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Standard Specification		Document No: IND-SS-Z-003	Page: 1 of 12
Equipment Erection		Supersedes: Rev 1	Revision: 2 Issue Date : 21-Mar-11
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TABLE OF CONTENTS

1.0 PURPOSE (INTRODUCTION)

The purpose of this specification is to define the Construction requirements of equipment erection.

2.0 SCOPE

2.1 This specification supplements the applicable code requirements / data sheets / drawings and specifications for fabrication, erection, inspection, testing, commissioning of equipments.

2.2 Engineering drawings/ specifications data sheets shall take precedence over this specification if there are any conflicting clauses.

3.0 ERECTION OF STATIC EQUIPMENTS

3.1 SCOPE OF WORK

3.1.1 The work under this specification covers transportation of vessels, exchangers, heaters, drums, condensers, tanks filters, etc., from Owners stores / storage point, erection on foundation, leveling, aligning and grouting including assembly and fixing of other internal / external fittings and completing the vessels, exchangers, filters, drums etc., in all respects for commissioning the plant all as per drawings, documents and specifications and as per instructions of the Owner/ Consultant.

The Contractor shall study related equipment layout, steel structural drawing, piping layout, foundation drawing, underground piping and equipment drawing before starting any installation work. Grouting of equipment and machineries shall be carried out by the Contractor.

3.1.2 Approximate total weights are given in the schedule of rates. Approximate empty weight, elevation at which the vessels, columns etc., are to be erected are given in the equipment list to the extent possible. Rigging procedures / installation schemes for all major lifts and all other equipment maximum crane capacity shall be submitted by the Contractor to the Owner/ Consultant for approval prior to installation of equipment. However, approval to rigging procedure proposed by the Contractor shall not relieve the Contractor from his responsibility.

3.1.3 For details of equipments refer relevant project equipment list.

3.2 ERECTION

3.2.1 Before taking up the equipment for erection, the Contractor shall check the orientation of the nozzles, centre lines, elevations, length and position of anchor bolts spacing and size of bolt pockets on foundation, the diameter of anchor bolting and diameter of bolt hole in the equipment base plate with respect to piping and other applicable drawings and also with physical measurement of the equipment wherever required, and discrepancies if any shall be brought to the notice of Owner/ Consultant. Providing enlarging of the holes on the brackets and / or skirts of the equipment during installation shall be carried out by the Contractor in accordance with the scope of works described in the contract. Prior to installation of equipment on foundations that top of concrete foundation shall be thoroughly cleaned with air, water and dried.

3.2.2 Normally all concrete pedestals shall have bolt holes pockets as required. However, where opening for introduction of grouting materials has not been provided, the Contractor may be required to drill holes before installation of equipment. Location and dimensions of foundations shall be checked with respect to general layout plans, civil floor layouts and other drawings well in advance before starting of actual erection work. The size, number and locations of foundation bolt pocket or holding down bolt holes shall be checked in advance by the Contractor and discrepancy if any, shall be brought to the notice of the Owner/ Consultant. Foreign matter if any, in the foundation bolt pocket, shall be completely removed by the Contractor. The rough foundation surface shall be chipped 5-6mm or more and the packers which need to lay in advance shall be leveled at the same level. Blue matching will be carried out wherever required at no extra cost by the Contractor.

3.2.3 When the Contractor intends to carry out installation work by using truck crane, chain block, or by any other lifting devices the following to be checked thoroughly before erection.

i. Rated load, working radius. Hoisting from height and safety factor of truck crane.
ii. Conditions of ground for safe planning work.
iii. Chain block used for installation shall withstand overloading and slant slinging to a certain degree.
iv. Strength of beams and girders on which chain block is hung.

When the equipment to be installed on the steel structure, necessary arrangements shall be made with frame builders so that beams, floors, railings, etc., are built in a removable way if so required or built after the installation of the equipment. It shall be recommended that the beams for swing stoppers of long equipment are installed to match setting holes of the equipment after installation and centering.

3.3 LEVELING, CENTERING AND ALIGNMENTS

3.3.1 The Contractor shall select and provide size and number of packets / shims and insert them on both sides of each foundation bolt and at such places where load is expected. More than three layers of packers shall not be used. For line adjustment, shims shall be used. Packers shall be black steel plate free from surface scales, unevenness, injurious burrs etc. Wherever possible flat packers shall be used. The leveling and centering should be done by using two taper packers which shall be ultimately fastened together by tack welding. Shims and packers shall be spaced to enable mortar filling in the bolt hole without trouble. All equipment shall be properly levelled and plumbed where manufacturer has provided levelling pads or marks the same shall be used as a guide.

3.3.2 Centering / alignment of al vertical equipment like towers, vessels, heat exchangers (vertical type) which are taller than 6M in height shall be done with the help of theodolite. Centers shall be measured at more than two points on the top and bottom with transits at two positions forming 90^0 approximately. The center line shall be 10mm wide and shall be marked by the equipment manufacturer.

Alignment / centering of small equipment shall be done with the help of bob weights.

Accuracy for centering shall be as under.

i. For towers containing trays - within $\pm$ 0.5mm per 1M.
ii. For vessels and heat exchangers - within $\pm$ 1mm per 1M.

However, in case of special / critical equipment's, manufacturers / owners recommendations should be followed.

Horizontal equipment like vessels, heat exchangers (horizontal type) etc., leveling shall be measured with water level on the datum point (punched) at both ends of the equipments. Where no datum points are available, leveling shall be measured by placing of 1/10 accuracy on the nozzle (largest diameter preferable) of the equipment. All horizontal vessels shall be checked for level across machined face of nozzle flange with precision level.

In case where nozzle is of small diameter of inclined and cannot be used for measuring the level by use of a level, the canter line of equipment shall be measured with theodolite.

Alignment / leveling of equipment with agitators shall be done with great care. Unless otherwise specified the accuracy shall be 5/100 to 10/100 on the rotary shaft.

It will be Contractors responsibility for marking arrangements for all measuring instruments to be used for centering and leveling purpose shall be as but not limited to transit, Y level, level gauge (accuracy 1/10 - 1/100) bob, scale etc.

The Contractor shall also carry out the assembly, erection, leveling and alignment of all types of trays, downcomers, and seal pans, wieplates, baffles, demisters, and other internal fittings. Work shall be carried out as per manufacturers standard / specification which shall be made available to the contractor at the time of erection.

Tolerances on assembly of internals like demisters, and other parts shall be specified by manufacturers / Owner.

All proprietary equipment shall be installed as per equipment layout and nozzle orientation and considering manufacturers manuals, installation instruction, catalogues / drawings and as per any specific directions of the Owner / Consultant. Some of the equipment and machineries may be supplied in dismantled condition.

The Contractor shall :

a) Check contents with packing list.
b) Check for any damage.
c) Check for any abnormality
d) Check for rusting or corrosion
e) Check for protectors, reinforcing material etc., which must be retained till end of erection.

Should there be any damage or discrepancy the Contractor shall immediately inform the Owner/ Consultant for taking necessary action.

Exchanger shall be set at level and square so that pipe connections can be made without strain. While setting on foundation bolts, bolts of one end shall be kept loose to allow free expansion of shell. Slotted holes are provided in supports to achieve this.

All items of equipment shall be properly oriented and the fabricated parts and connections should be installed as indicated on the drawings. Equipment to be installed on steel structural frame shall be leveled by use of shims, packers and wedges.

Equipment to be installed on concrete foundations shall be placed on the foundations together with the base plate and the bolts connecting the equipment to the base plate slackened.

The base plate shall be leveled on concrete foundations by putting wedges between the base plate and concrete foundations initially and subsequently replacing the wedges with concrete grout. All the wedges shall be removed after the concrete grout is set. Equipments shall be placed level on the base plate and bolts connecting the equipment and base plate tightened. If necessary inserting shims in between. Setting of anchor bolts shall be checked with the latest revision of manufacturers drawings / or other applicable drawings.

4.0 ERECTION OF ROTARY EQUIPMENT AND MACHINERIES

4.1 SCOPE OF WORK

The work under this specification covers transportation of machinery / equipment etc., from Owners stores / storage point to worksite, assembling of sub-assemblies / parts, erection on foundation, leveling, aligning and grouting, of equipment for trial runs, carrying out no load trial runs as per instructions of Owner/ Consultant and handover in fit condition for the start up of the plant.

Defects due to Contractors fault noticed during trail runs shall be rectified by him.

The work shall in all respect be carried out in accordance with good present day engineering practice and to the satisfaction of Owner/ Consultant. The Contractor shall study the respective specification given in this document for the work which he is required to carry out in this plant. The Contractor shall also study the related equipment layout, steel structure, piping layout foundation drawing, underground piping and equipment drawing before starting installation work.

4.2 ERECTION AND ALIGNMENT

4.2.1 Erection / alignment of all machineries shall be carried out by experienced fitters and technicians. Contractor shall employ experienced erection supervisors and crews who have done similar type of jobs.

4.2.2 Proper sequence for assembly erection / installation and trial runs shall be adhered to in accordance with drawings, catalogue and manufacturers instruction.

4.2.3 Couplings of machinery received with drive in assembled condition, shall be removed by the Contractor, if required and alignment shall be checked. Realignment if required shall be done before recoupling. In case where the drive unit and driven unit arrive separately, they are to be assembled at site, wherever necessary the Contractor shall mark and drill holes including tapping the box plate for fixing motors, fixing of coupling on shaft, if necessary file / scrap the keys and key ways for fixing coupling on shafts, dowelling including providing dowel pins for retaining the alignment of machineries. All operations mentioned in this para shall be carried out by the Contractor within the unit rates quoted by him. However, Owner shall provide the machining facility if required.

4.2.4 Cooling water flushing and other piping connections connected with equipment / machineries and its ancillaries shall be installed by the Contractor as per drawing, specification and instruction of Owner/ Consultant.

4.2.5 Items such as sight glasses, level gauges, etc., shall be installed by the Contractor as part of equipment erection work and no separate payment will be made for the same.

4.2.6 After initial alignment the equipment shall be properly grouted. Grouting shall be carried out as per the specification and insurrection of Owner/ Consultant. Shims shall be taken out and cavity formed shall be grouted wherever grout holes are provided in the base plates, grout shall be filled through them also.

4.2.7 To ensure that piping connections do not induce any undue stresses on the equipment, the alignment shall be checked by the Contractor again, after the piping has been connected. After making necessary corrections on the piping, if any, realignment shall be done by the Contractor and he will ensure that no undue stresses are induced in the equipment.

5.0 SPECIAL INSTRUCTIONS TO CONTRACTOR

Contractor in addition to general specifications for erection as outlined in 3.0 & 4.0 shall follow the following special instructions.

5.1 PUMPS, BLOWERS ETC.

5.1.1 Pumps may be supplied to the Contractor for erection either completely assembled, coupled to the drive and both mounted on a common based plate or in three individual parts as pump assembly, motor and base plate, or as pump assembly and motor mounted on separate base plate. The pumps shall be erected on foundation and leveled with shims and wedges with the help of precision levels and other instruments. The pump and the driver and reducing gear, if any, shall be then coupled and centering / alignment.

Initially centering shall be done and centering shall be made by placing a level of 1/10 accuracy on the pump base or nozzle.

Grouting of foundation bolts to be done after temporary centering.

5.1.2 First Centering

First centering shall be done after the anchor is fixed. Shaft center deflection and inclination shall be measured at four point on the top, bottom. Left and right side by way of turning, the coupling in single or both with dial gauge or clearance gauge etc.

After the first centering is over the space between the base and foundation shall be grouted.

5.1.3 Second Centering

Second centering / final alignment shall be done after all piping connections are done. The alignment and tolerance for alignment shall be maintained as specified in the manufacturers instruction manual. Shims and wedges where required will be arranged by Contractor.

The Contractor has to rectify, if any misalignment which might be observed after trial run of pump with water.

5.1.4 All auxiliaries like lube oil system, filters, cooling water systems, and other piping connections shall be supplied along with the pump in fabricated condition. If the piping are not received in fabricated condition then the Contractor shall have to fabricate the same form material issued by Owner and finally to be installed by the Contractor as per manufacturers instruction and instructions of Owner. The payment will be made as per piping schedule of rates.

5.2 EJECTORS

Ejectors shall be delivered in assembled or sub-assembled condition and shall be installed in accordance with manufacturers drawing, specification and instruction of Owner/ Consultant. The nozzles and diffusers shall be fixed on the associated piping as per arrangement drawings and shall be properly aligned.

5.3 COMPRESSORS

Compressors may be delivered to the Contractor in sub-assembled condition. The compressor and the whole equipment shall be grouted after obtaining approval from Owner. If the compressor is received in knock down condition, the Contractor has to assemble and fit various parts of the compressor as per instruction of Owner/ Consultant and manufacturers instruction.

The Contractor shall carry out the following as part of his work without any extra cost:

a) Placing the compressor on foundation after assembly with the motor.

b) Leveling the entire unit.

c) Rough alignment of motor.

d) Grouting after the leveling and alignments are checked by Manufacturers representative and Owner/ Consultant.

e) Rechecking of alignment after the grout is set.

f) If, necessary, Contractor has to open compressor cover and cleaning of Rotor, Impellers, Seals and Bearings to be carried out.

g) After cleaning and checking the compressor to be closed up.

h) Gear box to be cleaned and alignment of gear box to compressor to be carried out.

i) The manufacturer shall supply after coolers, pre-filters, after filters separately. The Contractor has to carry out erection, alignment and grouting of these equipment.

j) Piping connection such as water, steam, cooling water, other inlet and outlet connections, connections to coolers are made. Tolerance for alignment shall be maintained as specified in the manufacturers instruction manual. To ensure that piping connections do not induce any undue stresses on the equipment, the alignment shall be checked by the Contractor again after, the piping has been connected. Any

rectification / correction necessary for proper alignment shall be done by the Contractor.

k) All auxiliaries and other piping will be supplied with the compressor in prefabricated condition and shall be installed by the Contractor. If the piping are not supplied in fabricated condition, then the Contractor has to fabricate the piping as required.

l) After pipings are connected, the Contractor shall check the alignment finally after coupling the entire train i.e. motor, gear box and compressor. After this, trial run to be carried out and bearing temperature etc., to be noted and after this again alignment to be checked. If any defects are there, Contractor has to rectify the defects immediately.

The contractor shall study the layout drawings for compressors and other such machineries with their auxiliaries, controls, defining scope of supply and shall connect the gas steam and utility piping instruments and oil pipings as per manufacturers manual drawing specification and instruction of owner/ consultant and manufacturers representative.

5.4 PACKAGE UNITS

Units shall be supplied by the manufacturers as a package unit. The Contractor shall have to erect the unit on the foundation. In general all accessories connected with the unit will be installed by the manufacturer in the package unit. In case if the Contractor is required to carry out installation of any items as part of the package unit the same shall have to be carried out by the Contractor and will be paid on weight basis along with the units. The Contractor shall have to make all necessary facilities and fulfill the requirements for erection of the unit on the foundation.

5.5 AGITATORS/ CONVEYORS/ ELEVATORS

These items may be supplied in sub-assembled condition. However, if it is received in assembled condition, it has to be dismantled to the extent it is required and shall be erected at no extra cost. Erection of motor, gear box, etc., to be carried out separately. Contractor shall align Motor, Gear box etc., separately then couple with each other. This again final alignment to be carried out including assembly of structure, belts etc.

6.0 DELIVERY STORAGE AND CUSTODY OF EQUIPMENTS / MACHINERIES

The Contractor shall unpack, inspect, check the quantity extent of damage and rust if any of the equipment and accessories supplied to him at the time of taking delivery in presence of Owner/ Consultant.

The Owner shall not be liable for any claims or complaints whatsoever in respect of quality and quantity or condition of said materials once the Contractor has taken delivery thereof.

However, Owner shall keep the accessories which are not directly necessary for installation.

7.0 HANDLING, TRANSPORTING AND ERECTION

The Contractor shall be responsible for handling and transporting the items of equipment/ machineries from wherever stored at site, to the point of installation. The Contractor shall be responsible for organizing the lifting of the equipment / machineries in the proper sequence, so that orderly progress of the work is ensured and access routes for erecting the vessels, columns, heat exchangers, and other machineries etc., care should be taken not to damage nozzles, instruments, connections, structurals, clips etc.

Lifting tackles, slings and shackles before use at site must be tested by an approved agency, and a certificate to that effect shall be produced by the Contractor. These certificates shall be maintained at site. Lifting tackle shall be visually inspected before use and shall be sent for re-testing by the Contractor if any doubt is expressed by the Owner/ Consultant, about its

worthiness. Under no circumstances the Contractor shall use a defective or doubtful appliance.

The following shall be followed by the Contractor during transport, handling and lifting of the equipment / machinery.

i. Use suitable capacity crane / truck lifting tackle, lifting beam / hoist.

ii. Obtain prior permission of the Owner for using building or structure for slinging.

iii. Use wire rope as per IS 1835 or stronger for thimbles.

iv. Apply thimbles to lifting lugs taking into account center of gravity of the equipment. Never use other parts of the equipment except the lifting lugs.

v. When no lifting lugs are provided, take measures to be prevent slippage in consultation with the Owner/ Consultant. In case slip preventing device is not available, attach a wire to prevent slippage.

vi. Avoid swinging motion of the equipment while lifting.

vii. Use stay wire to prevent over turning.

8.0 GROUTING

For equipment installed on concrete foundations, the Contractor shall fill mortar / concrete under the base plate as soon as possible after final tightening foundation bolts. Mortar shall be used for smaller equipment and concrete shall be used for bigger equipment.

The surface of the concrete shall be thoroughly scraped, all waste material and dirt shall be removed, also all oil, grease, paint from the surfaces of the base plates (supports, lugs etc.) which are to be in contact with grout shall be cleaned.

The top surface of the foundation shall be chipped if necessary to maintain the required elevations of equipment as per drawings at no extra cost. The concrete foundation shall be thoroughly wetted and kept wet for 24 hours before grouting. Cement slurry shall be brushed into the concrete surface immediately before placing the grout.

8.1 GROUTING OF POCKETS

The grouting shall be done with cement water in proportion of one part of Portland cement plus one part of sand and one part of grit (maximum size 6mm). Adequate quantity of water shall be added. In case where anchor bolts with sleeves are provided it shall be the responsibility of the Contractor to keep them clean particularly threaded portion of bolts shall be greased to protect them from damage. Grout shall be gradually poured in the pockets without disturbing the holding down bolts, and shall be tamped with a steel rod for proper compactions. For initial grouting all foundation bolt holes shall be filled to a height of 75mm to 100mm below top. After initial set has taken place cure with water by filling the holes to the top for seven days. After 7 to 10 days of initial grouting all foundation bolts shall be pulled up tight and if necessary checked with Capstan gauge reading.

8.2 GROUTING UNDER BASE PLATES AND MACHINE BASES

Before final grouting of base plates and machine bases all water should be removed from pockets.

Grouting shall be done as per specification and instruction of Owner/ Consultant and manufacturers representative. The following mortar mixing ratio to be followed at the time of preparation of grout.

MIXING RATIO BY WEIGHT

01.	Mortar		Mix A	Mix B
	Cement	-	1	1
	Non Shrink grout	-	1	0
	Sand	-	1	1
	Gravel	-	0	0
	Water	-		(0.4 - 0.5)
02.	Concrete			
	Cement	-	1	1
	Non Shrink grout	-	1	0
	Sand	-	1	1
	Gravel	-	1.5	1.5
	Water	-		(0.4 - 0.5)

Note : Mix A - Mix with Non-Shrink Grout
Mix B - Mix without Non-Shrink Grout

To be adjusted at site for workability as per local conditions.
It shall be worked in and compacted so that the inside space under the base plate and around the anchor bolts is thoroughly filled with the dense grout. Care should be taken that no air bubbles are left inside the grout.

The grout shall be cured for a minimum of 7 days wetting the exposed areas.
The shim plates and pockets under the base should be left undisturbed while grouting is undertaken. Thickness of grout shall be as per the drawings but in no case the thickness of grout shall be less than 25mm.

Ordinary “SHRINKOMP” developed by the Research & Development Division of M/s. A.C.C. Ltd., or other equivalent Non-shrinking grout, approved by the Owner shall be used for grouting purpose in case of critical equipment like towers, compressors, turbines, centrifuges, D.G. sets and other such like items and ordinary grout shall be used for grouting purpose in case of non-critical equipment. All required precautions as per prevalent procedures not standard engineering practices will be followed while carrying out the grouting.

The grouting shall be done exactly as per manufacturers specification.

9.0 FINAL CHECKING AND FINISHING

Equipment such as thermowells, trays, demister pads, grills etc., shall be properly installed by the Contractor after proper installation of the equipment.

In case structural steel cleats are required to be welded and / or modified on the equipment, the same will be carried out by the Contractor at no extra cost to the Owner.

Minor access ladder and platforms when supplied by the vessel fabricator shall also be fixed by the Contractor. Packing materials which shall be supplied by the Owner shall be properly loaded in the equipment buy the Contractor wherever required.

Final alignment for machinery, shall be done after piping connections are made. Tolerances for alignment shall be as specified by the vendors / suppliers, specification and Owner.

Contractors should ensure that they do not induce any stress on the machinery. Care shall be taken to avoid undue strains or distortion of equipment caused by uneven bearing on foundations or equipment under operating condition, units such as pumps, fans, compressors, etc., shall be checked for proper alignment of driver.

All shafts shall be checked for freeness, alignment and freedom of rotation, cooling water, flushing exhaust air and other piping connections with the main equipment and auxiliaries shall be installed as per the drawings specifications and manufacturers instructions.

All accessories and fittings either shipped lose or removed from main equipment during erection shall be kept tagged separately and installed after completion of erection / installation of the main equipment. All flanged connections and openings shall be kept blank with plugs / covers to prevent entry of foreign matter and shall be removed while making connections to the respective piping or other associated components.

All the instruments like pressure gauges, temperature indicators etc., forming part of equipment supplied by a vendor shall be installed after the main equipment is installed as a part of the main equipment.

Safety valves with manifolds / distant piece, if any, shall be installed by the Contractor. Setting of safety valves will, however be carried out by the other agency. But the Contractor shall remove the safety valves for calibration as and when instructed by Owner and reinstall the same after calibration including to and fro transportation within plant premises at no extra cost to the Owner.
All equipment shall be thoroughly cleaned, oiled and greased and presented for inspection to the Owner before placing in for operation. A list of all oils and lubricants to be used as stipulated in the manufacturers instruction manuals shall be supplied to the contractor by the Owner.

While filling lubricants and oils, care shall be taken that they conform to manufacturers recommendations. The required quantities of oils and lubricants shall be supplied by the Owner.

10.0 TRIAL RUNS OF EQUIPMENT AND MACHINERY

10.1 Any construction defects shall be intimated to Owner before startup. Before trial runs all protection devices and guards shall be installed and equipment shall be checked for free movement by hand rotation. All foundation bolts and alignment shall be checked before starting the trial run.

10.2 Unless indicated to the contrary all the machinery will be subjected to trial runs for a period of 72 hours continuous. Contractor has to decouple and turn over to other agencies doing electrical work for testing and no load running of motors. After satisfactory completion of test the Contractor shall recouple the motors to the machinery and recheck the alignment. The trial shall start only after this is completed. In all, Contractor has to carry out coupling and decoupling twice. If it is required to do more than twice then Contractor shall be paid on manday rate basis.

10.3 During the trial run period the Contractor shall provide necessary skilled personnel round the clock as required. Any defect noticed during the run and after the trial run shall be made good by the Contractor at his own cost if that part of the work is done by the Contractor and if it is otherwise then the Contractor shall be paid extra. Skilled personnel and worker required for this purpose shall be supplied by the Contractor.

10.4 Where the initial running of items of equipment is carried out with gland packings wherever necessary the gland packing shall be replaced by mechanical seal. During the trial runs, reading of bearing temperature, cooling water inlet and outlet temperature, lube oil temperature, output pressure etc., shall be recorded by the Contractor.

11.0 OWNERS SCOPE OF SUPPLY

11.1 Owners scope of supply shall generally be as follows, however scope of supply prescribed in the enquiry document, special conditions of contract, specifications, schedule of item shall prevail.

11.2 Owner shall supply the equipment in assembled, package unit, or in condition received from the supplier.

11.3 Owner shall provide necessary foundations for the equipment.

11.4 Owner shall provide necessary foundations bolts and nuts for erection of equipment. However, please refer qualifications of this item under item 12.6 under Contractors scope of supply.

11.5 Owner/ Consultant shall provide drawings and necessary instructions required for installation of equipment machinery. Besides above information, instruction manual and other literature wherever furnished by manufacturer will be made available only for consultation of the Contractor. The Contractor shall on completion of job return all the documents and drawings supplied to him.

11.6 Owner/ Consultant shall provide assistance from manufacturers representative wherever applicable.

11.7 Owner shall supply ordinary Portland cement for grouting, if available on special request from Contractor cost recoverable basis. Wherever cement is supplied to the contractor, the Owner / Consultant shall deduct the value of cement thus taken form the Owner from Contractors bills, at the prevalent rate.

11.8 Oil charges required for pump sumps, compressor crank, cases, bearing housings, gear boxes, cylinder lubricators, flushing oil shall be provided by the Owner. However, please refer qualifications of clause 12.4 under Contractors scope of supply.

11.9 Owner shall provide free of cost at their direction and for duration of contract reasonable open space common for equipment, piping, structural and other works given in this tender document.

12.0 CONTRACTORS SCOPE OF SUPPLY

12.1 Contractors scope of supply shall generally be as follows, however scope of supply prescribed in the enquiry document, special conditions of contract, specifications, schedule of item shall prevail.

12.2 Contractor shall arrange necessary skilled and unskilled labour, supervising staff, engineers, stores personnel. The Contractor shall increase the strength of any of the above category of personnel as advised by Owner / Consultant.

12.3 The Contractor shall make his own arrangement of necessary erection and handling equipment tools and tackles such as but not limited to cranes, winches, slings, shackles, test equipment, pressure gauges, dial gauges and other measuring tools welding sets, electric tools, oxyacetylene gas torches, electrical cables, drilling tapping machines, hydraulic test pumps, scaffolding materials etc., required for expeditious completion of work.

12.4 In cases wherein oil required for pump sumps, compressor crank cases, bearing housings, gear boxes etc. are not available the contractor shall procure the same as per instructions and specifications of owner/ consultants. Non availability of lubricating/ cooling oil shall not be considered as a reason for delay in job completion. .

12.5 The Contractor shall arrange all consumable required for the purpose of erection. This will include but not limited to straight and tapper packers, SS, CS, and brass shims (SS & CS) wedges, cement, sand, gravel, drill bits, tapping sets, hacksaw blades, fixes, scrappers, chisels, cotton waste, rags kerosene oil, grease, anti rust compound, wooden blocks, emery paper, grinding wheels, bolts & nuts required for supporting structures for equipment, platforms, walkways, ladders, etc.

12.6 All foundation bolts and H.D. bolts shall be supplied by the Owner free of cost. The Special Conditions of Contract, Schedule of items will however supersede this clause if the two are in variance.

13.0 SYSTEM TEST / START-UP (PRE-COMMISSIONING)

During the phase of work the Contractor shall provide as part of his work any necessary skilled personnel as required by Owner. Any defects noticed in the equipment shall be made good by the Contractor at his cost, if such defects are attributable to the Contractor.

ANNEXURE 8.1

Consultant field HSE specification (IND-SS-Z-007)

JACOBS

Standard Specification	Document No: **IND-Z-SS-007**	Page:1 of 66
Standard Specification for Field HSE Activities	Revision & Effective Date: Rev. 07, 30-08-18	
Issuing Department: Safety / Process Owner: Jeewan Mahadik	Previous Revision & Effective Date: Rev. 06 , 09-05-14	

TABLE OF CONTENTS

1.0 PURPOSE

The purpose of the Field HSE specification is to provide minimum acceptable HSE standards which are to be followed during field execution.

2.0 SCOPE

The Field HSE specification shall be applicable to Jacobs contractor across all Indian project sites & office locations. For construction supervision contract, applicability of this specification shall be decided by owner.

3.0 DEFINITIONS

3.1	"OWNER"	:	Means authorized representatives / nominees and / or Its successor, or permitted assigns.
3.2	"CONSULTANT"	:	JACOBS ENGINEERING INDIA PRIVATE LIMITED
3.3	"CONTRACTOR"	:	Person, Firm or Corporation to whom the work will be awarded by the Owner but are working under the Jacobs HSE program (core elements) that is being managed by Jacobs AND Jacobs direct sub-contractors including those on a Jacobs contract (on our paper) with a defined scope of work.
3.4	"ENGINEER'	:	Authorized engineer of the Owner / Consultant in charge of the job.

4.0 METHOD (HSE REQUIREMENTS)

4.1 SAFETY PHILOSOPHY

The Site Safety Plan and HSE Procedures set forth in this manual are the minimum acceptable standards for the project execution. The contractors are required to implement these standards and any additional requirements as per Local Laws and statutory requirements and best practices in industry whichever are higher. Owner and consultant may issue further changing requirements from time to time as the work progresses to fit changing site conditions, which will be binding on the contractor.

The owner is fully committed for providing safe and healthy working conditions for all employees working on the project and our goal is zero accidents in our operation. Safety is an overriding value that the operation shall be conducted in such a manner that reasonably practicable measures are taken to protect people not only in our employment but also others who may be affected by our activities.

We believe that accidents are caused and eliminating the causes of accident can prevent them.

Safety is the responsibility of every employee but line management is ultimately responsible for the implementation of safety requirements.

Everyone involved must be committed for achieving high standard of HSE Performance with proactive approach at all levels in the organization with excellent teamwork.

All activities shall be in compliance with relevant local laws, statutory requirements, codes and practices pertaining to health & safety of employees.

All personnel should share a sense of empowerment on safety matters with an effective communication system to facilitate the flow of HSE information both up and down through the organization.

