

Annexure 1- List of Mandatory Spares/ Maintenance Equipment/ Special Tools & Tackles/ Test Equipment

PROJECT: LSTK job for ISBL work of 220KV Grid Power Import at IOCL, Panipat Refinery

CUSTOMER: Indian Oil Corporation Limited (IOCL)

CONSULTANT: Tata Consulting Engineers Limited (TCE)

REV. NO.: 00

This list is tentative and provisional and hence, details and quantity may vary during detailed engineering and execution stage.

Sl. No.	Item Description	Unit	Qty.
A. Main system			
1.0	Mandatory spares of 220/34.5kV, 50/65 MVA, ONAN/ONAF Power Transformers with associated accessories		
1.1	Transformer oil (1 Lot= 10% spare for total quantity, its containers, sampling bottles and other accessories)	Lot	1
1.2	Bushing (HV & LV) (1 Lot= 1 no bushing of all types)	Lot	1
1.3	Gasket (1 Set= 1 gasket of all types)	Set	1
1.4	MOG (1 Set= 01 no of each type)	Set	1
1.5	WTI & OTI (1 Set= 01 no of each type)	Set	1
1.6	Buchholz Relay (1 Set= 01 no of each type)	Set	1
1.7	Silika gel breather Assembly (1 Set= 01 no of each type)	Set	1
1.8	Other spares related to transformer auxiliary system (NIFPS and temperature based system)	Set	1
2.0	Mandatory spares of 220kV, 2000A, 3X1 Phase HCB Isolator (ISO) with associated accessories		
2.1	Male and female contact (1 set= 1 no. of each type)	Set	1
2.2	Limit switch (1 set= 1 no. of each type, rating and make)	Set	1
2.3	Motor with gear assembly & bevel gear assembly complete	Set	1
2.4	Auxiliary switch contacts assembly	Set	1
2.5	Earthing rod & blade contact side	Set	1
2.6	Hinge pins and terminal pad	Set	1
3.0	Mandatory spares of 198kV, 10kA, 1 Phase, Class-III, Metal oxide gapless Surge Arrester (SA) with associated accessories		
3.1	198kV, 10kA, 1 Phase, Class-III, Metal oxide gapless Surge Arrester (SA) complete with surge monitor inclusive of discharge counter and ammeter, and insulating base as per specification complete with all accessories	No	2
3.2	198kV Terminal Connector suitable for single/ Twin ACSR Moose Conductor	No	1
3.3	Insulated Cu Cable connecting Surge Arrestre to Surge Monitor.	No	2
4.0	Mandatory spares of 220kV, 1 Phase Tariff Metering dual core Current Transformer (Tariff CT) with associated accessories		
4.1	220kV, 1 Phase Tariff Metering dual core Current Transformer (Tariff CT) with associated accessories	NIL	
5.0	Mandatory spares of 220kV, 8800pF, 1 Phase, Capacitor Voltage Transformer (CVT) with associated accessories		
5.1	220kV, 8800pF, 1 Phase, Capacitor Voltage Transformer complete with all associated accessories	Nos.	2
6.0	Mandatory spares of 220kV, 1 Phase Tariff Metering Potential Transformer (Tariff PT) with associated accessories		
6.1	220kV, 8800pF, 1 Phase, Capacitor Voltage Transformer complete with all associated accessories	NIL	
7.0	Mandatory spares of 220kV, 1mH, 2000A, 1 Phase Wave Trap (WT) along with bird barriers with associated accessories		

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Sl. No.	Item Description	Unit	Qty.
7.1	220kV, 1mH, 2000A, 1 Phase Wave Trap (WT) along with bird barriers with associated accessories	NIL	
8.0	Mandatory spares of 220kV, 1 Phase Post Insulators with associated accessories		
8.1	220kV (Voltage Class 245kV), 6kN, 25 mm/kV , 1 Phase, Outdoor type, Post Insulator- Insulator for 220kV Isolator complete with all accessories, mounting hardware	Set	2
8.2	220kV (Voltage Class 245kV), 6kN, 25 mm/kV , 1 Phase, Outdoor type, Post Insulator- Insulator for 220kV Bus Support complete with all accessories, mounting hardware	Set	2
9.1	Maintenance Equipment for 220kV, 2000A GIS with associated accessories		
9.1.1	Dew Point Measurement Meter	Nos	1
9.1.2	Supply: Maintenance Equipment- SF6 Leakage Detector Meter	Nos	1
9.1.3	Supply: Maintenance Equipment- Precision Pressure Gauge	Nos	1
9.1.4	Supply: Maintenance Equipment- Gas recovery unit with required accessories	Nos	1
9.1.5	Supply: Maintenance Equipment- SF6 gas purity detector/ analyzer for SO2, H2O, CF4, AIR etc.	Nos	1
9.1.6	Supply: Maintenance Equipment- Online Portable PD analyzer/ measurement kit suitable for GIS along with required accessories	Nos	1
9.1.7	Supply: Maintenance Equipment- Air/ gas humidity tester	Nos	1
9.1.8	Supply: Maintenance Equipment- A mobile SF6 gas treatment plant, which shall be suitable for draining, filtration/ purification and refilling the equipment shall be provided. The plant shall have storage capacity for at least two of the largest switchgear compartments and shall be supplied with complete accessories such as vacuum pump, pressure gauge, valves, hoses, couplings, adaptors, etc., necessary for evacuating and filling, together with storage facilities for these items. Maintenance Equipment- A SF6 Gas maintenance cart, which shall be easily moved by one (1) person, shall be provided with enclosed storage facilities for proper storage of cylinders and other accessories including power leads. The enclosed storage shall have facilities for padlocking.	Nos	1
9.1.9	Supply: Maintenance Equipment- A two wheel gas maintenance cart fitted with a cylinder of SF6 gas, a vacuum pump, a vacuum and pressure gauge and all necessary valves, hoses and couplings for evacuating and filling the switchgear	Nos	1
9.1.10	Supply: Maintenance Equipment- SF6 gas leakage test equipment shall be suitable for testing SF6 gas as per recommendations of IEC 60376. a. Instruments for automatic and continuous monitoring for the presence of SF6 gas in the atmosphere of the switchgear room shall be provided. The recommended positions, exact number of detectors, type of mounting, facilities for alarm etc. shall be indicated during the drawing approval stage. b. Each set of analyser shall comprise of: i. SO2 content in SF6 gas ii. Purity of SF6 gas iii. SF6 gas moisture content	Nos	1
9.1.11	Supply: Maintenance Equipment- All special tools required for the purpose of installation, maintenance, overhauling and testing of GIS and also for the measurement of moisture in SF6.	Lot	1

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Sl. No.	Item Description	Unit	Qty.
9.1.12	Supply: Maintenance Equipment- Any other special tools and tackles required for proper maintenance of GIS units has to be supplied by the bidder	Lot	1
9.2	Mandatory Spares for 220kV, 2000A GIS with associated accessories		
9.2.1	Spare SF6 gas required for the complete GIS (1 Lot= 10% of the total quantity. This spare quantity shall be supplied in non-returnable containers in ready to use condition.)	Lot	1
9.2.2	Handle for dis-connector switch drive	No	4
9.2.3	Handle for earthing switch drive	No	4
9.2.4	Pre selection key for three position switch	No	1
9.2.5	Tripping coil	No	4
9.2.6	Closing coil	No	4
9.2.7	Capacitive type voltage detectors	Set	1
9.2.8	Control fuses / MCB (1 Set = 10 no of each type and rating)	Set	1
9.2.9	Density monitoring device (1 Set= 2 no of each type)	Set	1
9.2.10	Pressure Gauge (1 Set= 2 no of each type)	Set	1
9.2.11	Indicating lamps covers (1 Set- 5 no of each colour)	Set	5
9.2.12	Indicating lamps (1 Set= 20% or 3 no (min), whichever is more)	Set	1
9.2.13	Spring charging motor assembly with gear system (1 Set= 2 no of each type)	Set	1
9.2.14	PT of GIS system (1 Set= 2 no of each type)	Set	1
9.2.15	CT of GIS system (1 Set= 2 no of each type)	Set	1
9.2.16	Isolator power and auxiliary contact	Set	1
9.2.17	Isolator operating motor/ SOV assembly	Set	1
10.0	Mandatory Spares for 33kV AIS Local Isolation Breaker (LIB) Panel with associated accessories		
10.1	Closing coil (1 Set=2 No of each rating & type)	Set	1
10.2	Shunt trip coil (1 Set=2 No of each rating & type)	Set	1
10.3	Control fuses / MCB (1 Set=10 No of each rating & type)	Set	1
10.4	Indicating lamps covers (1 Set=5 No of each colour)	Set	1
10.5	Indicating lamps (1 Set=20% or 3 No (min.), whichever is more)	Set	1
10.6	Vacuum Bottle (1 Set=1 No of each type)	Set	1

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Sl. No.	Item Description	Unit	Qty.
10.7	Racking handle (1 Set=4 No of each type of breaker)	Set	1
10.8	CT and PT (1 Set=3 No of each type and rating)	Set	1
10.9	Bus support insulator (1 Set=6 No of each type)	Set	1
10.10	Spring charging motor (1 Set=1 No of each type)	Set	1
10.11	Auxilliary Contactors (1Set=20% of each type and make OR 1 No (min) of each type and make, whichever is more)	Set	1
11.1	Mandatory Spares for 33kV AIS Local Isolation Breaker (LIB) Panel with associated accessories		
11.1.1	Single Phase interrupters	No	3
11.2	Test Equipment for 33kV AIS Local Isolation Breaker (LIB) Panel with associated accessories		
11.2.1	Field Tester Unit	Set	1
11.2.2	Interrupter Simulator Unit	Set	1
B.	SECONDARY SYSTEM		
1.0	Manadatory Spares for Control and Relay Panels		
1.1	Main-1 Line Protection Relay	No.	1
1.2	Main-2 Line Protection Relay	No.	1
1.3	Transformer Differential Protection Relay	No.	1
1.4	Transformer REF Protection Relay	No.	1
1.5	220kV Cable Differential Protection Relay	No.	1
1.6	LBB Protection Relay	No.	1
1.7	Busbar Differential Protection Relay - Central Unit	No.	1
1.8	Busbar Differential Protection Relay - Bay Unit	No.	1
1.9	Grid Islanding Protection Relay	No.	1
1.10	Fast Bus Transfer Relay	No.	1
1.11	O/C and E/F Protection Relay	No.	1
1.12	Bay Control Unit	No.	1
1.13	LIU	No.	1
1.14	MODEM	No.	1
1.15	Control Fuse/ MCB	Set	10
1.16	Control Switches & Selector Switches	Set	1

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Sl. No.	Item Description	Unit	Qty.
1.17	Auxiliary Relays	Set	2
1.18	SAS/ HMI/ Data Concentrator: All Cards Such as input & output cards, power supply cards, processor cards etc.	Set	1
1.19	SAS/ HMI/ Data Concentrator: Ethernet Switch	Set	1
1.20	Transducer Panels & LMS: Interposing Relays	Set	5
1.21	Transducer Panels & LMS: All Type of Electronic Cards/ Processor/ IO Assembly/ Power Supply Cards/ Control Cards	Set	1
1.22	Transducer Panels & LMS: Transducers	Set	1
1.23	Transducer Panels & LMS: Function Generator Cum Counter	Set	1
1.24	Transducer Panels & LMS: 4-20 mA Signal Injection Set	Set	1
1.25	Transducer Panels & LMS: Isolation Transformer	Set	1
1.26	Transducer Panels & LMS: Network Switch	Set	1
1.27	SCAP/ Communication System/ Energy Metering System: All Type of Electronic Cards/ Processor/ IO Assembly	Set	1
1.28	SCAP/ Communication System/ Energy Metering System: Transducers	Set	2
1.29	SCAP/ Communication System/ Energy Metering System: Network Switch	Set	1
1.30	SCAP/ Communication System/ Energy Metering System: Discrepancy Switch	Set	2
1.31	SCAP/ Communication System/ Energy Metering System: Selector Switch/ TNC Switch	Set	1
1.32	SCAP/ Communication System/ Energy Metering System: Special Tariff Meters (ABT, TOD)	Set	1
1.33	SCAP/ Communication System/ Energy Metering System: CMRI/ MRI System	Set	1
1.34	UPS System: Power Thyristors / Transistors / IGBT /IGCT	Set	1
1.35	UPS System: Control cards	Set	1
1.36	UPS System: Power supply cards	Set	1
1.37	UPS System: Power fuses	Set	1
1.38	UPS System: Control fuses / MCB	Set	10
1.39	UPS System: Indicating lamps	Set	1
1.40	UPS System: Indicating lamps covers	Set	2
1.41	UPS System: Blocker Diode	Set	2
1.42	Contact Multiplication Relay	No.	2
2.0	Testing Instruments		
2.1	Primary current injection kit, portable, Input: 0-230V AC, Output: 2500A continuous with 10 meter cable, Make: Megger, ODEN AT/3S or equivalent	Set	2
2.2	Secondary Injection test Kit, 3 phase, Adjustable (voltage, current, frequency, phase angle, AC/DC output) Make: FREJA 300 equivalent	Set	2
2.3	VLF AC Test kit with attachments for PD assessments and analysis system/DAC@50Hz, Tandelta, Sheath Fault, Portable, 0-40KV AC as per IEC60229, Make: Megger TDM4540PTD or equivalent	Set	2
2.4	Battery Ground Fault Locator, Make: Megger BGFT or equivalent	Set	2

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Sl. No.	Item Description	Unit	Qty.
2.5	Phase sequence tester, Make: Megger PSI 410 or equivalent	Set	2
2.6	Power Quality Analyser, 3 Phase with 4 voltage and 5 current inputs, Make: Megger MPQ2000 or equivalent	Set	2
2.7	Transformer oil moisture analyser, Make: Megger KF875 or equivalent	Set	2
2.8	Cable route tracer, Make: SPX RD8100 or equivalent	Set	2
2.9	Transformer Oil BDV test Kit. Make: Megger OTS100 or equivalent	Set	1
3.0	Operating Tools & Safety Equipments		
3.1	Insulated hand gloves for HV systems	Pair	10
3.2	Contact type live line detectors upto 220KV voltage level	No	4
3.3	Non- Contact type Live line Detectors upto 220 KV voltage level	No	4
3.4	Arc Flash suit	No	2
3.5	Face shield	No	10
3.6	Discharge rod suitable for EHV system	No	6
3.7	Safety Goggles	No	10
4.1	Manadatory Spares for PLCC Equipment		
4.1.1	Manadatory Spares for PLCC Equipment	NIL	
4.2	Test Equipment for for PLCC Equipment		
4..2.1	Print test kit	Set	1
C. AUXILIARY SYSTEM (ELECTRICAL)			
1.0	Manadatory Spares for 33kV XLPE Cable System		
1.1	Manadatory Spares for 33kV XLPE Cable System	Not in scope	
2.0	Manadatory Spares for Power, Control, Signal and FO Cables		
2.1	Manadatory Spares for 33kV XLPE Cable System	NIL	
3.0	Manadatory Spares for CVT Junction Box		
3.1	Manadatory Spares for 33kV XLPE Cable System	NIL	
4.0	Manadatory Spares for Capacitor Junction Box		
4.1	Manadatory Spares for 33kV XLPE Cable System	NIL	

