SCOPE OF WORK

1. **Scope of Work**

The scope of contract work includes design and development of **6 MVA Shore power Connection to the ships calling at the International Cruise Terminal of CoPA, complete with required components so as to meet the below mentioned requirements, on Turnkey mode and Operation and Maintenance of the entire system during 2-year guarantee period and thereafter for 5 years on award of AMC contract.**

Since it is a budgetary offer the bidders are requested to furnish the detailed specifications of all the components of the system, say for example, transformers, Static Frequency Converter, cable management system etc. The output should be 11kV & 6.6kV with 50HZ & 60Hz frequency as detailed below. Operation and AMC rate for 5 years after the guarantee period shall also be quoted by the Bidder.

A. Complying IEC/ISO/IEEE 80005-1 standard for high voltage shore connection, to meet the requirement of shore power to the vessels in the below mentioned voltage and frequency levels:
   2nos. of 3MVA each power connections to the ship with the following selections:
   (i) 11kV, 50Hz AC power supply
   (ii) 11kV, 60Hz AC power supply
   (iii) 6.6kV, 50Hz AC power supply
   (iv) 6.6kV, 60Hz AC power supply

B. To meet the requirements of Low Voltage Shore power connections to the vessels in both 50 Hz & 60 Hz frequencies.

C. 1MVA shore supply system is additionally required at Q7 berth for cargo vessels. LT shore supply of 1MVA/440V system both in 50 Hz & 60 Hz frequencies by laying of 11kV cable from the new substation location proposed near Sagarika Cruise Terminal to Q7 berth location (250M) is in the vendor's scope, to meet the requirements of Low Voltage Shore power connections to the vessels in both 50 Hz & 60 Hz frequencies.

2. Since the contract is under EPC mode the contractor shall Design, Engineering, Supply, Installation, Testing, Commissioning of 6 MVA High Voltage Shore Connection for the International Cruise vessels calling at Ernakulam Wharf as per the Scope of Work.
3. Eventhough the minimum requirement size of the management should be 16MVA, as per contract requirement 6 MVA with minimum (4) four sockets 11/6.6KV, Neutral and communications cables as per IEEE 80005-1,2,3 etc. shall be provided.
4. Maximum 6 MVA to a single ship with further options of two numbers of 3MVA maximum ie. the system proposed to be installed shall have provisions of connecting one 6 MVA Power to the Cruise Vessels or two numbers of 3 MVA Power.
5. The complete system shall include the following:-

(i) Main Power System in 110 KV Main Receiving Station

11KV Bay extension in the existing 11kV HT Panels at 110kV main receiving station, Installation of 3 nos. of Circuit breaker Panels and associated cabling in HT including Metering, Monitoring & Protection system integrated to the existing panels and associated Cabling in LT auxiliary and control power supply for taking main 11KV supply for shore supply facility proposed. For flexibility and isolation of HT supply, bus coupler shall be provided in the incoming 11KV panel. The 11KV panels shall be compactable with existing Siemens make panels and shall integrate to the existing communication systems as required. The panels shall be fitted with existing compactable Smart TOD meter type with

required CT/ PT etc. including supply of SIM and commissioning the same by coordinating with Existing Smart meter service provider.

(ii) Cabling from 110 KV Main Receiving Station to the proposed Substation

SITC of the following:

a) Approx. 4.5kM length of Cabling through open trench/ HDPE Pipe etc.. from 110 KV Main Receiving Station to the proposed Substation near International Cruise Terminal with 3 runs of 3 x 400 sq.mm 11 KV grade (E)XLPE FRLSH UG Cables. The HT cable has to be laid through HDD, New RCC trench, Open trench, existing trench, through HDPE pipe with C- channel supports clamps etc. as per requirements and according to the site conditions the method of cable laying may be carried out with the approval of CoPA/ TPIA.

ii) Jointing &Terminations at both ends of each cable.