4.2 OBJECTIVES AND TARGETS

4.2.1 Objectives

Everyone working onthe Project shall be committed to a policy of ensuring that the highest standards of Health, Safety and Welfare, which are reasonably practicable, are adopted. To this end, the following objectives have been set for the Project:

- Successfully implement the Safety Policy.
- Unsafe acts and conditions must be identified and corrected, with action aimed to prevent recurrences.
- Achieve Safe and Healthy Workplace.
- The Safety & Health of all employees must receive prime consideration throughout all phases of work.
- Ensure compliance with all applicable laws, statutory requirements, codes of practices and standards set forth by Owner.
- In essence 'NO SAFETY NO WORK'.

4.2.2 Targets

The following Safety targets apply to the Project:

- Lost Time Injuries - Zero
- Reportable Injuries - Zero
- Occupational Illness - Zero
- Environmental Incidents - Zero

4.3 CRITICAL RISK MANAGEMENT

Ensure minimum requirements for planning, implementing, monitoring and assessing Critical Risk Activities are followed and integrated into work execution and support client requirements. Critical Risk Activities are identified below, with support information found in the Critical Risk Awareness Tools **Attachment – 7.5** and Life Saving Rules poster found in **Attachment – 7.6**. The Critical Risk Awareness tools focus attention on those risks that have potential to result in serious injury or death.

The following Universal Requirements must always be considered:

- Work must not be conducted without a pre-job risk assessment and safety discussion, appropriate to the level of risk.
- Personnel must be trained and competent for the work that they are assigned.
- Personal Protective Equipment (PPE) must be worn in accordance with the requirements identified by the risk assessment and work procedures.
- Suitable emergency response plans must be in place before work commences.
- If anyone has any questions or concerns about performing the work in a safe manner they should stop work and raise those concerns immediately

4.3.1 Work at Elevation

i. Work at elevation 6 feet or higher above the ground or working surface must not proceed unless properly managed so as to eliminate or mitigate the risk of falling, or dropped

objects. In addition, floor and roof openings must be properly managed to eliminate the risk of people falling through them.

ii. Contractor shall comply with the Contractor's 100% Fall Protection Policy. This policy states "anytime employees are exposed to an unprotected elevation of 6 feet or more, fall arrest or restraint shall be used." Working as stated above means while traveling, stationary, or at any time exposed to a fall from a surface not protected by approved handrails, guardrails or some other approved fall elimination device. This distance is measured from the walking working surface supporting the employee to the next lower surface onto which the employee may fall.

iii. In general industry settings, such as in completed buildings and in operating facilities, work near unprotected floors, platforms or leading edges 6 feet or more above the adjacent floor or ground requires fall arrest or restraint.

iv. All work that requires personnel to work in a fall arrest situation requires a risk assessment which shall include a rescue plan.

v. The contractor shall ensure that when providing personal fall arrest equipment that it has sufficient inertia reels, inertia blocks, shock absorbers and adjustable lanyards. Six foot fixed lanyards should be the last option when providing lanyards.

vi. All horizontal life lines shall be inspected by designated competent person prior to use. Horizontal lifelines require special attention during design and installation to: (1) limit the distance the worker can fall (a greater sag in the line can mean a farther fall); and (2) minimize the forces on the connectors at the anchorage (a greater sag in the line can mean lower forces on the anchorage connectors at either end).
   - Horizontal lifelines may, depending on their geometry and angle of sag, be subjected to greater loads than the impact load imposed by an attached component. When the angle of horizontal lifeline sag is less than 30 degrees, the impact force imparted to the lifeline by an attached lanyard is greatly amplified. For example, with a sag angle of 15 degrees, the force amplification is about 2:1 and at 5 degrees sag, it is about 6:1. Depending on the angle of sag, and the line's elasticity, the strength of the horizontal lifeline and the anchorages to which it is attached should be increased a number of times over that of the lanyard. Extreme care should be taken in considering a horizontal lifeline for multiple tie-offs. The reason for this is that in multiple tie-offs to a horizontal lifeline, if one employee falls, the movement of the falling employee and the horizontal lifeline during arrest of the fall may cause other employees to fall also.
   - The horizontal lifeline must have an unloaded sag no greater than one in 60. (E.g. one foot in a 60-foot span). The size of Stainless Steel Wire Rope grade 316 shall be used having min. 8 mm diameter. Life line should be designed and certified by TPI. As per general thumb rule, one can consider like, 8 mm wire rope for 1 person, 10 mm wire rope for 2 and 12 mm for three persons. Horizontal lifeline and anchorage strength should be increased for each additional employee to be tied off. For these and other reasons, the design of systems using horizontal lifelines must only be done by qualified persons. Testing of installed lifelines and anchors prior to use is recommended.

vii. Consultant prohibits the use of positioning devices as the sole means of fall protection when working above six feet. Positioning device means a body belt or body harness system rigged to allow a worker to be supported on an elevated vertical surface, such as a wall, and work with both hands free.

viii. The use of "passive" systems, such as safety nets, monitoring systems, or controlled access zones, as the sole means of fall protection when working above six feet, is prohibited. Consultant prohibits the use of safety nets as an independent means of fall protection.

ix. Whenever tools are used at elevation and there is a potential hazard of falling objects, the tool shall be tethered to prevent the fall.

x. Workers in mechanical lifts, including scissor lifts, boom trucks, suspended or supported personnel baskets, articulating lifts, and other similar devices must use fall arrest/restraint equipment at all times with lanyards/attachment devices as short as possible to minimize the hazard of being thrown out of the basket. Personal fall arrest systems, when stopping a fall, shall be rigged such that an employee can neither free fall more than 6 feet nor contact any lower level/equipment/material. Exiting and accessing an elevated platform is permissible only when it is determined to be the safest means of access to an elevated work area. This determination must be documented and have prior approval by the Site Manager or the Site HSE Manager. Handrails on lifts may only be used for fall arrest anchor points if approved by Engineer In charge and manufacturer. Such devices shall not be used as elevators to transport workers to different work locations.

xi. All portable ladders must be clearly marked with the ladder owner's name and inspected by a competent person at least quarterly. Ladders will be held at the base until secured at the top.

xii. The safest means of worker access for overhead work (e.g., rolling scaffolds, mechanical lifts, platform ladders, etc.) shall be considered as primary alternatives to the use of portable ladders. If ladders are used, then the top of all straight and extension ladders shall be tied to a substantial anchor point before use; a second worker must hold the ladder until the tie-off is secure. And, if a worker's feet are on or above the fifth rung of a stepladder, the top of the ladder must be tied to a substantial anchor or a second worker must hold the ladder throughout the task.

xiii. When ascending or descending a portable ladder, three-point contact is considered acceptable fall protection for fall exposures of less than 20 feet. When potential fall exposure exceeds 20 feet, personnel on ladders must be protected with a personal fall arrest system.

xiv. All scaffolding must be inspected and tagged by an Engineer In charge prior to initial use, before each work shift, and after any event that could affect its structural integrity. Suspended scaffolds must receive documented daily pre-use inspections. Untagged scaffolds must not be used.

xv. All scaffold platforms shall have self-closing swing gates for access unless it is not feasible. Contractor approval required and mitigation plan in place.

xvi. Scaffolds and floor openings: Fall protection shall be installed as soon as the opening is created. A scaffold platform or floor is incomplete leaving a floor opening, there shall be a cover secured over the hole capable of supporting twice the weight of employees and clearly marked with "hole" or "cover". During activities when the hole must be uncovered a guardrail must be installed around the hole or utilize personal fall arrest equipment must be used at all times by all workers on the platform. If the fall hazard inside the guardrail is within six feet of the scaffold access point, personnel shall be protected while transitioning from the scaffold ladder to an approved anchorage point at the platform level.

xvii. Whenever the scaffold is used as an anchorage point for fall arrest, the scaffold manufacturer's tie-off procedures for erection, dismantling, and use shall be followed.

xviii. Decking sections used for pour-in-place concrete floor construction shall be laid tightly and secured upon placement to prevent accidental movement. During initial placement, decking sections shall be placed in such a manner to ensure full support by structural members and each piece shall be individually secured. Pre-installation or shake-out of multiple sections of decking using temporary methods of attachment, such as tack welding, is not allowed. The use of controlled decking zones is not allowed.

xix. Flat and low sloped roof and leading edge work requires fall arrest or restraint protection to be provided when working within six feet of the edge. This distance may be increased based on risk assessment, project specific, client or regulatory requirements.

xx. It is recommended to make site level trial arrangement for ensuring the vertigo for those going to engage work at elevation. Details of arrangement to be mutually discussed and agreed at site level.

4.3.2 Lifting Operations

i. Lifting operations must be planned and performed by trained, authorized and Qualified Personnel using lifting equipment designed, certified and appropriate to the lift activity.

ii. The following are defined as "critical lifts" and require written approval from Contractor senior management. Crane lifts:
- over 50 tons,
- exceeding 85% of the crane's capacity, (75% for steel erection),
- involving more than one crane, where the load exceeds 50% capacity for either crane, or of a non-rigid object,
- Over active work areas,
- Lifting personnel

iii. Other activities that should be considered for classification by the Site Manager as a critical lift would include:
- Lifts made where the load or crane boom passes over or adjacent to active process facilities, pipelines, or within 20 feet of power lines.
- Lifts using more than 200 feet of boom.
- In confined or tight work areas.
- Lifts for highly valuable or hazardous material.

iv. Mobile crane operators must be qualified on each crane (model, type, and rating) that they are assigned to operate through a third party testing and qualification process recognized by Contractor. Contractor will furnish qualified lift supervisors that directly oversee the crane and associated rigging crews. All riggers and signal persons shall be qualified after completion of competency assessment followed by site HSE training. (Refer Attachment – 7.17 sample competency assessment questionnaire) Copies of their training and certification shall be maintained on the project site by the contractor and forwarded to the contractor upon request.
- **Note** - Consultant strictly prohibits Hydraulic Mobile Pick-n-Carry cranes without outrigger (HYDRA). Front mounted cabin pick and move cranes can be used with outriggers.
- Marching load shall not be permitted.
- For F15 Farana also SLI with Auto cut off should be provided.

v. A third-party certified Competent Person shall make a thorough annual inspection of all cranes and powered hoisting equipment. Cranes assembled on site shall receive an annual inspection prior to being put into service. Documentation of all crane inspections shall be provided to the Contractor and must be maintained on site by the contractor.

vi. Minimum two taglines are required on all crane lifts.

vii. At sustained or gusting wind speeds of 30 mph; elevated work on scaffolding, mechanical lifts and crane lifts must cease, unless Contractor site management has approved the work is protected from the wind. At 20 mph, all cranes must be de-rated for wind loads. The more stringent Client, manufacturer or Contractor requirements shall be followed.

viii. All outriggers on mobile cranes must be fully extended and fully deployed when the crane is used to lift or support a load. If, due to configuration or physical location, all outriggers cannot be fully deployed, calculations must be made from the "on-rubber" section of the load chart, unless the equipment manufacturer has provisions in the load charts for partial

deployment. On-rubber lifts and pick-and-carry operations require Contractor Site Manager's written approval.

ix. Anti-two-block devices that automatically disengage crane hoist/boom functions when the hook or block approaches the jib or boom tip are required on all cranes.

x. When crane assembly/disassembly (A/D) is required, it shall be done under the direction of a Qualified and Competent Assembly/Disassembly Supervisor. Site and ground bearing conditions must be adequate for A/D and for all lift operations.

xi. Consultant strictly prohibits multiple lift rigging (Christmas tree lifts).

4.3.3 Mobile Equipment

i. Mobile equipment must be selected, equipped, operated and maintained in a safe manner to protect personnel from harm. Never operate vehicles or mobile equipment while distracted or otherwise impaired.

ii. Develop and communicate site specific traffic management plan outlining traffic flow patterns, designated parking, material storage, off-loading zone, etc.

iii. Mobile equipment must receive daily pre-use inspections, which will be documented. Examples include forklifts, cranes, backhoes, personnel lifts/aerial lifts, etc.

iv. When forklifts are configured to raise and lower (by means of a winch or hook) and horizontally move a suspended load, then the lift requirements for cranes shall be used.

v. Contractors must maintain and submit records on site that all operators of mobile equipment such as forklifts, cranes, aerial/boom lifts, buses, etc., have been trained and/or certified on the proper operation of the equipment.

vi. Mobile work platforms shall not be driven onto or off transport vehicles by contractor. The contractor should make arrangements with vendor/supplier for loading and off-loading.

vii. All skid-steer style loaders shall be fitted with a manufacturer-approved safety glass front door, front cover of equivalent effectiveness, or other device designed to keep the operator's hands and arms inside the protective cage. Operators are also required to use a manufacturer-approved seat belt and/or shoulder harness.

viii. Golf Carts shall be equipped back-up alarms and require mandatory use of seat belts. Golf carts must be approved by Contractor before use.

ix. Utility Terrain Vehicles (UTVs), such as Rhino's, Mules, or Gators must be equipped with roll over protection, seat belts and leg/feet shields. Any such vehicles must be approved by the Contractor in writing before use.

x. All trailers, floats, and flatbeds that transport material shall be equipped with appropriate number and size of stanchions to eliminate unexpected movement of the load. All materials shall be secured during transport. Clearance should be maintained under loads on trailers to allow access rigging, forklifts, etc. All loaded trailers, regardless of ground conditions, shall have pads placed underneath trailer support legs to prevent legs from sinking into the ground.

xi. Establish a hierarchy of controls to minimize or eliminate the need to access the trailer.
- First level of control is to stay off the trailer through the use of a crane/lifting frame, forklift, or aerial lift.
- Second level of control is to establish engineered walkways/handrails on or adjacent to the trailer to access the bed.
- The third level of control is to utilize a fall arrest system.

- Ensure one set of trailer wheels are chocked and parking brake set prior to loading/unloading.

xii. For movement of mobile equipment and motor vehicles in congested areas, a designated and trained flag-person shall be in full view of the operator and shall direct the movement. In some cases, multiple flag-persons may be required. High-visibility vest shall be worn when directing traffic or flagging equipment.

xiii. The contractor shall obey delineated pedestrian walkways and motor vehicle roadways, with particular attention to those in close proximity to site entrances and gates, canteen facilities, and other areas where there is the potential for high concentrations of pedestrian traffic near moving vehicles.

4.3.4 Energy Isolation

i. Isolation separates you from dangerous energy, including but not limited to: electricity, pressure, hazardous materials, hot liquids, moving parts and stored energy. Potential sources of hazardous energy must be identified and isolated prior to starting work.

ii. Before working on any equipment or system which may have stored energy you must follow the site specific energy isolation plan or the Contractor must approve the contractor's energy isolation (Lockout/Tag out) procedures. Stored energy includes but not limited to: hydraulic, pneumatic, chemical, thermal, mechanical, electrical, or engine-driven, etc. This applies to equipment that may not be or is currently in service, and also to the procedures specific to your location.

iii. Lock-out/tag-out procedures shall be followed to minimize the potential exposure of workers to hazardous energy. Hazardous pipelines or vessels will be isolated by using a double block and bleed system or by blanking.

iv. Line breaks: Lockout and Tag out shall be utilized for all initial line and equipment openings (first-line break) and when there is any potential for the system to contain substances that may cause injury or illness, e.g., steam, hot stock, chemicals, high pressure. The last substance contained must be identified every time a line or equipment is to be opened. The task-specific work plan must specify the methods for isolation and means to verify that the system is not under pressure prior to opening the line or equipment.

- Before line breaking or equipment opening, the following must be completed:
- Proper isolation
- Know the former contents of the lines or equipment
- Wear appropriate PPE and take necessary precautions

4.3.5 Confined Space

i. A confined space, such as a tank, vessel, or pipe can contain explosive, toxic or oxygen deficient atmospheres or other hazards. Wherever possible, eliminate the need to work in confined spaces. If it is necessary to work in confined spaces, a permit is required and precautions must be taken to protect the safety of people who enter. A valid entry permit posted at the work site and all provisions of the permit must be met.

ii. Confined space entry work must follow a documented hazard assessment and safe work planning and rescue process, which must be submitted to the Contractor for review prior to entry.

iii. Ensure confined space entrant, attendant and supervisor are trained for their respective duties.

iv. Identify and isolate potential sources of hazardous energy that could be present in, or enter into, the confined space.

v. Test the confined space atmosphere prior to entry to determine if it safe for entry. Testing should be conducted by a Engineer In charge using calibrated equipment.

vi. Wherever possible, ventilate confined spaces.

vii. Establish continuous monitoring of the confined space as required.

viii. Entry in all permit required confined spaces shall have an executable rescue plan in place and the rescue team will be informed of the entry.

4.3.6 Electrical Work

i. Working around energized electrical equipment can be dangerous due to the potential for electric shock and arc flash. Work on energized or potentially energized equipment must only be performed by qualified and competent personnel.

ii. Contractors shall ensure that their employees are trained in safe work practices, and that they are qualified, and that they are provided and use equipment, tools, and PPE that are specified in Indian regulations.

iii. Every effort must be made to de-energize electrical equipment to be worked on and other electrical equipment in the area that may affect the work. If the equipment cannot be isolated or de-energized, written approval must be obtained from the Contractor's Site Manager and Operations Manager before work proceeds. Only "Qualified Electricians" may work on energized or potentially energized circuits.

iv. Earth Leak Circuit Breaker (ELCB) or Residual-Current Device (RCD) shall be used to protect all temporary electrical wiring and cord sets. The use of assured grounding (quarterly equipment inspections) in lieu of GFCIs is not an option.

v. A formal inspection plan conducted by a Competent Person shall be implemented for ELCBs and temporary power panels/boxes. The frequency shall be determined by Contractor but will be no less than monthly.

4.3.7 Excavations

i. Always obtain authorization before starting excavation activities, as you may encounter hazards such as electrical cables, confined spaces, collapse of walls or excavated material.

ii. When contractor is responsible for design of excavation, shoring, trenches, or barrier walls full design/approval documentation shall be provided to Contractor.

iii. The Engineer In charge shall be onsite while excavation activities are being performed.

iv. A rescue plan shall be established which can immediately be executed in case of cave in.

v. Identify and locate overhead and underground services and hazards including, pipelines, electric and telecom cables. Wherever necessary, remove or isolate them.

vi. Ensure suitable entry and exit routes are established.

vii. Ground movement shall be controlled to prevent collapse (e.g. shoring, sloping, benching).

4.3.8 Hazardous Materials

i. Hazardous Materials are any substances or compounds that may produce adverse effects on the health and safety of people if not properly managed. Management of hazardous materials includes storage, handling, use and disposal.

ii. Workers involved with hazardous waste operations, as defined by local regulations, shall have met, prior to any field work activity or exposure, the training requirements of the standard. Certification of individual worker training shall be provided to Contractor prior to commencing work.

iii. Contractors shall include planning for environmental compliance in the preparation of their Safe Action Plan (SPA). Issues to be considered include but are not limited to release reporting, air permits, water permits, asbestos/lead permits or notifications, hazardous waste generation and related disposal procedures, spill mitigation and clean-up methods, etc.

iv. Contractor shall have a written Hazard Communication Program and comply with the requirements of that program. A copy of the program along with chemical inventory for the particular job/project shall be forwarded to Contractor Site/Project Management prior to mobilization and a copy shall be in the possession of the contractor on the site.

v. Any potentially hazardous material or chemical brought onto the site shall be accompanied by a Material Safety Data Sheet (MSDS). Copies of SDSs shall be forwarded to the Site/Project Management before the product is brought onto the site. Some sites, do not permit the use of chemicals that are not on a pre-approved list.

vi. Small quantities of hazardous liquids, such as gasoline, diesel fuels, and solvents, brought onto the site shall be stored in a properly labeled safety container with a flame arrestor and self-closing lid.

vii. Site/Project Management shall be notified before any chemical or material is used that could create foul smelling, noxious, or toxic vapors or gasses. Safety Data Sheets for the substances shall be readily available.

viii. All accidents involving exposure to potentially hazardous materials and hazardous material releases must be immediately reported to the Contractor Site/Project Management. It is important to report all releases or exposures even though the incident may be considered minor or no adverse health effects or symptoms are apparent at the time.

ix. Develop and implement a program for monitoring exposure to hazardous materials and a health surveillance program where required, either by legislation or as part of a Health Hazard Assessment.

x. Contractor shall follow labeling requirements and is also responsible to ensure personnel are trained.

4.3.9 Motor Vehicle Operation

i. A Safe Plan of Action is required for all motor vehicle operations. The following are minimum requirements for Contractors:

ii. Only drive if you are appropriately licensed, competent and medically fit to operate the class of vehicle being used.

iii. High-visibility reflective safety apparel/vest must be worn by all personnel, who work on or near highways, roads, or parking lots. Vests are also required for other work that places personnel, such as flaggers, riggers, survey crews, etc., near mobile equipment.

iv. Evening or night work near an active roadway shall include reflective hard hat stickers and gloves.

v. Vehicles shall be equipped with a lighting package when working next to an active roadway.

vi. Also, it is recommended that high visibility reflective safety apparel/vests be worn by all workers in the construction environment. The project-specific HASAP shall clearly define this PPE requirement.

vii. The Contractor shall minimize the number of vehicles that enter the site. Contractor reserves the right to restrict the number of vehicles and drivers of vehicles on the site.

viii. The Contractor shall operate all motor vehicles in accordance with the established site-specific rules. Site-specific rules shall address at a minimum, the requirements for mandatory use of passenger restraints, driving within posted speed limits, the use of spotters or flaggers while backing, and a mandatory policy of no mobile phone use while driving.

ix. Motor vehicles and mobile equipment shall never be left running without an operator at the controls. Proper use of seatbelts by all occupants is mandatory.

x. Motor vehicle operators are prohibited from using a mobile phone or two-way radio. This applies to both hands-free and non-hands-free devices. The use of such a device by the motor vehicle operator is only allowed when the motor vehicle is stationary and in a safe location off the roadway.

4.4 CONTRACTOR'S MAIN RESPONSIBILITIES

- Contractor shall have a written statement of policy in respect of safety and health of workers, copy of which should be signed by an authorized signatory.

- The Contractor to firmly commit in maintaining the health and safety of its own employees, employees of its sub-contractor, and other personnel who may be affected by it activities, protecting the environment and preventing pollution because of its activities.

- Contractor shall prepare a comprehensive SAFETY ASSURANCE PLAN in the form of standard documents for implementation and monitoring of HSE requirements. This shall be submitted to CONSULTANT / Owner for approval and implementation.

- Contractor shall appoint safety personnel as given below for every work shift:
  - Safety Supervisor: Contractor shall depute one Safety Supervisor for every 50 workers.
  - Safety Engineer: In addition to above, one safety engineer for every 5 Safety Supervisor
  - Safety Manager: Minimum of one Safety Manager at all times required to be at site.

- Contractor shall ensure full coverage at every scattered work location. Contractor shall also ensure that safety personnel remain all the time during work at their designated locations and no other work is assigned to them which force them to leave the site frequently.

- When number of workers are 25 or less than based on criticality of activities, requirement of safety persons shall be decided by consultant's site construction manager.

- Safety personnel shall have following qualification and experience:

Description	Qualification	Institute	Industrial Experience in years
Safety Manager	Engineering Discipline + Diploma in Industrial Safety	Engineering & Diploma in Industrial Safety from a recognized and reputed university	10
Safety Engineer	Engineering Discipline or Bachelor's Degree in Science+ Diploma in Safety	Engineering or Bachelor of Science (B.Sc.) & Diploma in Industrial Safety from a recognized and reputed university	8
Safety Supervisor	Bachelor's Degree in any other discipline or Diploma engineer of any discipline or science graduate from a recognized university. + Diploma in Safety or NEBOSH IGC	Bachelor's Degree in any other discipline or Diploma or science graduate, Diploma in Industrial Safety from a recognized and reputed university	5

- Contractor shall arrange for initial Site orientation / induction of all Workmen / Supervising personnel and visitors on 'Safety practices' before commencing work at site. This shall include brief about project site, safety policy, site safety rules and site facilities.

- Contractor shall conduct toolbox talks daily for all workers about ongoing work activities and precautions to be taken.

- Contractor shall ensure participation of his site in-charge and safety officer in the safety meetings arranged at intervals decided by consultant / owner.

- Contractor shall submit Health & Safety report on monthly basis to consultants in the formats given with this document.

- The safety conditions specified and recommended here are being issued for guidance of the contractor. It is the primary responsibility of the contractor to ensure that jobs are executed in absolutely safe manner. These, however, do not absolve the contractor from any obligations or liabilities he might incur or transfer such obligations or liabilities to his subcontractors or agent or to the Owner / Consultant.

- These rules do not exempt the contractor from statutory duties on health and safety but are intended to assist in attending a high standard of compliance with those duties in order to provide a safe and healthy working environment.

- The contractor should obtain a "Work Permit" from Engineer-in-Charge before starting any work in factory premises. These permits are issued to prevent contractors working in unauthorized area and will be valid for specific area and for limited period.

- The contractor shall not store construction material, consumable, tools and tackles etc. at any place other than area allocated by the consultant/ owner.

- The contractor shall be responsible and shall indemnify the owner, against all injuries to persons both his own workmen and others.

- The contractor should take all precautions for safeguarding existing structures, equipment and / or parts of the owner's property during construction, erection and commissioning. The contractor shall repair / reinstate all such damages.

4.5 PROJECT SAFETY MANAGEMENT

4.5.1 Strategies

The following are some of the important strategies, which must be in place to accomplish the HSE Plan.

4.5.2 Construction

- The contractors should prepare Method statements and Safe Plan of Action minimum 2 working days in advance, for the respective activity.
- Monitor compliance with HSE Plan, Waste Management Plan and Emergency Preparedness Plan.
- Conduct Safety Audits and Inspections.

4.5.3 Resource Plan

- Adequate Resource planning for quantifying the safety materials / equipment relative to the quantum of work.
- Plan the execution of the fieldwork to avoid conflict between activities.
- Ensure the Safety Compatibility of adjacent tasks.
- Reduce congestion at worksite areas.
- Use appropriate lay down areas.

4.5.4 People

The contractor shall ensure training of all staff and workers, and must employ competent staff and workers and ensure the physical fitness of all.

4.6 ROLES & RESPONSIBILITIES

Safety is an integral part of normal activities performed by contractor personnel. Members of contractor's team are accountable for complete fulfillment of responsibilities in his area of work.

Project team shall support this HSE Plan and hold their members of team accountable for the proper execution of HSE activities.

4.6.1 Contractor Employees

It is the DUTY of every contractor's employee to:

- Take reasonable care for the health and safety of him and other persons who may be affected by his acts or omissions at work.
- Co-operate with his management or others to enable compliance with statutory requirements.
- Report to their immediate supervisor hazardous situations and defects found in premises, plant and equipment.
- Avoid improvisation, which might entail risk.
- Consider and suggest means of eliminating hazards.
- Co-operate in maintaining a safe and healthy working environment.
- Attend safety-training classes as and when organized.
- Attend safety meetings when invited.

- Participate in safety campaigns when organized.
- Never intentionally or recklessly interfere with, or misuse, anything provided in the interests of health, safety or welfare.
- Draw the attention of management / supervision towards improvements to health and safety which appear to be necessary or advisable.
- Report accident / near misses to his / her supervisor immediately.
- Demonstrate leadership of, and commitment to HSE, setting a personal example at all times.

4.6.2 Contractor's Construction Manager

Contractor's Construction Manager shall provide his workers with a safe and healthy working environment. He shall be responsible to promote safety and health consciousness among all his workers at all times. He is responsible to ensure that the HSE Plan duly approved by consultant / owner is implemented in its entirety and constantly monitored.

He shall:

Familiarize him and comply with all government regulations, consultant and owner's HSE procedures and practices.

Provide adequate safe construction equipment, tools suitable for the work, personal protective equipment and collective protective measures required for the workmen.

Ensure the construction work is being executed in the safest manner based on approved Method Statement and SPA.

Inspect and maintain the entire work area in safe and healthy condition. Instruct his supervisors to take immediate corrective actions if he detects discrepancies.

4.6.3 Contractor's Safety Engineer/Safety Manager

He shall:

Assist contractor's Construction Manager and coordinate with consultant's / Owner's Safety Officer in implementing HSE procedure within their respective work groups.

Familiarize them with all Government, consultant and owner's safety and health regulations, including reporting and work permit procedures.

Inspect the construction area frequently to examine appropriate corrective actions and prepare reports to their Construction Manager.

Review SPA prepared by line supervisors/ engineers.

Co-ordinate with supervisors and foremen, participate in safety meetings and lead daily safety walks of the site.

Participate in toolbox talks, assist in accident investigation and conduct safety-training classes for the workmen and suggest safety promotional activities.

4.6.4 Contractor's Supervisory Personnel

It is the responsibility of the contractor's supervisors / foremen to ensure that their workers strictly adhere to safety procedures in their specific works and work areas. They shall correct any unsafe acts and / or conditions promptly when these are recognized during the work.
Contractor supervisor to ensure that SPA of specific activity is prepared, approved and communicated to all concerned workmen before commencement of job.

4.7 SITE SAFETY ORGANISATION

See Attachment – 7.1 *"Site Safety Organization Chart"*

4.8 PRO-ACTIVE SAFETY MONITORING

A Pro-active Safety Monitoring Programme shall be used on the project.

The following are some of the elements of such programme

- *Safety Observation Reports*
- *Safety Inspection / Safety Audits. (Refer Attachment – 7.19)*
- Safe Plan of Action
- Method Statements
- Risk Assessment

Suitable formats will be provided for the purpose, if required by the contractor.

4.9 COMMUNICATION AND CO-OPERATION

Owner / consultant recognize the importance of ensuring that the HSE message is cascaded throughout all levels of workforce.

To facilitate communication the following elements will be used during the construction phase.

- All contractors will attend weekly safety meeting with consultant's Site management. At these meetings previous week Safety performance would be analyzed and the activities planned for the forthcoming week would be reviewed.

- Contractors Safety personnel will attend project safety committee meeting; typically these shall be held every week or as decided by Site Manager. The purpose of this meeting is to discuss the alternative safety strategies to be introduced on the project.

4.10 SAFETY PROMOTIONAL ACTIVITIES

In order to develop safety consciousness amongst the employees, the contractor site management shall organize suitable Safety campaigns, Safety competitions and Safety rewards on monthly basis.