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Sl. No.	Item Description	Unit	Qty.
5.0	Manadatory Spares for Battery System		
5.1	Manadatory Spares for 220V Battery Bank System	NIL	
5.2	Manadatory Spares for 48V Battery Bank System	NIL	
6.0	Manadatory Spares for 220V Battery Charger		
6.0.1	Manadatory Spares for 220V Battery Charger		
6.0.1.1	Power Thyristors/ Transistors/ IGBT/ IGCT (1set=1nos of each type & rating)	Set	1
6.0.1.2	Control Cards (1set=1nos of each type)	Set	1
6.0.1.3	Power Supply Cards (1set=1nos of each type & rating)	Set	1
6.0.1.4	Power Fuses (1set=20% of each rating or 1nos (min) of each rating, whichever is more)	Set	1
6.0.1.5	Control Fuses/ MCB (1set=10nos of each rating & type)	Set	1
6.0.1.6	Indicating lamps (1set=10% or 3nos (min), whichever is more)	Set	1
6.0.1.7	Indicating lamp covers (1set=2nos of each colour)	Set	1
6.0.1.8	Blocker Diode (1set=2nos of each type & rating)	Set	1
6.0.2	Manadatory Spares for 48V Battery Charger including DCDB (At Local End/ IOCL PANIPAT End - PR & PNCP)		
6.0.2.1	Power Thyristors/ Transistors/ IGBT/ IGCT (1set=1nos of each type & rating)	Set	1
6.0.2.2	Control Cards (1set=1nos of each type)	Set	1
6.0.2.3	Power Supply Cards (1set=1nos of each type & rating)	Set	1
6.0.2.4	Power Fuses (1set=20% of each rating or 1nos (min) of each rating, whichever is more)	Set	1
6.0.2.5	Control Fuses/ MCB (1set=10nos of each rating & type)	Set	1
6.0.2.6	Indicating lamps (1set=10% or 3nos (min), whichever is more)	Set	1
6.0.2.7	Indicating lamp covers (1set=2nos of each colour)	Set	1
6.0.2.8	Blocker Diode (1set=2nos of each type & rating)	Set	1
6.0.3	Manadatory Spares for 48V Battery Charger including DCDB (At Remote End/ HVPNL MUNDH S/S End)		
6.0.3.1	Power Thyristors/ Transistors/ IGBT/ IGCT (1set=1nos of each type & rating)	Set	1
6.0.3.2	Control Cards (1set=1nos of each type)	Set	1
6.0.3.3	Power Supply Cards (1set=1nos of each type & rating)	Set	1
6.0.3.4	Power Fuses (1set=20% of each rating or 1nos (min) of each rating, whichever is more)	Set	1
6.0.3.5	Control Fuses/ MCB (1set=10nos of each rating & type)	Set	1
6.0.3.6	Indicating lamps (1set=10% or 3nos (min), whichever is more)	Set	1
6.0.3.7	Indicating lamp covers (1set=2nos of each colour)	Set	1
6.0.3.8	Blocker Diode (1set=2nos of each type & rating)	Set	1
7.0	Manadatory Spares for Illumination System		
7.1	Manadatory Spares for Illumination System	Not in scope	

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D.	AUXILIARY SYSTEM (ELECTRICAL)		
1.0	Mandatory Spares for Clamp & Connectors		
1.1	Mandatory Spares for Clamp & Connectors	As per Annexure-D	
2.0	Mandatory Spares for String Insulator with Stringing Hardware		
2.1	Mandatory Spares for Disc Insulator for stringing	As per Annexure-D	
2.2	Mandatory Spares for Stringing hardware	As per Annexure-D	
3.0	Mandatory Spares for ACSR Moose Conductor		
3.1	Mandatory Spares for ACSR Moose Conductor	Mtrs.	100
4.0	Mandatory Spares for Shield Wire 7/9 SWG		
4.1	Mandatory Spares for Shield Wire 7/9 SWG	NIL	
5.0	Mandatory Spares for Earthing Materials		
5.1	Mandatory Spares for Earthing Materials	NIL	
6.0	Mandatory Spares for Cable Trench Materials		
6.1	Mandatory Spares for cable Trench Materials	NIL	

Annexure 2- Standard Scope Notes for ETC Works

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Sl. No.	Particulars
2.1	Individual item may vary up-to any extent and even may get deleted, however overall contract value may vary +/- 30%. Variation will be valid up-to contract stage.
2.2	Loading / Unloading, handling, shifting to & from stores, proper storage, assembly, installation, pre-commissioning test and commissioning tests (as per BHEL / Customer FQP) are included in the scope. Shifting of the material from store to site with truck/ trailer. The scope of work includes loading of material with hydra/ Ferana on truck/trailor at store, unloading of the material from truck/trailor at site with Hydra/crane e.t.c. complete in all respect. All T&P including hyrda / crane in bidder's scope.
2.3	Bidder Supplied Material - Contractor shall supply material of proven design and make, which have already been extensively used and tested (as applicable). Bidder to obtain approval from BHEL / Customer prior to supply at site. It may also to be noted that customer make list, if available shall prevail during procurement of materials.
2.4	Following documents will be required for billing of supplied items, (i) Lorry receipt (LR) (ii) Tax invoice
2.5	Supply of Insulating mats: The scope covers supply and laying of insulating mats of "class A" conforming to IS: 15652-2006. These insulating mats shall be laid in front of all floor mounted AC and DC switchboards and control & relay panels located in control room building/ Switchyard panel room / GIS LCC Panel etc. The insulating mats shall be made of elastomer material free from any insertions leading to deterioration of insulating properties. It shall be resistant to acid, oil and low temperature. Upper surface of the insulating mats shall have small aberration (rough surface without edges) to avoid slippery effects while the lower surface shall be plain or could be finished slip resistant without affecting adversely the dielectric property of the mat. Insulating mat (wherever applicable) shall be of pastable type, to be fixed permanently on the front and rear side of the panels except for the chequered plate area which shall not be pasted as per requirement. The insulating mats shall generally be fixed and joints shall be welded as per recommendations in Annexure-A of IS: 15652. Width of insulating mats shall generally be of 1.5 meters or as per site requirements. Length shall be supplied as per site requirements. The insulating mats offered shall conform to IS: 15652-2006.
2.6	Supply of Cable Tags and Markers Each cable and conduit run shall be tagged with numbers that appear in the cable and conduit schedule. The tag shall be of aluminium with the number punched on it and securely attached to the cable conduit by not less than two turns of 20 SWG GI wire conforming to IS:280. Cable tags shall be of rectangular shape for power cables and of circular shape for control cables. Location of cables laid directly underground shall be clearly indicated with cable route marker made of galvanised iron plate. Location of underground cable joints shall be indicated with cable route marker with an additional inscription "Cable joints". The cable route marker shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change in direction. They shall be located on both sides of road and drain crossings as per relevant standard. Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry and at each end & turning point in cable tray/trench runs. Cable tags shall be provided inside the switchgear, motor control centres, control and relay panels etc., wherever required for cable identification, where a number of cables enter together through a gland plate.
2.7	HV test kit along with operator is in scope of GIS OEM, however necessary support/ assistance shall be extended by contractor for successful completion of HV testing including unloading, assembly, testing, dismantling and loading of test kit etc.
2.8	All the drawings/ documents and technical specifications/ details enclosed/ mentioned/ referred shall be followed/ complied by contractor for completion of work in all respect.
2.9	Minor civil works such as modification of civil foundations, making holes in the trenches/ control room building, grouting, fixing of trench material will be in the scope of contractor.
2.10	Any cutting of masonry/ concrete work, which is necessary for completion of work shall be done by the contractor at his own cost and shall be made good to match the original work.
2.11	All final adjustment of foundation levels, chipping and dressing of foundation surfaces, setting and grounding of anchor bolts, sills, inserts and fastening devices shall be carried out by the contractor including minor modification of civil works as may be required for erection.
2.12	Wall openings at suitable locations for ventilation fans shall be made by the bidder. Civil works such as grouting, filling up of crevices/ cut outs etc. during installation of equipment shall also be in bidder's scope. Any other damage caused to civil works during ETC work of the equipment/ system shall be made good to the original finish by the bidder at no extra cost to the BHEL.

Annexure 2- Standard Scope Notes for ETC Works

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2.13	Removal of gravel, if gravelling is already done, for connection of Equipment earthing strip to the existing mat (wherever earthing mat is already laid), and after completion of earthing , contractor should place the gravel to bring it in original shape.
2.14	Quoted rates are deemed to be inclusive of miscellaneous works viz erection of clamps and connectors etc. as mentioned in BOQ.
2.15	All paint, welding electrodes & other consumable, under contractor scope for ETC works is subject to BHEL/CUSTOMER approval.
2.16	All the phases are to be identified by painting the structures Red, Yellow and Blue by reflecting colour as per as built condition. Phase identification colour is to be provided around the top of the structure with colour band of 100 mm width at a height of approximately 2000mm from the finished ground level.
2.17	All ground connections shall be made by electric arc welding. All welded joints shall be allowed to cool down gradually to atmospheric temperature before putting any load on it. All arc welding with large dia. conductors shall be done with low hydrogen content electrodes.
2.18	Equipment erection (say Surge Arrestor) means complete erection, metallics, connectors (expansion/ rigid tubular for Al.Tube/ single/ double/ quadruple conductor), connection to the next in line (if connected to overhead busbar or droppers) including PG clamps/ Tee connectors etc.
2.19	Equipment and tower erection would include supply and erection of miscellaneous items , viz Phase colour discs , labels painting of equipments, phase colour painting , phase marking , bay identification board , danger plates , rubber mats , device number marking on the equipment, keyboard etc as per site requirements. Supply & Mounting of phase color discs & Danger plates shall be as per IS-2551: 1982 & IS 5: 1978.
2.20	Welding of Aluminium tubes, if applicable (supply of welding sleeve excluded) is in ETC contractor's scope and joints shall be tested by radiography & dye penetration test. Welding and Bending machines and any other equipment will be in ETC Contractor scope.
2.21	Complete ETC package is under the scope of contractor. All T&P including oil filtering machine, cranes/ hydra/ farana/ manlift/ forklift etc. required to complete the job shall be provided by bidder only.
2.22	Quantity of supply items are provisional and shall be notified during detailed engineering stage/ site requirement.
2.23	MS Welding - The M.S. flat/angle/channel shall be finally painted with two coats of Red oxide primer and two coats of Zinc riched enamel paint.
2.24	In cable tray / ladder if minor fabrication is required the same shall be applied with one coat of red lead primer, one coat of oil primer followed by two finishing coats of aluminium paint. Supporting steel shall be painted before laying of cables. The painting shall be done with one coat of red lead paint and two coats of approved bituminous aluminium paint
2.25	Testing Equipment, duly calibrated with calibration report shall be arranged by ETC Contractor at it's own cost on returnable basis (List is only indicative, and hence, if any instrument not mentioned below but required for successful completion of ETC work shall be in ETC contractor's scope)
2.25.1	OMICRON or equivalent kit for Numerical relay testing
2.25.2	DCRM (Dynamic Contact Resistance Measurement kit) OPERATIONAL ANALYZER
2.25.3	CRM (Contact Resistance Measurement kit)
2.25.4	Relay test kit
2.25.5	Capacitance and Tan delta measurement Kit
2.25.6	Dew Point Measurement kit
2.25.7	5kV/1kV Megger
2.25.8	Primary current Injection Kit
2.25.9	Secondary current/ Voltgae Injection kit
2.25.10	1Ph Variac
2.25.11	Multimeters
2.25.12	Clamp on meter
2.25.13	Gas leak detector

Annexure 2- Standard Scope Notes for ETC Works

PROJECT: LSTK job for ISBL work of 220KV Grid Power Import at IOCL, Panipat Refinery

CUSTOMER: Indian Oil Corporation Limited (IOCL)

CONSULTANT: Tata Consulting Engineers Limited (TCE)

REV NO.: 00

Sl. No.	Particulars
2.26	General Tools & Tackles shall be arranged by ETC Contractor on returnable basis. (Based on general requirement for erection, testing and commissioning of GIS under scope). The following is the list of Items which may be extended further depending upon the site timely requirements
2.26.1	Tools for GIS erection (to be arranged by Bidder on returnable basis) as per ANNEXURE-B
2.26.2	14/16 ton Hydra/ Farana with lifting tools (Shackle, slings etc) for GIS Bay & accessories shifting from store to GIS room. Contractor shall have the provision for Manlift & scaffolding for Height work for GIS and structure work.
2.26.3	Hand Pallet Trolley Qty-2 for GIS modules & accessories boxes shifting
2.26.4	Power supply sockets with extension board inside GIS room Qty-2 nos.
2.26.5	Vacuum cleaner machine for GIS room cleaning Qty-2 nos.
2.26.6	Necessary numbers of fire extinguisher

Annexure 3- Project Specific Scope Notes for ETC Works

PROJECT: LSTK job for ISBL work of 220KV Grid Power Import at IOCL, Panipat Refinery

CUSTOMER: Indian Oil Corporation Limited (IOCL)

CONSULTANT: Tata Consulting Engineers Limited (TCE)

Sl. No.	Particulars
3.1	<p>Cable fire sealing - Cable/cable tray openings in walls and floors or through pipe sleeves from one area to another or from one elevation to another within the unit shall be sealed by a fire proof sealing system (FPSS). The FPSS shall effectively prevent the spread of fire from the flaming to non-flaming side of a fire. Wherever the cables/cable trays pass through walls/floors, fire proof cable penetration seals rated for one hour shall be provided. This shall be by suitable block system using individual blocks with suitable framework or by silicon RTV foaming system. In case foaming system is offered, damming board, if used, shall not be considered for fire rating criteria. Any of the system offered shall be of proven type as per BS: 476 (Part-20) or equivalent standard.</p> <p>In order to prevent fire propagation through cable penetrations, after laying, dressing & clamping of cables, all the openings shall be properly sealed by using Fire Stop Mortar</p> <p>Seal and Fire Retardant Cable coating compound. Also the cable runs both before and after the fire scale shall be suitably sprayed with anti-fire propagation liquid.</p>
3.2	<p>All ETC works shall be done as per BHEL/ IOCL/ HVPNL Specification and guidelines. Miscellaneous works pertaining to 220kV GIS are deemed inclusive. (enclosed).</p>
3.3	<p>Equipment bolted connection after being checked and tested shall be painted with anticorrosive paint / compound be welded. For rust protection, the welds shall be treated with zinc chromate primer and coated with zinc rich paint.</p>
3.4	<p>Attached Drawings i.e. SLD, Layou Plan & Section Drawing, Trench Layout-Indoor and Outdoor, Auxiliary SLD are tentative and subject for revision during detailed engineering/ contract finalization stage and Hence, bidder to quote accordingly.</p>



Annexure-A: General Tools, Testing Instruments to be arranged by BHEL Contractor

List of Tools, equipments & resources required for the erection and commissioning

Important Note : To be arranged by EPC Contractor (M/s BHEL) at site except CGPISL mentioned in below list.

A. GENERAL TOOLS FOR GIS ERECTION AND COMMISSIONING		
DESCRIPTION	QUANTITY	Scope
Industrial vacuum cleaner	2 pc.	
Spanner set complete : Size M6 to M50 (Round & Flat type)	3 sets	
Fork-round type wrenches size from 8x8 to 36x36	2 sets.	
Fork-round type wrenches size 19x19	6 pcs.	
Ratchet sets with normal head size from 4-40mm	2 sets.	
Sets of allen key size 1.5-14mm ("L" type) & also corresponding in inch	2 sets.	
Ratchets set with allen head size 5-36mm	1 set	
Hand drive set from 3-24mm	1 set	
Screw-cutter set from 3-24mm	1 set	
Scapper 200mm flat	1 pc.	
Scapper 200mm triangle	1 pc.	
Measuring tape 50m	1 pc.	
Measuring tape 25m	1 pc.	
Measuring tape 10m	1 pc.	
Measuring tape 5m	1 pc.	
Measuring tape 3m	1 pc.	
Spirit Level 1000mm	1 pc.	
Spirit Level 300mm	1 pc.	
Metal square angle 150x100	1 pc.	
Metal square angle 1000x660	1 pc.	
Torque wrench 200Nm	3 pc	
Universal pipi grip 300mm	1 pc.	
Slide caliper	1 pc.	
Framed steel saw with 20 pcs. Two sided spare blades	1 pc.	
Plastic spray bottle	2 pcs.	
Case opener stick	4 pcs.	
Plastic rope spanset type 2-4-6-8-10 meters long 2 tons.	4 pcs/each	
Plastic rope spanset type 12 meters long 5 tons.	4 pcs.	
Metal hammer 300-500-1000-1500gr.	1 pc./each	
Rubber hammer	1 pc.	
Hand operation greasing pump	1 pc.	
Extrusive for silicon paste	1 pc.	
File (flat/halfround/round/triangular/square/ type)	1 pc./each	
Chain lifter 3 tons.	2 pc.	
Pin file	1 set	
Crosscut head screwdrivers sizes: 1-2-3-4	1 pc./each	
Screwdrivers flat type: 3x80-4x100-5x100-6x125-7x150-10x200	1 pc./each	



TOOLS, EQUIPMENTS AND RESOURCES REQUIRED AT SITE FOR GIS ERECTION AND COMMISSIONING
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Combination plier	1 pc.	
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TOOLS, EQUIPMENTS AND RESOURCES REQUIRED AT SITE FOR GIS ERECTION AND COMMISSIONING
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Flat plier 200mm	1 pc.	
Half round nose plier 200mm	1 pc.	