(iii) Power Supply Distribution System:

Design and provide Power Supply Distribution System consisting of the following items:

i) Construction of Substation near International Cruise Terminal including all civil works involved.

ii) Installation of Ring Main Units, HV Circuit breakers (draw out type HT panels), transformers, distribution system, earthing etc. as per IEC 61936-1.

iii) Installation of 1 (one) No. Transformer 11KV /433V, 50hz is considered for the Auxiliary / Control supply for the Substation.

iv) Providing necessary battery backup for the station control system.

(iv) High Voltage Shore Connection System in accordance with the Standard IEC/IEEE 80005, the General requirements IEC/IEEE 80005-1 *'Utility connections in port – Part 1: High voltage shore connection (HVSC) systems'*. Design and Provide

High Voltage Shore Connection System to provide Shore connections to the vessels in 11KV and 6.6KV Voltage levels in both 50 Hz & 60 Hz frequencies as per the standard IEC/ISO/IEEE 80005-1consisting of the following items:

i) Installation of Power Transformers.
ii) The Power Convertors (Frequency converter)
iii) Shore- Side Protection Relaying
iv) Shore-side circuit-breaker and earth switch
v) Control system of shore connection
vi) Shore-to-ship connection and interface equipment including Cable Management System and Connectors.
vii) Communication equipments

(v) Power cable shall be of 4 (Four) nos. per IEC 80005-1, with sockets 11/6.6KV, neutral and communication cables.

(vi) Providing shore power connection in 440V System both in 50 Hz & 60 Hz frequencies with capacity of 1 MVA

(vii) The Data Communication between shore power system and ship shall be in accordance with IEC/IEEE 80005-2.

(viii) SCADA system connecting shore power substation equipments, shore power system and onboard power equipments for monitoring and control. SCADA shall be installed in the proposed substation near Berth.

(ix) The diagrams, specifications, standards, documents etc. given in tender are for reference only and successful bidder has to Design, Engineering, Installation and Commissioning has to done as per the requirements and recommendations of TPIA appointed by CoPA. It is contractor's responsibility to make good the areas/locations etc. to the original/ standard

condition after the work has been carried out in connection with project work proposed, by own cost and risk

(x) Scope of TPIA involves checking the design as per QAP, Design, Engg, Supply, Installation, Testing and Commissioning and handover of the High Voltage Shore connection of 6 MVA to the satisfaction of the Engineer i/c of CoPA.

(xi) Preparation of drawings, SL diagrams, earthing layout etc. and submitting the scheme to CEA for approval & arranging inspection, rectification of defects

(xii) The entire system shall be under guarantee for 2 years from date of taking over of system to COPA.

(xiii) **The project development shall be carried out on Turnkey mode and the Operation and Maintenance shall be carried out by OEM during guarantee period and thereafter on award of AMC contract.**

TECHNICAL SPECIFICATIONS

A. GENERAL INFORMATION

1. INTRODUCTION

- The International Maritime Organization (IMO) has set the global target to reduce Carbon intensity of emissions by 40% by 2030 across international shipping. The GoI also has encouraged introducing Green Port concept all over India to reduce its carbon footprint. The Green Port Policy recommends reduction of carbon emissions through implementing renewable energy initiatives including cold ironing which is an emerging global best-practice, to provide on shore power supply to vessels berthed in port. Cold Ironing is a well-known technology to reduce emissions by ships during their stay in the port. Without a Cold Ironing system in place, each ship will have to generate its own electricity by means of a diesel generator on board. This method of power generation is inefficient and causes harmful emissions in the port area. Cold ironing facilities allow ships to use power from the public electrical power grid during their stay in the port. The on-board generators can be switched off in that case. The Cold Ironing Facility needs to comply with IEC/ISO/IEEE 80005 international standard (Utility Connections in Port- **In 2012 a standardized connection system for Cold Ironing was developed. The standard, which was originally defined by the Port of Los Angeles in the USA, has been laid down in an IEC standard, the IEC 80005-1, entitled "Utility connections in Ports").**
- In this regard Cochin Port has initiated action plan for the project of providing Onshore Power Supply to the ships calling at the International Cruise Terminal at Q8& Q9 berths at Ernakulam wharf of CoPA. The new International Cruise Passenger Terminal at Ernakulam Wharf of CoPA was commissioned in February 2021, wherein it is proposed that at least 60 numbers of cruise vessels will be calling during a year. The range of harbor load requirements for the vessels calling at Cochin Port is about 6-15 MVA. As part of Green Port Policy, presently it has been decided to install High Voltage Shore Connection (HVSC) systems of capacity 6MVA at the Cochin International Cruise terminal of CoPA.