Contractor shall ensure implementation of monthly motivational program and recognize as per following categories

- Best Safety Observation (Monthly minimum One Supervisor)
- Best Safety Performer (Monthly Minimum One worker)
- Best Near Miss Report (Monthly minimum one Supervisor or Worker)
- Best Driver/ Operator of the Month (Monthly minimum one Driver or Operator)
- Best Housekeeping Group (Monthly minimum One group of up to 5 Nos)
- Best Scaffolder of the Month (Monthly minimum One Scaffolder)

4.11 WELFARE FACILITIES

Unless otherwise specified in the contract document or agreed with the Owner, the contractors shall provide required number of toilet for male and female, Crèche for worker children, washing facilities and rest shelters in suitable locations as per statutory regulations.
Wooden site offices and rest / work shelters covered with tarpaulin are not permitted. Sheets used for roofing and cladding of sheds must be secured by J-hooks. Rest room shall have sufficient fans, chairs, benches & lights.

4.12 INCIDENT / ACCIDENT REPORTING

All accidents (including Motor Vehicle Accidents) shall be reported immediately to consultant / owner's representative.

All near miss incidents shall be reported immediately to consultant / owner's representative and fully investigated.

Contractor shall ensure that any accident that occurs is fully investigated to find root cause and preventive measures are adopted to prevent its reoccurrence. Consultant shall have a right to conduct independent inquiry of the accident. Investigation report shall be submitted within two days in the format attached ***(Attachment – 7.3)***.

Submit Monthly HSE report in the prescribed format by 15th of every month (***Attachment – 7.7 & 7.8).***

4.13 FIRST-AID AND HOSPITALS

The owner at project site may provide a first-aid center for the treatment of minor injuries and illness. However all major injuries and sickness cases shall be referred to the Hospitals and contractor shall make his own arrangement for such treatment as required. The contractor shall submit the agreement letter of the tie-up with recognized hospital having adequate facilities for providing suitable treatment to the victim within a week of opening the site.

The contractor must have arrangement for rendering necessary first-aid in case of accidental injuries. Work site must be provided with first-aid-box (one first aid boxes at every 50 persons) containing items as specified in the Building & other Construction Workers' (Regulation of Employment and Conditions of Service Rules, 1998) and keep the same in a conspicuous place where it is easily accessible. When conditions permit, well maintained first-aid Centre must be provided at site. Contractor shall ensure deployment of medical professional as per below table during project execution. However, stringent local laws and regulations shall prevail these requirements.

Sr. No.	No. of workers	Requirement of Medical Professionals	Qualification Requirement
1	0 to 50	Trained First aider	• Qualification of First Aider: - Having undergone First Aider training course from approved agency • Qualification of Nurse: - B.Sc. Nursing, or Post Basic B.Sc. Nursing, GNM (General Nursing and Midwifery) or ANM (Auxiliary Nursing and Midwifery) – As per Indian nursing council or as per local applicable laws and regulations whichever is stringent • Qualification of Medical Officer: - (1) MBBS degree from a medical institute recognized by the Medical Council of India; and (2) Diploma in industrial health or equivalent post-graduate certificate of training in industrial health. (3) A medical officer having working experience in organization establishments involved in policy, execution and advice and safety and health of workers employed in mines, ports and docks, factories and building and other construction work, for a period of not less than three years may, subject to the satisfaction of approval, not be required to possessing the training referred to in item (2) above.
2	51 to 200	Trained First aider (s) along with Part Time Medical Officer who will visit atleast twice in a week	
3	201 to 500	One qualified nurse (min 1 year experience)	
4	501 to 1000 workers	One qualified nurse (min 1 year experience) +one dresser cum compounder + one sweeper cum ward boy with one construction medical officer	
5	For every additional 1000 workers	One additional construction medical officer	

Note: If client medical facilities are available as per contract, above requirement will be revisited or reviewed at site.

Contractor shall provide first-aid training to some of its staff and workers from an approved agency to act as first-aiders at work site. Such first-aiders must be available at all times during work hours. Contractor shall ensure that enough first-aiders are available during all times in the ratio of 1:50. Contractor to arrange first aid training from outside approved agency.

The contractor shall make arrangements for the emergency care and treatment of all contractors' employees at the nearest (or reasonably nearby) hospital including disposal arrangement of biomedical waste of site first aid facility. If any snake bite related hazard is envisaged at site, contractor to arrange snake antivenom at site.

Contractor to arrange alcohol test instrument at site for random check.

4.14 MEDICAL EXAMINATION

Contractor shall conduct medical examination viz., pre-employment and periodical medical examination, of all employees and a record thereof must be maintained as per provisions of the law. Validity of permanent medical examination shall be 01 (one) year.

Medical Certificate of employees for various works, in the prescribed format ***(Attachment – 7.9)*** must be submitted to Consultant periodically and prior to engaging the employee at work.

4.15 SITE EMERGENCY PROCEDURES

Contractor shall prepare a detailed site emergency procedure shall communicate to all employees at site. Necessary arrangements shall be made to deal with such emergency situations. An emergency response team will be formed to tackle such situations. Display emergency contact numbers of all key persons (Client, Consultant, Contractor, Electricians, First Aid Center, Ambulance, Fire and Security) at prominent locations.

Contractor shall ensure availability of rescue devices, arrangements for immediate first-aid and quick transportation of injured person(s) to place of treatment.

4.16 LOCAL LAWS AND STATUTORY REGULATIONS

The contractor shall comply with all local laws and statutory rules particularly the provisions under Contract Labour (Abolition and Regulation) Act, Building and other Construction Workers (Regulation of Employment and Conditions of Service) Act 1996 and Building and other construction workers (Regulation and Conditions of Service) Rules 1998. A list of important laws & IS codes applicable to the contractor are enclosed. ***See Attachment – 7.13 & 7.14.***

4.17 LABOUR LAWS AND RULES

The contractor shall maintain relevant records and fulfill all conditions and requirements in accordance with following:

- No person below the age of 18 (eighteen) years shall be employed for the work.
- The contractor shall not pay less than what is provided under law to any persons.
- Women labor must be facilitated and should be employed to work during day light hours as per provisions of the law.

4.18 CHILD WELFARE

The contractor at his own cost provides 'Creche' facility at site in case more than fifty female workers are employed. Such facility shall be in accordance with Bldg. & Other Construction Workers' (Regulation of Employment and Conditions of Services) Act, 1996.

4.19 INFORMATION TO BE PROVIDED BY CONTRACTOR

- Health, Safety and Environment policy
- Health, Safety and Environment Plan
- Waste Management Plan
- Emergency Response Plan
- Names of the Safety personnel
- Employer's liability insurance certificate
- Method statements and Risk Analysis for each work / activity
- Test Certificates for lifting gear, lifting equipment and appliances
- Monthly Activity Plan
- Training Matrix/Monthly Training Calendar
- Accident Trend Analysis
- Audit reports conducted by Third Party and Home Office
- Employee's Health Monitoring Plan
- Medical Certificate (of employees in prescribed format)
- Safe Plan of Action
- Risk Assessment of critical lifts and high volume equipment
- Information relating to hazardous materials used and their MSDS
- Daily labour returns
- Copies of all Statutory Registers maintained by the contractor when asked for
- Copies of the contractors Safety officer's reports of their findings on-site inspection
- Prepare the list of critical activities and submit with Owner / Consultant along with safety assurance plan. The contractor shall ensure that training and competency assessment for workers engaged in such critical activities before commencement of job by internal /external competent trainers.

4.20 SITE SUPERVISION

- The contractor must ensure that an employee of suitable seniority and authority with responsibility for health and safety is always present on site during the course of the work, to supervise and direct the work and to receive and implement instructions from the consultant's senior representative.
- All supervisory staff shall be made aware of their responsibilities for safety.

4.21 TRAINING AND COMPETENCE OF EMPLOYEES

- Contractor must ensure that his employees are adequately trained and experienced to carry out their work safely. Training should continue throughout the project and should include regular toolbox discussions.

- A competency training and assessment shall be conducted for employees who are working in HSE critical functions e.g Scaffolder, Rigger, Gas Cutter, Welder, Operator, Electrician, Radiographer, Driver. Format attached as Attachment – 7.17.
  The competency assessment can consist of 2 parts;
  - Technical and non- technical competency for the job
  - Medical competency (Fitness to work), depending on level of HSE exposure
  Competency assessment shall be done by Interview and/or by demonstration and/or by verification of records.

- Contractor must also ensure that specific hazards likely to be experienced on the site are notified to their workforce together with any precautions to be taken and local rules to be observed.

- Where particularly severe or unusual hazards arise, consultant reserves the right at no additional cost to request contractor's employees to attend safety training and instruction sessions, whether carried out on site or externally.

- Each contractor shall participate in the training program to help develop content, introduce training sessions, conduct training sessions, lead site tours that are part of the safety training, and other responsibilities that may be appropriate from time to time. The contractor shall prepare the training calendar for HSE activities and submit to consultants on monthly basis. ***(Refer Attachment – 7.12)***

- Contractor shall provide training room with all required training facilities at site.

- Contractor shall deploy dedicated HSE trainer for effective execution of HSE training plan. CV of HSE trainer to be submitted to consultant one month before his deployment at site for review and approval.

- Contractor shall provide HSE Training Card or passport to all site employees for easy identification of their training details.

4.21.1 Initial site orientation / induction

The number of orientation presented each week shall be organized to the extent possible to accommodate the contractor's need to bring labour on site. The following topics shall be included in the course, which may be changed during the course of the project to meet changing site requirements. This orientation course may take up to 2 hours to present and may include a proficiency test for supervisors/ managers and skilled workforce. The trainer for session should deliver orientation program in the language understood by the workforce.

- Introduction to the site and project, with a brief overview of the project that is being constructed.
- Owner and consultant's HSE policy and safety philosophy.
- Personal Protective Equipment (hard hats, safety glasses, steel-toed boots, etc.)
- Housekeeping
- Working in and around excavations
- Working at height (ladders, scaffolds, free edges and openings, etc.)
- The Safe Plan of Action (SPA)
- First aid facilities, Accident reporting system
- Emergency procedure
- Smoking restriction, prohibition of alcohol and drugs.
- The use of cellphone is permitted only in the specified areas of the construction sites.
- Taking pictures of the property/construction sites using mobile phones or cameras is strictly prohibited.
- Dress Code – Long pants and long sleeve shirts are required at all times on the construction site area. For female construction worker, clothes should cover both hands and legs completely. Female workers wearing sarees should not be allowed to work close to the rotary equipment.
- The contractor shall conduct a site visit for his new employees in groups of less than 25 to familiarize the new employees with essential services, their work place, and general site layout.
- Gate pass shall be issued only after completing the site orientation / induction and local statutory regulation formalities.
- It is the responsibility of the contractor to familiarize all new personnel to the project on the actual location of assembly points, fire alarm points, first aid center and other important locations.
- Contractors are responsible for arranging site safety induction for their workmen and they shall inform consultant's Safety representative at least one day in advance.

Contractor shall ensure implementation of Buddy system for all new employees joined at site. Identification mark in the form of RED band to be provided on the helmet for 30 days.

Besides initial orientation and induction at site, training on following minimum topics should be given:

- Scaffolding, Ladders, Safety nets etc., Fall Protection.
- Cranes, Hoists and Lifting Equipment
- Electrical safety
- Gas Cutting and Welding
- Hazardous material handling
- First Aid

Vendor's representatives' visit:

Contractors shall ensure that the vendor's representatives who are visiting to construction site for checking/ field inspection, etc. are under going safety induction program before entering into field. And necessary PPEs are to be issued and site personnel from contractor's side should accompany with them till their visit/ work is over.

4.21.2 Specific hazard training

Specialized training on following topics shall be given to the employees:

- Hot work
- Material handling
- Working at Height & Multiple Tier Working
- Scaffold
- Industrial Radiography
- Pressure testing
- Heavy equipment lifting & rigging
- Work permit system
- Lock out & tag out procedures
- Entry into confined spaces
- Fire prevention and control
- Emergency Response Team (ERT) etc.

These courses should provide the time needed to properly address the topic. Completion of specific hazard training is mandatory before working on such tasks. A list of all trained persons shall be maintained at site.
Contractor to prepare HSE training modules including HSE Induction modules as per site requirements and submit it to consultant for review and approval prior to use it at site.

4.21.3 Tool Box Talks

- Contractors shall conduct toolbox talks for all employees and workers daily before commencement of work.
- Topics should include current issues, incidents / accidents happened, near miss incidents and precautions to be taken for works in progress.
- TBT must be conducted by execution team and must cover all works in progress.
- Contractor shall maintain records of Toolbox Talks and shall forward the same to Consultant on regular basis.

4.22 METHOD STATEMENTS

Contractors shall submit method statements for each work to Consultant along with SPA. The method statement shall details:

- The job to be undertaken
- The individual activities required for completing the job.
- The individual trades / disciplines involved in each activity.
- Plant, equipment, tools to be used in each activity.
- Any hazardous substances / chemicals to be used along with their MSDS.
- A detailed description of how the work will be done including control measures and procedures to complete each activity and the overall job safely.

Compliance with the standards detailed on the work method statement and relevancy to current operations shall be monitored on a daily basis and during safety management meetings.

Contractors shall submit Erection Scheme and it should be got approved by Consultant at least 72 hours before commencement of the work.

4.23 SAFE PLAN OF ACTION (SPA)

- The SPA is the primary tool used at site to identify and plan to mitigate safety hazards. This form shall be completed by the employees and their supervisor of each crew before starting a new activity. Separate SPA needs to be prepared by respective execution team when:
  - similar activities / jobs are going on at different locations by different individuals / groups
  - change in work procedure is adopted

  It should be kept at the work place for ready reference.

  The Approved SPA shall be made available while obtaining the permission for activity. SPA shall be submitted for approval min. 2 days before of the commencement of activity and approved SPA to be kept at site along with the permit until completion of job.

- The SPA has sections for the employees to:
  - State the task to be performed
  - Location of the task to be performed
  - Safety hazards anticipated
  - Steps to be taken to prevent the risks identified
  - Equipment, tools, or materials needed for protection against the hazard and to perform the work safely.
  - The name(s) of the Supervisor(s) for each activity.
  - The name of the person in overall charge of the job.
  - Duration of the job.

- It is the responsibility of the supervisor to ensure that all equipment, tools, or materials needed to implement the preventions identified by the SPA are obtained and all the steps identified to prevent the safety hazards are implemented before starting the work task.

- It is the responsibility of the supervisor to ensure that SPA to be revised if any new hazards arises or identified due to change of site condition or learning from incident report or recommendation from site safety observation/ inspection or audit.

4.24 SAFETY OBSERVATION REPORT (SOR)

- The SOR is used as a tool for site employees' to record unsafe acts or conditions and the steps taken (immediately and as follow-up) to correct the unsafe acts or conditions and recommendation to prevent its recurrence.

- The SORs will be submitted to consultant and the data recorded by the SORs shall be summarized periodically to identify frequently occurring unsafe act / conditions.

4.25 PERMIT TO WORK SYSTEM

- A permit to work system is a safety strategy designed to protect personnel and plant and which consists of an organized and predefined safety procedure. It forms a clear record of all foreseeable hazards, which have been considered in advance of the construction operations.

- The identities of the permit "Issuing Authority" and "Permit Acceptor" will be based on assessment done by consultant, (Acceptors will be from Main contractors only, Sub contractors should not be approved as PTW Acceptor.)

- The following is the list of some of the activities, which would require permit, and list may change depending upon work situation.
  - Scaffolds
  - Excavations
  - Lifting Operations
  - Work at Height
  - Removal of Grating / Covering from Cutout & Opening
  - Hot Work / Naked Flame
  - Electrical Works
  - Confined Spaces
  - Radiography
  - Card Board Blasting
  - High Pressure Air / Steam Cleaning
  - High Pressure test
  - Commissioning of equipment
  - Road closure
  - Other non-routine activities such as Loading or unloading of heavy equipment/ machinery, crane assembly, maintenance work of heavy equipment, etc

- Written requests for permits must be submitted to consultant's representative at least 24 hours in advance.

4.26 SITE SAFETY COMMITTEE

In order to ensure better communication and coordination for realizing safety targets, the project shall establish an independent Safety committee comprising of Owner Representative, consultant's Construction Manager, consultant's Safety Manager, consultant's Discipline Heads, Contractors' Site Manager and Safety engineers.

4.26.1 Safety Meetings

- Safety Committee will form the agenda at all Site meetings
- At least once a month a consultant's Construction Manager shall convene meeting of all contractors. Attendees at the meeting shall be contractor's Safety engineers, Site Managers (or their nominee). The frequency of meetings may change depending upon the need.
- Contractor shall conduct an internal monthly safety meeting as per statutory requirements and Clients/ Consultant may participate.

4.27 PERSONAL PROTECTIVE EQUIPMENT (PPE)

The contractor must provide all his employees / workers, required PPE, which are duly inspected and approved by the Consultant. "NO PPE ZONE" would be identified separately. Contractor to demarcate the workplace in Green & Red Zone Area. All site office shall be in Green area and shall be considered it as "No PPE Zone". For all Red Area, PPE shall be mandatory. Safety Goggles, Safety Shoes, Safety Hand gloves, Reflective Jackets & Safety Helmet shall be minimum mandatory PPE requirements at site. Also to demonstrate use of Safety Equipment, Contractor to provide Safety Park at site. Contractor to ensure compliance of Long sleeve policy (e.g Full sleeve shirt) during project execution.

The contractor shall:

– Maintain all personal protective equipment in good working condition.
– Periodically check and replace all defective / broken personal protective equipment.
– Shall maintain inventory of all PPE on the basis of consumption per employee

As a minimum every worker needs to wear safety shoes, safety glasses, safety helmets, Reflective Jacket and hand gloves at all the times, while in PPE Zone. However special equipment may be required for certain operations depending upon the risks associated with the works, like:

- Face mask, dark eyeglasses and face protection
- Ear plugs and / or ear muffs
- Clothing for body protection
- Safety harnesses with shock absorber & double lanyards
- Respiratory (breathing) protection

The followings, but not limited to these, are considered to be collective protective measures:

- Barricades
- Guardrail, Handrails and Covers
- Stairs and Ladders
- Safety Nets
- Work Platforms
- Life line made of wire rope
- Shoring
- Cages, gondola and crane suspended working platforms
- Insulating Screens and Barriers

4.27.1 Head Protection

All personnel shall be issued safety helmets, which shall be used at all times by personnel while on the site. Helmets shall have stickers to identify the contracting company they belong.

A hard helmet must to be used in combination with face shield or ear muffs.

4.27.2 Hand Protection

Cut-resistant gloves level 3 will be considered the minimum protection for all personnel who enter into the work place and shall be worn 100% of the time, unless another type of glove is specified in the SPA.

Workers employed on bar bending, mixing asphalt materials, Cement, Lime mortar and Concrete shall be provided with protective gloves approved by the Consultant.
In addition to above, gloves shall be used by personnel involved in works with possibility of the risk from abrasion, cutting, tearing, electrocution, chemical or other burn and infection.

4.27.3 Foot Protection

All personnel shall wear suitable safety footwear with metal toe at all times while on the project site.

4.27.4 Ear Protection

Ear protection shall be worn by personnel involved in works in areas of high noise levels, or when working with equipment that generate high noise levels.

Ear protection can be of an external ‘cup-type’ defender which fits over the outside of the ear, or ‘plug-type’, usually made of compressible foam, which fits inside the ear.

Whenever practicable, equipment generating high noise should be located at the maximum possible distance from any work being performed. Sound reducing boxes also should be fitted to the equipment wherever practicable.

4.27.5 Eye Protection

Use of safety glasses at the work place is must, to protect eyes from following:

- Flying particles,
- Dust ingress,
- Chemical splash,

- Radiation glare,
- Hot sparks or metal spatter,
- Harmful vapors.

The correct selection of eye protection shall depend on the assessment of the risk, or combination of risks based on the site situation.

4.27.6 Respiratory Protection

Respiratory equipment whether stands bottled-type, or self-contained breathing apparatus shall only be worn by trained and qualified personnel.

- Persons with beards shall not be permitted to operate with respiratory equipment.
- Self-contained breathing apparatus shall generally be used in emergency situations, while scheduled works shall utilize the static bottled-type.

Those engaged in mixing or stocking cement bags or any materials, which are injurious to eyes, and lungs shall be provided with masks.

4.27.7 Fall Protection

Full body harness with double lanyards of length not more than 6 feet (including shock absorber) , having big Snap Hooks shall be worn by all personnel working at height greater than 6 feet above the ground level. Waist belts, half body safety belts and screw / small snap hooks are not permitted.

Harness must be fitted with shock absorbers. However, the height of location and the fall distance need to be considered while using shock absorbers.

Life line must be of wire rope (min 8mm dia). Use of polyimide rope is restricted only with rope grab fall arrestors.

All horizontal lifelines must be designed for the intended load (i.e. number of person likely to attach harnesses and spacing between supporting members of the lifelines… etc). The design criteria for lifelines should fulfill OSHA requirements (i.e. wires should be properly supported to withstand atleast 5000 pounds impact).

The horizontal lifelines should be constructed with IPS IWRC and three “cable clamps” for termination of the same at both ends. These lifelines shall be tightened using “Turnbuckles” to overcome sag.

4.28 SANITATION AND HYGIENE MEASURES

Provision of adequate sanitation facilities and hygiene measures is statutory. Contractor must provide and maintain temporary facilities as follows

- Provision of wholesome drinking water and cool water during summer
- Provision of toilets (1 for 25 persons) and hand wash basins both for male and female separately
- Garbage disposal and periodic collection
- Proper drainage and sewer disposal
- Other special hygienic operations viz. fumigation, pest control etc.
- Workers rest shed with sitting arrangement and fans
- Canteen facility dispensing at least tea and snacks

4.29 RADIOGRAPHY

Only qualified and trained Radiography Testing Level-I or Level-II personnel with required license issued by AERB should be assigned to install, adjust and operate radiography

equipment. The designated Radiography agency should have valid license for Handling and operation of Industrial Radiography Exposure.

AERB certified Radiological safety officer (RSO) must present during Radiography at site.

When working in areas with a potential exposure directly or indirectly to any workers / persons, the relevant statutory required protection shall be made.

Affected areas shall be posted and restricted with standard radiation warning sign, placards, barricades and blinking siren. Man guard radiography area to prevent infiltration.

All applicable rules pertaining to radiography shall be complied with regard to source pit, source movement, radiography license etc. Source pit to be made as AERB guide lines and the same should be approved by AERB. The Radiography source using at site should have source movement certificate issued by AERB to work in that location / site / plant.

Decay chart for the source using for Radiography should be available at site to check the current source strength (in curies).

Radiography must be done after obtaining required permit, with prior information to all concerned and the people working in the vicinity. Prefer doing conventional radiography during night hours.

All personnel working on radiography must wear dosimeter / film badges as required by the AERB norms. Required numbers of Calibrated Survey meter should be available at site during Radiography.

Maintenance of records as per AERB norms is essential.

Refer Attachment -7.15 , Safety checklist to be followed during Radiography.

4.30 WARNING SIGNS, BARRICADES AND SIGNALS

All floor openings, cutouts, open edges and excavations shall be properly barricaded, covered with load bearing grating / coverings and shall have proper guardrails and toe boards on all sides, and warning notices posted.

Site supervision shall make sure that signs, barricades and signals are used, erected and maintained as required to ensure the safety and health of site personnel.

4.31 NOISE

Noise must be kept to a minimum at all times and must not exceed acceptable and / or locally specified rules and conditions relating to noise imposed by the Contract. Due regard must always be given to noise levels, permissible duration for noisy work operations and other restrictions. Any work activity which is likely to expose any employee on site to a noise level of 85 dbA or above, assessments should be carried out. In such circumstances, the contractor must keep stocks of ear defenders or other suitable hearing protection and issue to the workmen who are exposed to the higher levels of noise.

The legal requirements for the protection of worker's hearing are contained in the Building & Other Construction Workers' (Regulation of Employment and Conditions of Services) Central Rules 1998.

General guide is, if one has to raise his voice to be heard, place is too noisy.

Grinders, Cutters, Jack Hammer (pneumatic drills), Engine driven plant and the like, all give off levels of noise that is harmful.

Install silent / sound proof DG Sets provided with canopy.

Earplugs and earmuffs are the commonest form of hearing protection to be used.
If there is a concern that personnel cannot hear warnings, shouts or gas monitor alarms, then a method statement / safety system of work should be provided for those operations.

4.32 HAZARDOUS SUBSTANCES AND ENVIRONMENT

The Statutory Regulations are to be complied with at all times. Hazardous substances include any flammable liquid or any substance likely to give rise to toxic, corrosive, irritant or harmful risk.

Substances hazardous to health must be identified prior to taking them onto site and, if they cannot be substituted or eliminated, assessments stating how the substances will be controlled and what precautions will be introduced must be carried out and recorded in writing by a competent person. This assessment must be communicated to and comprehended by the workforce who is likely to come in contact with the substance(s). A copy of all assessments should be handed to the consultant's Construction Manager.

Hazardous substances brought to site shall be kept to a minimum and must be stored in secure, appropriate containers with the contents clearly labeled. The containers must be stored in a secure area, preferably quarantined for the main stores areas, with suitable warning notices and signage posted.

Hazardous materials must not be allowed to discharge into natural watercourses or drainage systems.

All hazardous material waste must be kept separate from normal waste and be disposed of in a specialist disposal facility.

Contractor shall provide to every person working in hazardous and toxic environment with Personal Gas Detector and ensure its use.

4.33 HOUSEKEEPING

Very high standard of housekeeping shall be maintained at all times by the contractor.

- Keep the site neat and tidy. Keep adequate number of skips / waste bins.
- Keep the access clear of all obstructions.
- Remove the nails or bend them down from the wooden scrap and remove them from job site.
- Store the material in an orderly manner.

Contractor shall engage dedicated house-keeping team for each working area

The contractor shall on daily basis keep the premises and surrounding area free from accumulation of waste materials or rubbish caused by activities.

Monthly rewards will be given by the Contractor HSE Manager for the best "House Keeping" working groups in each area.

At the completion of days' work contractor shall remove these materials to avoid Slip / Trip hazards and provide safe areas for movement of all workers and supervisors.

Contractor should establish regular maintenance program of sweeping and hosing to minimize accumulation of dirt and dust in such areas.

The CONTRACTOR shall arrange for Pest Control treatment at project site office and other required site facility against pests, cockroaches, crawling and flying insects, etc. at least half yearly.

If the contractor fails to Clean-up as provided in this document, the owner may do so and cost thereof shall be charged to the contractor.

On completion of the job the contractor shall remove all his construction material, tools etc. and demolish all temporary constructions and leave the job site thoroughly cleaned up and ready for use. When required contractors have to suspend other operations and do housekeeping.

4.34 REMOVAL OF WASTE FROM CONSTRUCTION SITES

Waste generated at site shall be controlled and disposed off in accordance with environmental control regulations and municipality rules; consultant shall be informed of procedure followed by the contractor before disposal

Controlled waste is any kind of household, industrial or commercial waste. This includes for example:-

- Scrap metal
- Building, construction, demolition and excavation waste, including waste from any repair or renovation.
- Clinical waste.
- Anything, which is unwanted because it is surplus, broken, worn out, contaminated or spoiled in some other way.
- Where there is any doubt of the composition of excavation spoils, it must be analyzed before it is removed off-site.

Waste Disposal

All receptacles shall be constructed of metal or other suitable types of containers of non-flammable materials.

Cardboard, wooden boxes or crates and similar types of containers shall not be used for the collection of combustible waste.

The removal of waste shall only be taken in accordance with the rules prescribed by local Public Health Department.

Separate waste skips should generally be provided for:

- Scrap metal
- General construction waste

And fully enclosed skips for

- food waste (to deter vermin)
- waste and rags saturated with oil, grease and the like

Skips containing combustible waste should be strategically placed to ensure fire does not spread in the case of combustion within a skip.

4.35 FIRE PREVENTION AND CONTROL

The contractors shall plan and chalk out the measures for the elimination of possible conditions, which may lead to fire.

The contractors shall provide adequate number of well-maintained fire extinguishers, at each work area and with all hot works in progress.

The contractor shall ensure that workmen are trained in the use of fire extinguishers, understands the basics of fire fighting and train the workmen to become familiar with such Fire

Fighting Procedures. A competent person shall periodically inspect all fire extinguishers. Fire extinguishers should be located in easily approachable designated areas and clearly identified.

The contractor shall take every precaution and use all reasonable means to prevent an outbreak of fire and shall tender immediate assistance in case of fire. Any outbreak of fire in or near the workplace shall immediately be reported to the engineer in-charge of Owner / Consultants.

Fire drills should be held at intervals to ensure personnel are familiar with the location, of Assembly Point and response expected of them in case of emergency.

Smoking on site is not permitted, but may be allowed in restricted areas as may be authorized by the owner. Smoking and carrying matches in operating refinery and chemical plants are strictly prohibited. No smoking boards shall be displayed at prominent locations including stores / storage places.

Containers of flammable materials, oily rags, waste etc. must not be left lying around or allowed to accumulate. Covered metal skips should be used for disposal of flammable waste.

If welding / cutting operations are to be carried out, non-flammable screens and non asbestos type fire blankets shall be used to confine/ arrest sparks hot metal or slag. A fire extinguisher should also be readily available. Contractor shall submit the test certificate of fire blanket to consultant.

Chemicals and other such goods should be stored in stable racks properly labeled. Mutually reactive chemicals should be kept away from each other. Storage place should have proper ventilation.

4.36 EMERGENCY PROCEDURES

The following will be considered to establish emergency procedures.

- Make a list of available emergency services and confirm their communication channels.
- Ensure that supervisors clearly understand their responsibility and role in the site emergency procedures.
- Designate first aid and provide medical supplies and other material and equipment that may be required for emergency use.
- Set up emergency response teams.
- Determine emergency evacuation routes for work areas and construction site.
- Make sure that all personnel clearly understand emergency warning siren signals or other warning signals used by Owner or other authorities.
- Designate a supervisor to conduct a head count and give instructions to evacuees as necessary.
- Post-emergency information for each work area on the site.
- Conduct emergency response mock drill periodically once at least in three months.

4.37 SITE ACCESS

Access to the site must be at all times via recognized roadways and footpaths. Personnel must not access to construction areas through unauthorized areas. Anyone found disregarding this rule would be subject to disciplinary action.