TOOLS, EQUIPMENTS AND RESOURCES REQUIRED AT SITE FOR GIS ERECTION AND COMMISSIONING

Eyelet pliers strait, small-long, inner type sizes: A1-A2	1 pc./each	
End cutter plier 200mm	1 pc.	
Side cutter plier 200mm	1 pc.	
Stripping plier	1 pc.	
Trimming knife with 10 pcs. Spare blades	1 pc.	
Hand lamp & Head lamp (lamp in cap)	6 pcs. each*	
Plumbing bobs (hanging plumbs)	1 pc.	
Toolbox with padlock	1 pc.	
Wreking bars 1,5m or 2m	1 pc.	
Lifting hook (shackle) 12mm	4 pcs.	
Lifting hook (shackle) 16mm	4 pcs.	
Theodolit os laser level meter	1 pc.	
Extension cable 240V 20m (single phase) with Extension box	3 pc.	
Extension cable 400V 20m (thre phase) with Extension box	6 pc.	
B. GENERAL TOOLS FOR MECHANICAL ERECTION		
DESCRIPTION	QUANTITY	
Angel grinder d115 and d180 sizer	1 pc./each	
Brench drilling machine with drills	1 pc.	
Hand drilling machine with drills	1 pc.	
Hammer drilling machine (HILTI TE 72 or equal) with diamond drills	1 pc.	
Portable electronic welding machine	1 pc.	
Turning machine for Cu bars	1 pc.	
Vice-bench with 100mm bench	1 pc.	
Grinder with two disks, table fixed	1 pc.	
Bolt clipper	1 pc.	
Grip pliers	4 pcs.	
Puncher	1 pc.	
Rivetter	1 pc.	
Extension cables 240V 20meters (1 phase)	2 pcs.	
Portable electrical distribution board only for erection 3x20A		
-with 3 pcs.one phase and 2 pc. Three phase outgoings	1 pc.	
Lifting-jack (with wheels)	1 pc.	
Alu ladder 7m	1 pc.	
Instant alu. Mounting-plate min. 4m high	1 set	
C. STANDARD TOOLBOX FOR ELECTRICAL FITTER		
DESCRIPTION	QUANTITY	
Plastic or metal toolbox with padlock	1 pc.	
Wire stripper	10 pc*	
Metal housed cable knife with spare blades	1 pc.	
Cable stripper, spike type	10 pc*	
Wire crimper 1,5-6sqmm (for end pin connector)	10 pc*	
Wire crimper 1,5-6sqmm (for end ring terminals)	10 pc*	



TOOLS, EQUIPMENTS AND RESOURCES REQUIRED AT SITE FOR GIS ERECTION AND COMMISSIONING
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Insulated screwdriver tripped-100/3mm	2 pcs*	
Insulated screwdriver tripped-100/4mm	2 pcs*	


TOOLS, EQUIPMENTS AND RESOURCES REQUIRED AT SITE FOR GIS ERECTION AND COMMISSIONING

Insulated screwdriver tripped-160/5mm	2 pcs*	
Measuring tape metal 3m	2 pcs*	
Hammer 0,25kg. Metal	2 pcs*	
Pipe grip	1 pc.	
Side cutter 200mm	1 pc.	
End cutter plier insulated 200mm	1 pc.	
Round cutter plier insulated 200mm	1 pc.	
Half round plier insulated 200mm	1 pc.	
TORX Driver set 15-25-30-35 with handle	1 set	
Small drive socket set 5-13mm	1 set	
Scissors	1 pc.	
Heat gun	1 pc.	
D. GENERAL TOOLS FOR CONTROL AND AUXILIARY CABLING		
DESCRIPTION	QUANTITY	
Cable drum lifter	2 set	
Cable cutter	1 pc.	
Ratchet type cable cutter	1 pc.	
E. SPECIAL EQUIPMENT AND ACCESSORIES FOR GIS ERECTION		
DESCRIPTION	QUANTITY	
DILO SF6 gas handling device with compressor , vacuum pump, storage tank and accessories (rubber pipe, DN20-8 valve, coupling unit, elbow)	1 set	
DILO SF6 gas regulator with accessories (rubber pipe, elbow valve, DN8-DN20 connecting units)	1 set	
SF6 gas leak detector	1 set	
SF6 gas electronic moisture measuring device	1 pc.	
SF6 gas volume percentage measuring device	1 pc.	
F. EQUIPMENT AND INSTRUMENTS FOR TESTING		
DESCRIPTION	QUANTITY	
CB Analyser	1 pc.	CGPISL
Equipment for DC resistance measuring-min.100A	1 pc.	CGPISL
Equipment for primary current injection-2000A	1 pc.	CGPISL
5kV MEGGER for insulation test	1 pc.	CGPISL
Digital clampmeter for primary current measuring AC-DC 2000A	1 pc.	CGPISL
Digital clampmeter for secondary current measuring 10mA-20A	1 pc.	CGPISL
Digital multimeters	3 pc.	CGPISL
Electric timing meter	1 pc.	CGPISL
Test equipment for HV AC voltage test	1 set	CGPISL
CT analyser	1 set	CGPISL
Test equipments to perform site test as per client specifications	1 set	CGPISL
G. EQUIPMENT AND FACILITIES FOR ERECTION AND TRANSPORTING		


TOOLS, EQUIPMENTS AND RESOURCES REQUIRED AT SITE FOR GIS ERECTION AND COMMISSIONING

DESCRIPTION	QUANTITY	
Container for waste materials (emptying weekly)	1 pc.	
Autocrane Capacity 50tonne preferred (Lifting and Keeping shipping unit on first floor)	1 pc.	
Truck for site transport	1 pc.	
Material store	1 pc.	
Office room	1 pc.	
Telephone (STD & ISD) and internet facility	1 pc.	
Fire extinguishers at erection site	as required	
First aid kits for the erection team	as required	
Safety tools for the erection team	as required	
Hydraulic trolley cum jack (Capacity - 5 tonne)	4 Pcs.	
Ratchet lever hoist or hand operated chain pulley	2 Pcs.	
*Pallet Truck - Capacity- 3 Tonn	4 Pcs.	
H. AUX. ERECTION MATERIALS		
DESCRIPTION	QUANTITY	
Ethanol (99.99% PURE)	10lit	
Paper adhesive tape white (20-40mm)	4 pc./each	
Pattex glue	2 pc.	
Black marker (0,5-1mm)	4 pc./each	
White marker (0,5mm)	4 pc./each	
Insulation tapes different colors (black/green/yellow/red/yellow-green/b)	3 pc./each	
Cotton gloves	20 pcs.	
Protection gloves	20 pcs.	
Roll of white cotton	1 roll	
Roll of paper	2 roll	
Roll of plastic foil 1m wide	2 roll	
Spraying bottle for ethanol	2 pcs.	
I. HUMAN RESOURCE		
DESCRIPTION	QUANTITY (minimum)	
Qualified & Experienced Electricians with their supervisor	10 nos	
Qualified & Experienced Fitters & engineers	4 Nos	
Experienced EOT crane operator	1 no.	
Cleaner, Moppers	2 nos / Day	
Single Point Project Manager	1 no.	
Testing Engineer	1 No.	CGPISL

Note:

The list shall be modified & informed as and when necessary.□


Annexure-B: Special Tools, Testing Instruments to be arranged by GIS OEM

List of Tools, equipments & resources required for the erection and commissioning

Important Note : Arranged by GIS Manufacturer

A. GENERAL TOOLS FOR GIS ERECTION AND COMMISSIONING		
G. HUMAN RESOURCE		
DESCRIPTION	QUANTITY (minimum)	Scope
Testing Engineer	1 No.	CGPISL
H. EQUIPMENT AND INSTRUMENTS FOR TESTING		
DESCRIPTION	QUANTITY	
CB Analyser	1 pc.	CGPISL
Equipment for DC resistance measuring-min.100A	1 pc.	
Equipment for primary current injection-2000A	1 pc.	
5kV MEGGER for insulation test	1 pc.	
Digital clampmeter for primary current measuring AC-DC 2000A	1 pc.	
Digital clampmeter for secondary current measuring 10mA-20A	1 pc.	
Digital multimeters	3 pc.	
Electric timing meter	1 pc.	
Test equipment for HV AC voltage test	1 set	
CT analyser	1 set	
Test equipments to perform site test as per client specifications	1 set	
I. SPECIAL EQUIPMENT AND ACCESSORIES FOR GIS ERECTION		
DESCRIPTION	QUANTITY	Scope
DILO SF6 gas handling device with compressor , vacuum pump, storage		CGPISL
-tank and accessories (rubber pipe, DN20-8 valve, coupling unit, elbow valve)	1 set	
DILO SF6 gas regulator with		
- accessories (rubber pipe, elbow valve, DN8-DN20 connecting units)	1 set	
SF6 gas leak detector	1 set	
SF6 gas electronic moisture measuring device	1 pc.	
SF6 gas volume percentage measuring device	1 pc.	

Note:

The list shall be modified & informed as and when necessary.

Project: LSTK job for ISBL work of 220KV Grid Power Import at IOCL, Panipat Refinery
Customer: Indian Oil Corporation Limited (IOCL)
Doc. No.: TB-411-316-014 REV03
Doc. Name: 220/33kV Switchyard- Erection Key Diagram (Plan, Section & Bill of Materials)

Annexure: Bill of Quantity for 220KV Clamps & Connectors

BOQ Item No.	Connector Type	Current rating (A)	Unit	220KV Line Bay#1	220KV Line Bay#2	Transformer Bay#1, 2, 3, 4/ LLM	Total Quantity without Mandatory Spare	Quantity of Spares #In line with Section-1, Chapter-2, Clause 16.4.4 of IS	Total Quantity including spare	Remarks
	Bay No.----->			201	211	202/203/207/208				
	Section----->			A-A	Same as A-A	In A-A only				
	CONNECTOR									
15S	Connector for 198KV SURGE ARRESTER suitable for single moose ACSR conductor (universal approach through type)	1000	No.	3	3		6	1	7	
14AS	Connector for 220KV CAPACITOR VOLTAGE TRANSFORMER, 8800pF suitable for single moose ACSR conductor (horizontal approach through type)	1000	No.	3	3		6	1	7	
14BS	Connector for 220KV POTENTIAL TRANSFORMER, 4400/8800pF suitable for single moose ACSR conductor (horizontal approach through type)	1000	No.	3	3		6	1	7	
13S	Connector for 220KV, 2000A, CURRENT TRANSFORMER suitable for single moose ACSR conductor (horizontal approach)	1000	No.	6	6		12	1	13	Connector shall be used on both sides of equipment.
16AS	Connector for 220KV, 2000A, 1.0mH, WAVE TRAP suitable for single moose ACSR conductor (universal approach)*	1000	No.	4	4		8	1	9	Wavetrp for R&Y phase is considered. * Other end/ Mundh s/stn requirement is also considered. Connector shall be used on both sides of equipment.
16BS	Connector for 220KV, 2000A, 1.0mH, WAVE TRAP suitable for single moose ACSR conductor (universal approach)*	1000	No.	4	4		8	1	9	Wavetrp for R&Y phase is considered. * Other end/ Mundh s/stn requirement is also considered. Connector shall be used on both sides of equipment.
19S	Buspost insulator clamp suitable for single moose ACSR conductor (horizontal approach through type)	1000	No.	1	1		2	1	3	Bus post insulator for B phase only is considered.
12S	Connector for 220KV, 2000A, HCB ISOLATOR suitable for single ACSR Moose Conductor (universal approach through type)	1000	No.	6	6		12	1	13	
17S	Connector for 220KV, 2000A, SF6 TO AIR BUSHING suitable for single ACSR Moose Conductor (horizontal approach through type)	1000	No.	3	3		6	1	7	
21	Boltless C-type Wedge Connector for single ACSR Moose (Customer Scope) to single ACSR Moose	1000	No.	3	3		6	1	7	Boltless C-type Wedge Connectors along with PG clamps as per HPVNL specification is considered. Final connector diagram shall be submitted in OEM drawing, to be submitted separately.
22	PG clamp for Single ACSR Moose Conductor	1000	No.	6	6		12	1	13	Additional PG clamps are considered for strengthening of dropper/ jumpers
	STRING INSULATOR & HARDWARE									
SSDI	245KV single suspension string insulator (120 MN per string) with single anchoring points with 1X12 nos. antilog disc with all hardware accessories suitable for suspension of wave trap									As per OEM drawing, Disc insulator along with stringing hardware is considered.
a	Disc Insulator	NA	Set	8	8		16	1	17	
b	Hardware	NA	Set	8	8		16	1	17	
	EQUIPMENT AND ACCESSORIES									
15	198KV, 10KA, CLASS-II, 1 Phase Surge Arrester (SA)	NA	No.	3	3		6	2	8	
14A	220KV, 8800pF, 1 Phase Capacitor Voltage Transformer (CVT)	NA	No.	3	3		6	2	8	
14A-B	Junction boxes for Capacitor Voltage Transformer (CVT-B)	NA	No.	1	1		2		2	
14B	220KV, 1 Phase Tariff Metering Potential Transformer (PT)	NA	No.	3	3		6		6	
13	220KV, 1 Phase Tariff Metering Current Transformer (CT)	NA	No.	3	3		6		6	
19	220 KV, Solid Core/ polymer Post Insulator for Bus & Isolator (BPI)	NA	Set	7	7		14	2	16	For Bus, Post Insulator shall be with corona ring, whereas for Isolator, it shall be without corona ring.
16	220KV, 1 Phase, 2000A, 1.0mH Wave Trap" (WT)	2000	No.	4	4		8		8	Wavetrp in R&Y phase is considered. *Requirement of other end in Mundh S/s is also considered.
12	220KV, 2000A, 1X3 Phase, HCB Isolator (electrically operated mechanically ganged) with one Earth Switch (electrically operated mechanically ganged) (ISO)	2000	Set	1	1		2		2	Insulators for Isolators are considered in item no. 19.
17A	220KV, 2000A, SF6 to Air Bushing	2000	No.	3	3		6		6	
17B	220KV, 2000A Oil to SF6 Bushing	2000	No.			12	12		12	
17C	220KV, 2000A GS Duct	2000	Lot			1			0	
17	220KV, 2000A GS	2000	Lot			1			0	
	CLAMPS					LLM				
STE	7/3.66mm dia GS earthing strain/ tension clamps (bolted type) with D shackle assembly	NA	No.	6	3		9	1	10	Requirement for central tower/ down column is considered in bay 201.
SP	Strain plate to be fixed on building column and suitable for 7/3.66mm dia GS earthing strain/ tension clamps (bolted type) with D shackle assembly	NA	No.	2	1		3	1	4	Requirement for central tower/ down column is considered in bay 201.
PGE	PG clamp for 7/3.66mm dia GS earthing	NA	No.	8	4		12	1	13	Requirement for central tower/ down column is considered in bay 201.
CC1	Cleat type clamp for Earthing down conductor 7/3.66mm dia GS earthing @ 2m interval suitable for structure	NA	No.	21	11	18	50	1	51	Requirement for central tower/ down column is considered in bay 201.
CC2	Cleat type clamp for Earthing down conductor 7/3.66mm dia GS earthing @ 1m interval suitable for holding with building down condcor	NA	No.	40	20		60	1	61	Requirement for central tower/ down column is considered in bay 201.
CC3	Cleat type clamp for suitable for holding 75x12mm flat with pipe structure cleat	NA	No.			145	145	1	146	
PC	Pad type clamp for connecting 7/3.66mm dia GS earthing on one side and 75x12mm GS flat on other side	NA	No.	4	2	1	7	1	8	1no. per tower with peak/ LLM and down column from GIS cum Control Room Building is considered. Requirement for central tower/ down column is considered in bay 201.
LG	Lug type clamp For connecting 7/3.66mm dia GS earthing on one side and lightning spike structure	NA	No.			1	1	1	2	1no. per LLM is considered.
	BUS BAR/ CONDUCTOR									
1	ACSR Moose Conductor	NA	Mtr.	780	780		1560	100	1660	
2	7/3.66mm dia GS earthing	NA	Mtr.	107	53	65	225	100	325	

Notes:

1. All hardwares shall be bolted type.
2. Insulators considered are for creepage 25mm/kV.

IOCL, PANIPAT REFINERY	220kV/33kV, 50/65 MVA Power Transformers	SECTION
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Annex- S-3/C-2/7

GENERAL GUIDELINES FOR ERECTION OF POWER TRANSFORMER

- 1.1 The below guidelines for erection of power transformers are only for reference and may not be comprehensive. Complete erection planning, erection of transformers, arrangement of all required tools and tackles including all accessories, lifting equipments along with manpower shall be in the scope of LSTK contractor. Erection plan of the transformer and accessories shall be duly endorsed by OEM of the equipments.
- 1.2 Erection includes entire vacuum by proper capacity of vacuum pump, for not less than 48 hours, or more if required as per the instruction of engineer in charge.
- 1.3 Oil may be supplied in tanker/steel drums, which should be properly sealed during transportation and storage. Seal shall be verified and opened in front of IOCL representative before filling in transformer. Contractor should have enough storage capacity for handling oil. Filling the oil from tank/drums to the transformer through 6000 liters capacity of high quality filter machine and filtration of the same to get desired BDV & PPM as specified by engineer in charge and transformer manual.
- 1.4 Transformer oil filtration may be required multiple times such as during pre-commissioning, commissioning and final charging stage. Same is in the scope of LSTK contractor including supply of filter machines, all tools and tackles, accessories and required manpower as directed by Engineer In-charge.
- 1.5 Contractor has to replace all the gaskets by new ones if required by engineer –in –charge.
- 1.6 Erection shall include complete wiring of cooling fans, RTCC panels, terminations of alarm and trip contacts from buchholz relay, WTI, OTI, PRD, RPRR, Fast De-pressurization system, FO sensors, online dehydration system, High velocity water spray system, NIFP system, OLTC, as per project scope. Required cabling on the transformer as well as from transformer to control room shall also be included in scope of work. The testing and commissioning of OLTC as well as cooler control scheme shall be carried out as per instruction of engineer in charge.
- 1.7 The contractor shall arrange nitrogen cylinder required at site for above work.
- 1.8 Good skilled fitters, qualified supervisors and senior engineer having sufficient experience should be posted at site during the above work.
- 1.9 Contractor has to repaint the transformer tank with two coat of anti rusting good finish LTBS grey shade 632 of IS:5 by spray painting as per the direction of engineer in charge.
- 1.10 Contractor is required to carry out all minor/major fabrication work of pipes and hangers if required at site as per direction of engineer in charge.

