd

## XII. INDICATORS & CONTROLLERS

1. Yokogawa
2. Eurotherm Chessel
3. Honeywell
4. Emerson

## XIII. BARRIERS

1. MTL
2. STHAL
3. P&F
4. Phoenix

## XIV. GAS CHROMATOGRAPH

1. ABB
2. Emerson
3. Instromet International, NV

4. RMG Regal+Messtechnik GmbH
5. Yokogawa

**XV. I/P CONVERTERS**

1. ABB
2. Emerson
3. IMI Watson Smith Ltd.
4. Moore Controls Ltd
5. Shreyas Instruments Pvt Ltd, India
6. Thermo Brandt Instruments

**XVI. SS FITTINGS, INSTRUMENT VALVES & MANIFOLDS**

1. Aura Inc.
2. Hoke
3. Excelsior Engg Works, India
4. Parker
5. Swagelok Co.
6. Swastic Engineering Works, India
7. Comfit & Valves Pvt.Ltd
8. Arya Crafts & Engg.Pvt. Ltd

**XVII. SS TUBES**

1. Sandvik
2. Hoke
3. Parker
4. Swagelok Co.
5. Heavy metal & tubes LTD
6. Nuclear Fuel Complex .India

7. Ratnamani Metal & Tube Ltd
8. Jindal Saw

**XVIII. GAS DETECTION SYSTEM**

1. Crowcon Detection Instruments Ltd
2. Detection Instruments (I) Pvt Ltd
3. Detector Electronics Corporation
4. Drager Safety AG & Co. KGAA
5. General Monitors Ireland Ltd
6. Mine Safety Appliances Company
7. MSA – Mines Safety Appliances (India) Ltd
8. Industrial Scientific Oldham France S.A.
9. Riken Keiki Co Ltd
10. Simrad Optronics Icare
11. Honeywell Analytics
12. Net Safety Monitoring Inc.
13. Simtronics SAS

## 5. LIST OF RECOMMENDED MANUFACTURERS

### E. (SHOP & FIELD PAINTING)

#### I. Indian Vendors

1. Asian Paints(I) Ltd.
2. Berger Paints Ltd.
3. Goodlass Nerlolac Paints Ltd.
4. Jenson And Nicholson Paint Ltd & chokuGu Jenson & Nicholson Ltd.
5. Shalimar Paints Ltd.

6. Sigma Coating, Mumabai
7. CDC Carboline Ltd.
8. Premier Products Ltd.
9. Coromandel Paints & Chemicals Ltd.
10. Anupam Enterprises
11. Grand Polycoats
12. Bombay Paints Ltd.
13. Vanaprabha Esters & Glycer, Mumbai
14. Sunil Paints and Varnishes Pvt. Ltd.
15. Courtaulds Coating & Sealants India (Pvt.) Ltd.
16. Mark-chem Incorporated, Mumbai (for phosphating chemicals only)
17. VCM Polyurethane Paint (for polyurethane Paint only)

**II. Foreign Vendors for Overseas Products**

1. Sigma Coating, Singapore
2. Ameron, USA
3. Kansai Paint, Japan
4. Hempel Paint, USA
5. Valspar Corporation, USA
6. Courtaulds Coating, UK.

## 6. RECOMMENDED MANUFACTURE LIST FOR TELECOM BOUGHT OUT ITEMS

**Fiber Optic Cable and Accessories**

**Vendor Details**

1. Aksh Optifibre Limited
2. Vindhya Telelink Limited

3. Finolex Cables Ltd
4. RPG Cables Limited
5. Tamilnadu telecommunication Limited
6. UM Cables Limited
7. Himachal Futuristic Communications Limited
8. Birla Ericsson Optical Limited
9. Uniflex Cables Ltd
10. Sterlite Optical technologies Limited

**HDPE Duct (For OFC) and Accessories**

Manufacture/Procurement, Testing and supply of suitable HDPE duct pipe including all necessary accessories of any of the following make:

1. Raychem
2. 3M
3. Siemens
4. Sangir
5. Duraline
6. Any other make from the approved vendor list of client with supporting paper.