All personnel will be issued with a photo pass, which will be required to enter the site. Passes must be carried at all times. At the completion of the project, all passes must be returned to the consultant's Construction Manager.

4.38 SITE SECURITY PROCEDURES

Following minimum controls on movement on men and material should be followed.

4.38.1 Site Entry Control

- Site Entry Permit (Personnel) System
- Site Entry Permit (Vehicle) / Equipment
- Contractors shall abide by Owner Security system.

4.38.2 Prohibited Items and Activities

Contractor shall closely monitor to ensure that the employees adhere to the following code of conduct:

- Alcoholic beverages will not be consumed, brought onto, or manufactured on the site. Individuals under the influence of alcohol or drugs will not be permitted to remain on duty or entry to the site. Awareness about local laws on this issue shall form part of the Induction Training.
- Non-prescription drugs, intoxicants or substances will not be used, brought onto or manufactured on the site.
- Firearms, explosives, knives or other types of weapons will not be allowed on the site.
- Gambling or any other form of betting game is prohibited.
- Discrimination or intimidation on the basis of race, sex or national origin is prohibited.
- Aggressive or abnormal behavior is prohibited.
- Violation and / or failure to comply with the above requirements will require a written report detailing facts and corrective actions taken.
- Visitors shall always have inducted and escorted by responsible contractor.

4.39 HSE AUDIT & INSPECTIONS

Consultant may plan to conduct the following two types of audits from time to time during a project life.

- Formal Audit
- Regular and Ad-hoc Inspection

4.39.1 Formal Audit

Formal audit would be a comprehensive assessment of compliance with project program, procedures and local codes and regulations.

Consultant's home office management and / or HSE specialist / advisor at key points will carry out this audit during project life cycle by means of pre-determined formats.

The results of formal audit will be reported in a written assessment form and feedback is given to all relevant parties including consultant's top management. Site management and supervisors should take corrective actions immediately and submit their compliance report.

4.39.2 Regular and ad-hoc inspection

Initial Inspection & Approval: All heavy equipment shall be offered for Initial inspection & Approval by Consultant Safety prior to entering the site.

Periodical/Monthly Inspection & Approval: Consultant Safety Manager / Engineer will visit the Sites and carry out Site safety inspections. Contractors Safety Personnel shall conduct Safety inspection / Safety Audits and report to contractor's Site In-charge for taking corrective action. A copy of their reports shall be forwarded to the consultant's Construction Manager and

provide a report of their findings and any necessary corrective action to be undertaken. As per the scope of the work, contractor to perform various types of HSE Inspection at site as per Attachment – 7.19.

Regular and ad-hoc inspection is an audit providing regular or special means of checking compliance with project HSE requirements at key stages of project life.

Regular and ad-hoc inspections will be carried out by site management and / or site Safety Officer / Manager.

Contractor's senior safety representative from corporate office will conduct quarterly audit at site and ensure compliance. The reports of such audits shall be shared with the Consultant.

4.40 HSE ASSURANCE PLAN

The contractor shall submit HSE Assurance Plan in the form of matrix indicating the extent of checking of various activities enlisted in the plan. The plan shall be approved by consultant and it shall be used as main tool for HSE surveillance.

A typical plan prepared for the project is attached for guidance ***Refer Attachment – 7.11*.**

4.41 HSE AWARDS AND COMPETITIONS

4.41.1 Awards and Recognitions

Construction site Safety awards programs may be instituted with focus on remarkable achievements and contributions towards safety.

To motivate employees, person making exemplary contribution towards safety shall be recognized in public in presence of Client and Consultant during celebration of Monthly Safety Day. Also refer section 4.10 for details.

4.41.2 HSE Competitions

The site management and the contractors may plan for various safety competitions to motivate employees to take active part in safety program.

4.42 CONSTRUCTION EQUIPMENT AND VEHICLES

4.42.1 Pre-Construction Examination and Inspection

The contractors shall provide a list of equipment and vehicles needed to safely perform the work. Cranes, hoists, slings, lifting tackles and other lifting equipment shall be selected as per load carrying capacities.

The contractor must include in his Safety Assurance program, a procedure relating to construction equipment and vehicle inspection, operation and maintenance plan. It must be consistent with the manufacturer's recommendations and consultant's requirements as contained in the program.

All hoisting and lifting equipment shall be thoroughly examined by a competent person as per applicable local laws and regulations. A report on the result of examination shall be submitted (in prescribed form) before equipment is brought into site.

4.42.2 Scheduled Inspections and Maintenance

Contractor's construction equipment and vehicles are to be periodically inspected and maintained according to pre-determined schedule. Complete record of all inspection and maintenance shall be maintained and submit to consultant when called for.

4.42.3 Equipment Operator Qualification and Training

Consultant through the contractor shall review the qualifications of all crane operators, crane maintenance personnel and other mobile equipment operators in accordance with the following procedure:

- Possession of valid driver's license and job site authorization card signed by consultant's Safety Officer.
- To drive construction Heavy equipment or Vehicles, operator shall be, where permitted by law, and have at least four years' experience driving the type of vehicle concerned.
- Successful completion of a practical operating examination administered by third party competent and authorized personnel.
- Training – Operator responsibilities, familiarity and comprehension concerning all crane safety and O&M requirements, load capacity charts, rigging methods and practices, hand signals and other requirements will be examined by competent and authorized personnel. Contractor shall ensure imparting of regular training to operator at site.

4.43 VEHICULAR AND TRAFFIC SAFETY

The following elements shall be taken care to eliminate traffic accidents.

- Suitable traffic signs & warning notices shall be posted at Site.
- Drivers and operators shall comply with all traffic safety regulations, traffic controls and traffic signs.
- Drivers of passenger vehicles must have valid driving license and operators of construction equipment must have valid license issued by transport authorities.
- Accredited Defensive Driving Course prior to employment of driver and refresher training at least every two years from approved agency or client / consultant or contractor to conduct on yearly basis for which training report will be prepared by contractor.
- Minimum proven experience for drivers (including light vehicle) is 4 years out of that min One year experience with same or similar equipment/vehicle will be more preferable.
- The maximum speed limit on the construction site is 20-km / hr. The maximum speed limit in work areas is 10-km / hr.
- Drivers or operators who violate the site traffic safety regulations will be removed from the site.
- Personnel must not be transported while standing on the bed of trucks or trailers or on material handling / earth mounting equipment or they shall be allowed to sit on doors.
- Site vehicles should be fitted with seat belts, horn, mirrors, lights and reversing alarm.
- Seat belts must be fastened by all occupants of LMVs and drivers of all vehicles, prior to movement. It should be unfastened at the time of alighting when the vehicle has stopped.
- Transportation of material on road by pick and carry hydraulic crane is not permitted.
- Engaging two crane for transporting long material is prohibited. Such material should be transported on trailer.
- Conduct road survey, especially during rainy season to know about pits, ditches, and escalation etc, before transporting any material.
- While transporting material must be properly tied and secured with chain & turn buckles / cargo lashing webbings. Use of PP / manila / polyamide / wire rope is not permitted.
- Provide barriers to prevent roll / slide off and topple of material.
- People must be mobilized in passenger vehicles. Transporting people in dumpers, trailers, trucks or other construction vehicles is prohibited.
- Any load over 1.5 meters beyond the rear or 0.5 meter over side shall be escorted.
- If any vehicle has to reverse on site this shall be carried out under the control of signalman who is Wearing a high visibility vest & using hand signals/flags, at night signal man shall use marshalling band. A whistle shall be provided to signalman.
- All vehicle must have three point seat belt while enter in work premises.
- Contractor to conduct alcohol testing (randomly/compulsory)
- PPEs for Drivers - Contractor shall provide safety shoes, goggles, Helmet, Hand gloves and reflector jacket to driver and helper.

- No vehicle should be older than 5 years including bus for labour camp to site &back.

A trained banks man or guide should be deployed to ensure safe reversing for each equipment. The banks man should be a designated person, one of whose tasks is to ensure a reversing area free of pedestrians and ensure a safe vehicle maneuver.

Use of Farana-15 or equivalent /Crane for lifting operations:

- Conventional type of Hydra is not allowed at site. Consultant strictly prohibits Hydraulic Mobile Pick-n-Carry cranes without outrigger (HYDRA). Front mounted cabin pick and move cranes can be used with outriggers.
- Marching load shall not be permitted.
- Contractor shall mobilize Farana type or equivalent / cranes of latest make and having valid registration certificate and in any case date of manufacture shall not be older than 10 years for Farana type or equivalent.
- Contractor shall ensure that the Farana type or equivalent / crane Operator possesses Crane/HMV (heavy Motor Vehicle) license (original) from statutory authority and also valid document (original) certifying his training / competency from competent authority. For F15 Faran also SLI with Auto cut off should be provided.
- Contractor shall arrange medical fitness (with test reports) of Farana type or equivalent /crane operator from registered medical practitioner every half-year.

4.43.1 Vehicle Maintenance, Inspection.

Vehicles must be frequently inspected and properly maintained. Each vehicle must be equipped with the required safety features that function properly.

- Preventative maintenance shall be performed on all vehicles on a monthly schedule. All safety features shall be checked and repaired as necessary to ensure proper operation.
- Available of maintenance log along with equipment/vehicle or available at site to be produced on demand.
- Drivers and operators shall perform pre-operational checks of their assigned vehicles and equipment prior to the start of each working day.
- Each driver shall keep a record of the daily and monthly pre-operational vehicle and equipment checks.

All site vehicles should have following as a minimum:

- First Aid kit
- Fire extinguishers
- Parking brake and brake light

4.43.2 Motor Vehicle Accident Investigations

All motor vehicles and equipment accidents shall be reported; investigated and remedial measure shall be taken to prevent recurrence. ***Refer Attachment – 7.3.***

4.44 HAZARD WARNING

Hazard warnings come in different forms, which include signs, tags, permits, barriers etc. The primary factor with any hazard warning is that all personnel; visitors' etc. shall be educated as to the types of warnings and their definition.

4.44.1 Tags

Various tags may be utilized during the construction and commissioning phases, e.g.

Electrical – to designate that electrical equipment has been taken out of service, or men are working on the equipment.

Danger – designating a possible hazard such as “valve open”, “do not use”, and “spade inserted”.

Defective – designating unsafe materials and / or equipment, e.g. “out of order, “failed safety checks”.

4.44.2 Warning Tapes / Flags

Hazard warning tapes should be utilized to attract the eye to avoidance of hazards or local services. Tapes, whilst warning of potential hazards, should not be employed as safety barriers and are considered as a guidance indicator.

4.45 EXCAVATIONS

- The planning of excavation works should consider:
  - Nature of the soil, including the proximity of any make-up ground
  - Weather and moisture conditions
  - Method, size and duration of the excavation job
  - Proximity of other structures, services
  - Dewatering systems
- Unless otherwise specified or agreed with the Owner, before starting excavation permit should be taken from Owner in order to check for underground facilities.
- All excavations more than 600 mm shall be barricaded. The barricade should be made of steel pipes of minimum dia 40 mm NB. These barriers should have minimum two horizontal members (waist rail & knee rail) located at 1100 mm and 550 mm from the ground and vertical members located at spacing not more than 1000 mm.
- Excavations less than 600 mm shall be cordoned off and suitable notices / warning tapes posted.
- The most appropriate method of stabilising the sides of an excavation can be achieved by properly designed shoring, which is to be approved by consultant.
- Ladders should be provided at intervals of not more than 15 m, depending on the number of men present.
- All excavated materials shall be deposited minimum 1.5 meters away from the edge of the excavation.
- Illumination inside the excavations, whether natural or artificial, should be adequate at all times.
- Walkways between trenches should be kept clear of obstruction.

Any openings in barricade that may have been necessary for operational purposes should be securely closed before the site is left at night.

4.46 BLASTING AND DEMOLITION

All activities including but not limited to the storage, transportation and blasting shall be carried out in accordance with the rules and regulations and as per the instructions of local authorities.

Before any demolition work is commenced and also during the process of the work all roads and open areas adjacent to the work site shall either be closed or suitably protected.

Whenever making an opening in the existing wall adequate supports to be provided against the collapse or cracking of the wall portion above.

4.47 PILING

- Stability of the rig on even ground is must.
- Provide guy ropes with strong anchorage to conventional rigs and secure tripod rigs / engine driven winch, in order to prevent topple.
- To prevent toppling of rigs during movement, check prior ground conditions for loose earth and move after concreting of the pile.
- Secure guards of all moving parts.
- Barricade the area of conventional rig.
- Install silencers to prevent noise pollution and contain oil spillage.
- Always keep the bore covered while boring and until completion of concrete placing.
- Hard barricading of bentonite muck pit and display of warning signage and red light is must.
- Suitable disposal of bentonite muck to prevent environment pollution is must.
- Pile test area should have adequate head room access. Load applied should not collapse. Prevent unauthorized trespassing.

4.48 SCAFFOLDS

No structure, temporary support, scaffolding to be loaded beyond allowable loads. If there is a doubt on the structural stability the scaffolding to be tested to two and half times of live load.

- Bamboo and wooden scaffolding is prohibited. Only pipe scaffolding is permitted.
- Scaffolds shall be designed by a competent engineer.
- Contractor shall appoint exclusive specialized full time scaffolding contractor based on scaffold requirement at site. Scaffolding contractor shall be approved by Consultant. In-house trained & experienced scaffolder is acceptable however the competency and capability (certificates, experience etc) needs to be demonstrated and same will be reviewed by consultant and scaffolding team shall be exclusively for scaffold work only.
- For any kind of scaffolding, certified scaffolder with valid certificate from approved agency for erecting scaffolds shall be allowed to build any kind of scaffold. Only certified and license holder inspector shall be allowed to inspect and approve any kind of scaffold. Training Academy & Certification agencies are
  - Coatsman for scaffolder and scaffolding inspector
  - ASK EHS training center
  - CITB - Construction Industry Training Board
  - TUV India
  - RINA Approved Certification

  For introducing any new scaffold agency, contractor shall take prior approval from consultant.
- Scaffolders and scaffolding inspector should have minimum 4 years of experience and well versed with HSE norms.
- Shifting of the scaffold clamps from ground level to elevated area shall be through certified lifting bag with secured rope only. Use Pulley and Rope to shift the scaffold materials from Floor to the Elevated area.
- Contractor shall submit for approval of consultant the scaffolding plan detailing erection, dismantling, preservation, inspection and tagging procedure.
- Scaffold erection and dismantling activity should be an independent activity under skillful agency.
- Only approved and competent scaffolders shall erect or dismantle scaffolding under Competent Person's supervision.
- During erection, dismantling or modification, scaffolds must be cordoned off and adequate precautions must be taken to prevent materials falling. People unconnected with the work should be kept away from the area by the use of signs and barriers.
- Hand railings – top rails, mid rails and toe boards shall be provided for all working platforms. Metal planks to be used for platform and toe board.
- Wire shall not be allowed to secure the scaffold plank

- Provision of base plate is essential irrespective of floor conditions.
- Provision of sole boards on soft ground is must.
- Dismantle scaffold immediately after completion of work.
- A sample scaffold shall be erected at site to serve as a model and for training purposes.
- All materials must be raised and lowered in a controlled manner, and under no circumstances should components be dropped from heights during erection and dismantling.
- Properly positioned and secured ladders must be used for access up or down the scaffolding. Climbing using the framework is not permitted and this includes scaffolders.
- Staging: Scaffolds used for supporting form work should be constructed on a firm ground with a base plate. The staging should be as per IS 3636. Staging should be inspected frequently even after completion of concrete work, or after completion of intended use.
- Scaffolders shall be identified by unique color helmet (any highly radioactive color) which may be useful for our effective site follow ups on them directly as they are more prone to work at height in very unsafe manner.
- Shifting of the scaffold clamps from ground level to top platform through lifting bag with secured rope only.
- Use of soleplates beneath footplates is mandatory and footplates shall be centered on the soleplate.

4.48.1 Scaffold Inspection

- Scaffold must be inspected at regular intervals by a competent person
- For scaffolds used by several contractors at the same time, it is the responsibility of every contractor and every employer to ensure that any scaffolding used by their own employees is safe and complies with the requirements
- Scaftag system should be followed and the 'tags' should be placed within easy sight of users to show the condition, e.g. green for safe, red for do not use when the scaffolding is still being erected, altered and/or dismantled. Sample scaff tag is attached as Attachment – 7.18.
- Scaffolding register to be maintained and updated on regular basis.

4.48.2 Mobile Tower Scaffolds

For erecting Tower Scaffold, instructions of manufacturers, suppliers for erection must always be followed and supervised by a competent person. A mobile tower scaffold must be erected on the leveled ground.

All components must be inspected before use for damage, cracks, broken welds or defects. Where the assembly is connected by latching hooks or pins they should be inspected to ensure that the spring and the release trigger are operative.

- The height of the working platform in relation to the width of the base is critical.

The normal acceptable ratio is:

MOBILE TOWERS USED INTERNALLY 3.5 TIMES THE MINIMUM BASE DIMENSIONS

MOBILE TOWERS USED EXTERNALLY 3.0 TIMES THE MINIMUM BASE DIMENSION

These recommendations are when all outriggers / stabilisers are in a supporting position. If the tower is exposed to movement, from the operations or are exposed to more than light winds physical ties must be used.

Stabilizers / outriggers may be used to increase the effective base size.

- Towers with stabilizers or outriggers should be moved only after any necessary dismantling to ensure that the height to platform level is not more than 2.5 times the effective least base dimensions.

- Mobile tower scaffolds must have wheels fitted at base with a locking device. Tower / mobile scaffold should be moved only when empty.

Climbing, using the horizontal members of the frames is not permitted. Access should be provided by attaching a ladder to narrow side or internally by providing inclined ladder.

A level surface should be provided for mobile towers.

4.48.3 Tower Scaffolds (Not Access Towers)

- Stationery tower scaffolds from tube and fittings should be erected and used on firm ground, fitted with metal base plates and, unless the foundations are concrete or other solid material, the load should be spread by timber sole plates.

- Bracing should be fitted at ledgers and transoms by right angle couplets, braced either by Diagonal bracing in zigzag fashion to the full height of the tower on all four sides, or any other designed method.

Pre-designed modular Tower Scaffolds may be preferred.

4.49 CONSTRUCTION GOODS HOISTS

Construction goods hoists must be installed and tested by a competent person in accordance with the manufactures instructions.

An enclosure of at least 2 meters high must be erected around the hoist way at ground level with suitable gates giving access to the platform / cage. Same system shall be used at every level.

- Operator hoist must be competent and adequately trained.
- All operations are conducted from a position outside the hoist at a point where they have a clear view of the platform throughout its travel,
- All gates are closed and unobstructed when the platform is in motion,
- No one travels on the hoist platform,
- The hoist is never left unattended with the engine running and the platform must be at ground level when not in use, and effectively immobilized at the end of normal working hours.
- Limit switches to be installed on hoists

The safe working load must be clearly marked on the platform or cage and must not be loaded more than safe working load. Proper notices should be displayed for the hoist.

Any loose materials, such as bricks, must be placed in containers.

4.50 WORK AT HEIGHT

Any work more than two meters and above from any level will be termed as work at height. Contractor is responsible for provision of safe access up to work location, temporary working platform with proper railing, life line or a fixed point to secure lanyards of harnesses, safety net to arrest fall of person / material, fall arrestors with ladders having proper landing and fall retractable where required.

Working at height should start from 6 feet and any personal working above 6 feet should be 100% tied off either with full body harness or retractable.

Railing must be made of MS pipe having top and mid rail and toe board (150 mm width). Railing pipe must be free from defects: bend, pitting etc.

Anchoring of safety harness with temporary railing is not acceptable.

Racks and ducts must have adequate access and safe working platforms along with life line.

All height works shall be suspended during rains, high wind and extreme cold weather.

Scattered working needs to be adhered to, where multiple tier works are in progress.

4.50.1 Cutout and openings

Contractor shall ensure that all cutouts and openings are properly covered with suitable warning signage and barricaded at all times. Even under remote conditions, these should not be left uncovered. Provision of permanent covers is desired. Permit system must be enforced to have a control that these are covered after completion of required work.

Cutouts and openings should not be used for lifting materials.

4.50.2 Ladders and staircases

Ladders must be of good construction, sound material, light weight and made as per standard specifications. Ladders made of wood or with rebar rungs will not be permitted at site. Ladders shall be checked for defects such as worn rungs, loose tie rods, and split or frayed feet.

Ladder can be put in use only after inspection and approval.

The following controls are required.

- Straight and extension ladders and step ladders (10 feet and over) require a 6-foot length of 1/2" rope (manila or synthetic fiber) spliced to top rung.
- Straight and extension ladders require non-skid safety feet.
- Wooden painted ladders will not be acceptable on the project site.
- Purchase and use only approved ladders, for industrial use.
- Metal ladders shall not be used.
- All ladders must be inspected by a qualified inspector on a quarterly basis.
- Owners requirements for use of specific type of ladders i.e., fiberglass shall be complied with.

When a ladder is erected for use it must:

- have a good footing (level)
- be fixed at both top and bottom points of rest
- extend at least 1 meter above the top landing level
- Ladders are a means of access, and they should not be used as working platforms.
- Carrying of load while ascending and descending would not be allowed.
- Ladders to scaffolding shall be clamped at a minimum of two points and shall extend a minimum of 1.0 m above the level of the platform it accesses.
- All vertical ladders should be provided with fall arrestors and landing at every six meters.
- All staircases should have guardrails till permanent parapet or railings are installed.
- Use of rope ladder is strictly prohibited.
- Ladder clamp to be provided for secured the ladder instead uses of binding wire or other material.

4.50.3 Work platforms

All works to be carried out at a height greater than 6 feet above the ground level must be performed from a properly constructed and maintained working platform.
Safe access to all points of work should be provided in the form of suitable ladders / stairways located at appropriate interval, which should not be more than 15 m.

The working platform shall be,

- Wooden planks/MS Grating must be closely placed and well secured.
- At least 0.7m wide if used only as a footing,

- If used to store materials the width of the platform should be plus 0.7m in addition to existing,
- Provided with toe-boards of minimum 0.15m in height,
- Provided with handrails, knee rails and toe board,
- Constructed as close to the structure or building as possible with adequate back ties.

All working platforms shall be kept clean and free from grease, oil, rubble, debris or rubbish to ensure safe movement for personnel performing the works.

4.51 ELECTRICITY

The contractor shall appoint a competent person to the satisfaction of the engineer, on site who will be responsible for the control of all maintenance and repairs to any electrical switchboard, distribution board, hand tools, etc.

4.51.1 Power Supply

If the owners supply electricity, it will be provided at one point, which would be determined by the engineer. The supply would be of 230V, 50Hz, and single phase or of 440V, 50Hz, three phase. Power distribution beyond this point shall be through armored cable only. No deviation on this would be permitted. The provision of all connections and equipment required beyond this point shall be responsibility of the contractor.

All electrical works must be performed by electrician possessing valid license under the strict supervision of qualified electrical engineer. No works shall be executed in the absence of electrical engineer.

- All power distribution cables should be taken overhead with sufficient headroom.
- All switch boards, extension boards, etc. should be protected from rain and water. No water logging should be allowed around switchboards.
- Earth Leakage Circuit Breakers (ELCB) / Residual Current Circuit Breakers (RCCB), of rating 30mA, should be provided on all distribution boards and main switchboards. Their functioning must be checked at least once in a week by the ELCB test meter.
- Single switch multiple socket system would not be permitted. Independent Switch shall be made available for each socket.
- Connections must be made using industrial socket and plugs. Use of domestic socket and plug is not permitted. Only IP rated Plugs/ Sockets allowed.
- Approved fuses of good quality and correct ratings are permitted. Use of makeshift wires, conductors as fuse wire and cut out fuses are strictly prohibited. HRC fuse to be used in PDBs.
- Electrical maintenance workman must use wooden platforms, insulated tools and shock resistant safety shoes of rated capacity.
- Working on energized circuit / live wires would not be permitted. While working on live panels, there must be minimum two persons on single work location. Valid work permit shall be obtained to work on energized circuit.
- Place cable joints and distribution boards vertically at least 700 mm above the ground.
- Earth resistance to be checked on monthly basis and records to be maintained.
- Before providing any power earth pit network should be prepared and should be certified by Electrical engineer with all the values. Earth pit should have numbering system and regular maintenance with record should be maintained.
- Fire extinguisher/Sand buckets to be made available near panel.
- Single Line Diagram(SLD), Emergency contact numbers, Warning signs, Shock treatment charts to be displayed
- All incoming cables entry to be glanded, unused holes to be sealed.
- Double earthing shall be provided for all the electrical panels and metal body of all tools from 2 distinct earth pits.
- Special Check list for electrical checks that are to be performed during monsoon or wet climatic conditions shall be mentioned.
- Cable detectors, ELCB tester and Megger to be available with contractor.

- Basic electrical testing instruments to be available with contractors (LT and HT Merger, Multimeter, Clamp meter, Portable hand lamp), which are very useful during unprecedented construction power failures.
- IS marked rubber mats of required rating to be placed in front of the distribution boards/panels.

4.51.2 Electrically Operated Hand Tools

All electrically operated hand tools and cables would be periodically inspected by the contractor and properly earthed prior to their use.

- Use of lighting circuits for portable tools shall not be permitted.
- Portable tools shall not be used near inflammable vapour or gases.
- At no time shall two or more power tools be connected to a single power plug.
- Portable power tools must be of light weight, insulated body and equipped with dead man switch.
- For circuits having voltage over 250 V suitable warning labels should be posted such as "Danger-440V". Boards also shall be displayed during the repairs / maintenance.

4.51.3 Connections to / from Owner's Power Sources

Before connecting any electrical equipment to any power source or removing / rerouting any cable, belonging to the Owner, approval must be taken from client / consultant engineer.

4.51.4 Care of Cable

Periodic check shall be carried out for defective cables, cracked or perished insulation, loose joints in conduits, damaged fuse boxes and switchboards, loose pins, faulty sockets and defective earth wire. Kinking, twisting, binding or crushing of cables shall be avoided all the time.

No electrical equipment shall be left open or unsecured at the end of the day's work

4.51.5 Work at Night

For working at night adequate supervision and lighting shall be ensured by the contractor. Contractor's employees will not be allowed to work on live circuits and heavy critical erections at night unless special permission to the contrary has been obtained from the engineer.

For working beyond normal working hours prior approvals should be taken from HSE & Concern discipline engineer. Approval can be provided based on area light survey report and working condition.

Work permit and isolation of the electrical system before taking up the work would be necessary for all works of electrical maintenance.

Temporary site supplies and permanent installation should be installed in accordance with The Indian Electricity Rules and other relevant Indian Standards.

Before work commences, an assessment of the following characteristics of the proposed installation are:

- purpose, supplies and structure
- external influences
- compatibility of equipment
- maintainability of equipment

The inspections and tests required to be done before starting, are listed in IS-732 Part-III and Part I Section 10 of National Electrical Code (NEC) but the construction site user should satisfy him that the tests have been carried out. Written certificates should be completed for these tests.

The following are general safety rules to be followed:

- Low voltage 24V equipment should be used in confined spaces
- Electrical equipment used in flammable atmosphere should be of flameproof construction.
- Whenever work is to be done on an electrical circuit, the circuit should be isolated.
- All temporary electrical cables should be buried to a depth of two feet or laid overhead to a height of 10 feet.
- If electrical wires lay on the surface should be protected from damage due to vehicles passing on them / mechanical damage.
- Proper plugs should be used for tapping power supply. Inserting the leads into the sockets would not be allowed.
- Hand lamps should be provided with guards over the bulb to protect from mechanical damage.

4.52 WELDING SETS

- As far as possible D.C. Generator sets / Rectifiers should be used in preference to A.C. Transformer sets.
- The contractor shall get welding sets certified by the Owner's Elec. Engineer before start of work and shall obtain a certificate valid for a period of three months renewable after every three months.
- A copy of the certificate shall be displayed on respective welding sets.
- The length of supply cable to welding set shall not exceed 5 Meters and the body of the welding set shall be properly earthed.
- Fire extinguisher shall always be carried with each welding set, preferably a dry chemical powder type.
- DC type transformer welding machines shall not be allowed and shall be prohibited.
- Welding transformer to be kept away from any wet area and shall be located close to work site.
- The body of the welding transformer shall be properly earthed.
- The length of supply cable to welding transformer shall not exceed 5 m.
- The size of the cable used shall be proportional to the voltage supply.
- Damaged supply and lead cables are not used.
- Ensure use of Lugs for connecting the lead and return cables with welding transformer.
- The welding transformer shall have separate on/ off switch.
- The electrode holder handle shall be of non-metallic body.

4.53 COMPRESSED GASES AND COMBUSTIBLE LIQUIDS

4.53.1 Gases

- Cylinders must have valve protection caps at all times.
- All compressed gas cylinders shall be used, stored and transported in an upright position.
- Compressed gas storage facilities shall be positioned at a sufficient distance from work area, offices and roads in such a manner as not to cause a hazard to employees, facilities and / or other contractors.
- Cylinders should be stored in suitably designed racks, which must have chains so that any number of cylinders can be securely and safely stored.
- Signs indicating the contents with separate storage for "full" or "empty" shall be displayed. Warning signs must be posted – "DANGER – HIGHLY FLAMMABLE – NO SMOKING OR NAKED FLAME". Fire extinguisher shall be located within accessible distance.
- Oxygen cylinder shall be separated from other combustible gas, oil or grease.
- The storage of gas cylinders shall be according to statutory regulations pertaining to the use of industrial gases and gas cylinder rules.
- Conduct daily gas leak test using soap water solution and maintain records.
- During work, cylinders must be kept upright duly chained at two locations in trolley along with cylinder key.