IOCL, PANIPAT REFINERY	220kV/33kV, 50/65 MVA Power Transformers	SECTION
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- 1.11 All tools and tackles, testing equipments required for erection and commissioning are to be arranged by the contractor.
- 1.12 Contractor shall arrange required capacity of oil tanker at site.
- 1.13 Any other items not mentioned above but required for successful completion of erection shall have to be arranged by the contractor.
- 1.14 Provision of complete earthing network for Power Transformers and accessories, Area lighting, Auxiliary Power supplies etc shall be in the scope of LSTK contractor including its design, engineering, supply and commissioning of system.

5.12 INSPECTION AND TESTING AT SITE:

The successful bidder shall carry out a detailed inspection and testing program for field activities, namely covering area right from the receipt of material stage up to commissioning stage. An indicative program of inspection as envisaged by the Engineer is given below.

This is however not intended to form a comprehensive program as it is bidder's responsibility to draw up and carry out such a program duly approved by the Engineer.

5.13 RECEIPT AND STORAGE CHECKS:

(a) Check and record condition of each package, visible part of the transformer etc. for any damage.

(b) Check and record the gas pressure in the transformer tank as well as in the cylinder.

(c) Visual check for welding of core and coils before filling up with oil and also check condition of core and winding in general.

5.14 INSTALLATION CHECKS:

a) Test on oil samples taken from main tank top and bottom and cooling system as per IS:335. Sample should be taken only after the oil has been allowed to settle for 24 hours.

b) Check the whole assembly for tightness, general appearance, etc.

c) Oil leakage tests.

d) The bidder shall warrant that oil furnished is in accordance with the specifications given in this specification.

e) Capacitance and tan delta measurement of bushings before fixing / connecting to the winding. Bidder shall furnish these values for site reference.

f) Sweep Frequency Response Analysis (SFRA) test.

5.15 COMMISSIONING CHECKS:

(a) Check the color of silica gel breather.

(b) Check the oil level in the breather housing conservator tank, cooling system, condenser bushing etc.

(c) Check the bushings for conformity of connection to the line etc.

(d) Check for correct operation of all protections and alarms:

(i) Buchholz relay

(ii) Excessive winding temperature

(iii) Low oil flow

(iv) Excessive oil temperature

(v) Low oil level indication

(e) Check for adequate protection on electronic circuit supplying the accessories.

(f) Insulation Resistance measurement for

(i) Control wiring

(ii) Main winding

(g) Check for cleanliness of the transformer and the surrounding.

5.16 TESTS AT SITE:

After erection at site, the transformer shall be subject to the following test

- (i) Insulation resistance & winding resistance test
- (iii) Ratio and polarity test
- (iii) Dielectric test & water content test of oil
- (iv) SFRA test
- (V) PD and Tan delta test
- (vi) Magnetic Balance Test.

5.17 TEST REPORTS:

- 5.17.1 On completion of all the tests have been completed 3 copies of each TPI certified test reports shall be furnished to the IOCL prior to the dispatch of equipment. pdf copy and Soft copy of test reports for tests results obtained from software shall also be submitted.
- 5.17.2 All the reports of inspections like stage, acceptance, routine & type tests carried out on each transformer including test certificates for bought out items, in bound volume, shall be submitted before dispatch. Also one copy shall be sent along with transformer.

6.0 DOCUMENTATION:

- 6.1 The LSTK contractor shall submit the documents for owner's approval post endorsement of the documents by listed agencies/consultancy firm as detailed in clause 10.6 of Section-1 Chapter-1.
- 6.2 Drawings in AutoCAD/PDF format and in hard copy, incorporating the following particulars shall be submitted by each bidder during detailed engineering.
 - i) General outline drawing showing dimensions, wheel loading, net weight of transformer, tap change gear, marshalling box, control cubicles required for all the monitoring devices, etc.
 - ii) General arrangements of foundations and structural mounting.
 - iii) Sectional views showing the general constructional features and disposition of various fittings and sectional view of Core Coil assembly clearly indicating boltless construction and other necessary specific details.
 - iv) Dimensions of the largest packages to be transported.
 - v) Drawing showing the complete details of all class condenser bushing and connectors.
 - vi) Drawings showing details of Buchholz relay, winding temperature indicator, oil temperature indicator, air cell, cooling systems, tap changer, all the monitoring devices and NIFPS, breather, REF-CT, WTI-CT,SEF-CT etc.
 - vii) Cooling calculations for ONAN/ ONAF.
- 6.3 The successful bidder shall submit final version of drawings complete in all respects in quadruplicate within 15 days of placement of order for purchaser's approval.
 - a. After receipt of purchaser's approval to drawings, the manufacturer will submit five sets of all approved drawings and five sets of manual of instructions to our Design Office.
 - b. One set of all the approved drawings and manual of instructions will be supplied along with each equipment without which the supply will not be considered as complete supply.



SPECIFICATIONS & GUIDELINES FOR CABLES INSTALLATION / LAYING FOR CABLES UP TO & INCLUDING 33 KV RATING

SECTION-3

CHAPTER-13

1.0 INTENT OF SPECIFICATION

2.0 INTRODUCTION

The document defines the limits prescribed by IOCL for each of the following parameters:-

- Maximum pulling tensions.
- Minimum static and dynamic bending radii.
- Depth of cover.
- Positioning of cable markers and protection bricks.
- Multiple cable spacing.

2.1 The following sections detail out the procedures which shall be followed when handling and installing cables as referred to under **clause 2.1 above**. These procedures are based on safe working practices and are designed to minimize the risk of damage to the cable being installed.

3.0 STORAGE AND HANDLING

3.1 Storage

3.1.1 The cable drums shall be stored on a well drained, hard surface, so that the drums do not sink in the ground causing rot and damage to the cable drums. Paved surface is preferred, particularly for long term storage.

3.1.2 The drums shall always be stored on their flanges, and not on their flat sides.


3.1.3 Both ends of the cables should be properly sealed to prevent ingress/absorption of moisture by the insulation during storage.

3.1.4 Protection from rain and sun is preferable for long term storage for all types of cables. There should also be ventilation between cable drums.

3.1.5 During storage, periodical rolling of drums once in, say, 3 months through 90 degrees shall be done. Rolling shall be done in the direction of the arrow marked on the drum.

3.1.6 Damaged battens of drums etc. should be replaced as may be necessary.

3.2 Handling

 IndianOil Panipat Refinery	<p style="text-align: center;">SPECIFICATIONS & GUIDELINES FOR CABLES INSTALLATION / LAYING FOR CABLES UP TO & INCLUDING 33 KV RATING</p>
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- 3.2.1 When the cable drums have to be moved over short distances, they should be rolled in the direction of the arrow marked on the drum.
- 3.2.2 For manual transportation over long distances, the drum should be mounted on cable drum wheels, strong enough to carry the weight of the drum and pulled by means of ropes. Alternatively, they may be mounted on a trailer or on a suitable mechanical transport.
- 3.2.3 For loading into and unloading from vehicles, a crane or a suitable lifting tackle should be used. Small sized cable drums can also be rolled down carefully on a suitable ramp or rails for unloading, provided no damage is likely to be caused to the cable or to the drum.

4.0 INSTALLATION

- 4.1.1 All cables and associated materials for installation on the IOCL refinery premises shall be Brand New and Approved.
- 4.1.2 Cables shall be bedded in and surrounded by appropriate materials as per **Appendix- B** enclosed to this specification.
- 4.1.3 Cables with kinks, straightened kinks or any other apparent defects like defective armoring etc. shall not be installed.
- 4.1.4 Cables shall not be bent sharp to a small radius either while handling or during installation. The minimum safe bending radius for PVC/XLPE (MV) cables shall be 12 times the overall diameter of the cable **(12D)**. The minimum safe bending radius for XLPE (HV) cables shall be as given in **Table-2, Appendix-B**. At joints and terminations, the bending radius of individual cores of a multi core cable of any type shall not be less than 15 times its overall diameter **(15D)**.
- 4.1.5 In case of PVC cables, suitable sealing compound/tape shall be used, if it is likely to be exposed to rain in transit or storage. Suitable heat shrinkable caps may also be used for the purpose.
- 4.1.6 Where site temperatures are below 3°C, the cables should be warmed before the laying out, since otherwise the bending would damage the insulation and protective coverings of cables. The cable laying must be carried out swiftly, so that the cable does not cool down too much.

4.2 Cable Route

Before the cable laying work is undertaken, the route of the cable shall be decided by the Engineer-in-Charge considering the following factors.

- 4.2.1 While the shortest practicable route should be preferred, the cable route shall generally follow fixed developments such as roads, foot paths etc. with proper offsets so that future maintenance, identification etc. are rendered easy. Cross country run merely to shorten the route length shall not be adopted.
- 4.2.2 Cable route shall be planned away from drains and near the property, especially in the case of LV/MV cables, subject to any special local statutory requirements that may have to be necessarily complied with.
- 4.2.3 As far as possible, the alignment of the cable route shall be decided after taking into consideration the present and likely future requirements of other services including cables enroute, possibility of widening of roads/lanes etc.
- 4.2.4 Corrosive soils, ground surrounding sewage effluent, oil infiltrated soils etc. shall be avoided for using as cable routes.
- 4.2.5 Cable routing given on the cable layout drawings shall be checked in the field so as to avoid interference with structures, heat sources, drains, piping, air conditioning duct etc. Any change in routing shall be done to suit the field conditions wherever deemed necessary, after obtaining approval.
- 4.2.6 Route of cables of different voltages.**
- Whenever cables are laid along well demarcated or established roads, the LV/MV cables shall be laid farther from the kerb line than HV cables.
 - Cables of different voltages, and also power and control cables shall be kept in different trenches with adequate separation. Where available space is restricted such that this requirement cannot be met, LV/MV cables shall be laid above HV cables.
 - **High voltage, medium voltage power and control cables shall be separated from each other by adequate spacing or by running through independent pipes, trenches, cables trays or segregated cable ducts,** as shown on layout drawings/ installation standards.
 - Where cables cross one another, the cable of higher voltage shall be laid at a lower level than the cable of lower voltage.

- *The telephone, communication and fire alarm cables shall run on instrument trays / ducts / trenches in the units. Wherever these are not available, cables shall be taken in a separate trench / tray with a min. spacing of 600 mm from power and control cables but in any case such separation shall not be less than 300 mm.*

4.3 Methods of laying

4.3.1 The following methods shall be adopted of cable laying as per relevant drawings and cable schedules etc.:

- Laying direct in ground
- In pipes,
- Closed or Open ducts,
- Cable trays and
- On surface of wall

4.3.2 Cables shall be laid in directly buried trench or in RCC trench (underground trench) or in cable tray along pipe sleepers or in overhead trays as shown on cable layout drawings.

4.3.3 Overhead trays shall be installed 2700 mm (minimum) above grade level. At road crossings overhead trays shall be installed at 7000 mm (minimum) above grade level or cables shall be routed cable tray culvert / electrical road crossings as per layout drawings. Sufficient care shall be taken while laying cables to avoid formation of twist, sharp bend etc. in order to avoid mechanical injuries to cables. Sufficient nos. of rollers shall be used for pulling of cables. The rollers will be provided on such a pattern that it will make a cable bending radius of 12D for the largest size cable while lifting / pulling the cable from ground elevation to the pipe rack tray elevation.

4.3.4 Cable installation shall provide minimum cable bending radii as recommended by cable manufacturer.

4.3.5 Trenching

4.3.5.1 Width of the trench shall first be determined on the following basis:

- The minimum width of the trench for laying a single cable shall be **350 mm**
- Where more than one cable is to be laid in the same trench in horizontal formation, the width of the trench shall be increased such

that the inter-axial spacing between the cables, except where otherwise specified, shall be at least **200 mm**.

- There shall be a clearance of at least **150 mm** between axis of the end cables and the sides of the trench.

4.3.5.2 Depth of the trench shall be determined on the following basis

- *Where the cables are laid in a single tier formation, the total depth of trench shall not be less than 750 mm for cables up to 1.1KV and 1200 mm for cables above 1.1KV.*
- When more than one tier of cables is unavoidable and vertical formation of laying is adopted, *the depth of the trench shall be increased by **300 mm** for each additional tier to be formed.*

4.3.5.3 Excavation of trenches shall be done as per the following guidelines:

- The trenches shall be excavated in reasonably straight lines. Wherever there is a change in the direction, a suitable curvature shall be adopted complying with the requirements of IS: 1255.
- Where gradients and changes in depth are unavoidable, these shall be gradual.
- The bottom of the trench shall be level and free from stones, brick bats etc.
- The excavation should be done by suitable means-manual or mechanical. The excavated soil shall be stacked firmly by the side of the trench such that it may not fall back into the trench.
- Adequate precautions should be taken not to damage any existing cable(s), pipes or any other such installations in the route during excavation. Wherever tiles or protective covers or bare cables are encountered, further excavation shall not be carried out without the approval of the Engineer-in-Charge.
- Existing property, if any, exposed during trenching shall be temporarily supported adequately as directed by the Engineer-in-Charge. The trenching shall be done in short lengths, necessary pipes laid for passing cables therein and the trench refilled in accordance with **Clause 6.6** of this specification.

- It there is any danger of a trench collapsing or endangering adjacent structures, the sides may be left in place when back filling the trench.
- Excavation through lawns shall be done in consultation with the Department concerned.

4.4 Laying of Cable in Trench

4.4.1 Sand Cushioning

- The trench shall be provided with a layer of clean, dry sand cushion of not less than 8cm in depth, before laying the cables therein.
- Sand cushioning as per above shall be invariably provided in all types/ grades of cables.

4.4.2 Cables Laid in Concrete Trench

4.4.2.1 Cables shall be laid in 3 or 4 tiers in concrete trench as per layout drawings. *Concrete cable trenches shall be filled with sand in hazardous area to avoid accumulation of hazardous gases and oil. RCC covers of trenches shall be effectively sealed to avoid ingress of chemical and oil in process area.*

4.4.2.2 In the concrete trench there shall be clearly separated compartments for MV power and control cables and HV cables and cables shall be laid accordingly.

4.4.2.3 All wall openings / pipe sleeves shall be effectively sealed after installation of cables to avoid seepage of water.

4.4.3 Testing Before Laying

At the time of issue of cables for laying, the cables shall be tested for continuity and insulation resistance.

4.4.4 The cable drum shall be properly mounted on jacks, or on a cable wheel at a suitable location, making sure that the spindle, jack etc. are strong enough to carry the weight of the drum without failure, and that the spindle is horizontal in the bearings so as to prevent the drum creeping to one side while rotating.

4.4.5 The cable shall be pulled over on rollers in the trench steadily and uniformly without jerks and strain. The entire cable length shall as far as possible be laid off in one stretch. PVC/XLPE cables less than 120 sq.mm. Size may be moved by “Flaking” i.e. by making one long loop in the reverse direction.