- **This document focuses on the provision of shore power facilities at Q8 & Q9 berths at Ernakulam Wharf of Cochin Port Authority, mainly for the** visiting **International cruise passenger vessels** when she is at berth. Cruise business is seasonal one restricted to 6-month period in a year; hence t**he proposed shore supply system for cruise vessels can be used for other vessels also.** The proposal is to install the following infrastructure at Q8 & Q9 berths at Ernakulam Wharf:
    a) 2 sets of shore power systems with a maximum power at 3MVA each with 60Hz or 50Hz and voltage ratings of 6.6KV or 11KV.
    b) Mobile Cable management system for taking the supply from shore facilities and giving connection to vessels from the shore supply installations at berth having protection and communications systems as per IEC standards. One Cable Management System shall be designed and supplied to give power supply to one ship at a time.
- **Connections from the ship to the shore Cold Ironing (CI) power distribution system are made by means of cable reel system. At the end of each cable shall have a standardized plug, suitable up to 400A/required capacity. Pilot wires within the cables, plugs and sockets are used for interlocking and to make the system fail safe.**
- ***Equipotential bonding*:** Equipotential bonding between the ship and the shore is to be provided. An interlock is to be provided such that the HV shore connection cannot be established until the equi-potential bonding has been established. The equipotential bonding cable may be integrated into the HV shore power cable. When the equipotential bonding cable is intended to carry the shipboard earth fault current, the cable size is to be sufficient to carry the design maximum earth fault current.
- A major number of Cruise and other vessels visiting in the Port are working in the power supply of 60 Hz frequencies. The system shall be capable of giving 50Hz supply also as per requirements. The public electrical power distribution system in India operates at 50Hz. Power supplies to the cruise ships will therefore require the installation of frequency converters.
- Power supply to the Cold Ironing system will be taken from the existing High Voltage (HV) system that is already operational in the Port. The required power for the input needs to be an HV feeder. Voltage level is not critical, as the frequency converter will be connected via a transformer. This transformer has functions of adjustment of voltage level (Incoming feeder – Frequency converter operating voltage) and smoothening the power waveforms.
- Transformers shall be of minimum Level 2 with latest BEE standard and OLTC is not required since SFCs can take care of the voltage regulations/ fluctuations.
- This document proposes **AFE frequency converters** (active front end drive) to avoid system disturbances. Prevention of higher harmonic influences affecting the power distribution system when the frequency converters are in operation and generating harmonic components shall be effectively blocked. Frequency converter shall be designed as per IEC/IEEE80005-2.
- The frequency conversion shall be done with combinations of Converter units according to the maximum power requirements of each system. The Convertor units shall be designed in such a way that during the time of operation if any unit in stack goes off other units shall work with reduced power to maintain the supply without any disturbance. The individual units used in the stack shall of same rating, type and model so that interchangeability is

possible between the individual units in the stack. Each frequency converter is based on power electronic components. The incoming voltage is initially rectified (converted into DC voltage) and following stabilization the DC voltage is inverted back into an AC voltage at the required frequency. The output voltage of the frequency converter does not have the shape of a pure sine-wave and is therefore not immediately suitable for power supply to ships. A combination of the output side transformer and other passive electrical components (Chokes and capacitors) are applied to improve the converted voltage waveform into an acceptable sine-waveform. Having two converters improves the availability of the shore power system. In case of one converter is stopped, the shore power system can still deliver power with reduced capacity.