- Approved Flash Back Arrestors must be provided with Oxygen and DA / LPG cylinders at both cylinder and torch ends. All gas cutting set accessories must confirm to relevant Indian/International standards including torch, regulators & hoses.
- If contractors are using LPG, it must be of industrial cutting gas and necessary approval to be taken from consultant / client. Domestic LPG cylinders are not allowed.
- All the rubber hose, cutting torch, pressure gauge & Flash back arrestor used at site should have a valid TC from the manufacture or in case of old item TPI should be submitted

4.53.2 Combustible Liquids

- Flammable and combustible liquids must be stored in a metal storage cabinet with a prominent notice – "FLAMMABLE – NO NAKED FLAME".
- The area should be well ventilated and free from flammable material & water logging.
- Suitable fire extinguishers must be approachable and located adjacent to the cabinet.
- Code of practice for storage of compressed gases and combustible liquids shall be followed.
- Full cylinders must always be stored in an area away from empty ones and all cylinders secured in an upright position.
- All cylinders, valves and equipment shall free from oil and grease, secured in an upright position and when not in use have the valves shut with cap on.
- Under no circumstances oxygen cylinders are stored with liquefied petroleum gas cylinders, or within three meters of an LPG storage area.
- Cylinders must be stored in an area, which is under cover to protect them from extreme weather, well ventilated, and away from flammable materials, solvents or excessive heat.
- Store in such a position to be easily moved in the event of a fire.
- Cylinders should not be subjected to rough treatment, if moved by mechanical means then a cradle or strip must be used, lifting by the neck or valves is not permitted.
- For transportation of flammable liquids like diesel & petrol Metal Gerry cans should be used. Plastic cans should not be allowed inside construction area.

4.53.3 Acetylene Cylinders

Storage precautions are the same as for oxygen cylinders with additional points to observe.

- Acetylene should be kept away from copper and alloys containing more than 70% copper.
- Must be stored and used in well-ventilated areas due to a narcotic effect if inhaled.

Check the code of practice for storage of gas cylinders.

4.54 COMPRESSED AIR

Air receivers / compressors shall be:

- In good condition and properly maintained.
- Individually identified and marked with their safe working pressure.
- Be accompanied by a valid Third Party Inspection report
- Fitted with a properly set pressure relief valve.
- Examined and the pressure relief valve tested by an independent examiner.
- A register containing relevant details about the air receivers, compressors shall be maintained at site such as identification numbers, dates of inspections, pressure ratings etc.
- All compressed air fittings shall be wired and / or restrained to prevent them from whipping should the coupling separate.
- Only hose clamps designed for compressed air service shall be used. Worm drive (jubilee) clips are not acceptable.

<u>COMPRESSED AIR MUST NEVER BE USED FOR CLEANING CLOTHES AND DUSTING BODY PARTS</u>

4.55 WELDING AND CUTTING (CHECK IF A PERMIT IS REQUIRED)

Safety procedures for welding and cutting have been elaborated below.

Gas cylinders used in cutting and welding shall: (follow all safety procedures mentioned for oxygen / acetylene gas cylinders).

- When handling cylinders, ensure hands, clothes, gloves, etc. are free from oil, dirt, grit and grease. Under no circumstances oil shall be allowed to contaminate a cylinder containing oxygen.
- All gas and oxygen regulators shall be fitted with flashback arresters, being non-return valves designed to prevent an explosive mix developing in either cylinder, they are must before use.
- Prior to use, all equipment shall be thoroughly checked to ensure tight connections, condition of hoses and gauge.
- The welders shall wear good quality insulated welding gloves and use proper welding shields for eye protection and welding holders shall be of insulated type with finger guard.
- The helper engaged with the welder should also have proper eye protection. Holding a piece of broken colored glass is not permitted.
- When not in use, power supply to the holder and electrode must be turned off.
- Work area beneath or adjacent to fabrication of welding works shall be made free from combustible materials and cordoned-off to prevent personnel being injured by weld spatter or molten metal.
- Placing of cylinders directly beneath the work area shall not be permitted.
- Hoses to be protected from damages.
- Arrangements of booths and trays to contain bright light of welding and spatters and molten metal are required.
- To obviate fire hazard, keep work area free from rubbish and flammable material.

Good ventilation must always be provided during gas welding works.

4.56 LIFTING OPERATIONS

Lifting machine, chains, ropes and lifting tackles used by the contractor on site must conform to the following,

- All parts must be of good construction, sound material, and adequate strength and free from defects.
- Must be properly maintained, thoroughly examined and load tested by the contractor's competent person regularly.
- Conduct lifting lug integrity test prior to lifting old equipment's.
- No lifting machine and no chain, rope or lifting tackle should, except for the purpose of test, be loaded beyond safe working load and this safe working load must be plainly marked on the gear concerned.

Note: It is to be ensured that all lifting operations & erections are performed and fully completed during day light. Under no circumstance it should be done thereafter.

The contractor shall offer his tools and tackles for inspection and approval of owner's Engineer/ Supervisor before start of work. Contractor shall produce valid Test- Certificates from Govt. approved certifying authorities for all of his lifting gear and hoists (Slings, chains, hooks, chain-pulley blocks, winches, hoists, cranes, etc.) as well as Electrical, Pneumatic and Hydraulic equipment and appliances.

These certificates shall be retained at the site with the contractor's Supervisor/ Site-in-charge for subsequent spot checks also.

4.56.1 Man Basket

- Must be designed by an engineer and certified by a competent person
- Provide four separate slings of suitable capacity with lifting hooks (duly tested) and individual sling with hook to anchor safety harness of the people boarded
- Gate should open inward and should have lock arrangement.

4.56.2 Crane & Rigging

The contractor shall appoint a suitably qualified and experienced person to act as supervisor for rigging and lifting works. His responsibilities shall include preparation of the 'rigging plan', and the safe rigging and lifting of the load at work site. Contractor shall submit their rigging plan/ lifting plan for approval one week before commencement of job.

All works involving the use of a crane shall be properly planned in advance and a 'rigging study' carried out to ensure that:

- The crane is capable of lifting the load, given the known working radius, boom length, weight of the load, etc.
- The condition of the ground at the crane location is satisfactory to support the crane and the load.
- The rotation of the cab, and therefore the boom is not restricted.
- The load should be able to freely rotate 360º without touching the boom when the load has been lifted to the maximum required height.
- Suitable 'matting' or plates are available to protect underground services and paving.
- All slings, shackles, hook, etc., of the correct rating are available and in good condition (i.e. without lapping, knots or artificial extensions).
- Outriggers must be fully extended and placed on wooden sleepers with MS plate for resting of outriggers.
- Cranes must be equipped with automatic Safe Load Indicators.

Crane hooks shall be fitted with properly functioning safety latch to prevent the displacement of the sling from the hook during the lift.

For wheeled cranes outriggers shall be used for each lift, regardless of the size, shape and load always be fully extended.

Shackles shall be complete with the original pin and under no circumstances shall a substitute bolt be fitted.

A 'trial' lift shall be carried out, raising the load a short distance above its pick-up point, to check the stability of the crane, and the efficiency of the brakes.

Only one person, usually the Supervising Rigger, shall give instructions to the crane operator.

CONTRACTOR shall arrange medical fitness (with test reports) of crane operator from registered medical practitioner every half-year.

At no time whilst the crane's machinery is running, shall the operator leave the cabin.

At no time whilst a load is suspended shall the crane's engine(s) be intentionally turned off.

At no time whilst a load is suspended shall personnel perform any works directly beneath.

Particular consideration to the presence of low-level structures such as pipe badges shall be given where crane is to move about the site.

Consideration shall be given to prevailing weather conditions, and where a greater than normal risk exists, the lift shall be postponed until more favorable condition develop.

The training, skill and experience of the crane operator and crew are important element of a properly organised lifting operation. For day-to-day routine crane operations, careful selection of the most suitable type of crane, plus the establishment of a safe system and method of work would be essential.

The statutory provisions, which apply to lifting operations during construction operations, are contained in Building & Other Construction Workers' (Regulation of Employment and Conditions of Service) Act 1996 and Rules, 1998.

Every contract agreement for a Contract Lifting Operation should state the following:

- That all work will be carried out in accordance with safe practices, and that the contractor will appoint one person to have overall control of the Lifting Operation

The following item should be checked before allowing the crane to work:

- Crane more than 15 years old shall not be allowed to deploy at site.
- Certificate of Testing and Examination issued by a competent person as per statutory rules.
- Record of the periodic inspections on the crane, signed by a valid competent person of contracting agency.
- That the lifting equipment to be used is suitable for the job and that the test certificates for such items are available and submit the same for review of consultant. All such documents shall be subjected to audit by consultant and joint inspection shall be carried out. CONTRACTOR shall ensure issuance of relevant stickers with validity up to 1 month issued by consultant.
- The crane hook is provided with safety latch.

Loads should only be moved when the signaler can see the load *and* communicate with the driver.

- Copies of the sling chart and safe working load tables shall be used.
- The counter weight of the crane and boom movement area shall be cordoned off.
- No one should ride on load being slung.
- Tag lines (Min. two lines) should be used to control load swinging.
- Load shall not be lifted if there are knots / kinks in the slings.

4.56.3 Lifting Gear

The severe usage to which lifting gear is often subjected, may result in failure, it is important that attention be paid to the correct use and maintenance of such lifting gear. This can best be achieved by:

- Good design and workmanship
- Careful testing and inspection after manufacture or repair and regular maintenance.
- Detailed planning, correct and careful use of the gear and storage under cover

When 'U' clamps are used on wire rope slings the rounded portion of 'U' clamp shall be on the free end of the wire rope. Minimum 3 no's of 'U' clamps shall be used for splicing and more clamps required depending upon the diameter.

The Safe Working Load (SWL) markings on an item of lifting equipment shall be inspected before it is used. These numbers are normally stamped on to the master eye or ferrule of slings and the body of eyebolts, shackles, etc. Alternatively, metal tabs, which bear this information, may be fitted to slings. On web slings the information may be on a label stitched into the sling, normally at the eye, and they may be additionally colour coded to identify SWL.

4.57 MANUAL HANDLING

Building & Other Construction Workers' (Regulation of Employment and Conditions of Service) Act 1996 requires employers to make a suitable and sufficient assessment of the risks to the health and safety of their employees while at work. Where this general assessment indicates

the possibility of risks to employees from the manual handling of loads the requirements of the present regulations should be observed, as follows:

- Avoid hazardous manual handling operations so far as is reasonably practicable
- Assess any hazardous manual handling operations that cannot be avoided, and reduce the risk of injury so far as is reasonably practicable

Where, load-handling operations are essential, consideration should be given to the use of mechanical handling, for example by the use of lifting appliances or fork lifts. The contractors should consider the use of such mechanical aids at the planning stage of their activities. Capability of employees to follow the advice in case of material handling should be considered in making assessments.

4.58 ABRASIVE WHEELS

Before any abrasive wheel / disc / cutter / side grinder is mounted on a grinding machine, the person mounting the wheel shall be fully trained and competent to do the job.

Selecting the right abrasive wheel for a particular application is critical.

Abrasive wheels must always remain dry; these must be destroyed if got wet or humidified. Conduct knock test and check for expiry date prior to use.
Only reinforced resin-bonded or resin-bonded abrasive wheels must be used with portable grinding machines. As the most serious injuries involving abrasive wheel occur when wheels burst and flying fragments strike people in the vicinity.
Grinding machines are marked with the maximum working speeds of their spindles, whilst abrasive wheels are marked with the maximum speed at which they may be operated. Speed of machine must never exceed the speed of abrasive wheel.

Eye protection along with face shield shall be worn during all grinding operations. Protection for those not involved in the operations shall also be protected by the erection of screens, or barriers to keep personnel out of the danger zone.

4.59 WORK IN CONFINED SPACES

A confined space is any enclosed or partially enclosed area where there is a possibility that the atmosphere or conditions may become injurious to health and safety of persons entering. The danger may be as a direct result of a process being undertaken by persons within the confined space or:

- Oxygen enrichment
- Oxygen deficiency
- Flammable atmosphere
- Accumulation of flammable or toxic fumes

All entry into confined spaces shall be controlled by means of a “permit to work”. Persons authorizing entry into confined spaces must have the necessary competence to issue any permits, and to check for contamination and / or dangerous atmospheres.

Natural / mechanized means must be administered for circulation of fresh breathable air.

Ensure provision of educator during hot work inside the confined space and Emergency rescue arrangement

Strictly use of 24 V supply and flame proof hand lamps / lights / portable power hand tools, are permitted.

Entry Requirements:

Safety precautions, restrictions of the operations and personal protection will be identified on the permit to work. Check if retrieval / harnesses are required. A standby man is required outside the confined space. Air / Gas detectors will normally be required.

Maintain & display – Entry and Exit log sheet at the entrance of confined space.

Provide ladders, minimum at two locations, at a distance of 15 meters or part thereof, to enable easy egress of people during exigency.

4.59.1 Roles & Responsibility

- Entrants:
  - To complete the confined spaces training course.
  - To use personal Protective Equipment as directed.
  - To verify that atmospheric tests have been conducted and the results are known.
  - Enter the confined spaces only after ensuring all the precautions have been completed.
  - To alert the attendant and exit confined spaces whenever: -
    a. Any warning sign or symptoms of exposure to a dangerous situation is recognized.
    b. A prohibited condition is noted.
  - To exit confined spaces if attendant orders an evacuation.

- Attendants:
  The duties of the attendant(s) or standby person(s) outside the confined space are specifically related to those inside the enclosed space and include:
  - To check person(s) into, and out of, the confined spaces.
  - To be alert to all situations which may adversely effect those inside, including the danger of leaving the space unattended.
  - To maintain continuous contact (visually or verbally) with personnel inside.
  - To summon help if anyone inside gets into difficulties, e.g. via phone or radio communications.
  - To be aware of possible behavioural effects of exposure to low oxygen or toxic chemicals.
  - To order entrants to evacuate confined spaces if;-
    a. Condition is detected that the Entry Permit forbids.
    b. Symptoms or behavioural effects of exposure are detected.
    c. A situation that could endanger the entrants is detected inside or outside the confined spaces.
  - To warn unauthorized person(s) to keep away from the confined spaces.
  - To be trained in first aid and cardiac pulmonary resuscitation.

- Entry Supervisors.
  - To ensure that the entrants and attendants are properly trained and competent.
  - To identify hazards of the confined spaces.
  - To prepare the Entry Permit. Prepare SPA and attached it with permit.
  - To post the approved Entry Permit in a conspicuous location near the entrance of the confined space and use the Entry Permit to ensure necessary safety precautions have been taken.
  - To verify that the confined space and equipment within the confined space have been appropriately isolated and locked-out/tagged-out in accordance with the Permit to Work System.
  - To ensure that atmospheric tests have been conducted and that the results meet the acceptable environmental standards.
  - To verify that the required alarms, ventilation equipment, monitoring equipment, communications equipment, and rescue equipment are present and operational.
  - To ensure that entry operations are consistent with the terms of the Entry Permit and that acceptable environmental conditions are present.

- To cancel the Entry Permit and terminate entry if acceptable environmental conditions are not present or if the conditions or work procedures described on the Entry Permit change.
- To take the necessary measures to conclude the entry operation, such as closing off the confined space and cancelling the Entry Permit once the work inside the confined space has been completed.

4.59.2 Rescue.

The procedure for rescue in an emergency will be set out clearly in the safe system of work wi th specific jobs allocated to specific persons.

Training should ensure that if a rescue becomes necessary, all persons concerned are thorou ghly familiar with the routine procedures through frequent practice drills.

The essentials for rescuing someone from a confined space are that:

1) The outside observer must have means of knowing immediately that a person is gassed or has met with an accident.
2) The rescue team, alerted by the observer, must get the casualty out into free air speedily.
3) The casualty must be given first aid quickly, either at the work location or immediately they are brought out into free air, and the appropriate medical attention as soon thereaf ter as possible.

4.59.3 Rescue equipment.

The rescue equipment as identified in SPA as part of risk assessment should be available at site include breathing apparatus, resuscitation apparatus and oxygen. It should include as pe r job requirement:

1) 2 safety harnesses with adequate length of rope taking account of the workplace location.
2) Intrinsically safe hand torches.
3) At least 1 set of suitable breathing apparatus and emergency breathing pack.
4) First aid equipment.
5) Firefighting apparatus.
6) Emergency breathing pack.
7) Audible alarm for summoning help.
8) Resuscitation equipment.
9) Means of communication with the surface observer.

4.59.4 Entry for rescue.

Where the casualty has had an accident, and is injured in an atmosphere certified on entry a s safe, rescuers can enter without breathing apparatus provided there are no indications that the atmosphere has become unsafe.

Where, however, the casualty has collapsed and the cause is not known, then rescuers must wear breathing apparatus. This applies even if, when the person entered the confined s pace, it was certified as safe to enter. The reason for the collapse could be an overall deterioration in the atmosphere since entry was made, or a deterioration in the particular area where the casualty has been overcome.

4.60 CONTRACTORS TOOLS & EQUIPMENT

The following four basic principles shall be applied to and govern the safe use of hand and power tools and principles are:

- Choose the right tool for the job;
- Use only tools in good conditions;
- Use the tools correctly.

High speed rotating equipment, such as grinders, shall be fitted with protective guards.

Spark Arresters shall be fitted to all equipment exhausts where a risk of combustible gases in the atmosphere exists. CCOE approved Spark Arrestor to be fitted.

- Electrical trip switches must work effectively and must not be removed or bypassed.
- Contractors shall provide suitable storage with suitable racks and bins for storing tools and equipment.
- The contractor shall nominate or employ the services of a competent qualified electrician to inspect and tag electrical power hand tools transformers, distributing boards, extension cables etc on an at least quarterly basis. The tag shall display name, signature of the individual inspecting the tool, date of inspection.
- The contractor shall keep, on site, a register of all electrical power hand tools in use giving all relevant details about the tool and its inspection.
- No electrical powered hand tool shall be used other than it is tagged with a current "INSPECTION" tag.
- All electrical leads must be connected to the power source through standard industrial waterproofed plugs and sockets, which shall be in good condition.
- While working at higher elevation, adequate precaution to be taken to ensure that they do not fall down.
- Metal body of all tools shall be properly earthed.
- For work near flammable material or flammable atmosphere, special tools made of non-ferrous metals for the purpose shall be used to avoid sparking.
- Lifting tools & tackles, machines and power hand tools must be examined monthly and colour coded as per the ***Attachment – 7.4***.
- All lifting tools, tackles & machines and Pressure plants & equipment; must be got examined and certified by the Competent Person prior to use (irrespective of new purchase & having manufacturers test certificate) under the provisions of law within the stipulated time frame.

4.61 MACHINE GUARDING

All moving parts of the machine must be guarded such that a person should not be able to reach the moving part of machinery.

4.62 HIGH PRESSURE TESTING

- Contractor needs to get the scheme approved at least 72 hours prior to commencement from the consultant stating the safety precautions adhered to will be with hydraulic / pneumatic procedure.
- Do not exceed the pressure more than specified.
- Test area must be barricaded, warning signs displayed and manned.
- People should not remain in front of flange joints and hoses which can injure on bursting. Provide barriers and screens to arrest the flying material / bursting during the course and to obviate injury to the people working in vicinity.
- Provision of calibrated and certified hoses, pressure gauge and pressure relief valve installation at the highest point is must. No testing shall commence in absence of these.
- Make sure blinds used are of adequate thickness as per standard specification.

4.63 PIPELINE FLUSHING

Utmost care needs to be taken during pipeline flushing activity, high pressure air and steam purging and card board blasting. People working at the outlet end should be made aware of very high noise and ejection of material while card board blasting. Barrier curtain should be provided at outlet to prevent flying of left over material, rubbish and water in the pipeline to obviate personnel injury. These activities should be controlled with the permit system

4.64 MOBILE PHONE

Mobile communication is subjected to the permission of the Client / Owner. Carrying mobile in running refineries and chemical plants is STRICTLY prohibited. Where permitted, contractor shall ensure that employees

- Refrain from using mobile while working at height and carrying out any critical activity
- Do not use mobile phone while driving and when necessary, park the vehicle aside and attend to calls.
- Do not play music at work site while doing any site activity or while driving.

4.65 SUSPENSION OF WORK

If the contractor is found by the engineer not complying and or persisting in non-compliance with safety requirements or with statutory obligations, the engineer may suspend his work at any time by notice, in writing, and the work shall not be resumed unless and until the engineer shall cancel in writing his suspension order. The Engineers decision in this matter shall be final. No claims arising from such suspension shall be made by contractor.

4.66 LIQUIDATED DAMAGES

The contractor shall take full care to implement provisions of HSE requirements. In case if the contractor is persisting with non-compliance, not complying with Critical Risk Management (CRM) expectations and Life Saving Rules (LSRs) and consultant / Owner would take action to terminate the contract after giving a reasonable time to improve. Consultant / Owner may impose stoppage of work without any cost and time implication to the Owner and or impose a suitable liquidated damage which would be up to 10% of contract value. It shall be directly deducted from contractor's bills.

The decision of imposing stop-work-instruction and imposition of damages lies with Consultant / Owner. The same shall be binding on the contractor. Imposition of damages does not make the contractor eligible to continue the work in unsafe manner.

4.67 ZERO TOLERANCE

All employees are expected to conduct themselves in a responsible manner. Consultant / Owner reserves the right to suspend or dismiss an employee for any of the following reasons:

- Not complying with expectations of Critical Risk Management (CRM) and Life Saving Rules(LSRs)
- Reporting for work when under the influence of non-prescription chemicals or alcohol
- Unsafe working at height – not using safety harness or not securing lanyard or 100% tie off not followed.
- Removing or making safety devices inoperative
- Gambling at site
- Carrying weapons
- Use of crane without permit.
- Working inside confined space without authorization.
- Work without work permit

Supervisors will be held responsible for unsafe actions of the employees under their supervision and will be subject to disciplinary action as deemed fit.

4.68 GRIT BLASTING

Procedure to be followed by the contractor for acceptance of hopper and connected equipment to be used for grit blasting inside work premises

- The hopper shall be constructed as a pressure vessel as per ***ASME Section VIII or applicable IS codes*** by a pressure vessel manufacturer using sound engineering practices and shall be free from defects as per local ***Factories Rules.***
- The hopper shall be offered for inspection to Consultant / Owner Inspection personnel through the Engineer-in-charge (EIC) immediately after bringing it inside work premises.
- Contractor shall produce all manufacturers' documents that include the ***fabrication drawings with weld details of the vessel, material test certificates, NDT/hydro-test reports and manufacturer's test certificate for the vessel***. The hopper shall be given a ***Unique Identification Tag Number by*** *Consultant / Owner*. The Unique Identification Tag Number shall be ***marked permanently*** on the vessel (engraved on the shell or on the name plate) and also painted on the vessel by the contractor.
- The hopper shall be offered for external inspection to Consultant / Owner inspection personnel. The recommendations of Consultant / Owner Inspection shall be carried out and on clearance, the vessel shall be offered for hydrostatic test by the contractor. The hydrostatic test pressure of the hopper shall be minimum of 1.5 times the MAWP (Maximum Allowable Working Pressure) of the receiver vessel in the compressor or 12.5 kg/cm2 (g).
- The hopper shall be fitted with a Pressure Safety valve (PSV) approved and certified by a competent person. Safety valve shall be adequately sized as per ASME Sec VIII. No isolation valve shall be installed during operation in upstream of the PSV. The PSV shall be offered for bench-test once in six months by the contractor to Consultant / Owner Inspection and the set pressure shall be the MAWP of the hopper i.e., 7 kg/cm2 (g). Capacity adequacy of the PSV shall be demonstrated at site by the contractor by raising the pressure of the hopper to 7 kg/cm2 (g) and checking if the PSV is able to reduce the pressure in the hopper on popping.
- A calibrated pressure gauge shall be fixed on the hopper with range of 1.5 to 2 times the working pressure of the hopper and the calibration certificate shall be submitted to the Engineer-in-charge (EIC).
- The contractor shall get the hopper externally examined (once in 6 months) and hydrotested (once in 2 years) by a competent authority as per local Factories Rule.
- The air compressor that supplies compressed air for the blasting operation shall have the following features:

- The unloading of the compressor shall be at the ***maximum allowable working pressure of the receiver vessel in the compressor i.e. 8.5 kg/cm2 (g).***
- The receiver vessel shall be of ***ASME Section VIII or applicable IS code construction***. The same shall be considered as a pressure vessel and the contractor shall get the same ***externally inspected (once in 6 months) and hydro-tested (once in 2 year***s) by a competent authority as per local Factories Rule. The copy of the test certificates shall be submitted to the EIC.
- The compressor receiver vessel shall have a maximum allowable working pressure of 8.5 kg/cm2 (g) and the ***pressure safety valve on the receiver vessel shall be bench tested at*** Consultant / Owner ***before usage***, and at a frequency of once every year and shall be set to open at 8.5 kg/cm2 (g) (MAWP of the receiver vessel).

- The hoses used for grit blasting operation shall be of good quality make and the manufacturer's test certificate for the same shall be submitted to the EIC. Prior to usage at site, ***the same have to be offered for a hydro-test of 20 kg/cm2 (g)*** to Consultant / Owner Inspection for clearance.
- On compliance to all the above requirements and necessary clearances from Consultant / Owner Inspection and Competent authority, the contractor shall apply to the Joint Director of Industrial Safety & Health, vide ***Form 8 (B) – Application for testing or examination of pressure vessel or plant*** (as per Factories Rules) paying the applicable Inspection fee). Form shall be obtained from the EIC for the hopper and the receiver vessel of the compressor. A copy of the application along with acknowledgement from the Office of the Joint Director of Industrial Safety & Health shall be handed over to the EIC.

- The contractor shall arrange for necessary External Inspection (once in 6 months) & hydro-static inspection (once in 2 years) as prescribed under factory Rule by Directorate of Industrial Safety & Health and obtain necessary certification vide ***Form 8 – Report of examination of pressure vessel*** (as per Factories Rules) for the hopper and receiver vessel of the compressor. A copy of the Form-8 certified by the Directorate of Industrial Safety & Health shall be submitted to the Engineer-in-charge (EIC). Certificate validity details shall be painted on the hopper and air receiver vessel of the compressor.
- The contractor shall use the hopper only after completion of all above procedures and receipt of approval from Factory Inspectorate and clearance is accorded by the EIC for usage and only till the period it is accepted for. ***Before obtaining clearance, the hopper or its auxiliaries shall not be used by the contractor inside work premises***.
- ***As and when the job is completed, the hopper shall be de-mobilized from work premises immediately***. The same shall be communicated to Joint Director of Industrial Safety & Health, through a letter mentioning the unique identification tag number given by Consultant / Owner . The acknowledgment of the communication shall be forwarded to the EIC immediately.

Procedure to be followed by the contractor for hopper and connected equipment in service

- Prior to usage of the hopper, the opening of the safety valve at the desired set pressure (7 kg/cm2 (g)) shall be checked by the contractor and a register shall be maintained in which the same shall be ***recorded on a daily basis*** when in use.
- While operating the compressor, ***a trained compressor operator*** shall be available on continuous basis to monitor the operating parameters and perform periodical checks to ensure working of the equipment as per the operating manual.

4.69 SAFETY DURING PRE-COMMISSIONING AND COMMISSIONING

During Pre-commissioning & commissioning phase of the project, Contractor shall ensure compliance of Consultant Procedure & checklists as attached in Attachment – 7.16.

4.70 PENALTY OR DISCIPLINARY ACTION FOR NON-CONFORMANCE

Based on client approval and recommendation in contract requirement, Contractor shall be penalized or disciplinary action shall be taken against contractor employees based on severity of safety violation. as per Attachment – 7.20.

4.71 DEVIATION

If contractor requires any deviation on any of the above points, contractor shall require to take prior approval from consultant / client construction manager.