- 4.4.6 Short runs and sizes up to 50 sq.mm of MV cables, any other suitable method of direct handing and laying can be adopted without strain or excess bending of the cables.
- 4.4.7 After the cable has been so uncoiled, it shall be lifted slightly over the rollers beginning from one and by helpers standing about 10m apart and drawn straight. The cable shall then be lifted off the rollers and laid in a reasonably straight line.
- 4.4.8 Cables shall be neatly arranged in the trenches / trays in such a manner that **criss-crossing** is avoided and final take off to the motor / switchgear is facilitated. Arrangement of cables within the trenches / trays shall be in line with cable layout drawings. Cable routing between cable trench and equipment/motors shall be taken through GI pipe sleeves of adequate size. **Pipe sleeves shall be laid at an angle of maximum 45 to the trench wall. Bending radii of pipes shall not be less than 8D.** It is to be ensured that both the ends of GI pipe sleeves shall be sealed with approved weather proof sealing plastic compound after cabling. In places where it is not possible, cables shall be laid in smaller branch trenches.

4.5 Testing Before Covering

The cables shall be tested for continuity of cores and insulation resistance and the cable length shall be measured, before closing the trench. The cable end shall be sealed /covered as per **clause 7.0**

4.5.1 Sand Covering

Cables laid in trenches in a single tier formation shall have a covering of dry sand of not less than **170 mm** above the base cushion of sand before the protective cover is laid. In the case of vertical multi-tier formation, after the first cable has been laid, a sand cushion of **300 mm** shall be provided over the base cushion before the second tier is laid. If additional tiers are formed, each of the subsequent tiers also shall have a sand cushion of **300 mm** as stated above.

Cables in the top most tiers shall have final sand covering not less than **170 mm** before the protective cover/ bricks are placed.

4.5.2 Extra Loop Cable

[Back](#)

- At the time of original installation, approximately **3m** of surplus cable shall be left on each terminal end of the cable and on each side of the underground joints. The surplus cable shall be left in the form of a loop. Where there are long runs of cables such loose cable may be left at suitable intervals as specified by the Engineer-in-Charge.
- Where it may not be practically possible to provide separation between cables when forming loops of a number of cables as in the case of cables emanating from a substation, measurement shall be made only to the extent of actual volume of excavation, sand filling etc. and paid for accordingly.

4.5.3 Mechanical Protection over the Covering

Mechanical protection to cables shall be as per the following clauses to provide warning to future excavators of the presence of the cable and also to protect the cable against accidental mechanical damage by pick-axe blows etc.

4.5.3.1 Unless otherwise specified, the cables shall be protected by second class bricks of nominal size 22cmX11.4cmX7 cm or locally available size, placed on top of the sand. The bricks shall be placed breadth-wise for the full length of the cable. Where more than one cable is to be laid in the same trench, this protective covering shall cover all the cables and project at least **50 mm** over the sides of the end cables.

4.5.3.2 Where bricks are not easily available, or are comparatively costly, there is no objection to use locally available material such as tiles or slates or stone/cement concrete slabs. Where such an alternative is acceptable, the same shall be clearly specified in the tender specifications.

4.5.4 Laying of GI Pipes

4.5.4.1 All GI pipes shall be laid as per layout drawings and site conditions. Before fabrication of various profiles of pipes by hydraulically operated bending machine (which is to be arranged by the contractor) all the burrs from the pipes shall be removed. GI pipes having bends shall be buried in soil / concrete in such a way that the bend shall be totally concealed. For GI pipes buried in soil, bitumen coating shall be applied on the buried lengths, installation of GI pipes shall be undertaken well before paving is completed and necessary co ordination with paving agency shall be the responsibility of Electrical Contractor.

- 4.5.4.2 For sizing of GI pipes for number of cables **TABLE-7 of Appendix-B** shall be referred to.
- 4.5.4.3 After the cables are installed and all testing is complete, conduit ends above grade shall be plugged with a suitable weatherproof plastic compound / bitumen/suitable sealing compound. Alternatively rubber bushes shall be employed for the purpose of sealing.

4.6 Back filling

- The trenches shall be then back-filled with excavated earth, free from stones or other sharp ended debris and shall be rammed and watered, if necessary in successive layers not exceeding 300 mm depth.
- Unless otherwise specified, a crown of earth not less than 50 mm and not exceeding 100mm in the center and tapering towards the sides of the trench shall be left to allow for subsidence. The crown of the earth however, should not exceed 100 mm so as not to be a hazard to vehicular traffic.
- The temporary re-statements of roadways should be inspected at regular intervals, particularly during wet weather and settlements should be made good by further filling as may be required.
- After the subsidence has ceased, trenches cut through roadways or other paved areas shall be restored to the same density and materials as the surrounding area and are re-paved in accordance with the relevant building specifications to the satisfaction of the Engineer-in-Charge.
- Where road beams or lawns have been cut out of necessity, or kerb stones displaced, the same shall be repaired and made good, except for turfing /asphalting, to the satisfaction of the Engineer-in-Charge and all the surplus earth or rock shall be removed to places as specified.

4.7 Laying of Single Core Cables

[Back](#)

- 4.7.1 Three single core cables forming one three phase circuit shall normally be laid in close trefoil formation and shall be bound together at intervals of approximately **1m**.
- 4.7.2 The relative position of the three cables shall be changed at each joint at the time of original installation, complete transposition being effected in every three consecutive cable lengths.
- 4.7.3 When single core cables are laid in flat formation, the individual cable fixing clamps and spacers shall be of non-magnetic material. As a general practice, the sheath of single core cables shall be earthed at one point to keep sheath at earth potential unless otherwise stated.

5.0 ROUTE MARKERS

5.1 Route markers shall be provided along the runs of cables at locations approved by the Engineer-in-Charge and generally at intervals not exceeding **100 m**. Markers shall also be provided to identity change in the direction of the cable route and at locations of underground joints.

5.1.1 Plate Type Marker

Route markers shall be made out of 100mm X 5mm GI/ aluminum plate welded / bolted on 35mm X 35mm X 6mm angle iron, 60cm long. Such plate markers shall be mounted parallel to and at about **0.5m** away from the edge of the trench.

5.1.2 CC Marker

Alternatively, cement concrete 1:2:4 (1 cement:2 coarse sand: 4 graded stone aggregate of 20mm in size) shall be laid flat and centered over the cable. The concrete markers, unless otherwise instructed by the Engineer-in-Charge, shall project over the surrounding surface so as to make the cable route easily identifiable.

5.1.3 Inscription

The words '**From S/S # To S/S #; MV/HV CABLE**' as the case may be, shall be inscribed on the marker to clearly give the *origin* and *destination* of the cable.

5.2 Laying in pipes / closed ducts

5.2.1 In locations such as road crossing, entry into buildings, paved areas etc. cables shall be laid in pipes or closed ducts. Metallic pipe shall be used as protection pipe for cables fixed on poles of overhead lines.

5.2.2 Stone ware pipes, GI, CI or spun reinforced concrete pipes shall be used or cables in general; however only GI pipe shall be used as protection pipe on poles.

5.2.3 **The size of the pipe shall not be less than 100 mm in diameter for a single cable and not less than 150 mm for more than one cable.**

- 5.2.4 *Where steel pipes are employed for protection of single core cable feeding AC load, the pipe should be large enough to contain both cables in the case of single phase system and all cables in the case of poly phase system.*
- 5.2.5 Pipes for MV and HV cables shall be independent ones.
- 5.2.6 In the case of new construction, pipes as required (including for anticipated future requirements) shall be laid along with the civil works and jointed according to the relevant Building Specifications.
- 5.2.7 Pipes shall be continuous and clear of debris or concrete before cables are drawn. Sharp edges if any, at ends shall be smoothened to prevent damage to cable sheathing.
- 5.2.8 These pipes shall be laid directly in ground without any special bed except for SW pipe which shall be laid over 10cm thick cement concrete 1:5:10 (1 cement:5 coarse sand:10 graded stone aggregate of 40mm nominal size) bed. No sand cushioning or tiles need be used in such situations.
- 5.3 **Road crossings**
- 5.3.1 The top surface of pipes shall be at a **minimum depth of 1000 mm** from the pavement level when laid under roads, pavements etc.
- 5.3.2 *The pipes shall be laid preferably askew to reduce the angle of bend as the cable enters and leaves the crossing. This is particularly important for HV cables.*
- 5.3.3 When pipes are laid cutting an existing road, care shall be taken so that the soil filled up after laying the pipes is rammed well in layers with watering as required to ensure proper compaction. A crown of earth not exceeding **100 mm** should be left at the top.
- 5.3.4 The temporary re-instatements of roadways should be inspected at regular intervals, particularly after a rain, and any settlement should be made good by further filling as may be required.
- 5.3.5 After the subsidence has ceased, the top of the filled up trenches in roadways or other paved areas shall be restored to the same density and material as the surrounding area in accordance with the relevant CPWD Building Specifications to the satisfaction of the Engineer-in-Charge.
- 5.3.6 Manholes shall be provided to facilitate feeding / drawing in of cables with sufficient working space for the purpose. They shall be covered by

suitable manhole covers. Sizes and other details shall be indicated in the Schedule of work.

- 5.3.7 Cables for road crossings shall be taken through ERC (Electrical Road Crossing) as shown in the cable layout drawing.
- 5.3.8 *At road crossing and other places where cables enter pipe sleeves adequate bed of sand shall be given so that the cables do not slack and get damaged by pipe ends.*
- 5.3.9 Wherever cable trench crosses storm water, waste water channel / drain, cables shall be taken through PVC/RCC pipes. *Where cables are required to cross drains of depth more than 1200 mm, cables shall be taken over the drain on cable trays supported suitably using ISMC 150 / 200 sections.*

5.4 Cable Entry into the Building

- 5.4.1 Pipes for cable entries to the building shall slope downwards from the building. The pipes at the building end shall be suitably sealed to avoid entry of water, after the cables are laid.
- 5.4.2 Cable-grip / draw-wires, winches etc. may be employed for drawing cables through pipes / closed ducts.
- 5.4.3 Measurement for drawing / laying cables in pipes / closed duct shall be on the basis of the actual length of the pipe / duct for each run of the cable, irrespective of the length of cable drawn through.

5.5 Laying in Open Ducts

- 5.5.1 Open ducts with suitable removable covers (RCC slabs or chequered plates) are generally provided in sub-stations, switch rooms, plant rooms, workshops etc. for taking the cables. The cable ducts should be of suitable dimensions for the number of cables involved.
- 5.5.2 The angle iron inserts provided in the ducts for cable support shall be designed for **dynamic loading** of the cable so that the inserts so provided do not give way at the time of cable installation or due to dead weight of the cable when the cable is finally placed on it.
- 5.5.3 The inserts shall be **installed/ erected on one wall of the duct and not in a staggered manner** after maintaining adequate inter tier clearance as specified elsewhere in this specification. A maximum of 5 tiers of insert-supports shall be employed.

- 5.5.4 Laying of cables with different voltage ratings in the same duct shall be avoided. Where it is inescapable to take HV & MV cables through the same trench, they shall be laid with a permanent barrier between them or alternatively, one of the two (HV & MV) cables may be taken through pipe(s).
- 5.5.5 **Splices or joints of any type shall not be permitted inside the ducts.**
- 5.5.6 The cables shall be laid directly in the duct such that unnecessary crossing of cables is avoided.
- 5.5.7 Where specified, cables may be fixed with clamps on the walls of the duct or taken in hooks/ brackets/ troughs in ducts.
- 5.5.8 Ducts shall be filled with dry sand after the cables are laid and covered as above, or finished with cement plaster, especially in high voltage applications.
- 5.6 **Laying on surface**
- 5.6.1 This method may be adopted in places like switch rooms, workshops, tunnels, rising (distribution) mains in buildings etc. This may also be necessitated in the works of additions and/or alterations to the existing installation, where other methods of laying may not be feasible.
- 5.6.2 Cables may be laid on surface by any of the following methods as specified:
- Directly clamped by saddles or clamps,
 - Supported on cradles,
 - Laid on troughs/trays duly clamped.
- 5.6.2.1 The saddles and clamps used for fixing the cables on surface shall comply with relevant standards in construction and quality.
- 5.6.2.2 Saddles shall be secured with screws to suitable approved plugs. Clamps shall be secured with nuts on to the bolts, grouted in the supporting structure in an approved manner.
- 5.6.2.3 In the case of single core cables, the clamps shall be of non-magnetic material. A suitable non-corrosive packing shall be used for clamping unarmored cables to prevent damage to the cable sheath.
- 5.6.2.4 Cables shall be fixed neatly without undue sag or kinks.

- 5.6.3 The arrangement of laying the cables in cradles is permitted only in the case of cables of 1.1KV grade of size exceeding 120sq.mm. In such cases, the cables may be suspended on MS flat cradles of size 50mmX5mm which in turn shall be fixed on the wall by bolts grouted into the wall in an approved manner at spacing of **not less than 600 mm**.
- 5.6.4 All MS components used in fixing the cables shall be either galvanized or given a coat of red oxide primer and finished with 2 coats of approved paint.
- 5.7 Laying on Cable Tray**
- 5.7.1 This method may be adopted in places like indoor substations, air-conditioning plant rooms, generator rooms etc. or where long horizontal runs of cables are required within the building and where it is not convenient to carry the cable in open ducts. This method is preferred where heavy sized cables or a number of cables are required to be laid. The cable trays may be either of perforated sheet type or of ladder type.
- 5.7.2 Cables installed above grade shall be run in cable trays, clamped on walls, ceiling or structures and shall be run parallel or at right angles to beams, walls or columns. Cable routing shall be planned to be away from heat sources such as hot piping, gas, water, oil, drainage piping, air-conditioning duct etc. Each cable tray shall contain only one layer of cables as far as possible for power cables. However control cables may be laid in double layer in the cable trays.
- 5.7.3 Individual cable or small group of cables (up to 3 to 4 cables) which run along structures / walls etc. shall be clamped by means of **16 SWG GI saddles on 25x6 mm saddle bars**. Alternatively small group of cables can be taken through 100/150 mm slotted channel tray / ISMC 100. Cables shall be supported so as to prevent sagging. In general, distance between supports shall be approximately 300 mm for cables up to 25 mm diameter and maximum **450 mm for** cables larger than 25 mm dia. to prevent the sagging of cables.
- 5.7.4 Cable laid on supporting angle in cable trenches, structures, columns and vertical run of cable trays shall be suitably clamped by means of G.I. saddles / clamps, whereas cables in horizontal run of cable trays shall be tied by means of nylon cords. **Distance between supporting angles shall not exceed 600 mm.**

- 5.7.5 All cable trays (other than galvanised trays) and supporting steel structures shall be painted before laying of cables. The under surfaces shall be properly degreased, derusted, descaled and cleaned.
- 5.7.6 Where cables rise from trench to motor, lighting panel, control station, junction box etc., they shall be taken in GI pipe for mechanical protection up to a minimum of **300 mm above grade**. Cable ends shall be carefully pulled through conduit to prevent damage to cable.
- 5.8 **Ladder Type Cable Tray**
- 5.8.1 The ladder type of cable tray shall be fabricated of double bended channel section longitudinal members with single bended channel section rungs of cross members welded to the base of the longitudinal members at a center to center spacing of **250cm**.
- 5.8.2 Alternatively, where specified, ladder type cable trays may be fabricated out of 50mmX50mmX6mm (minimum) angle iron for longitudinal members, and 30mmX6mm flat for rungs.
- 5.8.3 The maximum permissible loading, jointing of channel sections, width of the cable tray, provision of elbows, bends, reducers, horizontal tee/ cross junctions etc. suspension of cable tray from the ceiling slab; painting and measurement of the cable tray etc. shall be as per Clause 7.8, except that the **overall width of one cable tray may be limited to 800 mm**.
- 5.8.4 Cables laid on cable trays shall be clamped on to the tray at suitable intervals.
- 5.8.5 **Cable identification tags**
Whenever more than one cable is laid / run side by side, marker tags as approved, inscribed with cable identification details shall be permanently attached to all the cables in the manholes / pull pits / joint pits / entry points in buildings / open ducts etc. These shall also be attached to cables laid direct in ground at specified intervals, before the trenches are backfilled.
- 5.8.6 All cables shall be identified close to their termination point by cable tag numbers as per cable schedule. Cable tag nos. shall be punched on aluminum straps (2 mm thick 20 mm wide and of enough length) securely fastened to the cable and wrapped around it.) Embossing will be done for: (1) Cable Tag, (2) Size & (3) Panel No. & Feeder No.