5.0 RELATED DOCUMENTATION (REFERENCES)

- The Factories Act 1948
- The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996
- Jacobs Global HSE Procedures

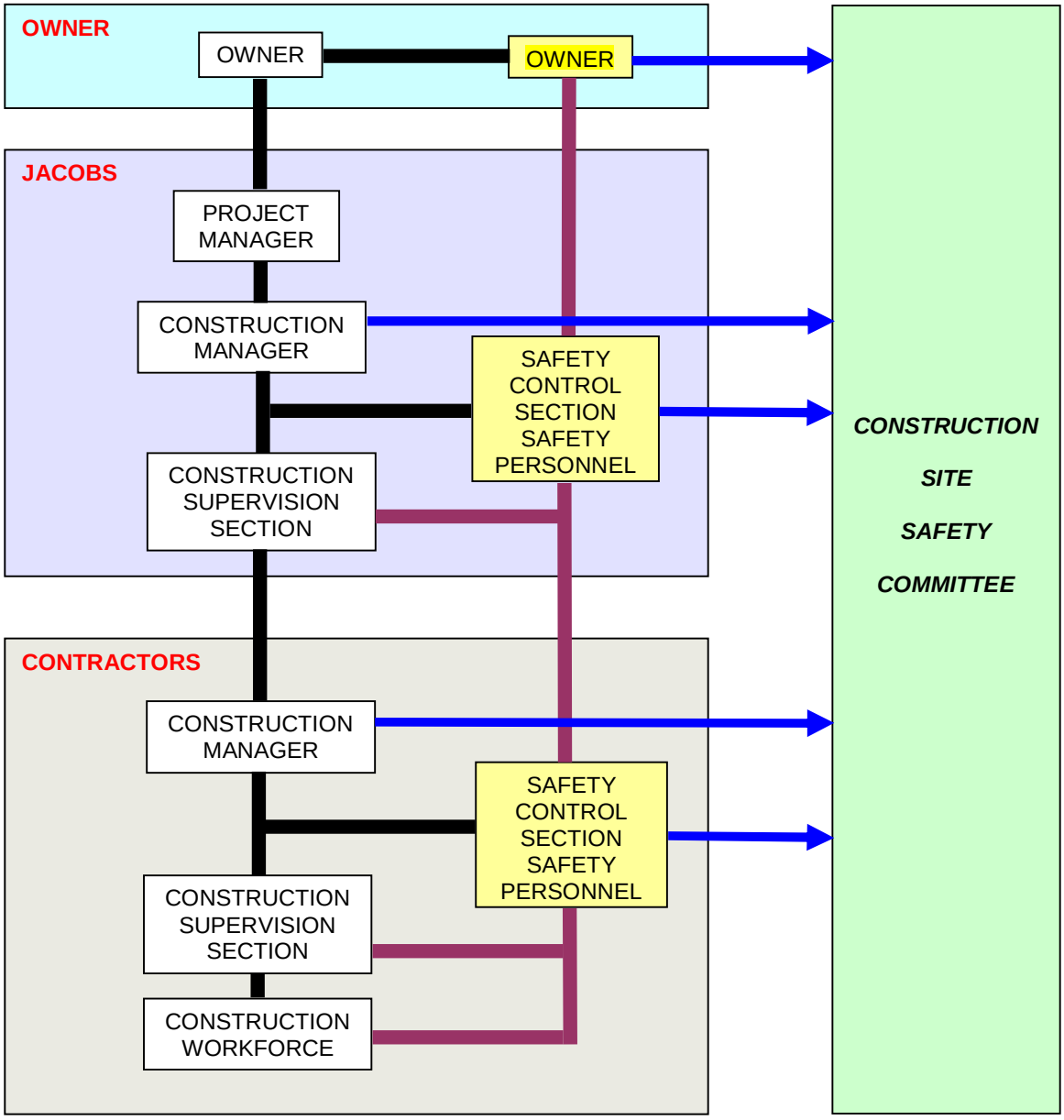
6.0 RECORDS

Contractor shall maintain following records at project site till project completion

- SOR
- SPA
- Site HSE Inspection checklist
- Incident Records
- HSE Assurance Record
- Weekly and Monthly Safety Report

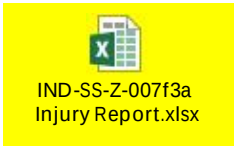
7.0 ATTACHMENTS

7.1 SITE SAFETY ORGANIZATION CHART



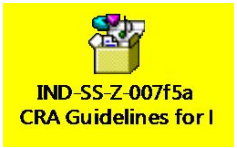
7.2 CONTRACTOR SAFETY AUDIT CHECKLIST

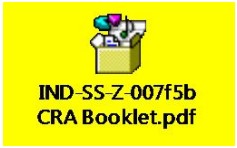
7.3 INCIDENT INVESTIGATION REPORT



7.4 MONTHLY COLOR CODE

7.5 CRITICAL RISK TOOLS





7.6 LIFE SAVING RULES POSTERS

7.7 MONTHLY HEALTH, SAFETY & ENVIRONMENT (HSE) REPORT

(To be submitted by each Contractor)

Date of Starting Work: For the month of:

Project :

Name of Contractor: Name of Work:

Sr. No.	Item	This Month	Cumulative
1	Total Strength (Staff + Workmen)		
2	Number of HSE meetings organized at site		
3	Whether workmen compensation policy taken		
4	Whether workmen compensation policy is valid		
5	Whether workmen registered under ESI Act		
6	Number of Fatal Accidents		
7	Number of Lost Time Accidents (other than Fatal)		
8	Other accidents (Non Lost Time)		
9	Total No. of Accidents		
10	Total work-hours worked		
11	Accidents without Injury (Dangerous occurrences)		
12	Compensation cases raised with Insurance		
13	Compensation cases resolved and paid to workmen		
Remarks :			

Please mark**: 'Yes'** or **'No'** in Item No. 3, 4 & 5.

Safety Officer Site Manager

7.8 MONTHLY SAFETY STATISTICS

Project:	Period:
Name of Contractor:	Name of Work:
Number of Personnel on Site:	Total Hours Worked:

SUMMARY

Number of Fatalities

Number of Recordable Incidents

Number of Lost Time Incidents

Number of First aid Cases

	CLASSIFICATION OF CAUSE		I *	R *	LT*	F *
1.	Falls of Persons	-				
2.	Falls of Materials	-				
3.	Trench Collapses	-				
4.	Transport including Mobile Cranes	-				
5.	Handling Materials	-				
6.	Stepping on or striking objects	-				
7.	Hand Tools (other than power driven)	-				
8.	Mechanical Equipment including power tools	-				
9.	Electricity	-				
10.	Toxic or harmful substances	-				
11.	Fire or Burns	-				
12.	Other causes (specify as appropriate)	-				
		Total				

' * '

I : Safety Incident **R** = Recordable
LT : Lost time **F** = Fatal

Safety Officer

Site Manager
Date:

7.9 MEDICAL CERTIFICATE

Form for Medical Check Up for the Workmen engaged by the Contractor
To be issued on Doctor's printed letter head

Date

Certified, that I have examined Mr.
Aged Years His Gate Pass No. is

The details of his examination as required are given in the enclosed Medical Examination Report.

I certify that all clinical and pathological tests were done in my hospital under my instructions.

General and Physical examinations do not reveal any abnormality. He does not suffer from any acute / chronic diseases, skin diseases, any contagious & infectious diseases and hearing impairment.

* A. For Working at Height
  - He is medically fit to work up to any height above 1.5 meter since there is no history of Vertigo, Epilepsy or Fits, General Giddiness, Height related diseases and Height Phobia.
  - His Blood Pressure, Lung Function, Hearing Ability, Eye Sight, Pulse rate are normal.

* B. For Painter / Blaster (Grit / Shot / Copper slag)
  - He is medically fit to do the work of * Painter / * Blaster.
  - His Chest X-Ray and Pulmonary Function Test results are normal.

* C. For Driver / Rigging Gang
  - His eye vision is truly correct *without / *with correction glasses.
  - He needs correction glasses.
  - He has no hearing deficiency.

That in my opinion he is physically fit to perform the work.

Note: 1. * Strike off whichever is not applicable.
2. This certificate is valid for 180 days from the date of issue.

Signature of Workman		Stamp & Signature of Doctor
He has signed in my presence.		Qualification Registration No. Address

7.10 SAFE PLAN OF ACTION

Contractor:		Date : From To		Doc. No. & Rev. No.:	
Job / Task				Work Location / Area	
Job Description					
PPE Required	☐ Helmet ☐ Nose mask	☐ Safety Shoes/ Gumboot ☐ Hard hat with welding shield	☐ Safety Goggles ☐ Ear plug	☐ Hand gloves ☐ Face shield	☐ Full body double lanyard harness ☐ Fluorescent jackets ☐ Others:_____
Safety Device	☐ Safety Net ☐ Fire blanket	☐ Caution tape / hard barricading ☐ Lifeline/ fall arrestor	☐ Flashback arrestor ☐ Caution Signboard	☐ Fire Extinguisher ☐ Warning lights	☐ Others:_____

Steps of Task	Hazard / Reaction to Change	Safe Plan	Resources

Signatures of Person Involved in Development of SPA

Description	Contractor				Consultant	
	Prepared by (Supervisor)	**Checked by** (Lead)	**Reviewed by Safety**	**RCM**	**Lead Execution Engineer**	**Safety Officer**
Name						
Signature						
Company						
Date						

The signature of supervisor confirms the completion of hazard assessment and safe action plan
Supervisor Signature:_____ Date:_____

Instruction: 1) Write name of job or task in space provided; 2) Conduct walk-through survey of work area; 3) Write the steps of the task in a safe sequence; 4) List all possible hazards involved in each step and reaction to change; 5) In the safe plan column, state actions that will be taken to prevent the hazards or injury from reaction to change; 6) In resource column, list equipment , tools, etc needs to do the job; 8) Ensure each concerned team members sign the SPA; 9) If condition change, or job change or deficiency discovered in the plan or learning from an incident , stop the work and review & revise the SPA.

7.11 HSE ASSURANCE PLAN

Sr. No	Activity	Frequency		Extent of Checking					Remarks
		Operating	Checking	Contractors			Consultant	Owner	
				Area Engineer	Safety Supervisor	Safety Officer			
1	HSE Policy	Communicate to all working at Project site.	Once in the beginning.	As applicable			Review implementation system		Contractor to submit.
2	Safety committee	Through meetings at predefined interval.	To be formed consisting Owner, consultant, Contractor and Representatives of workers.						
3	Training (Induction and Periodic)	For everyone	**As per Training Matrix**						Entry passes to be issued only after induction.
4	Reporting								
4.1	Safety Statistics	Monthly	Monthly	NA	NA	Monthly	Monthly		
4.2	Weekly First Aid and Illness Reports	Weekly	Weekly	DC	Weekly	Once a Week	RAN		
4.3	Labour Report with Work hours	Daily	Daily	Daily	Daily	Daily	RAN		
4.4	Accident Reports	NB	**As applicable**						
4.5	Investigation Report	NB	**As applicable**						

HSE ASSURANCE PLAN

Sr. No	Activity	Frequency		Extent of Checking					Remarks
		Operating	Checking	Contractors			Consultant	Owner	
				Area Engineer	Safety Supervisor	Safety Officer			
5	Statutory requirements (Registration, Records of Payment, Licenses)	Regular	Once in 3 months	NA	NA	Monthly	Once in Quarter		
6	Facilities								
i	First Aid	Regular	RAN	N.A	Daily	RAN	RAN		Once in a Month
ii	Emergency care services (Doctor, Ambulance)	Advance arrangement.	RAN	N.A	Daily	Periodic	N.B.		Once in a Month
iii	Medical examination (Pre & Periodic)	Regular	Periodic	N.A	N.A	Periodic	N.B.		Once in a Month
iv	Temporary accommodation	In the beginning.	RAN	N.A	RAN	RAN	RAN		
v	Drinking Water tank	Filling every day, cleaning once a week.	Through Records	RAN	N.A	RAN	N.B		
vi	Urinals & Latrines	Daily sweeping arrangement.	RAN	N.A	RAN	RAN	RAN		If applicable
vii	Septic tank / Disposal system	In the beginning.	NB	N.A	RAN	RAN	RAN		If applicable

HSE ASSURANCE PLAN

Sr. No	Activity	Frequency		Extent of Checking					Remarks
		Operating	Checking	Contractors			Consultant	Owner	
				Area Engineer	Safety Supervisor	Safety Officer			
viii	Mosquito control	Once a week, disinfecting arrangement	Through records	N.A	RAN	RAN	RAN		If applicable
ix	Crèches for Children below 6 yrs.	Required if 50 or more females employed at site	RAN	N.A	Daily	Monthly	RAN		
x	Canteen	Required if more than 250 workers are employed.	RAN	N.A	Daily	Monthly	RAN		If applicable
xi	Waste disposal	Daily	RAN	N.A	Daily	Monthly	RAN		
7	Fire fighting system	NB	Once in a month	N.A	RAN	RAN	RAN		
8	Traffic rules	Daily	Daily	N.A	DC	RAN	RAN		
9	Use of PPE	Daily	Daily	**By all on regular basis.**					
10	Work permit system	NB	DC		DC	RAN	RAN		As applicable
11	Safety publicity	Continuous	Periodic	N.A	N.A	DC	RAN		
12	Excavation	NB	NB	DC	DC	RAN	RAN	NB	
13	Cutouts / openings	NB	Daily	DC	DC	RAN	RAN	NB	

HSE ASSURANCE PLAN

Sr. No	Activity	Frequency		Extent of Checking					Remarks
		Operating	Checking	Contractors			Consultant	Owner	
				Area Engineer	Safety Supervisor	Safety Officer			
14	Barricading	NB	Daily	DC	DC	RAN	RAN		
15	Scaffolds	NB	Regularly	DC	DC	DTC	RAN		
16	Ladders	NB	Regularly	RAN	RAN	RAN	RAN		
17	Welding / Cutting M/C.	NB	Once in 3 months	DC	DC	DC	RAN	NB	
18	Elect. Hand tools & Distribution Boards.	NB	--"--	DC	DC	RAN	RAN	NB	
19	ELCB / RCCB	On Installation	Weekly	DC	DC	DC	RAN	NB	
20	Mechanical Equipment	NB	Once in 6 months	DC	DC	DTC	RAN	NB	
21	Load tests	For Heavy lifts.		DC	N.A	DTC	DTC		Formal procedure Required for heavy Lifts

Note:
1. Contractors would be required to maintain records of inspection.
2. Contractor will comply with any additional checks asked by consultant during execution of work from time to time.
3. Consultant / Owner will have right to increase extent of checks.

Legends: -

DC	:	Detail checking (100%),
DTC	:	Check in detail for critical items,
RAN	:	Random verification,
NB	:	Need based (involving co-ordination with Owner).
NA	:	Not applicable
I	:	Issue

7.12 HSE – TRAINING ACTIVITIES

Sr. No.	Activity	Training Hours Month-wise																Remarks
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
1	Induction																	Daily
2	Toolbox Talks																	Daily
3	Fire Fighting																	Four times over Project period
4	First Aid																	Two times
5	Emergency Response																	Every Quarter
6	Risk Analysis																	For every new activity
7	Safe Plan of Action																	For all activities

N.B. : Contractors to conduct for Labour as well as Supervisor / Engineer.

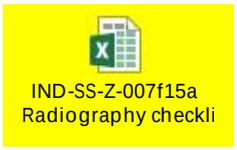
7.13 LEGAL OBLIGATIONS

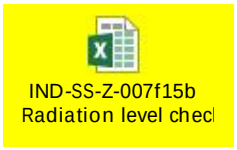
- Building and other Construction Workers' Act, 1996.
- Buildings & other Construction Workers' Welfare Cess Act, 1996.
- Contract Labour Act, 1970.
- Employees Provident Fund & Miscellaneous Provisions Act, 1952.
- Employees State Insurance Act, 1948.
- Explosive Act 1884 & Rules 1983.
- Indian Electricity Act & Rules.
- Gas Cylinder Rules 1981.
- Fatal Accidents Act, 1855.
- Labour Laws Act, 1988.
- Minimum Wages Act, 1948.
- Payment of Bonus Act, 1965.
- Personal Injuries (Compensation Insurance) Act, 1963.
- Public Liability Insurance Act, 1991.
- Weekly Holidays Act, 1942.
- Workmen Compensation Act, 1923.
- Environment (Protection) Rules, 1986.
- Employers Liability Act, 1938.
- The Factories Act - 1948 also applies in part.

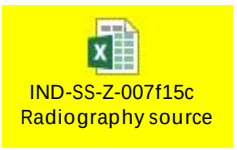
7.14 IS CODES FOR PPE

■ IS : 1179 - 1967 (REAFFIRMED 2013)	Equipment for eye and face protection during welding.
■ IS : 1989 -1986 (Part - I & III) (REAFFIRMED 2016)	Leather safety boots and shoes.
■ IS : 2925 -1984 (REAFFIRMED 2015)	Industrial Safety Helmets.
■ IS : 3521 - 1999 (REAFFIRMED 2014)	Industrial Safety belts and harness.
■ IS : 3778 -1993 (REAFFIRMED 2013)	Rubber knee boots.
■ IS : 4770 -1991 (REAFFIRMED 2017)	Rubber gloves for electrical purposes.
■ IS : 5424 - 1969	Rubber mats for electrical purposes.
■ IS : 5557 -2004 (REAFFIRMED 2016)	Industrial and Safety rubber knee boots.
■ IS : 5983 -1980 (REAFFIRMED 2013)	Eye protectors.
■ IS : 6519 -1971 (REAFFIRMED 2018)	Code of practice for selections, care and repair of Safety footwear.
■ IS : 6994 -1973 (Part - I) (REAFFIRMED 2013)	Industrial Safety Gloves.
■ IS : 8519 - 1977 (REAFFIRMED 2013)	Guide for selection of industrial safety equipment for body protection.
■ IS : 8520 - 1977 (REAFFIRMED 2013)	Guide for selection of industrial safety equipment for eye, face and ear protection.
■ IS : 8990 - 1978 (REAFFIRMED 2013)	Code of practice for maintenance and care of industrial safety clothing.
■ IS : 9167 - 1979 (REAFFIRMED 2016)	Ear protectors.
■ IS : 9623 - 2008 (REAFFIRMED 2013)	Recommendations for the selection, use and maintenance of respiratory protective devices.
■ IS : 10667 - 1983 (REAFFIRMED 2013)	Guide for selection of industrial safety equipment for protection of foot and leg.
■ IS : 11226 -1993 (REAFFIRMED 2018)	Leather Safety footwear having direct moulding sole.

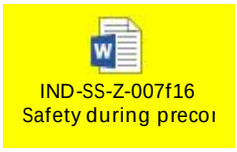
7.15 REDIOGRAPHY CHECKLIST





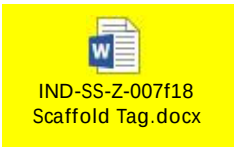


7.16 SAFETY DURING PRE-COMMISSIONING & COMMMISSIONING

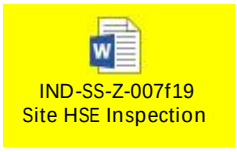


7.17 COMPETENCY ASSESSMENT QUESTIONNAIRE

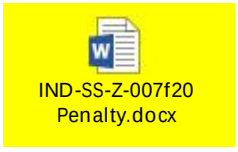
7.18 SAMPLE SCAFFOLD TAG



7.19 SITE HSE INSPECTION PROGRAM



7.20 PENALTY OR DISCIPLINARY ACTION



Monthly Safety Audit Checklist (IND-SS-Z-007f2)

JACOBS

Project Name & No.	Date:	Location:
Contractor Name	Audit No.:	Audit Team Member:

Sl.No	Description	Possible Points	Obtained Score	Observation
A	**Training**	**20**	**0**	
1	Induction training given to all new joining workers	5		
2	Toolbox talks conducted frequently	5		
3	Fire drill & site specific training conducted frequently	5		
4	Records maintained for all training given at site?	5		
B	**Personal Protective Equipment**	**25**	**0**	
5	PPE issue and inspection register maintained?	5		
6	Compliance of safety shoes, safety goggles and helmets	5		
7	Full body safety harness (lanyard length - 1.8 m) anchored	5		
8	Welding shield & grinding visor mounted helmet used	5		
9	Other necessary PPEs	5		
C	**House Keeping**	**35**	**0**	
10	Clear walkways are maintained without any obstructions?	5		
11	All materials are stacked properly?	5		
12	Waste materials/ scraps dumped properly at identified areas?	5		
13	Electrical cables are properly routed to prevent trip hazards or damages due to vehicle movement	5		
14	Nails or other sharp objects being removed or bent?	5		
15	Clear walkways are maintained without any obstructions?	5		
16	Scrap yard identified at site and waste disposed from site regularly	5		
D	**Work at height**	**20**	**0**	
17	Edge protection & floor opening protection provided?	5		
18	Fully planked working platform with handrails, mid rails & toe-guards with secured access ladder extending 1 m from the landing platform	5		
19	Fall arrestors, lifelines & safety nets in use wherever necessary?	5		
20	Ensuring everyone anchoring the safety harness when exposed to a fall of 2m and above	5		
E	**Scaffolds & ladders**	**40**	**0**	
21	Scaffold designed & erected by trained personnel	5		
22	Scaffolding checklist prepared and displayed? Scaffold tags displayed?	5		
23	Scaffold erected on a level surface with base plate / sole plate?	5		
24	Appropriate scaffold materials are used & installed properly with necessary supports and back ties wherever necessary.	5		

Monthly Safety Audit Checklist (IND-SS-Z-007f2)

JACOBS

Project Name & No.	Date:	Location:
Contractor Name	Audit No.:	Audit Team Member:

Sl.No	Description	Possible Points	Obtained Score	Observation
25	Staging for shuttering is designed for loads like worker movement, impact loads and other incidental loads during various construction activities?	5		
26	Dismantling of scaffolds done under proper supervision? Are all materials properly lowered?	5		
27	Ladders in use are without defects? Positioned in a safe angle and secured properly?	5		
28	Mobile scaffolds are used with proper lock system and appropriate access to the working platform?	5		
F	**Excavation**	**20**	**0**	
29	Sloping/ benching or shoring maintained	5		
30	Adequate barricading provided for the pit/trench	5		
31	Access ladder in place where work is carried out	5		
32	Excavated earth removed or deposited 1.5 m away	5		
G	**Electrical**	**50**	**0**	
33	Electrical Inspection register maintained?	5		
34	All power tools are inspected and tagged?	5		
35	Does cabling provide sufficient headroom?	5		
36	Electrical connections are free of insulation damages, joints and provided with plug tops	5		
37	All electrical connections are taken through ELCB (30 mA)	5		
38	Proper earthing for main panel & body earhting for DBs?	5		
39	All DBs are provided with a rain protection canopy?	5		
40	Adequate safety provisions at panel room?	5		
41	Is there enough number of first-aiders having knowledge of CPR for electrocution?	5		
42	DG inspected and maintained	5		
H	**Control of hazardous energy**	**15**	**0**	
43	Have specific energy control (LOTO) procedures been developed?	5		
44	Are the procedures being implemented? Are the personnel trained and qualified?	5		
45	LOTO register mainained properly, Is it reviewed periodically?	5		
I	**Vehicle movement**	**35**	**0**	
46	All vehicles installed with safety devices, seat belt, reverse horns , tires, windshields, mirrors, lights, etc.	5		
47	Authorised driver/ operator with a valid driving license is engaged?	5		
48	Vehicle operators given adequate training on speed limit, overloading & site rules	5		
49	Spark arrestors available?	5		
50	Banksman available for controlling the vehicle movement?	5		

Monthly Safety Audit Checklist (IND-SS-Z-007f2)

Project Name & No.	Date:	Location:
Contractor Name	Audit No.:	Audit Team Member:

Sl.No	Description	Possible Points	Obtained Score	Observation
51	Maintenance record and inspection record maintained	5		
52	vehicle parking areas are well-marked with safe walkways for pedestrians.	5		
J	**Welding, gas cutting and grinding**	**50**	**0**	
53	Adequate PPEs are provided and used?	5		
54	Earth connectors are securely connected to the job and not to the adjoining structure or scaffold?	5		
55	Welding cable used is maintained in good condition without any cut or open/ tapped joints? Gas cutting hose is without any crack/ damage?	5		
56	Flash Back Arrestors installed in the cutting set (both at cylinder end and torch end)	5		
57	Cylinder storage area clearly identified for fuel gas and oxygen? It is not exposed to sunlight and proper system for keeping it in upright position made?	5		
58	Cylinder keys are always available on acetylene cylinders? Double pressure gauges are in working condition?	5		
59	Grinding machine are with proper guards?	5		
60	Grinding wheel used of proper RPM rating as marked on the grinding machine?	5		
61	Grinding wheel is without any crack or deformation on circumference?	5		
62	Adequate precaution taken to prevent the hazards from hot spatters and sparks	5		
K	**Rigging**	**30**	**0**	
63	Inspection and test certificate records maintained for all lifting tools and tackles, hydras and cranes?	5		
64	SWL & date of testing are visibly marked/ painted on all lifting tools/ tackles and equipments?	5		
65	Crane operators are trained, qualified, and have valid license.	5		
66	All rigging tools and lifting equipment are in good condition, properly inspected and have current certification.	5		
67	Min. two tag lines are used appropriately.	5		
68	Cranes are set up properly including extended outrigger pads.	5		
L	**Health hazard & hazardous chemical**	**20**	**0**	
69	Hazardous materials are properly stored and labeled.	5		
70	MSDS is available and displayed near storage areas of all chemicals	5		
71	Specific training on hazardous chemicals is provided to personnel required to work with those chemicals.	5		
72	Adequate safety measures taken in case of chemical spills and releases and also mentioned in SPA	5		
M	**Emergency Response**	**20**	**0**	
73	Emergency response plan established at site and communicated to all. Assembly point identified?	5		
74	Adequate First aid facilities maintained. First Aid register maintained at site?			
75	Emergency mock drill conducted periodically and maintained the records properly?	5		

Monthly Safety Audit Checklist (IND-SS-Z-007f2)

JACOBS

Project Name & No.	Date:	Location:
Contractor Name	Audit No.:	Audit Team Member:

Sl.No	Description	Possible Points	Obtained Score	Observation
76	Is the emergency plan reviewed and updated periodically?	5		
N	**Work Permit**	**20**	**0**	
76	All workers and supervisor trained for work permit system? Proper training record maintained?	5		
77	Valid work permit taken for all the works excecuted at site and controlled all hazardous work	5		
78	Permit closed regularly after completion of concerned activity	5		
79	Confined space works are carried out with a valid authorized permit and is the permit displayed? All requirements specified in the permit are fulfilled before confined space entry?	5		
N	**Other**	**45**	**0**	
80	SPAs are prepared and displayed at site?	5		
83	Fire Extinguishers in place for all hot works	5		
84	Are illumination levels at workplace and passage ways adequate? Sufficient lighting arrangements are made for night works?	5		
85	Sign boards and caution boards are kept / displayed wherever necessary?	5		
86	All hand tools are in good condition and stored properly	5		
87	All rotary parts of machinery are properly guarded?	5		
88	Restrooms are made & well maintained. Designated place for drinking water & clearly labeled	5		
89	Participation of execution engineers in implementation of safety program	5		
90	Safety awareness and promotional activity	5		
	TOTAL SCORE	**445**	**0**	
	% PERCENTAGE		**0%**	

Safety Performance Rating Indicator (Score%)		Contractor's Safety Performance
VERY GOOD	90 – 100 %	No of points attended
GOOD	80 – 90 %	Possible Score
SATISFACTORY	70- 80 %	Scores Obtained
UNACCEPTABLE	< 70 %	Score %

JACOBS

IndianOil

DEPARTMENT	:	**CONSTRUCTION**
DOCUMENT NO	:	**44AC7501/K.01/0002/A4**
DOCUMENT TITLE	:	**SPECIFICATION FOR POSITIVE MATERIAL IDENTIFICATION AT SITE**
PROJECT NO.	:	**44AC7501**
LSTK	:	
PART/ SECTION	:	
PROJECT LOCATION	:	**IOCL, PANIPAT**
PROJECT TITLE	:	**HOT OIL HEATERS (EPCM SERVICES FOR PTA UNIT)**
CLIENT	:	**INDIAN OIL CORPORATION LIMITED**
CLIENT PROJECT NO.	:	
CLIENT AUTHORIZATION	:	
PM AUTHORIZATION	:	**NITIN PHATAK**

				APPROVALS		
Rev. No.	**Issue Date**	**Pages**	**Revision Description**	**Prepared**	**Checked**	**Approved**
0	15-Oct-19	14	Issued for Enquiry	SC	DM	NP

✓	Entire Document Issued this Revision	DOCUMENT ISSUED FOR: (please ✔ as applicable)		
☐	Revised Pages Only Issued this Revision	☐	In-house Review	☐ Purchase
		☐	Client Approval	☐ Construction
		✓	Enquiry	

CONTENTS

1.0 PURPOSE

1.1 This specification applies to metallic alloy materials purchased for use in piping, heater coils, storage tanks and vessels at construction sites. Any deviation from this specification must be approved by Owner/PMC in the prescribed format.

1.2 This specification covers the procedures and methods to be used to assure that the chemical composition of alloy materials conforms to the material Specification as specified in purchased documents/contract using Alloy Analysers.

1.3 Carbon steels are excluded from the scope of this Specification (except for low temperature pressure containing components as defined in clause 3.1.8 of this Specification).

1.4 Actual alloy verification application shall be controlled and coordinated by PMI agency appointed by the responsible party of the CONTRACTOR.

1.5 Alloy verification shall not be considered as a substitute for required material test reports. This also means that material test report shall not be considered as acceptable alloy verification.

1.6 Alloy verification shall be performed by the inspector of the contractor or appointed agency contracted by the contractor.

1.7 The inspector who is instructed by the PMI Agency shall perform alloy verification tests to ensure that verified material is traceable to the order and any required material documentation.

1.8 The PMI tests shall be performed in accordance with the approved procedure by qualified personnel at the point, which ensure the correct material has been used.

1.9 The all involved personnel shall fully understand the alloy verification requirements, the verification method to be used, the period to be carried out, and the methods of marking verified material.

1.10 The alloy verification procedures, including complete descriptions of the methods, equipment to be used, and personnel qualification procedure shall be established.

1.11 If the conduct of any verification is unacceptable or if any material has been incorrectly identified, all further tests shall not be performed until the problem is corrected.

2.0 DEFINITIONS

2.1 The term Positive Material Identification (PMI) refers to determination / verification of alloy type or its composition using portable or mobile optical emission spectrometer / XRF alloy analyzer.

3.0 SPECIFIC APPLICABILITY

3.1 The following items require PMI unless specifically exempted through a Waiver/Deviation permit by Owner /PMC.

3.1.1 All welds performed at construction job site

a) Where accessible, the alloy verification of welds shall preferably be made on the process side of the weld.

b) For welds made by the GTAW, SMAW or other processed not using continuous wire electrodes, a minimum of one alloy verification analysis shall be made for each five meter (5m) of individual weld length. for individual pressure-containing welds made by the saw process or other approved process using continuous wire electrode, a minimum of one alloy verification analysis shall be made on each weld on the individual.

c) Repair welds.

3.1.2 All pressure containing piping components including welds, thermowells, instruments, manifolds, RTJ gaskets, fasteners etc.

3.1.3 Tubular products used in the fabrication of heaters.

3.1.4 Pressure – containing instrument housings (e.g. gauge glass housings, orifice meter tubes).

3.1.5 Internal metallic linings / cladding and weld overlay, done at site, used for protection against corrosive environment and column trays.

3.1.6 Tubing (except as excluded in Paragraph 3.2).

3.1.7 Stud, bolts and nuts of ASTM A-193/A-194 Specification etc.

3.1.8 Parts which have been alloy verified at the fabricator's shops with sufficient marking and records are the exceptions unless PMI Agency instructs otherwise.

3.1.9 Plate and pipe material to be used as pressure-containing parts may be alloy verified prior to cutting at construction job site provided the transferred marking properly identify the subsequent components with heat/lot traceability and alloy verification status.

3.1.10 For low temperature carbon steel piping and other pressure containing components intended for service at – 29℃ or colder, traceable mill certificates shall be used to verify notch toughness and chemical composition for each component. Documentation of compliance as per this specification shall be included in the permanent inspection records.

3.1.11 All pressure containing welds.

3.1.12 Any other components or material specifically designated for PMI on the purchase order/ contract.

3.2 Exclusions

3.2.1 The following items are exempted unless specifically designated for PMI in the purchase order / contract

a) Gaskets (spiral wound or carbon steel only)

b) Internal instrument parts

c) Internal machinery parts

d) Internal non-pressure – containing baffles, supports, pall-rings, support rings etc.

e) Electrical components.

f) Non pressure – containing welds, including seal welds, piping supports welds, structural parts.

g) Internal valve components.

h) ASTM A 213 Type 304 SS tubing ¾ inch (19mm) outside diameter and less when properly identified by paint stencil (exchanger tubing is not included in this exemption).

i) Compression-type ferrules and fittings for use with ¾ inch (19mm) outside diameter and smaller tubing.

4.0 NORMATIVE REFERENCE

ASME BPV Code Section – Ii Part A, B, C And D

ASTM: As Applicable

Any Other Material Specification Referenced by The Purchase Order / Contract.

Piping Material Specification (PMS)

5.0 GENERAL REQUIREMENTS

5.1 The Contractor shall submit a procedure for PMI to comply with the requirements of this Specification. Approval of PMI procedure shall be obtained prior to commencing fabrication/ erection as the case may be.

5.2 A copy of Records of PMI shall be submitted to Owner / PMC.

5.2.1 Tabulation of tested items must be keyed to as-built drawings and Mill Certification Document-Stampings through the use of reference numbers. One (1) copy of test results shall be provided to Owner's Engineer as part of the as-built document.

5.3 PMI test results must conform to purchase documents, be properly identified to the applicable Specifications such as Piping Material Specification, ASME, ASTM, BS and Colour coded as required by contract Specifications. Upon receipt, purchased materials or equipment that has been subject to PMI by the vendor shall be examined by the CONTRACTOR. This examination shall include verification of stamping, marking and records of PMI per this specification.
After installation, but prior to painting/insulation, the CONTRACTOR /Vendor shall examine all components requiring PMI for proper compliance to this Specification A record of this final check shall be submitted to PMC/Owner and made part of the Contractor'/Vendor's permanent inspection records
PMI shall be done on each component (100 percent PMI inspection), unless specifically exempted by Owner/Engineer-in-Charge.

5.4 Marking

5.2.1 Marking methods

a) Principally the marking shall be done by certified low stress stamp.

b) If the material or item is too light, too small, or cannot otherwise be stamped, vibro-etching or color coding shall be applied in conjunction with the Vendor's standards and the requirements of the above paragraph and noted on the alloy verification reports.

c) Marking material used for Color Coding, Tubes, and Rejected Components

- The marking material shall be a water insoluble material that contains no harmful substance, such as metallic pigments, sulphur, or chlorides, which would attack, or harmfully affect austenitic or nickel alloy steel at ambient or elevated temperature.
- The analysis of marking material shall be confirmed.

These markings are in addition to markings required by other Codes/ Specification/ Technical notes.

5.2.2 Failed Components

a) Materials, items and welds which are found to be unacceptable during verification testing shall be immediately marked with a red "R" pending resolution.

b) Marking material for failed components shall meet the requirements of marking materials in Para 5.4.1 (c)

5.2.3 Accepted Components

a) All verified materials with acceptable analysis shall be marked with the letters "AV", as appropriate using certified low-stress stamp or other acceptable methods.

b) The marking shall be placed as follows

- Pipe: Two Marks, 180 Degrees Apart, 75mm (3 In) From Each and Of Each Length on The Outer Surface Of The Pipe
- Welds: Adjacent to The Welder's Mark on The Weld
- Fittings and Forgings: Adjacent to The Vendor's Marking
- Valves: Adjacent to The Vendor's Marking on Bodies and Other Pressure Parts
- Plates: Adjacent to The Heat Number
- Casting: Adjacent to The Manufacturer's Marking and Number
- Tubes for Heat Transfer Service: Stenciled, Not Stamped, On Each End

5.5 If the alloy verification test results fall outside of the acceptance criteria, then the following shall be done by PMI Agency.

5.5.1 Obtain a quantitative check analysis performed by an independent test laboratory using the applicable method referenced by the material specification. If no method is referenced, an appropriate chemical analysis method specified in this standard shall be used. Result of this analysis shall govern.

5.5.2 Find other corrective action plan.

5.6 All items of the type in question or all similarly identified materials of that lot or shipment shall not be accepted pending results of the independent tests. If the test results of the independent laboratory tests are not within the acceptable range of the ASTM or other applicable material specification, the material shall be rejected.

6.0 PMI OF PIPING AND HEATER COIL COMPONENTS

6.1 PMI examination (irrespective of PMI done at earliest stages) shall be carried out when piping loops/heater coils have been cleared for hydrostatic testing by Engineer-in-Charge/Owner. Hydrostatic Testing shall be carried out only when non-conforming components have been replaced with conforming components and Non-Destructive Testing, Post Weld Heat Treatment, Hardness checking etc., as required by Specifications have been completed. The contractor shall provide a third party certification of PMI and evidence in the form of print outs from Alloy Analyzer. PMI records shall form a part of piping inspection records. Contractor shall demonstrate to Engineer-in-Charge that each and every component of the piping system and heater coils has been subjected to PMI.

7.0 ACCEPTABLE METHODS FOR PMI

7.1 Positive Material Identification (PMI) will be done by verifying materials after proper cleaning and to be recorded as per Table – I.

7.2 Alloys verified by an approved analysis method shall contain the amount of alloy elements within the ranges permitted by the material specification increased by the tolerance of the equipment or method used.

7.3 Instruments used for PMI shall have the sensitivity to detect the alloy elements in the specified ranges. Instruments or methods used for examination shall be of the type that will provide quantitative, recordable, elemental composition results for positive identification of the alloy elements present.

7.4 Testing shall be done per the procedures outlined by the manufacturer of the portable alloy analyzer or alloy sorter being used. Modification of these procedures must be approved by Owner/Engineer-in-Charge. Each analyzer must be calibrated using known alloy standards.

Table – I
Positive Material Identification Report

Contractor	:	Date	:
Project	:	Inspection Agency	:
Location	:	PMI Equipment	:
Line No. / ISO Drg. No	:	Make & Serial No	:
Heater No	:		:

Sl No.	Part Identification	Material as per Drawing/Specification	Material as per PMI	Result

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Standard Specification		Document No: IND-SS-Z-004	Page: 1 of 22
Fabrication and Erection of Piping		Supersedes: Rev 2	Revision: 3 Issue Date : 21-Mar-11
Issuing Department: Construction – Asia Region	Functional Manager: AL.Benny@jacobs.com	Previous Rev. & Issue Date: Rev 2, 30-Sep-03	Effective Date: 01-Apr-11

TABLE OF CONTENTS

7.0 ATTACHMENTS / APPENDICES

7.1 TOLERANCES
7.2 BRANCH REINFORCEMENT
7.3 HEAT TREATMENT REQUIREMENTS

1.0 PURPOSE

The purpose of this specification is to define the pre-fabrication, Heat treatment, Inspection, Erection, construction and protection requirements of Carbon steel, Chromium Molybdenum, Carbon ½ MO Pipe Work based generally on American National Standard Code for Pressure Piping.

2.0 SCOPE

2.1 This Specification does not apply to Low Pressure Ducting.

2.2 This specification supplements the applicable code requirements / data sheets / drawings and specifications for fabrication, erection, inspection, testing of pipelines.

3.0 DEFINITIONS

Client/ Owner:	The Company, which intends to put up the Plant/ It's nominated representative
Consultant:	The Company nominated by the Client/ Owner to carry out Detailed Engineering / Construction Supervision.
Contractor/ Fabricator:	The successful bidder for Piping construction works.
IBR	Indian Boiler Regulations

4.0 GENERAL

4.1 TECHNICAL REQUIREMENTS

4.1.1 All Conflicts between the requirements of this specification, related Engineering documents/ Drawings/ Codes shall be immediately brought to the notice of the Construction Manager/ Engineer-in -charge or the Site Representative nominated by the Client/ Owner.

4.1.2 This specification is intended to cover the technical requirements for the execution of piping fabrication and erection of entire piping work defined hereinafter. The work will include installation of inline instruments such as Control Valves, Orifice Flanges, Rotameter etc., and Impulse Piping up to 1st block valve.

4.1.3 The quantities of piping material listed in the Schedule of Rates are approximate and are subject to variations.

4.2 SCOPE OF WORK

4.2.1 Contractor's Scope of Work

Contractor's scope of work will generally be as follows, however scope of works prescribed in enquiry/ order document, special conditions of contract, schedule of items shall prevail.

a) Installation of piping system which shall include but not limited to pipes, pipe fittings, flanges, bolts, nuts, gaskets, inline fittings such as valves, strainers, traps, filters, thermo wells, orifice plates, safety valves, control valves, relief valves, pressure reducers, flame arrestors, sight glasses, rain hoods etc., and pipe supports at all elevations.

b) Testing and flushing / cleaning of all piping systems as per specification.

c) Fabrication and erection of all support elements such as shoes, rollers, wooden saddles, guides, stop / anchors, U-bolts, clamps, cradles, hangers, turn buckles, etc.,.

d) Fabrication and erection of supporting fixtures, brackets, cantilever struts etc..,

e) Fabrication, excavation, laying, inspection, testing, flushing / cleaning, coating and wrapping and backfilling of underground piping, with all specials and fittings.

f) Fabrication and erection of pipe supports like shoe, saddle, guides, stops, Anchors, clips, cradles, hangers, turn buckles, supporting fixtures, Bracket cantilevers, struts, Tee Posts, sway braces.

g) Erection of prefabricated spring supports as specified in the schedule of items

h) Prefabrication of threaded and unthreaded nipples and Swage Nipples made from pipes.

i) Construction of 60 degrees and 30 degrees or other angle elbow by cutting 90 degrees and 45 degrees.

j) Modification of piping that has been completed and / or is being fabricated.

k) Fabrication of 90 degrees, 60 degrees, and 45 degrees mitre bends from pipes.

l) Fabrication of Stub-in / Stub-on connections with or without reinforcement.

m) Pickling and passivation of S.S. Pipes, if required, after fabrication and before erection or after erection as per specifications.

n) Fabrication and installation of spool pieces with scrap pipes and plate flanges, in place of valves and other on-line fittings wherever required, to continue erection of piping.

o) Any other items as required in the drawings / specifications to be fabricated from the pipe material.

p) Additional cleats for pipe supports to be welded with vessels and columns not stress relieved.

q) Radiography and / or heat treatment of weld wherever applicable.

4.3 APPLICABLE STANDARDS, CODES AND SPECIFICATIONS.

Code of Petroleum Refinery Piping	:	ASME B31.3
Code of Procedure for Manual metal Arc Welding of mild steel	:	IS 823
Welding procedure specification, welders procedure, qualification tests and performance qualification tests.	:	ASME-Sec.IX
Standard for welding pipe and related facilities	:	API Code 1104
Indian Boiler Regulations	:	IBR

All codes referred to shall be the latest editions. The contractor shall bear the cost of repairs, changes, replacement etc., due to non-compliance with the standards, codes and this contract or due to disregard of the instructions given by the Owner / Consultant.

4.3.1 All piping systems shall be fabricated, installed, tested, flushed in accordance with this specification, piping specifications, general arrangements and other applicable drawings / standards and good engineering practice.

4.4 PIPING MATERIAL CLASSIFICATION

4.4.1 The complete piping system is broadly divided into various piping classes based on design pressure, temperature and medium conveyed and the material of construction used in the piping. All the components used in a given pipeline shall be in conformity with the piping specifications assigned to it.

4.5 DRAWING & SPECIFICATION

4.5.1 Piping specifications, Engineering Line Diagrams, Piping General arrangement drawings, Piping Isometrics, Equipment layout drawings, Supporting standards and other relevant drawings shall be furnished to the Contractor during the execution of the work.

4.5.2 The following drawings shall be supplied to the contractor.

i) FOR CARBON STEEL (NON IBR LINES):The contractor shall be supplied with construction drawing, General Arrangement drawings, P&IDs, Isometric Drawings, support standards, etc., for Carbon Steel Pipe 2"NB and Above. Preferred Routings for 1½"NB and below in General Arrangement Drawings.

ii) The contractor shall be supplied with isometric drawings for all sizes of stainless steel, alloy steel and Composite isometric for *IBR* carbon steel pipe work.

iii) The Owner / Consultant shall provide the Contractor standard pipe support and steam trap assembly sketches and location. Further detailing / routing of the lines are Contractors responsibility.

4.5.3 If any details specifically required for fabrication and erection are missing from the drawing supplied by the Owner / Consultant, the contractor shall develop the same and submit to the Owner / Consultant for approval.

4.5.4 The Contractor shall bear the cost of repair, changes, replacements, etc., due to non-compliance with the standards, codes, of this tender of due to disregard of instruction of Owner / Consultant.

4.5.5 Contractor shall prepare Sketches / Isometrics for field routed lines.

4.6 METHOD OF WORK

4.6.1 PREFABRICATION

4.6.2 The contractor shall fabricate all pipe work in conformity with the requirements of pertinent general arrangement drawings, isometrics, piping specification and other specifications / documents. The piping layouts, isometric drawings and other documents specify the conditions of design, viz. Pressure ratings, clarifications, shape dimensions of pipe and piping components sufficient for fabrication. However, if necessary, the contractor shall prepare SHOP FABRICATION drawings, based on piping drawings and actual field measurements.

4.6.3 All Carbon steel piping 1½"NB and below are called as Field runs, unless otherwise specifically Isometrics are issued, shall be fabricated, erected, supported and tested by the contractor in consultation with the Owner / Consultant.

4.6.4 Where specific details of fabrication are not indicated on the drawings or not specified herein fabrication and erection shall be done in accordance with the code of Petroleum Refinery Piping ANSI B31.3 latest edition and INDIAN BOILER REGULATION of latest edition, as applicable.

4.6.5 Steam piping falling under jurisdiction of INDIAN BOILER REGULATIONS shall be fabricated in accordance with the requirements of the applicable drawings, the latest edition of INDIAN BOILER REGULATIONS and to the entire satisfaction of local Boiler Inspector. Documents

certifying the fabrication and testing of fabricated components of the piping system shall be obtained from the local Boiler Inspector in Form IIIA and IIIB of IBR by the contractor.

4.6.6 The contractor shall be responsible for working to the exact dimensions as shown on the drawings irrespective of individual tolerance permissible. Where errors are / or omissions occur on the drawing with respect to site conditions, it shall be the contractors responsibility to notify the Owner/ Consultant prior to fabrication or erection.

4.7 ALIGNMENT

4.7.1 The pipes to be joined by welding shall be aligned correctly with the existing tolerance on diameters, wall thickness and out of roundness. The same alignment shall be preserved during welding. Pipes with the higher wall thickness shall be internally machined / ground so that the adjoining surfaces are approximately flushed. No extra payment will be made for this purpose.

4.8 FABRICATION

4.8.1 GENERAL

4.8.2 Pipes shall be of plain *or* beveled ends of random lengths (6.0 Mtrs) or double random lengths (12.0 Mtrs) depending on the availability in the market. Wherever beveling is required as per welding procedure, contractor shall do the beveling at his own cost.

4.8.3 Longitudinal seam in seam-welded pipe shall be located so as to clear the pipe opening and external attachments wherever possible. Longitudinal seems in adjoining courses shall be preferably at 180 degrees but a minimum distance of 150mm between seams, measured around pipe circumference shall be provided, where pipe size permits and external attachments wherever possible.

4.8.4 Sections of Pipes shall not be welded together for lengths below 3m(10ft.) and the number of welds shall be kept minimum for longer lengths.

4.8.5 Materials found to be damaged or found to have defects shall not be used in fabrication except that minor surface marks may be dressed up provided that the nominal wall or minimum wall thickness is not encroached upon after considering the manufacturing tolerances defined in the appropriate material or purchase specifications.

4.8.6 All pipe branches shall be 90 degrees unless otherwise indicated in the drawings. All changes in direction of piping shall be 90 degrees / 45 degrees unless otherwise specified. The dimensions indicated in the drawings are true and contain no allowance for weld gaps. Gaskets less than 1/16" (1.5mm) are ignored in dimensional computations.

4.8.7 For laying out headers, tees, laterals, and other irregular details cutting templates shall be used to ensure accurate cutting and proper fit-up. All cuttings shall follow the outline of the template.

4.8.8 Branch connections shall be made by fabricated intersections, welded or screwed fittings, forged branch attachments, couplings or manifold extrusions as specified in the Piping material specifications/ Drawings.

4.8.9 Fabrication details of special items; jacketed pipelines; multi-nozzle headers, extrusions etc., will be specified on the order.

4.8.10 The contractor shall be responsible for working to the dimensions shown on drawings, Isometrics and standards. The dimensions shown on the drawings/ Isometrics and those actually existing may not be matching for unknown reasons. To take care of these variations "FIELD WELDS" shall be provided in X, Y, Z directions during prefabrication stage. Extra length of 200 mm shall be provided at the field weld point over and above the dimension shown in the drawings/ Isometrics. During erection the pipe with extra length shall be suitable

cut to obtain the actual dimension. Provision of field welds and cutting the extra length of pipe to achieve the actual length will not entertained as extra claim for the contractor.

4.8.11 Installation and protection of proprietary items, during fabrication shall be as per Manufacturer's instructions.

4.9 PREPARATION

4.9.1 PIPE JOINTS

4.9.2 Piping Material Specification specifies the type of Pipe joint for each piping class to be adopted. In general, for Pipe sizes 2" NB and above, erection joints are Butt-Welded and maintenance joints are flanged. For Pipe sizes 1 ½" NB and below erection Joints are socket welded/ threaded, maintenance joints are flanged / with Unions.

4.9.3 Machined out bevels to form the welding groove are preferred in carbon steel pipe. However, smooth, clean, slag-free, flames cut bevels are acceptable. In cases of alloy steel, S.S. Pipes weld bevels shall be generated with file or a grinder. Arc cutting in stainless steel pipe and alloy steel pipes is prohibited. "C" Cleats buttered on the edges with electrodes compatible with parent pipe is also acceptable.

4.9.4 Tack welds with full penetration shall be used and shall become the part of the finished weld. Neither defective welds nor tack welds with lack of penetration are acceptable and shall be chipped / ground out.

4.9.5 If thermal cutting is used, at least 1.6mm thickness of the flame cut edge material shall be dressed back to clean material.

4.9.6 Prior to welding, all fusion surfaces shall be free from foreign substances such as rust, loose scale, slag, swarf, oil and grease etc., including any protective coating, for a distance of at least 25mm internally and externally back from the welding edges.

4.9.7 *No joint* within the distance of 20 pipe diameters upstream and 8 pipe diameters down stream of orifice flange shall be allowed in straight running pipes. For other configurations of piping orifice flanges shall be located strictly as per drawings. In all cases, weld inside orifice flange shall be ground flush.

4.9.8 BRANCH CONNECTIONS

- All the branch connections, except where forged tees are required as per the specifications, shall be accomplished by pipe to pipe connections as per relevant code requirements and piping specification.
- Fabricated intersections shall be of the "Set-On" type with the branch pipe prepared to suit a full penetration weld of a quality comparable to the girth welds.
- Branch reinforcement shall be of the type specified in the "BRANCH TABLE" of the Piping material specification.
- For reinforcement and non-reinforcement branch connections, the pipe longitudinal, girth and attachment welds be clear of the branch reinforcement perimeter, by a minimum of six times the header wall thickness.
- Forged branch attachments shall be of the type specified in the Piping material specification/ Isometrics and fitted accurately to the contours of the Pipes.
- Couplings and Half-couplings shall be accurately shaped and "SET-ON" to suit the contour of the run pipe. Those for "pressure taps" shall header drilled after welding.

- *Reinforcement of branch connections of all piping systems if required shall be done in accordance with the requirements of the ANSI code for Petroleum Refinery, Piping B31.3 and the Indian Boiler Regulations wherever applicable.*

4.10 FLANGE CONNECTIONS

4.10.1 All flange facing shall be true and perpendicular to the axis of the pipe to which they are attached. Flanges bolt holes shall be straddle to the normal centre lines unless different orientation shall be shown in the drawing to match the equipment connection etc., Tolerance in fabrication shall be as per relevant standards / execution drawings.

4.10.2 Flanged connections shall be used at connections to vessels and equipment and where required for ease of erection and maintenance unless otherwise stated.

4.10.3 Wherever spectacle blinds are to be provided as per drawings, drilling and tappings in the flanges will be done by the contractor before welding of the flanges with the pipe to facilitate installation and operation of the jackscrews.

4.11 BENDING, FORGING AND FORMING

4.11.1 Bends shall be used up to and including 40mm dia, pipe sizes where essentially required as indicated in piping specifications. Carbon steel, alloy steel, stainless steel bends shall be cold bent to a radius of 5 times the nominal pipe diameter using formers or shoes which fit the desired contour of the pipe. The completed bend shall lie in one plane, have a smooth surface and shall be free from defects such as cracks, buckles, wrinkles, bulges, flat spot etc. They shall be true to dimensions. The flattering of a bend as measured by the difference between maximum and minimum diameters at any cross sections shall not exceed 5% and 3% of the nominal outside diameter for internal and external pressure respectively, wherever specified piping components shall be fabricated by hot or cold forming, rolling, forging, hammering etc., in any case, wall thickness after bending shall not be less than 87 ½ % of nominal wall thickness.

4.11.2 Proper account of spring back during bending shall be taken. Tolerance of angle of bend shall be $\pm$ 1/2 degrees.

4.11.3 Hot forming shall be adopted with a temperature range consistent with material characteristics and post heat treatment shall be done wherever necessary as indicated in piping specifications. The rates quoted by the contractor for carbon steel, alloy steel and stainless steel piping of 40mm NB and below shall be inclusive of fabrication and erection of piping components as specified in drawings / specifications and or as required by the Owner / Consultant at site.

4.12 THREADING

4.12.1 Threading of pipes shall be preferably done after bending, forging or heat treatment operations. When this is impossible or very difficult to perform the threading may be done prior to such operations but precautions shall be taken to properly protect the threads from damage. Thread joints that are to be seal welded shall be made up dry (without using thread compound or tape). Unless otherwise stated, the threads shall be to IS 554 in case of G.I. Pipes and fittings. However, in other cases, it shall be NPT tapped and smooth to ANSI B2.1 unless otherwise mentioned in the material specification.

4.12.2 The threads shall be full length and free from defects. The threads on each joint of pipe shall be carefully inspected and examined prior to installation. All threaded pipe joints (except those to be seal welded) shall be lubricated or tapped on the male and with thread joining component or P.T.F.E. tape acceptable to the Owner / Consultant. The contractor shall connect all joints of pipe into a screwed line sufficiently tight to withstand the test pressure specified.

4.12.3 On all threaded connections like vents, drains, couplings, etc., the threads shall be protected from rusting by applying grease / oil when in open conditions.

4.12.4 While fixing the plugs / caps for pressure testing or otherwise the tightness of the joints shall be ensure by using proper thread seal and suitable to the service temperature. Oil, grease and other sealing and protecting materials / consumables shall be supplied by the contractor at his cost. The rates quoted by the contractor shall be inclusive of threading and seal welding as required. Threaded connections wherever specified in drawings / documents or if required by the Owner / Consultant shall be seal welded by the contractor. Such thread joints shall be made up dry (without using thread compound or tape).

4.13 MITRE BENDS & FABRICATED REDUCERS

4.13.1 The specific application of welded mitre bends and fabricated reducers shall be governed by the piping specification furnished to the Contractor. The radiographic requirements shall be as per the piping material specification for process and utility systems with the exception of steam piping falling under INDIAN BOILER REGULATIONS where radiographic requirement of IBR should be complied with.

4.14 TOLERANCES

4.14.1 In addition to tolerances contained within the specified codes or standards, the following shall also apply.

- For bending of pipes subjected to internal pressure, the difference between maximum and minimum outside diameters, at any cross section along the axis of bent portions of the pipe, shall NOT exceed 5% of the nominal outside diameter. The wall thickness of pipes after bending shall be not less than (Nominal wall thickness) x 87 ½ % (Minimum wall thickness).

4.14.2 All linear dimensions involved in relative position of branches, bases, flanges end, instrument tappings and changed in directions, each to each other shall be maintained within $\pm$ 3mm (1/8").

4.14.3 In case of long lines this tolerance in linear dimension cannot be added that is the overall dimension should be within $\pm$ 3mm.

4.14.4 All angular dimension of bends and branches shall be maintained within $\pm$ 3mm. All angular dimension of bends and branches shall be maintained within + 1/4 degree.

4.14.5 Flange joint contact surfaces shall be flat and true as machined. Should warping take place due to fabrication processes, the joint contact surfaces may be restored to their original accuracy, provided that the flange thickness dimensions are not reduced below the minimum required by the relevant ASME/ API/ MSS flange specification.

4.14.6 The rotation of flanges away from their axis shall be measured as indicated in ***Attachment 7.1.*** Tithe misalignment shall not exceed 1.5mm between diametrically opposed boltholes.

4.14.7 Alignment of flanges and branch welding ends measured as shown in ***Attachment 7.1.*** across any diameter shall not deviate from the true position more than 1/32" per foot (2.5mm per metre) of diameter.

4.15 PREPARATION OF PIPE AND OTHER FITTINGS

4.15.1 Prior to aligning pipe for welding the ends, the pipe shall be machine bevelled. Bevel dimensions shall be as per applicable codes / standards and piping specifications given to the contractor.

4.15.2 The bevelled ends of each joint of the pipe shall be thoroughly cleaned of paint, rust, mill scale, dirt or other foreign materials to avoid defects in the completed welds. This shall be done by use of power driven wire brushing wheels or other methods approved by the consultant.

4.15.3 Any foreign matter or obstruction remaining inside the pipe shall be removed by appropriate means.

4.15.4 Couplings and half couplings shall be accurately shaped and set on to suit the contour of the run pipe, weldolets shall be fitted accurately to the contour of the run pipe. Pipe shall be properly supported and aligned by jigs or clamps as required in order to preclude extraneous loads and minimise strains during tacking.

4.15.5 Small tack weld i.e. between 1/2" (12.5mm) and 3/4" (18mm) in length penetrating to the bottom of the groove may be used in fitting up.

Tacks should be equally spaced as follows:

For 2 1/2" pipe and smaller	-	2 tacks
For 3" to 12" pipe	-	4 tacks
For 14" and large pipe	-	6 tacks

Unless otherwise specified, all pipe to pipe joints shall be butt welds.

4.15.6 Pipe with a wall thickness of 1.4" (6mm) and greater shall not have internal mis-alignment of pipe wall exceeding 1/16" (1.5mm).

4.15.7 Pipes with a wall thickness less than 1.4" (6mm) shall not have internal mis-alignment of pipe wall exceeding 25% of pipe wall thickness. When mis-alignment is greater than the above component shall be aligned by drifting, rolling or machining in accordance with the code, ensuring that the nominal wall of minimum wall thickness is not encroached upon after considering the manufacturing tolerances defined in the appropriate material specifications.

4.16 INSPECTION OF FABRICATED PIPING

4.16.1 Pipe work that has been done shall be checked with the isometric drawings and other related documents to verify that it is fabricated, complies with the dimensions and specifications.

4.16.2 Fabrication shall have dimensions falling within the tolerances defined earlier.

4.16.3 All welds shall be visually examined and shall also be subjected to radiographic inspection as provided for in para Radiographic inspection thereof. Joints shall have proper weld penetration without undercuts, overlaps, or abrupt ridges or valleys. Visual defects such as cracks, pin holes incomplete fusion, etc., shall be removed and joints rewelded at contractors cost and particular case should be exercised in butt welding of small diameter pipes and stainless steel pipes so as to prevent reduction of internal diameter at the joint beyond the limits specified below. The root pass of butt joints, regardless of techniques use shall be such that the projection of weld metal into the pipe bare shall not exceed specified limits indicated in standard codes and piping specifications.

4.17 CLEANING OF PIPES

4.17.1 On completion of fabrication, all pipes and fittings shall be cleaned inside and outside by a suitable means (mechanically driven rotary cleaning tool, wire brush, compressed air, detergent etc.). Before erection to ensure that assembly is free from all loose foreign material such as scale, sand, weld spatter particles, cuttings chips etc.

4.17.2 All field fabricated piping shall also be cleaned at the completion of the fabrication. All burrs welding icicles and weld spatter shall be removed by any suitable means (mechanical tools, wire brush etc.). The pipe interior shall be water flushed to eliminate cement mortar, sand, heavy oil films and loose scale etc., and ends shall be capped.

4.17.3 Both shop and field fabricated piping shall be blown with compressed air at the termination of cleaning. The ends of complete section of pipe line shall be closed with suitable plugs, caps

or other approved methods. All fabricated piping shall be protected against rust and corrosion pending erection, by the contractor at his own cost.

4.17.4 Cleaning requirements for special services, if any, shall be followed by the contractor as specified in the piping specifications.

4.17.5 Pickling and passivation of S.S. pipes if required shall be carried out as specified in the attached specifications.

4.18 HEAT TREATMENT

4.18.1 PRE-HEATING

Piping joints shall be preheated before welding to the extent required for different types of materials as per the requirement of standards / codes and specifications and also refer to ***Attachment 7.3***

4.18.2 POSTWELD HEAT

Welded joints shall be heat treated for the various types of steel as specified in the piping specifications and also refer to ***Attachment 7.3***

4.18.3 Flange seal surfaces must be protected against oxidation during Heat –Treatment.

4.18.4 All bends and other parts worked either cold or hot shall be heat treated as indicated in ***Attachment 7.3***

4.18.5 In all cases maximum Brinell hardness values given in ***Attachment 7.3*** shall not be exceeded.

4.19 WELDING

4.19.1 All welding shall be in accordance with the code and with any amendments or additional requirements noted on drawings or within this specification.

4.19.2 All welding procedures and supporting qualifications to be used by the contractor shall be presented to the company for written approval.

4.19.3 Welder qualification shall be in accordance with section IX of the ASME Boiler and Pressure vessel code and shall be witnessed by the client/ company's representative. In case of IBR piping welders & welding, procedure shall be subject to approval from IBR inspectorate.

4.19.4 Backing rings shall not be used without the approval of the company.

4.19.5 During welding, sections of pipe shall be adequately supported so that the joints are relieved of any strain.

4.19.6 All welding shall be supervised and records maintained, identified with the individual welder concerned.

4.19.7 Electrodes shall be stored, dried and utilized as per manufacturer's recommendations.

4.20 ERECTION

4.20.1 For erection of piping, use of davits, welding of temporary supports on adjacent equipment / structure, use of existing foundation or steel structure shall be allowed only after approval of Owner / Consultant. In each case maximum load and erection procedure shall be as direct by the Owner / Consultant.