- 5.8.7 Each underground cable shall be provided with cable tags of aluminium securely fastened every **30 m** of its underground length with at least one tag at each end before the cable enters / leaves the ground, at every change of direction / branching of cable routes, inside the cable chamber below the panel and at both end of ERCs. In unpaved areas, cable trenches shall be identified by means of cable markers as per installation drawing. These cable markers shall be placed at location of changes in the direction of cables and at intervals of not more than **30 m** and also at cable straight through joint locations.

6.0 JOINTING

6.1 Location

6.1.1 Before laying a cable, proper locations for the proposed cable joints, if any, shall be decided, so that when the cable is actually laid, the joints are made in the most suitable places. As far as possible, water logged locations, carriage ways, pavements, proximity to telephone cables, gas or water mains, inaccessible places, ducts, pipes, racks etc. shall be avoided for locating the cable joints.

6.1.2 Joints shall be staggered by **2m to 3m** when joints are to be done for two or more cables laid together in the same trench. When two or more cables are laid together, the joints are arranged to be staggered so as to reduce the excess width of trench and also to isolate the joints from each other and reduce the possibility of one joint failure affecting the other joints.

6.2 Joints pits

6.2.1 Joint pits may be provided as per site conditions & shall be of sufficient dimensions as to allow easy and comfortable working. The sides of the pit shall be well protected from loose earth falling into it. It shall also be covered by a tarpaulin to prevent dust and other foreign matter being blown on the exposed joints and jointing materials.

6.2.2 Sufficient ventilation shall be provided during jointing operation in order to disperse fumes given out by fluxing.

6.3 Safety precaution

6.3.1 A caution board indicating **“CAUTION – CABLE JOINTING WORK IN PROGRESS”** shall be displayed to warn the public and traffic where necessary.

6.3.2 Before jointing is commenced, all safety precautions like isolation, discharging, earthing, display of caution board on the controlling switchgear etc. shall be taken to ensure that the cable would not be inadvertently charged from live supply. Metallic armour and external metallic bonding shall be connected to earth. Where “Permit to work” system is in vogue, safety procedures prescribed shall be complied with.

6.4 Jointing materials

- 6.4.1 Jointing materials and accessories like conductor ferrules, solder, flux, insulating and protective tapes, filling compound, jointing boxes, heat shrinking joint kit etc. of right quality and correct sizes, conforming to relevant Indian Standards, wherever they exist, shall be used.
- 6.4.2 The design of the joint box and the composition of the filling compound shall be such as to provide an effective sealing against entry of moisture in addition to affording proper electrical characteristic to joints.
- 6.4.3 Where special type of splicing connector kits or epoxy resin spliced joints or heat shrinkable jointing kits are specified, materials approved for such application shall be used. Storing as well as jointing instructions of the manufacturer of such materials shall be strictly followed.

6.5 Joints

Jointing work shall be carried out by a licensed/ experienced (where there is no licensing system for jointers) cable jointer. *It would be preferable to call OEM's cable jointers to do the job.*

7.0 TESTING

7.1 Testing before laying


All cables, before laying, shall be tested for IR values as per **TABLE-8 of Appendix-B** The cable cores shall be tested for **continuity, absence of cross phasing, and insulation resistance from conductors to earth / armor and between conductors.**

7.2 Testing before backfilling


All cables shall be subjected to the tests as **per Cl. 7.1** mentioned above before covering the cables by protective covers and back filling and also before taking up any jointing operation.

7.3 Testing after laying/ Installation

The following pre-commissioning tests on site shall be carried out on cable after installation:

 IndianOil Panipat Refinery	SPECIFICATIONS & GUIDELINES FOR CABLES INSTALLATION / LAYING FOR CABLES UP TO & INCLUDING 33 KV RATING
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- 7.3.1 Insulation Resistance of each cable drum length *after laying and before jointing*.
- 7.3.2 Tests for detection of damage to outer sheath, if any.
- 7.3.3 Serving insulation resistance after laying each cable length shall withstand a voltage of 10 KV DC for one minute between each reinforcement and external conducting surface; In addition, the serving insulation resistance shall be measured and checked with the values obtained during routine factory tests.
- 7.3.4 **On completion of the *cable laying and jointing* work, the complete installation shall be checked with a D.C. voltage of $3XU_0$ applied for 15 minutes between each conductor and sheath. Alternatively** the cable may be subjected to a **15 minutes HV VLF test**. The test voltage shall be $3XU_0$.
- 7.3.5 Conductor resistance of each cable of each complete circuit.
- 7.3.6 *Test for 5 min. with system voltage applied between the conductor and the screen.*
- 7.3.7 *Test for 24 hours with normal operating voltage of the system.*
- 7.3.8 Continuity & Phase confirmation.

 IndianOil Panipat Refinery	<p>SPECIFICATIONS & GUIDELINES FOR CABLES INSTALLATION / LAYING FOR CABLES UP TO & INCLUDING 33 KV RATING</p>
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APPENDIX-A

8.0 GUIDELINES ON CABLE LAYING

The following guidelines on cable handling and installation should be adhered to by the Contracting Agency while carrying out cable laying job at a project site or anywhere inside the Refinery Complex/ Township etc. that fall under the jurisdiction of IOCL.

8.1 Setting up Drum Prior to Cable Pulling

8.1.1 General safety principals

- Carry out site specific risk assessment.
- Always wear appropriate PPE.
- Always push drums in the direction of travel.
- Never pull drums with back to the direction of travel.
- Push squarely on the flanges and watch for any projecting nails in wooden drums.
- Always use approved equipment for handling drums, never use improvised equipment.
- Never allow a drum to move in an uncontrolled manner.
- Never position or store a drum underneath an overhead line.

8.1.2 Positioning the Cable Drum

Always observe the correct direction of roll indicated by the “roll this way” arrow on the drum flange. Position the drum so that the pull from the drum to the trench is as straight as possible, in any case, the lead in angle of the cable to the trench shall not be greater than 30 degrees. A lead in roller shall always be used to guide the cable into the trench.

8.1.3 When pulling a cable into a duct the drum shall be positioned above the duct so that the cable leaves the drum and enters the duct in a smooth curve. The drum shall be rotated by hand during the installation to ensure that the cable does not become tight between the drum and the duct mouth.

8.1.4 Cable drums should be arranged such that the “A” end of one length is positioned for jointing on to the “Z” end of the next length.

8.1.5 Using Drum Jacks

Check that the jacks and spindle are adequate for the size and weight of the cable drum, the gross weight of the cable drum will be marked on one flange.

8.1.6 Removing Battens & Lagging

Battens or other drum protection should be removed carefully to ensure that any nails or tools do not damage the cable. Care should be taken when removing any metal strapping used to secure lagging, this strapping may be under considerable tension and can spring forcefully when cut. Make sure that no nails are left protruding from the drum flanges as these may result in injury when moving or handling the drum. Ensure correct Disposal of any excess materials.

8.2 Checking cable details and sealing cap integrity

The end of the cable should be freed and inspected to ensure the following:

- The cable is of the correct size and type.
- The cable sealing cap is intact and undamaged.
- On a new drum the length marking on the over sheath agrees with the details marked on the cable drum.

8.3 10.3 Preparation of Trench and Ducts

- The trench bottom shall be as level as possible and any change in gradient or level shall be made as gradually as possible.
- The trench bottom shall be free of stones and the edges of the trench shall be cleared of any stones, tools or objects which may fall into the trench and damage the cable.
- Ducts shall be cleaned out prior to cable installation by pulling through a cleaning pig of suitable diameter.
- Duct entries shall be fitted with split bell mouths to prevent damage to the cable and to the duct entry. The Bell mouth shall be fitted so that the cable does not run on the split during installation as this is likely to damage the cable over sheath.
- A shallow pit shall be dug at duct entry positions to ensure that stones etc are not dragged into the duct.

9.0 CABLE PULLING

9.1 Installation Parameters

Depth of cover, maximum pulling tensions, minimum bending radii, minimum cable spacing and position of marker tapes and protection tiles are detailed in **Appendix B**.

9.2 Drum control during pulling

At all times during the pulling operation, at least one member of the team shall be stationed at the drum to control its rotation and check on the stability of the drum and jacks.

9.3 Winches

Where a winch is used to pull in cables, the winch shall be fitted with a suitable dynamometer. The dynamometer shall be continuously checked to ensure that the maximum pulling tension is not exceeded at any time. In all cases an appropriate swivel eye shall be fitted between the pulling bond and the pulling attachment on the cable.

9.4 Cable Guides and Rollers

9.4.1 Straight Horizontal Run

The cable shall be supported on free running cable rollers which have no projections or sharp edges. Rollers shall be suitably placed in the trench to prevent the cable from dragging on the trench bottom or in mud. The roller spacing required to achieve this will depend on the cable type being installed and the pulling tension along the route.

9.4.2 A leading roller shall be used to support the cable over the entire drum width immediately before being fed into the trench.

9.4.3 Bends in Route

Vertical corner rollers shall not be used as they may damage the cable and produce “flats” on the cable sheath. Skid plates of a radius greater than the cable’s minimum dynamic bending radius shall be used on all bends.

9.4.4 Roller Adjustment and Protection of Other Services

Prior to commencement of pulling, initial tension should be taken up to take the slack out of the bond wire. The rollers along the route should be checked and adjusted to line up with the taut bond and a final check should be made to ensure that other services which may be rubbed by the cable during installation are suitably protected. When final roller positions are confirmed and all other services are suitably protected the pull can be started.

9.5 Single Core XLPE cables

9.5.1 Configuration

Where single core cables are laid direct in the ground to form one three-phase circuit, they shall, unless otherwise instructed by the Engineer-in-Charge, be laid in touching trefoil configuration. They shall be bound together using nylon cable ties at intervals of **one metre**. The nylon cable ties shall have a smooth internal surface and have a minimum **loop tensile strength of 54kg**.

9.5.2 Ducted Single Core Installations

Where single core cables are to be installed in ducts to form a three-phase circuit, they shall, unless otherwise instructed by the Engineer-in-Charge, be installed with each core in an individual duct and with the ducts laid in touching trefoil configuration. The duct groups shall be bound together using nylon cable ties at intervals of **one metre**. The nylon cable ties shall have a smooth internal surface and have a **minimum loop tensile strength of 54kg**.

11.5.2.1 It is acceptable to install three single core cables in a single duct for short lengths such as road crossings. *In this case all 3 cores must be pulled in simultaneously.*

9.6 Completion of Installation

9.6.1 When installation is complete, all cut cable ends must be sealed by capping in accordance with approved procedures. All unused cables must be capped before returning to stores.

9.6.2 The loose end of the cable remaining on the drum shall be rewound tightly onto the drum by means of a length of rope tied around the cable end and secured to the drum.

- 9.6.3 After securing the cable end lower the drum jacks keeping the drum level. Remove, clean and store the spindle and drum jacks.

9.7 Cable Sealing

- 9.7.1 All cut ends of cables, including cable left on the drum, shall be sealed immediately and not left exposed to the atmosphere. This applies equally whether the cables are cut in the yard or on site.

- 9.7.2 All end caps, including factory fitted end caps, shall be examined after laying and any cap found to be damaged shall be removed and the cable resealed immediately.

9.7.3 *Cables with Lead Sheath*

For cables with lead sheaths the sealing cap shall be applied directly onto the lead sheath. Measure the diameter over the lead sheath and select the appropriate size of sealing cap. Expose the lead sheath for a distance equal to the length of the sealing cap **plus 50 mm** from the cut cable end. Clean the exposed lead sheath using approved cable degreasing solvent wipes. Install the sealing cap in accordance with the instructions provided with each cap.

9.7.4 *Cables without lead sheath*

For cables without lead sheaths the sealing cap shall be applied directly onto the PVC or MDPE cable over sheath. Measure the diameter over the PVC / MDPE over sheath and select the appropriate size of sealing cap. Install the sealing cap in accordance with the instructions provided with each cap.

10.0 ALTERNATIVE INSTALLATION TECHNOLOGIES

The requirements specified in this document apply in general to all underground cable installations irrespective of the installation method used. Installation shall be carried out by experienced teams with a thorough understanding of the risks specific to the installation methods being used. The installation design, equipment and techniques shall be designed to:-

- Minimize pulling forces on cables.
- Cause no damage to cable sheaths during handling and installation.

- For single core cables, be capable of reliably installing the cables or ducts in touching trefoil formation.

11.0 BLINDING OF CABLES AND JOINTS

The following points are **recognized as good cable laying practice** and should be followed where reasonably practicable:-

- Blinding shall be completed immediately following the installation of sections of new cable, with the exception of joint bays.
- Joint bays shall be opened for as short a time as possible prior to commencement of jointing.
- All 11kV and 33kV joints and associated cables shall be blinded before the Jointer leaves site.
- LV joints and associated cables shall preferably be blinded before the Jointer leaves site and by the next day at the latest.

12.0 CODES & STANDARDS

All standards, specifications and codes of practice referred to hereunder shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and the ISs referred hereunder, the former shall prevail. All the cables shall conform to the requirements of the following standards and codes:

IS-694	:	PVC insulated cables for working voltages up to and including 1100V.
IS-1554 (Part-I)	:	PVC insulated (heavy duty) electric cables for working voltages up to and including 1100V
IS-1554 (Part-II)	:	PVC insulated (heavy duty) electric cables for working voltages from 3.3kV up to and including 11kV
IS-3961	:	Recommended current ratings for cables
IS: 7098(Part-I& II)	:	Specification for Cross linked Polyethylene insulated PVC Sheathed cables- Part-II: For working voltages from 1.1 KV up to and including 33 KV
IS-1255	:	Code of practice for installation and maintenance of power cables up to and including 33kV rating

SPECIFICATIONS & GUIDELINES FOR CABLES INSTALLATION / LAYING
FOR CABLES UP TO & INCLUDING 33 KV RATING

IS-12943	:	Brass glands for PVC cables
IS-10418	:	Drums for electric cables
IS-10810 (Part 0 to 63)	:	Method of test for cables
IS: 3961(Pt-I & II)	:	Recommended current ratings for cables, PVC insulated and PVC sheathed heavy duty cables
IEC: 540/540A	:	Test methods for insulation and sheath of electric cables and cords
IEC-10333	:	Cable joints and terminations
NEMA Std.: VE2-2000	:	Cable Tray installation Guidelines

APPENDIX- B

PREScribed INSTALLATION PARAMETERS

13.0 GENERAL

The requirements of this section must be complied with for all cables, up to and including 33kV, which are installed with the intention that they will become **integral part of the Refinery Power Generation & Distribution network of IOCL.**

14.0 BEDDING MATERIALS

14.1 All cables and ducts shall be bedded and blinded as defined below:

14.1.1 Soft fine fill material.

Soft fine fill material shall be of consistent composition under all conditions of humidity and temperature and shall not contain any readily visible foreign matter such as pieces of clay or organic detritus. The material shall not contain any sharp stones or flints.

14.1.2 Selected sand backfill.

Selected sand backfill shall be of consistent composition and shall not contain any readily visible foreign matter such as pieces of clay or organic detritus. Not less than 95% by weight of the material shall pass through a British Standard 5mm sieve. The material shall not contain any sharp stones or flints. The Dry relative density of the selected sand backfill shall not be less than 1.6.

14.2 LV Cables

All LV cables shall be surrounded by 50mm of soft fine fill material.

14.3 11kV Cables

All 11kV cables shall be surrounded by **75mm** of either soft fine fill material or selected sand backfill.

14.4 33kV Cables

All 33kV cables shall be surrounded by a minimum of **75mm** of selected sand backfill.

15.0 MAXIMUM PULLING TENSIONS

Maximum permissible pulling tensions for some of the cable types/sizes are given below in **TABLE-1**. *These tensions must not be exceeded under any circumstances*. Efforts should always be made to achieve lower figures by careful setting out of the work and positioning of the cable drum. General guidelines for pulling of cables are given in the following clauses.

15.1 For Cables **Pulled with Stocking**

PVC and XLPE insulated **armored** power cables $P = 9 D^2$

PVC and XLPE insulated **unarmored** power cables $P = 5 D^2$

Where

P = pulling force in Newtons, and

D = outer diameter of cables in millimeters.