4.20.2 The intent of prefabrication at the shop is to accelerate progress of pipe work and to minimize work in the field. Such prefabrication should be based on approved isometrics and piping

layouts furnished to the contractor. 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 dimensions between those appearing in the isometrics and those actually occurring at the site due to minor variations in the location of equipments, inserts etc. Therefore field welds shall be decided by the contractor permitting preassembly to be installed without any modifications. The shop fabricated pieces shall be largest practicable size limited for easing transportation to site. In any case, no extra claims will be entertained on this score. After prefabrication, during intermediate storage pipe ends shall be sealed off. Before, sealing the ends, piping shall be cleaned inside to remove welding spatter and foreign debris (brush clean).

4.20.3 All piping shall be routed and located as shown in piping drawing keeping in view the piping specifications. No deviations from the arrangement shown shall be permitted without the express consent of the Owner / Consultant.

4.20.4 All piping shall be straight and direct with requisite slopes provided to headers and jacketed lines as indicated on drawings. Piping shall generally be routed parallel to or at right angles to the plant columns and beams and shall be neatly and evenly spaced as shown in drawings

4.20.5 Pipes shall be installed at elevations and dimensions indicated on piping drawings and the contractor shall be fully responsible for accurately laying out the pipe work. Should changes be necessary at site in order to avoid interference, this shall be carried out by the contractor in consultation with the Owner / consultant at no extra cost.

4.20.6 Steam lines shall be provided with steam traps at low points in general. Drains and vents shall be provided on all pipe lines at low and high points respectively as well as at locations necessary for pressure testing, even though the same may not have been shown in the piping drawings.

4.20.7 Installation of jack screws will be done by the Contractor.

4.20.8 Lines requiring steam tracing shall be laid by the contractor in strict compliance to the specification drawings and details provided. Payment for tracer lines will be made at the corresponding unit rates quoted separately.

4.20.9 Location and design of pipe supports shown in Construction drawing, general arrangement drawings, support manuals should be strictly adhered to. Pipe supports have been designed and located to effectively sustain the piping system for weight and thermal effects. Erection and fabrication of supports i.e. restraints, such as guides steps, anchors must be made in such manner that they will not contribute to the over stressing of a line, while protecting a weaker or more sensitive sections of a line, while protecting a weaker or more sensitive component e.g. turbine, pump, compressor of approved nozzles. Supports other than these specified above shall be designed fabricated and erected by the contractor.

4.21 FLANGES

4.21.1 While fitting up mating flanges, care shall be exercised to properly align the pipes and to check the flanges for stress, so that faces of the flanges can be pulled up together without inducing any stresses at the pipes and equipment nozzles. The bolt holes of the flanges in the vertical plane shall straddle the vertical centre line of the pipe in the erected position and for flanges in the horizontal plane the bolt holes shall straddle the plant north south axis unless otherwise indicated on the drawings.

4.21.2 Flanged connections at the pumps, turbines, compressors shall be made in such a way so as not to induce any stresses due to misalignment excessive gaps etc. The final tightening shall be redone when the machines are aligned completely and specifically authorized by the Owner / Consultant. Temporary protective covers shall be provided at all flanged connections of pumps, compressors, turbines and other similar equipments until the piping is finally connected.

4.22 FITTING

4.22.1 Wherever cold spring is specified, the contractor shall maintain the necessary gap provided for cold spring as indicated in the drawings. Before cold pulling two sections, Consultant / Owner must check the gap and confirmation in writing is to be obtained in this respect that gap provided is in accordance with the drawings.

4.22.2 Expansion loops shall be fabricated from pipe and prefabricated bends and installed by the contractor from material supplied by Owner / Consultant.

4.22.3 Slopes specified for various lines in the drawings shall be maintained by the contractor. In case the contractor unable to maintain the indicated slope, he shall check the sagging of pipe with a precision spirit level. Vents and drains are shown in the isometrics of each line and these are intended, during hydraulic test, for releasing the trapped air and draining out the test fluid after testing. Valved vents and drains are also shown wherever required. The contractor shall provide vents and drains connections even these are not shown in the drawings and are found necessary by the Consultant/ Owner. The details of the type of connections to be adopted shall be given to the contractor at the time of work.

4.22.4 Avoid any metal to metal pressure contact between stainless or acid resistant steel and unalloyed steel, as such contact can cause corrosion damage.

4.22.5 When applying wire-rope slings, keep these chaffing against the item being handled by interposing cushioning material. Take care during field assembly that structural members of unalloyed steel do not rub against stainless steel and acid resisting steel components.
If any piping components have to be held in vices, or similar clamping devices, cover the vice jaws or holding surfaces with work protectors of the same stainless steel or of lead or copper sheet.

4.22.6 After the piping is erected in final position, it shall be cleaned, tested for tightness and kept dry wherever instructed as described in this specification.

4.23 VALVES AND ON-LINE FITTINGS

4.23.1 All on-line fittings such as valves, strainers, traps, filters, thermowells, safety valves, control valves, pressure reducers, ejectors, flame arrestors, sight glasses, rainhoods etc., shall be installed as specified in the drawings. Valves should preferably be with stem pointing upwards or horizontal as directed. They shall be installed in such a manner that hand wheels, stem and motors will not obstruct platforms and walkways. Temporary spool pieces in place of any of the on-line fittings shall be provided. Should such items be not available at the time of erection / testing the spool pieces shall be replace with the appropriate fittings when the same is available.

4.23.2 In case of control valves spool pieces shall be provided in their place on pipelines at the time of testing and flushing. The spool pieces shall be removed and control valves shall be installed in their place before trial running and pre-commissioning. Fabrication installation and removal of spool pieces is in the Contractors scope of work and no extra payment shall be made for the same.

4.23.3 All globe valves shall be installed with the fluid pressure acting on the bottom of the discs.

Globe valves, check valves, control valves shall be installed in the correct sequence and direction as shown in line diagrams and piping drawings. In case the direction of flow is not given in the valve body, the Contractor shall check then and mark the correct direction on the valves prior to their installation.

4.24 SUPPORTS, GUIDES AND ANCHORS

4.24.1 Pipe supports shall be provided generally as per the standard piping support details shown in drawings / pipe support manual, location and design of main pipe racks only are given in

drawings. But, for certain critical piping, location and design of pipe supports are also given in piping drawing. The contractor shall strictly adhere to these details and provide proper pipe supports.

4.24.2 For the field run piping, the contractor shall locate suitable and adequate supports consistent with the design and type supports used in the rest of the plant.

4.24.3 Additional supports may have to be provided at site where necessary to avoid sagging and / or transmitting undue loads to interconnecting equipment. Discretion for providing all such additional support lies with the Owner / Consultant.

4.24.4 If temporary pipe supports are required during installation, the Contractor shall provide the same at no extra cost and remove the same on fixing of permanent supports.

4.24.5 Welding on any piping, machinery or equipment for the purpose of pipe / valve support shall not be done unless otherwise indicated on drawings or written permission is obtained from the Owner/ Consultant.

4.24.6 Correct installation of supports at pumps and compressors is a must. The following points are to be checked after installation with Owner / Consultant and necessary confirmation in writing is to be obtained in this respect.

i. Restraints installed properly.

ii. Clearance as per support drawings.

iii. Restraints strength adequate (visual)

iv. Insulation (does not restrict thermal growth)

v. Spring supports located as per support drawings, spring removed and cold load setting checked. Interference and travel from cold to hot to be checked.

4.24.7 Lines shown with the pipe hangers shall be installed with hanger rods set at a slope in the direction opposite to the pipe movement from the operation. No supports shoe/ cradle shall be offset unless shown specifically in the drawing. Spring supports shall be checked for the range of movement and adjusted if necessary to obtain correct positioning in the cold condition.

4.24.8 Fabrication and erection of supporting elements and structural fixtures wherever required and as pointed out by the Owner / Consultant shall be carried out by the Contractor.

4.24.9 For fabrication of pipe supports, payment will be made in line with the enquiry/ order condition.

4.25 INSTRUMENTS

4.25.1 In case of instruments the limits of piping contractor are clearly shown in the drawings provided (such as up to first block valve, nozzle and flanges taps, etc.). In addition to this, the Contractor shall install all on-line instruments such as restriction orifices / orifice assemblies with first block valves venturies, control valves, flow integrators, positive displacement meters, with strainers, pressure relief / safety valve, rotameters, rots transmitters, etc. Though exact location is indicated on drawing for take off for temperature pressure flow level, sample connections etc. The contractor shall ensure correct orientations site in consultation with the Owner/ Consultant before starting final welding. Care shall be used a control valves, flow meters, etc., to avoid contamination with dust and foreign matters.

4.26 BOLTS & NUTS

4.26.1 During erection of the piping, the contractor shall use proper number and size of bolts and nuts as per drawings and specifications. The contractor shall clean all bolts and nuts if

required with rust removing compound and provide approved quality of grease mixed with graphite powder thoroughly on all the bolts and nuts to prevent rusting during storage of his stores, immediately after erection and when the flanged joints are opened and remade for any purpose including flushing, testing and alignment of equipment etc. The grease and graphite powder shall be supplied by the contractor within the rates for piping work.

4.27 STRAINERS

4.27.1 The installation of the *conical* strainers *between two flanges* shall be part of piping erection work and no separate payment will made for this work.

4.28 ASSEMBLY

4.28.1 The assembly of various piping components shall be done so that the completely erected piping conforms to the requirements of the specification as wells as the arrangements and details shown in construction drawings.

4.28.2 All flanged pipe sections and flanged appurtenances shall be accurately lined up before making up flanges in order to prevent any stresses from slinging or forcing the piping in to place by means of flange bolts. Flange facings shall be true and perpendicular to the axis of the pipe.

All bolts shall extend completely through their nuts but not more than 1/2".

All flange bolts connections shall be *off - centre* lines unless otherwise required.

4.29 FLANGE JOINTS WITH A GASKET

4.29.1 The following procedure shall be adopted when assembling

a) Brush off the flange surfaces.
b) Align the flanges.
c) Insert two or three aligning pins.
d) Remove the gasket from the package, drop into its place.
e) Cleaning bolts and nuts if required with rust removing compounds and grease with graphite powder.
f) Insert bolts into free holes and tighten.
g) Replace aligning pins with bolts and nuts.
h) Tighten all bolts evenly first on the quarter and then gradually in symmetrical pattern to ensure equal torque on the bolts.

4.29.2 Full face drilled gaskets shall be used on all flat faced flanges unless specified otherwise. During erection / installation of the piping, proper number and size of the nuts and bolts shall be fitted as per drawings and specifications. All flanged joints shall be so fitted that the gasket contacts faces bear uniformly on the gasket and then made up with relatively uniform bolt stress.

4.29.3 In case of Tie-in-joints the joint fit up will be checked and approved by Owner/ Consultant. Root run will be checked by dye penetration testing. The joint will be fully radiographed and defects, if any will be rectified and re-radiographed. All these will be carried out at contractors cost. The tie-in-joints will not be tested hydrostatically.

4.30 STRUCTURAL ATTACHMENTS

4.30.1 Reinforcement pads for structural attachment shall be provided with an untapped hole of 6mm diameter for venting, drilled prior to welding to header. Attachment welds shall be in accordance with 4.18 & 4.19

4.31 TREATMENT AFTER FABRICATION

4.31.1 Where pipe work is required to be lined, coated or given treatment of any kind after fabrication, these operations will be subject of separate specification.

4.32 FABRICATION PRIORITIES AND MATERIAL

4.32.1 Where contract requirements demand, the company will inform the contractor/ Fabricator of the fabrication priorities, which are subject to periodic revision and updating. The contractor/ fabricator shall provide a fabrication control system that is flexible enough to accommodate reasonable change in priority.

4.32.2 Optimisation on weight or work content shall not be factors of fabrication priority.

4.32.3 The company reserves the right to request the production of pipe spools where minor items of the materials are not available in time, e.g half couplings, full couplings, bosses, sockolets etc.

4.32.4 The contractor/ Fabricator shall be able to maintain production with these variations and absorb any double handling necessary.

4.33 INSPECTION

4.33.1 Pipe work shall be checked against the Engineering Drawings issued for construction and other related documents to verify that it complies with the company's requirements, as fabricated.

4.33.2 Fabrication shall have dimensions falling within the tolerances defined elsewhere in this document.

4.33.3 All completed welds shall be visually examined for visible defects.

4.33.4 For non-destructive test requirements, reference should be made to the Annexure in piping material specification.

4.34 PROTECTION

4.34.1 The contractor/ fabricator shall ensure that all fabricated pipe work is protected against corrosion and mechanical damage during storage, transportation and erection.

4.35 PIECE MARKING

4.35.1 All spool pieces shall be marked with proper identification for ease of assembly. Each spool shall be marked with the following, starting from the direction of flow arrow shown in the Isometrics/ drawings.

- Piece identification mark e.g. MK-1, MK-2 etc.,
- Line Number
- Isometric number

4.35.2 Hard stamping shall not be used as a method for marking pipe work.

5.0 RELATED DOCUMENTATION (REFERENCES)

Z SS 005 : Specification for Piping-Welding

Z SS 006 : Specifications for piping –flushing, testing and inspection

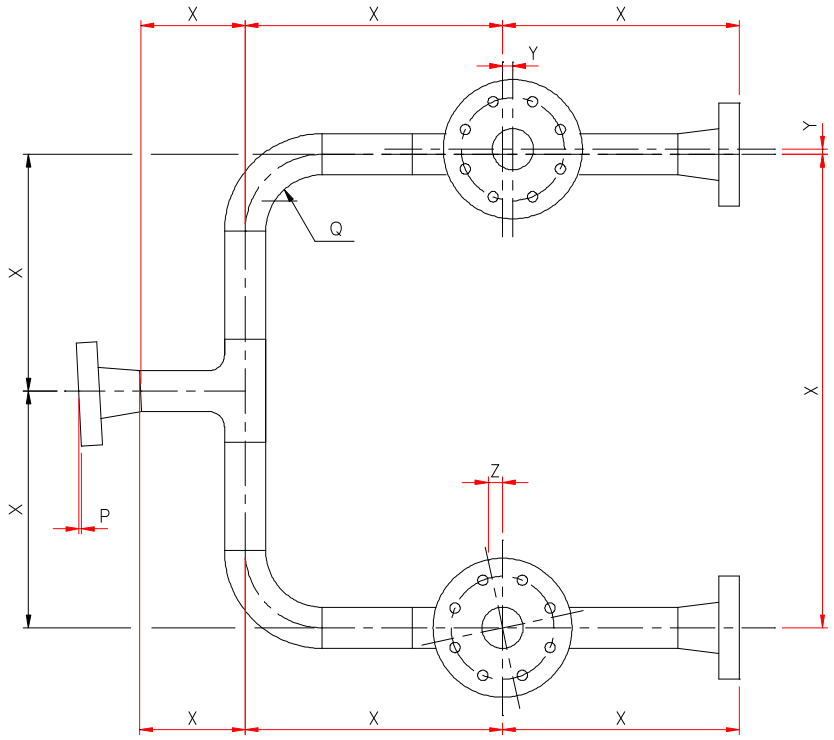
6.0 RECORDS

None

7.0 ATTACHMENTS/ APPENDICES

Refer to "Table of Contents"

ATTACHMENT: 7.1



FIGURE–1

X: MAX. TOLERANCE, FOR FACE TO FACE CENTER TO FACE, LOCATION OF ATTACHMENT ETC., FROM THE INDICATED DIMENSIONS SHALL BE ± 3.0mm.

Y: MAX. TOLERANCE IN LATERAL TRANSLATION IN ANY DIRECTION FROM THE INDICATED POSITTON SHALL BE ± 1.5mm.

Z: MAX. TOLERANCE IN ROTATION FROM THE INDICATED POSITION, SHALL BE ± 1.5mm BETWEEN DIAMETRICALLY OPPOSITE BOLT HOLES.

P: MAX. TOLERANCE FOR OUT OF ALIGNMENT FROM THE INDICATED POSITION SHALL BE ± 2.5mm PER M MEASURED ACROSS ANY DIAMETER.

Q: MAX. TOLERANCE IN FLATTENING, MEASURED AS DIFF. BETWEEN THE MAX. AND MIN. O.D. AT ANY ACROSS SECTION.

a) PIPE WITH EXTERNAL PRESSURE ± 5%

b) PIPE WITH INTERNAL PRESSURE 3%

REV. NO.	REVISION DESCRIPTION	DRAWN	CHK	APPROVED			DATE
0	ISSUED FOR USE	HCT	RVM	BK	–	–	31.07.01

PIPE FABRICATION TOLERANCES

JACOBS H&G
ENGINEERS AND CONSTRUCTORS

PROJ.NO.	DRAWING NO.			REV
LWI	L SD 695			0
DATE	FILE NAME	DRAWING SCALE	PLOT SCALE	DRAWN BY
31.07.2001	LSD695	–	–	HCT

JACOBS HOUSE.
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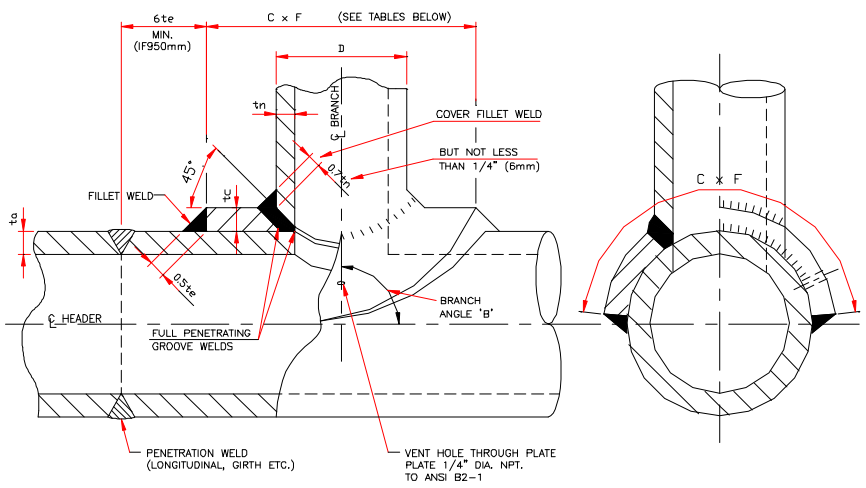
REVISED ON : 31.07.2001 PLOTTED ON : 31.07.2001

ATTACHMENT: 7.2



DETAILS OF PLATE – TYPE BRANCH REINFORCEMENT

NOTES :

1) REINFORCEMENT PLATE THICKNESS PLATE THICKNESS IS EQUAL TO HEADER PIPE WALL THICKNESS.
2) IF PLATE IS MADE IN MORE THAN ONE PIECE, THE SPLIT SHALL BE CIRCUM-FERENTIAL REJOINED BY A FULL THICKNESS FULL PENETRATION WELD.
3) EACH PLATE SECTION SHALL BE PROVIDED WITH A VENT / TEST HOLE, BEFORE FITTING TO THE HEADER.
4) ALL HOLES SHALL BE LOCATED AT THE SIDES AND NOT AT THE CROTCH.
5) WELD PREPARATION & WELDS SHALL BE ACCORDING TO ANSI.B31.3.
6) IN ALL CASES, THE PLATE SHALL BE ATTACHED AFTER THE BRANCH TO HEADER WELD HAS BEEN MADE & INSPECTED.
7) THROAT DIMENSIONS OF WELDS GIVEN ARE THE MINIMUM ALLOWABLE.

BRANCH ANGLE B	ANGLE FACTOR F
45°	1.42
50°	1.31
55°	1.22
60°	1.16
65°	1.10
70°	1.06
75°	1.04
80°	1.02
85°	1.00
90°	1.00

N/B BRANCH (INCHES)	C	
	INCHES	MM
2	4 3/4	120
2 1/2	5 3/4	145
3	7	180
4	9	230
6	13 1/4	335
8	17 1/4	440
10	21 1/2	550
12	25 1/2	650
14	28	710
16	32	815
18	36	915
20	40	1015
22	44	1120
24	48	1220
26	52	1320
28	56	1420
30	60	1525

REV. NO.	REVISION DESCRIPTION	DRAWN	CHK	APPROVED			DATE
0	ISSUED FOR USE	SSV	BSD	BK	–	–	13.08.03

DETAILS OF PLATE
TYPE BRANCH REINFORCEMENT

TYPE OF SUPP.

JACOBS H&G
ENGINEERS AND CONSTRUCTORS

PROJ.NO.	DRAWING NO.	REV
BTG	L SD 177	0

DATE	FILE NAME	DRAWING SCALE	PLOT SCALE	DRAWN BY
13.08.2003	LSD177	~	~	SSV

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REVISED ON : 13.08.2003 PLOTTED ON : 13.08.2003

ATTACHMENT 7.3

1. THERMAL CUTTING

TABLE 1

PREHEAT TEMPERATURES FOR THERMAL CUTTING	
MATERIAL	**Preheat Minimum ° C**
Carbon Steel	See Notes below
1 Cr ½ Mo.	100, See Notes below
1 ¼ Cr ½ Mo.	100, See Notes below
2 ¼ Cr 1Mo.	150, See Notes below
5 Cr ½ Mo.	150, See Notes below
7 Cr ½ Mo.	150, See Notes below
9 Cr ½ Mo.	150, See Notes below
Carbon ½ Mo.	100, See Notes below

Notes:

- Where carbon content is greater than 0.25% or wall thickness is greater than 19mm (¾ in.) a preheat of 80 degree C minimum shall be applied.
- Preheat shall be applied uniformly around pipe circumference prior to cutting.
- Treatment after thermal cutting
    1. Remove all slag.
    2. Oxide skin on weld preparation to be dressed back to clean metal by grinding, machining or filing.

2. COLD BENDING OR FORMING

TABLE 2

Materials	Max bending Temp ^{0}C	Heat treatment after Bending
Carbon steel	620	Note-1
1 ¼ Cr. ½ Mo.	650	None
2 ¼ Cr. 1Mo.	680	None
5 Cr. ½ Mo.	720	None
Carbon ½ Mo.	650	None
Austenitic Cr. Ni.	425	Note-2

Notes:

1. Cold bent carbon and low alloy steel pipes in all thicknesses shall be stress relieved when impact tested. All pipes intended for caustic, or any other service, likely to induce stress corrosion cracking, shall also be stress relieved (Table 5). This information will be defined in the contract specification.
2. Under certain circumstances e.g. when the fabrication is to be exposed to conditions which promote stress- corrosion cracking, solution annealing at 1050-1100^0 C should be considered.

Definitions:

1. For ferritic steels, cold bending involves operations at temperatures below the lower critical point; the temperature limitations of Table 2 make allowances for safe margin below this temperature.

3. HOT BENDING OR FORMING

TABLE 3

Materials	Hot bending Temp ^{0}C	Heat treatment after Bending
Carbon steel	850- 1050^0 C	(N) 900 - 950^{0}C, Note 1
1 – 9 Cr. Mo.	900- 1100^0 C	(N) 900 - 950^{0}C and (T), Note 2
Carbon ½ Mo.	900- 1100^0 C	(N) 900 - 950^{0}C, Note 3
Austenitic Cr. Ni.	950- 1100^0 C	Solution Annealing at 1050- 1100^0 C, Note 4

Notes:

1. Heat treatment may not be necessary. Precise requirements are defined in the contract piping specification.
2. Normalise (N) and Temper (T) as defined in contract piping specification.
3. Normalise (N) as defined in the contract piping specification.
4. The complete item shall be normally be heat-treated. Local heating shall not be used except under special circumstances with Company approval.

4. PREHEATING REQUIREMENTS FOR WELDING

TABLE 4

PRE-HEATING REQUIREMENTS FOR WELDING				
Material	**Low Hydrogen Metal (Note 2)**		**Non Low Hydrogen Metal (Note 2)**	
	Thickness (mm) Note 1	Minimum Pre-heat	Thickness (mm) Note 1	Minimum Pre-heat
C.S Less than or equal to 0.25% of Carbon	Greater than 30	80^0 C	Greater than 20	80^0 C
	Less than or equal to 30	10^0 C	Less than or equal to 20	10^0 C
C.S greater than 0.25% of Carbon	Greater than 12.5	100^0 C	Greater than 12.5	100^0 C
	Less than or equal to 12.5	10^0 C	Less than or equal to 12.5	10^0 C
Carbon ½ Mo.	Greater than 12.5	100^0 C	Note 3	
	Less than or equal to 12.5	10^0 C	Less than or equal to 12.5	100^0 C
1 Cr. ½ Mo. 1 ¼ Cr. ½ Mo	Greater than 12.5	150^0 C	Note 3	
	Less than or equal to 12.5	100^0 C	Note 3	
2 ¼ Cr. 1Mo. 3 Cr. 1Mo.	Greater than 12.5	200^0 C	Note 3	
	Less than or equal to 12.5	150^0 C	Note 3	
5 Cr. ½ Mo. 7 Cr. ½ Mo. 9 Cr. 1 Mo	ALL	200^0 C	Note 3	
3 ½ Ni. 5 Ni. 9 Ni.	**Consult Company Construction department**			

Notes:

1. Greater component thickness at weld joint.

2. Low hydrogen weld metal shall contain not more than 10 ml of diffusible hydrogen, per 100g of deposited weld metal (BS 639).

3. Only Low hydrogen weld metal shall be used.

5. POST WELD HEAT TREAMENT REQUIREMENTS

TABLE 5

Material	Thickness	Temperature	Minutes of Soak Time		Maximum Hardness (Note 1)	
	(mm)	^{0} C	Per mm	Minimum	Vickers	Brinell
Carbon Steel	Less than or equal to 20 (Note 2)	Nil (Notes 2 & 3)	Nil	Nil	237	225
	Greater than 20	580- 620 (Note 3)	2.5	30	237	225
1 Cr. ½ Mo. 1 ¼ Cr. ½ Mo	All (Note 5)	705- 740 (Notes3, 4 & 6)	5	120	237	225
2 ¼ Cr. 1Mo. 3 Cr. 1Mo.	All	710- 750 (Notes3, 4 & 7)	5	120	253	241
5 Cr. ½ Mo. 7 Cr. ½ Mo. 9 Cr. 1 Mo	All	720- 760 (Note 3, 4)	5	120	253	241
3 ½ Ni. 5 Ni. 9 Ni.	**Consult Company Construction Department**					
Carbon ½ Mo.	All (Note 6)	650- 680 (Notes 3, 4 & 5)	2.5	60	237	225

Notes:

1. The method employed for hardness testing shall be of identifying peak hardness values, which occur in the heat-affected zone. Acceptable methods are the Vickers test preferably with a load of 10 Kg for laboratory evaluation of weld test pieces and portable dynamic tests for assessment of production welds.

2. Post weld treatment may be required on carbon steel and low temperature carbon steel for process reasons, e.g. caustic or chloride service, regardless of wall thickness. Such requirements will be defined in the Piping specification.

3. i) Where a static furnace is used, the furnace temperature shall not exceed 400^0 C when inserting the weldment.

   ii) The heating rate shall not exceed the following

   For pipes of thickness up to and including 25mm- 220^0 C per hour; for pipes of thickness over 25mm- 220^0 C x (25^0 C /t) per hour, or 55^0 C whichever is greater.

   iii) For pipes thickness t up to and including 25mm - 275 x (25^0 C /t) per hour or 55^0 C per hour, whichever is greater.

4. The cooling rate down to 400^0 C shall not exceed the following:-

   For Pipes of thickness t up to and including 25mm – 275^0 C per hour.

   For pipes thickness t over 25mm - 275 x (25^0 C /t) per hour or 55^0 C per hour, whichever is greater.

5. Post weld heat treatment is not required for thicknesses up to and including 12.5 mm providing the hardness in the weld and heat affected zone does not exceed 237 Vickers (225 Brinell).

6. Post weld heat treatment shall be carried out at 630^0 C - 670^0 C, when optimum creep properties are required.

7. Post weld heat treatment shall be carried out at 680^0 C - 720^0 C, when optimum creep properties are required. In this case the minimum soaking time shall be 180 minutes regardless of thickness.

8. DISSIMILAR METAL WELDS

TABLE 6

1ST Base Metal	2nd Base Metal	Filler Material	Pre-Heat	Post Heat	Notes
Carbon Steel	C. ½ Mo. 1-3 Cr. Mo.	As for 2nd Base metal	As for 2nd Base metal	As for 2nd Base metal	Note 1
Carbon Steel	5- 9 Cr. Mo.	2 ¼ Cr. Mo.	As for 2nd Base metal	As for 2nd Base metal	Note 1 & 2
Carbon Steel	Austenitic S.S	E309 Inconel82/182 or Equiv.	As for 1st Base metal	Consult the company	-
Cr. Mo.	Higher Cr. Mo.	As for 2nd Base metal	As for 2nd Base metal	As for 2nd Base metal	Notes 1 & 2
Cr. Mo. Carbon.½ Mo.	Austenitic S.S	E309 Inconel82/182 or Equiv.	As for 1st Base metal	As for 2nd Base metal	
Carbon.½ Mo.	1-3 Cr. Mo.	As for 2nd Base metal	As for 2nd Base metal	As for 2nd Base metal	Note 1
	5- 9Cr. Mo.	2 ¼ Cr. Mo.	As for 2nd Base metal	As for 2nd Base metal	Note 1 & 2
Austenitic S.S	C.S, C.½ Mo., Cr. Mo.	E309 Inconel82/182 or Equiv.	As for 2nd Base metal	Consult the Company Piping Group (piping shall consult FEG)	
Austenitic S.S	Another Austenitic S.S	As for 2nd Base metal	None	None	

Notes:

1. When welding any of the Cr. Mo. Steels in situations where P.W.H.T is impractical and higher hardness values are likely occur, consideration shall be given to welding with INCONEL 82/ INCONEL 182.

2. When joining of steels widely variable compositions, such as:

   Carbon steel/ 1Cr. ½ Mo./ 1 ¼ Cr. ½ Mo. Welding to 5Cr. ½ Mo./ 7Cr. ½ Mo./ 9Cr. 1Mo. Consideration shall be given to use of mutually compatible intermediate transition piece. Where such changes occur, the company construction Department shall be consulted.