15.2 For Cables **Pulled by Pulling Eye** — if the cables are pulled by gripping the conductor directly with pulling eye, the maximum permissible tensile stress depends on the material of the conductor and on their cross-section as given below:

For aluminum conductors 30 N/mm²

For copper conductors 50 N/mm²

15.3 The following values of *pulling force* are expected when **Pulling of the Cables is attempted by Winch**:

P = (approximately percentage of cable weight):

PULLING FORCE In TERMS OF % WEIGHT OF CABLE	
In trenches without large bends	15-20 percent
In trenches with 1 or 2 bends of 90° each	20-40 percent
In trenches with 3 bends of 90° each (Assuming the use of easy-running Support and corner rollers)	50-60 percent
In ducts with bends totaling 360°	Up to 100 percent

TABLE-1 (MAX. PULLING TENSIONS)

SPECIFICATIONS & GUIDELINES FOR CABLES INSTALLATION / LAYING
FOR CABLES UP TO & INCLUDING 33 KV RATING

Conductor size (mm ²)	Maximum Pulling Tension (KN)							
	95	150	185	240	300 Al	300 Cu	500	630
3 / 4-Core LT Cable	2.89	-	7.78	8.67	9.79	-	-	-
11kV 1-core XLPE	2.85	-	5.55	-	9.0	15.0	-	31.5
11kV 3-core XLPE	3.91	-	6.36	-	9.79	-	-	-
33kV 1-core XLPE	-	5.5	-	-	-	-	14.6	18.0

16.0 MINIMUM PERMISSIBLE BENDING RADII

16.1 Minimum bending radii for some important cable sizes/ types to which cables in new condition may be bent are given below in **TABLE-2** for the installation conditions stated. The following installation conditions apply:-

- Dynamic – When cables are being pulled in.
- Static – When cables are bent in-situ adjacent to joints or terminations.

16.2 Under no circumstances must the minimum dimensions given in the Table below be infringed, as damage will be caused to the cable's insulation and screening systems resulting in premature failure.

16.3 For other cables the guidelines given in **Clause 6.1.4** shall apply.

TABLE-2 (MINIMUM PERMISSIBLE BENDING RADIUS)

Cable Type		Conductor area (mm ²)					
		95	150	185	300	500	630
		Minimum Bending Radius (mm)					
3 / 4 Core LT Cable	Dynamic	500	-	650	85-	-	-
	Static	240	-	400	540	-	-
11kV 1-core XLPE	Dynamic	560	-	650	750	900	-
	Static	420	-	490	560	680	-
11kV 3-core XLPE	Dynamic	600	-	750	900	-	-
	Static	500	-	600	750	-	-
33kV 1-core XLPE	Dynamic	-	900	-	-	1150	1250
	Static	-	650	-	-	850	950

17.0 DEPTH OF COVER

SPECIFICATIONS & GUIDELINES FOR CABLES INSTALLATION / LAYING
FOR CABLES UP TO & INCLUDING 33 KV RATING

Cables and ducts shall be installed so as to provide the minimum depth of cover detailed below in **TABLE-3**. The **depth of Cover** is the vertical distance measured from the top of the sand covering of the final resting place of cable up to the final finished ground level.

- 17.1 On railway property, other than across or near railway track, normal depth of cover shall be used subject to a minimum depth to comply with the railway standards.
- 17.2 In certain situations it may not be possible to achieve the minimum cover detailed above. In these cases, it will be necessary to:-
- Minimize the length over which minimum depth is not attained.
 - Install additional mechanical protection as appropriate for the location and circumstances.
 - Install additional warning, for example, in the form of posts or signs, appropriate to the location and circumstances.
 - Ensure that the cable records clearly detail the shallow section of cable.

TABLE-3 (MINIMUM DEPTH OF COVER)

Surface Type	Voltage		
	33 KV	11 KV	MV
	Minimum Depth of Cover (mm)		
Unmade ground, footways / footpaths	775	600	450
Roads	775	700	600
Cultivated ground inc. gardens	775	700	600
Agricultural land	910	910	910
Cables at Road Crossings	1000	1000	1000
Cables at Railway Crossings	1000	1000	1000

Note: Trench depth = Minimum Depth of Cover + Sand Cushion (80 mm) + Sand Cover (170 mm). Please refer to Clauses 6.4.1 and 6.5.1 of this specification.

18.0 POSITION OF CABLE MARKERS & PROTECTION COVERS ON CABLES

- 18.1** Approved cable markers & cable protection covers shall be installed 200mm above all low voltage **cables and joints**.
- 18.2** Approved cable markers & cable protection covers shall be installed 250mm above all **11kV cables and joints**.
- 18.3** Approved protection covers shall be installed 75mm above all 33kV **cables and 33kV joints**.
- 18.4** Where existing cable markers on any cable are disturbed or removed during excavation, these cable markers shall be replaced or renewed as appropriate.
- 18.5** Where existing cables without cable markers are uncovered during the course of excavation, new cable markers and /or protection cover shall be installed over the complete exposed section of the existing cables.

19.0 MULTIPLE CABLE SPACING

Minimum allowable spacing between adjacent cables is as shown below in **TABLE-4**. These spacings are the minimum required to allow for future access and jointing works. They do not take into consideration any ratings requirements. The actual minimum spacing requirement may be greater than those given above depending on ratings requirements and the proximity of other cables or sources of heat.

TABLE-4 (MINIMUM CABLE SPACING)

Voltage Grade of Cable	Minimum Spacing between Adjacent Cables
33kV	450 mm
11kV	300 mm
LV main	250 mm
LV service	100 mm
Power cable to control cables	200 mm
Power cable to communication cable	300 mm
Power cable to gas/water main	300 mm

20.0 JOINT BAY DIMENSIONS

Minimum required **Joint Bay Dimensions** are shown below in **TABLE-5:-**

TABLE-5 (MINIMUM JOINT BAY DIMENSIONS)

Type of Cable Joints	Joint Bay minimum dimensions (length x width x depth) (mm)
33KV 3 x 1-core straight joints (x3)	2000 x 1100 x 1400
33kV Other joints (trifurcating transition joint, 1-core breech joint etc)	3500 x 1400 x 1400
11kV	2000 x 1100 x 900
LV	1200 x 900 x 700

TABLE-7 PIPE SIZING FOR CABLES

No. Of Cables per Pipe	% of Pipe Cross Section Occupied by Cables
1 cable in a pipe	53% of pipe cross-sectional area occupied by cables.
2 cables in a pipe	51% of pipe cross-sectional area occupied by cables.
3 cables in a pipe	43% of pipe cross-sectional area occupied by cables.
4 and above cables in a pipe	40% of pipe cross-sectional area occupied by cables.

TABLE-8 TESTING VOLTAGES

Voltage Grade of Cable	Voltage Rating of IR Tester
1.1 kV	500 V
3.3 kV	1 000 V
6.6 kV	1 000 V
11 kV	1 000 V
22 kV	2.5 kV/5 KV (see Note)
33 kV	2.5 kV /5 KV(see Note)

Note: For long feeders, motorized insulation resistance tester should be used

Chapter-14

Section-3

RTF CHECKLIST HT DISTRIBUTION SYSTEM (Primary & Secondary)

Note:- Vendor to give point by point compliance and ensure design and selection of equipment in compliance with below checklist point

S.No.	Area/ Sub Station	
	Switch Board No. →	Reliability check point
1		Adequacy of switchgears regarding phase barriers / HT tapes / sleeves.
2		Proper structural support / clamps provided for HT cables.
3		Provision of DC control supply for each HT section.
4		Has adequate back up control supply scheme provided in each switchgear
5		Provision of dedicated control supply for the numerical relays.
6		Provision of control supply failure alarm at manned locations.
7		Review of DC system for fuse proper coordination.
8		Labelling of control fuse rating in the panels above the fuse base
9		Confirm failure of the DC control supply shall not trip any breaker / process equipment
10		Use of ICT in Bus/ cable differential protection not to be provided
11		Availability of differential protection in all the HT switchgears.
12		Adequacy of the differential CT's w.r.t. knee point voltage.
13		Confirmation regarding similarity of CT characteristics.
14		Use of Dedicated CT for differential protection
15		Prominent marking on differential CT's for differentiation with other CT's.
16		Confirm that each sectionalize generation bus is provided with ONLY differential scheme with cross over zones
17		Review of differential scheme that entire switchgear including breaker is covered.
18		To confirm that bus differential is having overlapping with other differential zones.
19		To confirm that Differential protection is based on proven current balance principle.
20		Provision of numerical relays for differential protection with spill current display or practice of periodic spill current measurement available.
21		Adequacy of the differential scheme w.r.t. stabilizing resistance.
22		Provision of dedicated control supply for the differential protection relays.
23		Inter-tripping of upstream incomer on actuation of differential relay of the downstream switchgear.
24		Provision of tripping of each (Incoming and out going) breaker of a particular switchgear section, on differential protection.
25		Provision of cable differential protection in all HT radial feeders.
26		Zone crossover of cable differential protection with bus differential protection in upstream / downstream switchgear.
27		Checking of adequacy of knee point voltage of cable differential CT's in line with relay vendor recommendation.
28		Confirmation regarding similarity of CT characteristics at both ends.
29		Proper CT connection configuration at both ends as per relay vendor guidelines.
30		Provision of window type CT's in differential protection schemes
31		Proper dressing / clamping of control wire in the panels.
32		Provision of transformer differential protection in transformer having HV primary & secondary windings.
33		Ensuring that instantaneous (High Set) Over current protection in HT breaker of transformer feeders is in line.

S.No.	Areal Sub Station Switch Board No. → Reliability check point
34	Inter-tripping of upstream breaker from the master relay contact of the downstream incomer breaker.
35	Availability of trip circuit supervision thru continuous monitoring in all HT switchgears
36	Are binary inputs to numerical relays for critical interlocks, for long cable lengths, are provided directly or through interposing relays
37	Ensuring direct tripping of breaker from field PB and TNC switch at panel without involving Numerical relay
38	The breaker service position contact should not be included in the tripping logic of breakers
39	The control fuse ratings of protection schemes like CDV / bus bar differential scheme/under voltage scheme etc. to be reviewed and correct rating of the fuse to be ensured as per design requirement.
40	The master trip relay shall be VAJH type only.
41	The surge arrestors provided in the vacuum circuit breakers of Motor Feeders shall be rated for maximum continuous operating voltage. The maximum continuous operating voltage should be equal to the highest system voltage i.e. equal to the line to line voltage plus 10%.
42	The surge arrestor installation in some cases are before the CTs that is in the bus section which is not desirable. In new projects, the installation of surge arrestors to be done after the CTs so that in the event of surge arrestor failure particular motor feeder shall trip only without affecting other feeders. In the existing system wherever such type of surge arrester is provided, necessary modification after suitable engineering / OEM consultation to be carried out.
43	Proper installation of numerical relays in the HT panels to be ensured and all fastening screws to be in position to prevent the draw out portion of the relays coming out from its operating position during breaker operation / panel door operation.
44	Availability of IR(infra Red) windows in all HT switchgears
45	Control schemes for incomer, bus coupler, feeder incorporating the critical reliability aspects have been prepared as a standard scheme / philosophy. The same shall be utilized while finalizing engineering drawings, new procurements etc.

RTF RECOMMENDATION UNDER VOLTAGE MANAGEMENT and BUS TRANSFER SCHEMES (HT)

Note: - Vendor to give point by point compliance and ensure design and selection of equipment in compliance with below checklist point.

S.No.	Areal Sub Station Switch Board No. → Reliability check point	Compliance
1	All incomer breakers up to the PCC level are having Under Voltage Tripping Scheme	
2	Upstream (primary side) feeders for Transformer & MCC incomers are not provided with UV tripping.	
3	The under voltage tripping scheme provided for entire distribution system at various voltage levels is time graded	
4	Under Voltage tripping of the incomer breakers shall be direct and not through the master relay.	
5	The under voltage tripping is initiated from the line side PT of the incomer breaker and not from bus PT	
6	Inputs from all three phases are used for UV tripping	

S.No.	Areal Sub Station Switch Board No. →	Reliability check point →
7	UV	Blocking of under voltage tripping in case both the Incomers are experiencing UV
8		Blocking of under voltage tripping scheme in case of PT fuse failure in order to achieve faster restoration of the system after total power failure, under voltage tripping relay contact multiplication (if required) shall be provided through self reset relays.
10		All critical distribution sections are provided with Bus Coupler Changeover Scheme
11		Provision of check sync. Relay for Manual mode
12		Reliable control Supply to bus coupler changeover scheme
13		Blocking of bus coupler thru' Master relay contact of Incomers
14		Time out of B/C change over. scheme
15		Inter tripping provided for downstream breaker
17		Breaker contact used for inter tripping
18		UV relay setting for Unhealthy bus (Dead Bus) is 40 % or less.
19		UV relay setting for Healthy bus is 80 %
20		No time delay in provided in Auto C/O scheme
21		Confirm provision of separate UV relays for detecting Bus healthy and bus unhealthy condition
24		Confirm Cable Differential Protection is not blocking the bus coupler auto change over at downstream substation.
27		Adequacy of interlocks in Momentary paralleling scheme
29		Provision of " Auto C/O Supervision scheme" for Bus couplers through soft logic.

RTF CHECKLIST - Uninterrupted Power Supply		
Note:- Vendor to give point by point compliance and ensure design and selection of equipment in compliance with below checklist point.		
S.No.		
1	Provision of separate UPS system for group of associated process units.	
2	The incoming power supply sources shall not fall on the same primary Generation / distribution source at 11 kV level	
3	UPS systems are parallel redundant type.	
4	In case single UPS is feeding to large no. of units, feasibility of installation of two battery banks may be explored – New projects	
5	Confirmation regarding healthiness of battery bank based on last discharging.	
6	Date of last discharging to be furnished	
7	Is the schedule and history record of battery testing available	
8	Type of power supply module for input feeders to the UPS	
9	Fuse coordination to be reviewed from ACDB to downstream distribution level	
10	Provision of critical UPS alarms at the manned location / control room	
11	Internal cooling fans are healthy	
12	Adequate inventory of internal cooling fans available	
13	UPS systems are installed in dust free air conditioned atmosphere	
14	The power supply to auxiliary equipments e.g. tube light, fans, space heater etc. shall be provided from the normal plant supply	

RTF CHECKLIST- DC SYSTEM

S.No.	Areal Sub Station Switch Board No. →	Reliability check point →
Note:- Vendor to give point by point compliance and ensure design and selection of equipment in compliance with below checklist point.		
S.No.		
1	Provision of separate DC Charger system for each HT substation.	
2	Battery chargers are redundant with paralleling or changeover facility.	
3	The incoming power supply sources shall not fall on the same primary Generation / distribution source at 11 kV level.	
4	Incoming power supply to chargers is from SFUs / MCB's and not from contactors.	
5	Provision in battery charger to come into service automatically after voltage dips or after plant restoration.	
6	DCDB provided with dual section with a bus coupler switch.	
7	Single battery charger is feeding to large no. of units.	
8	Feasibility of installation of dual battery banks or separate chargers.	
9	Availability of redundant DC supply for Critical DC loads.	
10	Availability of emergency interconnection between DC systems to facilitate battery maintenance.	
11	If not available, Feasibility of emergency interconnection between DC systems to facilitate battery maintenance.	
12	Provision of DC ground fault alarm for all DC systems (220 / 125 / 110 V etc)	
13	Review of the DC distribution system upto downstream level for proper fuse coordination.	
14	Marking of fuse ratings above fuse base inside the panels.	
15	Availability and display of DC systems diagram for the sub station.	
16	Redundant DC control supply to each HT bus is available.	
17	Provision of boost charging alarm at the manned location / control room.	
18	Provision of critical battery charger alarms at the manned location / control room.	
19	Provision of Alarm / MIS for ripple measurement in output supply of battery charger.	
20	Confirmation regarding healthiness of battery bank based on last discharging.	
21	Date of last discharging to be furnished.	
22	Maintaining record of Auto / Manual boost charging of battery bank.	
23	Provision of Separate battery bank for emergency lighting and process units instrumentation supply.	

Annexure-F

Scope of work

The TRANSFORMER / REACTOR tank is boxed up and ready for further operation.

The contractor has to execute the following scope of work: -

1. Vacuuming of TRANSFORMER / REACTOR up to 1 mm of mercury and maintaining for 24hrs. Dry N2 filling up to 2.0 psi for 24hrs duration. Heating of the tank externally to raise the temperature upto 75⁰C and continue purging operation till desired dew point is achieved. (3 cycles tentatively estimated). Each cycle will comprise of 24hrs vacuuming and 24hrs heating after nitrogen filling.
2. Oil filing & hot oil circulation to achieve BDV & PPM values.
3. Oil settling , testing and re-commissioning of TRANSFORMER / REACTOR

Infrastructure and facilities required for restoration.

1. Vacuum pump with booster capable of pulling 1mm of hg vacuum
2. 30 Nos. dry N2 cylinders (99.9% pure & -55 deg. Cent. dew point).
3. 50 Nos. industrial finned 2kW heaters with mounting structure 1 feet away from tank wall at 1/3, 2/3 height. Enclosure around TRANSFORMER / REACTOR to prevent heat loss and proper heating of insulation.
4. Dew point meter for dew point measurement cylinders & reactor tank.
5. Filter machine (High VAC)
6. SFRA & Tan delta kit. Low voltage testing instruments.

Testing of Transformer:-

1. IR values of windings & bushings at 5 kV for 60sec/600 sec.
2. Tan delta measurement of windings and HV bushing, neutral bushing at 10kV
3. Ratio test by turn ratio meter & vector group verification.
4. Resistance measurement on all taps of HV winding & LV winding.
5. Measurement of magnetization current of HV& LV windings.
6. Measurement of dew point of N2 used for dry out & that of transformer.
7. BDV test of oil before filling in the tank.
8. BDV, PPM, resistivity & tan delta tests on oil after completion of oil filtration.
9. SFRA measurement of transformer.
10. Functional checks of all TRANSFORMER / REACTOR protections like PRV, buchholz relay etc.
11. Pre-commissioning checks for charging of the TRANSFORMER / REACTOR

TECHNICAL SPECIFICATION
FOR INSULATING MAT

- 9.11 **Insulating mats**
- 9.11.1 The scope covers supply and laying of insulating mats of "class A" conforming to IS: 15652-2006.
- 9.11.2 These insulating mats shall be laid in front of all floor mounted AC and DC switchboards and control **& relay** panels located in control room building/**Switchyard panel room**.
- 9.11.3 The insulating mats shall be made of elastomer material free from any insertions leading to deterioration of insulating properties. It shall be resistant to acid, oil and low temperature.
- 9.11.4 Upper surface of the insulating mats shall have small aberration (rough surface without edges) to avoid slippery effects while the lower surface shall be plain or could be finished slip resistant without affecting adversely the dielectric property of the mat.
- 9.11.5 Insulating mat **(wherever applicable)** shall be of pastable type, to be fixed permanently on the front and rear side of the panels except for the chequered plate area which shall not be pasted **as per requirement**. The insulating mats shall generally be fixed and joints shall be welded as per recommendations in Annexure-A of IS: 15652.
- 9.11.6 Width of insulating mats shall generally be of 1.5 meters or as per site requirements. Length shall be supplied as per site requirements.
- 9.11.7 The insulating mats offered shall conform to IS: 15652-2006.

BHARAT HEAVY ELECTRICALS LIMITED
TRANSMISSION BUSINESS ENGINEERING MANAGEMENT
NEW DELHI

DOCUMENT No.	TB-XXX-316-041	Rev. No.	02		Prepared	Checked	App.
TYPE OF DOC.	STANDARD TECHNICAL SPECIFICATION			NAME	NK	MK	KK
TITLE PVC PIPE & BENDS				SIGN	Sd/-	Sd/-	Sd/-
				DATE			
				GROUP	TBEM	W.O. No	
CUSTOMER							
CONSULTANT							
PROJECT	RATE CONTRACT						

SCOPE AND SPECIFIC TECHNICAL REQUIREMENT

1.0 SCOPE

This technical specification covers design, manufacture, testing at works, packing and dispatch of 'PVC pipe, its fittings and bends'. The material supplied shall fully comply with relevant Indian Standard given below and the product shall be BIS certified. The sizes and types of Pipes shall be as specified below. No Technical Deviations shall be acceptable in this regard.

1.1 SPECIFIC TECHNICAL REQUIREMENT

1.1.1 UPVC Pipe

The UPVC pipes shall be of nominal diameter 50 mm and/ or 110 mm, as per the indent. The pipe shall be of Class-II & Class-IV Grade as per IS 4985: 2000 and shall be of standard length of 6 meters. The pipe shall fully comply with specified standard and carry the BIS certification marking.

1.1.2 Sockets

The sockets shall fully comply with the requirements of IS 7834 (Part-6)-1977.



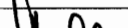
1.1.3 For Bends

The bends shall be of 45°, 60°, 90° and Tee as specified, for above mentioned pipes. The bends shall, in general, comply with the requirement of IS 10124. The specific requirements and BIS certification marking of these bends shall be as per IS 10124 (Part-9) and IS 10124 (Part-10) respectively.

1.2 BILL OF MATERIAL

As per enclosed Annexure-1.

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02	06.09.13				90° Bends added.	
01	30.11.10	-SD-	-SD-	-SD-	Document revised.	
Rev No.	Date	Altered	Checked	Approved	REVISION DETAILS	
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IS : 10124 (Part 10) - 1988

2.2.2 Dimensions — The dimensions of 45° bends shall comply with Table 1 read with Fig. 1.

2.2.3 The bends may either be plain at both ends or socketed either at one end or at both ends as agreed to between the manufacturer and the purchaser. In the case of socketed bends, the socket measurements shall comply with IS : 10124 (Part 1)-1988*.

NOTE 1 — For 0.25 MPa pressure class, fabricated bends should not be made from 0.25 MPa pressure class pipes. For this, bends made from 0.4 MPa pressure class pipe should be used.

NOTE 2 — The drawing is only intended to define the terms used in Table 1 and is not intended to illustrate specific design features.

3. MARKING

3.1 Each 45° bend fitting shall be marked with the following information:

- a) Manufacturer's name or identification mark,

- b) The size of the bend and the appropriate class (working pressure) of IS : 4985-1988* to which the pressure rating of the fitting corresponds,

- c) The degree of bend, and

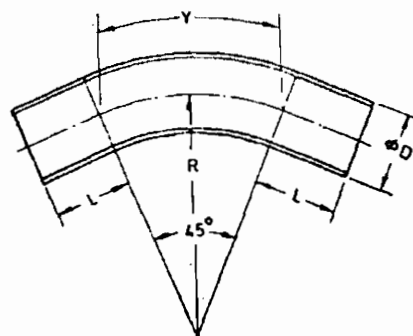


FIG. 1 45° BEND

*Specification for fabricated PVC fittings for potable water supplies: Part 1 General requirements.

*Specification for unplasticized PVC pipes for potable water supplies (second revision).

TABLE 1 DIMENSIONS OF 45° BENDS
(Clauses 2.2.2 and 2.2.3, and Fig. 1)

All dimensions in millimetres.

Size	Y* Min	L Min (Only for plain ends)	R† Min	MINIMUM WALL THICKNESS (t) FOR WORKING PRESSURE		
				0.4 MPa (Class 2)	0.6 MPa (Class 3)	1.0 MPa (Class 4)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
63	149	63	189	1.4	2.0	3.2
75	177	75	225	1.7	2.4	3.8
90	212	90	270	1.9	2.8	4.5
110	259	110	330	2.3	3.4	5.5
125	295	125	375	2.7	3.9	6.3
140	330	140	420	2.9	4.4	7.0
160	377	160	480	3.4	4.9	8.0
180	424	180	540	3.8	5.5	9.0
200	471	200	600	4.2	6.2	10.0
225	530	225	675	4.7	6.9	11.2
250	589	250	750	5.2	7.7	12.5
280	660	280	840	5.8	8.6	13.9
315	742	315	945	6.5	9.7	15.6
355	837	355	1 065	7.3	10.8	17.7
400	842	400	1 200	8.2	12.2	19.8
450	1 060	450	1 350	9.3	13.7	22.4
500	1 178	500	1 500	10.3	15.3	24.8
560	1 319	560	1 680	11.6	17.2	27.8
630	1 484	630	1 890	13.0	19.2	31.3

NOTE — Minimum wall thickness if calculated on the basis of 90 percent of the minimum wall thickness of the corresponding size and pressure class of pipe rounded off to the next higher 0.1 mm.

*Y is calculated from $\frac{45^\circ}{360^\circ} \times 2\pi R$.

†R, radius of the bend, is equal to 3 times the nominal outside diameter (D).

IS : 10124 (Part 8) - 1988

2.2.2 Dimensions — The dimensions of 90° bends shall comply with Table 1 read with Fig. 1.

2.2.3 The bends may either be plain at both ends or socketed either at one end or at both ends as agreed between the manufacturer and the purchaser. In the case of socketed bend, the socket measurements shall comply with IS : 10124 (Part 1)-1988*.

NOTE — For 0.25 MPa pressure class, fabricated bends should not be made from 0.25 MPa pressure class pipes. For this, bends made from 0.4 MPa pressure class pipe should be used.

NOTE — The drawing is only intended to define the terms used in Table 1 and is not intended to illustrate specific design features.

3. MARKING

3.1 Each 90° bend fitting shall be marked with the following information:

*Specification for fabricated PVC fittings for potable water supplies: Part 1 General requirements (*first revision*).

- Manufacturer's name identification mark,
- The size of the bend and the appropriate class (working pressure) of IS : 4985-1988* to which the pressure rating of the fitting corresponds,
- The degree of bend, and
- The bend shall be marked in colour as indicated below for different classes of fittings:

Class of Fitting	Colour
Class 2 (0.4 MPa)	Blue
Class 3 (0.6 MPa)	Green
Class 4 (1.0 MPa)	Yellow

*Specification for unplasticized PVC pipes for potable water supplies (*second revision*).

TABLE 1 DIMENSIONS OF 90° BENDS

(Clauses 2.2.2, 2.2.3 and Fig. 1)


All dimensions in millimetres.

SIZE	Y* Min	L Min (Only for plain ends)	R† Min	MINIMUM WALL THICKNESS (t) FOR WORKING PRESSURE		
				0.4 MPa (Class 2)	0.6 MPa (Class 3)	1.0 MPa (Class 4)
				(5)	(6)	(7)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
63	297	63	189	1.4	2.0	3.2
75	354	75	225	1.7	2.4	3.8
90	424	90	270	1.9	2.8	4.5
110	519	110	330	2.3	3.4	5.5
125	589	125	375	2.7	3.9	6.3
140	660	140	420	2.9	4.4	7.0
160	754	160	480	3.4	4.9	8.0
180	848	180	540	3.8	5.5	9.0
200	942	200	600	4.2	6.2	10.0
225	1 060	225	675	4.7	6.9	11.2
250	1 178	250	750	5.2	7.7	12.5
280	1 319	280	840	5.8	8.6	13.9
315	1 484	315	945	6.5	9.7	15.6
355	1 673	355	1065	7.3	10.8	17.7
400	1 884	400	1200	8.2	12.2	19.8
450	2 120	450	1350	9.3	13.7	22.4
500	2 355	500	1500	10.3	15.3	24.8
560	2 638	560	1680	11.6	17.2	27.8
630	2 968	630	1890	13.0	19.2	31.8

NOTE — Minimum wall thickness is calculated on the basis of 90 percent of the minimum wall thickness of the corresponding size and pressure class of pipe rounded off to the next higher 0.1 mm.

*Y is calculated from $\frac{90^\circ}{360^\circ} \times 2\pi R$.

†R, radius of the bend, is equal to 3 times the nominal outside diameter (D).

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	DOCUMENT No.	TB xxx 618 002a		Rev 04	Prepared	Checked	Appd
	TYPE OF DOC.	TECHNICAL SPECIFICATION		NAME	BVG	PLK	RMS
	TITLE G I HARDWARES		SIGN	-SD-	-SD-	-SD-	
			DATE				
			GROUP	TBEM			
			W.O. No				
CUSTOMER/CONSULTANT							
PROJECT							
<p style="writing-mode: vertical-rl; transform: rotate(180deg);"> COPYRIGHT & CONFIDENTIAL The information in this document is the property of BHARAT HEAVY ELECTRICALS LIMITED This must not be used directly or indirectly in anyway detrimental to the interest of the company. </p>	<u>Contents:</u>						
	Section No.	Description					No of Pages
	SECTION-1	SCOPE, SPECIFIC TECHNICAL REQUIREMENTS and QUANTITIES					01
	SECTION-2	STANDARD SPECIFICATION					03
	SECTION-3	PROJECT DETAILS AND GENERAL SPECIFICATION					01
	SECTION-4	GUARANTEED TECHNICAL PARTICULARS (Not Applicable)				
	SECTION-5	MANUFACTURING QUALITY PLAN (Not Applicable)				
	SECTION-6	CHECK LIST					01
	04	18.11.10				Unit wt of hardware added	
02	13.4.06.	BVG	PLK	RMS	Eqpt mounting hardwares added.		
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SECTION - 1

SCOPE, SPECIFIC TECHNICAL REQUIREMENTS & QUANTITIES

1.1 SCOPE

The scope of this specification is to specify all details required by a supplier for supply of galvanized hardware for projects being executed by BHEL on turnkey basis for NTPC, PGCIL, SEBs and other Customers.

1.2 SPECIFIC TECHNICAL REQUIREMENTS

The specific technical requirements shall be as per Standard Technical Specification (Refer Section 2).

1.3 QUANTITIES

The quantities shall be as per attached BOQ.

SECTION - 2

2.0 GENERAL

This section covers the standard technical specification for GI Hardware.

2.1 BOLTS:

M16 bolts shall be used in all types of structures except equipment mounting/ earthing bolts which shall be as per equipment requirement.

All bolts for member connections in towers, beams & equipment support structures shall conform to IS: 12427 - 2001 and for step bolts shall conform to IS: 10238 - 1982.

The mechanical properties shall conform to property class 5.6 of IS:1367 (part 3) - 1991.

All bolt heads shall have hexagonal shape, the heads being forged out of the solid material truly concentric and square with the shank, which must be perfectly straight.

Fully threaded bolts should not be used.

All bolts shall be threaded with metric standard thread to take the full depth of the nut and permit firm grip of the member.

All bolts shall be hot dip galvanized as per IS: 1367 (Part 13) - 1983.

2.2 NUTS:

All nuts shall conform to IS: 1363 (Part 3) -1992.

The mechanical properties shall conform to property class 5 of IS:1367 (part 6) - 1980.

The nuts shall be capable of being worked with fingers along the entire threaded portion of the bolt with a neat fit capable of developing the full strength of the bolt.

All nuts shall be hot dip galvanized as per IS: 1367 (Part 13) - 1983.

2.3 PLAIN WASHERS:

All plain washers shall be punched washers, A type conforming to IS: 2016-1967.

These shall be hot dip galvanized as per IS: 4759 - 1984.

2.4 SPRING WASHER:

All spring washers shall be of spring steel, positive lock type and conforming to type B of IS: 3063-1972. The thickness of spring washer shall be as specified under:

<u>Bolt Diameter</u>	<u>Thickness of Spring washers</u>
16 mm	3.5 mm
12 mm	2.5 mm

These shall be electro-galvanized as per IS: 1573 – 1986.

2.5 UNIT WEIGHT OF BOLTS I/C NUT, PLAIN AND SPRING WASHERS:

For purpose of payment, following unit weights as indicated below shall be considered.

A.) STANDARD BOLTS I/C ONE NUT UNIT WEIGHTS

S. NO.	TYPE	SIZE OF BOLTS	TOTAL WT (KG)
1	M16	16 ϕ X 35 LG	0.117
2	M16	16 ϕ X 40 LG	0.125
3	M16	16 ϕ X 45 LG	0.133
4	M16	16 ϕ X 50 LG	0.141
5	M16	16 ϕ X 55 LG	0.149
6	M16	16 ϕ X 60 LG	0.157
7	M16	16 ϕ X 65 LG	0.164
8	M16	16 ϕ X 70 LG	0.172
9	M16	16 ϕ X 75 LG	0.180
10	M16	16 ϕ X 80 LG	0.188
11	M16	16 ϕ X 85 LG	0.196
12	M16	16 ϕ X 90 LG	0.204
13	M16	16 ϕ X 95 LG	0.212
14	M16	16 ϕ X 100 LG	0.220
15	M12	12 ϕ X 35 LG	0.0620
16	M12	12 ϕ X 40 LG	0.0664
17	M12	12 ϕ X 45 LG	0.0708
18	M12	12 ϕ X 50 LG	0.0753
19	M12	12 ϕ X 55 LG	0.0797
20	M12	12 ϕ X 60 LG	0.0842

106

Bharat Heavy Electricals Ltd.
Doc. No. TB-XXX-618-002a R4
Technical Specification
GI HARDWARES

B.) SPRING WASHER

S. NO.	TYPE	TOTAL WT (KG)
1	3.5mm thk (M16 bolt)	0.00891
2	2.5mm thk (M12 bolt)	0.00382

C.) For supplies of bolts i/c nuts, plain washers and spring washer other than those listed above, payment shall be made based on unit weights worked out considering theoretical dimensions & density of steel as 7850kg/cum.