- Redundancy feature should be available in the proposed 3 MVA system. In case of failure of one module, the system can operate on reduced capacity up to 2 MVA.
- N+ 1 redundancy, to have same power from SFC in case of failure of one unit of SFC.
- SFC can be modular type with total capacity of 6MVA with splitting of 6 modules of 1MVA each. 3MVA SFC with stack as per design, with Galvanic isolation as per the contract requirements shall be provided.
- SFC of 3MVA 2nos. can also be designed and offered.
- Power factor shall be at minimum 0.95 lag.
- After conversion to the correct voltage and frequency, shore power is distributed to the connection points. Each MV outlet socket in a shore power point will be switched and protected individually. The system needs to be interlocked in such a way that MV outlet sockets cannot be powered without the presence of a plug and that sockets cannot be unplugged while voltage is present. Interlocking will be provided via the pilot contacts in the plug and socket.
- MV switchgear with outgoing feeders for each individual connection points is required to provide protective functions and interlocking for fail safe operation.
- The following assumptions have been made in giving shore power supply to the vessels calling at Cochin Port:

Cold ironing provisions at Berths:	Q8/ Q9 Berth
No. of Cruise vessel/ bulk carrier connected simultaneously:	1
No. of Connection Points:	2
Operating voltage:	6.6KV&11KV/ 60Hz; 6.6KV&11KV/ 50Hz
Maximum total power supply capacity per point:	3 MVA per point

- Each connection point will be equipped with 1 standardized socket with appropriate safety provisions that is rated for 3MVA.
- Length of Berth Q8 and Q9 is 200metre each, width of berth will be 30metres and maximum length of vessel will be 265metre. EPC contractor shall design as per the maximum height of the ship power connection from Berth and extension length within the ship as per the vessels' standards. The height of power connection opening is about 5 to 6 Meters from Wharf / berth level in most of the ships. Length within the ship can be 3 to 4 metres.

Connection Points: It is proposed for 2 No. connection points to be provided for use by the Cruise Vessels/ other ships calling at Ernakulam Wharf of CoPA and the connection points are to be provided at the Q8 & Q9 berths. Each connection point shall provide 400A at 6.6kV/ 11KV.

2 nos. (11/6.6KV) outdoor SS 316 marine grade junction boxes are required at the connection points. The Junction boxes/ connection points are envisaged to be fixed at about 30M from the wharf edge. The trench is under the scope of the bidder. Existing trenches at berth frontage can be used by EPC by modification if any, and after laying the cables same has to be restored to the original condition by the contractor.

Power Distribution: The power supply for the Cold Ironing system for the Cruise Vessels/ other ships shall be provided from the existing 110kV substation of CoPA. **3 Runs of 11kV cables have to be laid from the 110kV substation to the proposed substation at Ernakulam Wharf.**

- The following has been assumed:
  1) **6MVA power supply capacity is available additionally in the existing 11 KV Substation of the Main 110 KV Receiving Substation.**
  2) **Available space for the extension of 11kV Switchgear (side space) within 11 KV Substation of the Main 110 KV Receiving Substation.**
  3) **A new OPS Substation for the Cold Ironing System equipment;**
  4) **Available routing for the cables between the new Substation and the Shore connection box.**

Power supply to the Cold Ironing system will be taken from the existing High Voltage (HV) system that is already operational in the Port. The required power for the input needs to be an HV feeder. Voltage level is not critical, as the frequency converter will be connected via a transformer.

- **Proposed Concept:**
  (i) The power supply for the Cold Ironing system of Cruise Vessels/ other ships shall be provided from Port's existing 110kV substation, 11KV distribution system. 3 Runs of 11kV cables have to be laid from the 110kV substation to the proposed substation at Ernakulam Wharf up to the Sagarika Cruise Terminal.

  (ii) The project includes a new system with centralized Static Frequency Converter (SFC); The system will contain, in addition to the SFC, the associated equipment for the distribution of the 60Hz power supply to the shore power connection and also the auxiliaries system for the equipment like step down and step up transformers, incoming 50 Hz MV switchboard, downstream 60Hz MV switchboard. The system design shall be compliant with IEC/ISO/IEEE 80005-1. (the Global Standard on shore to ship power supply).

  (iii) It is proposed that the shore power system (OPS) shall contain the Transformers, Static Frequency Converters, HT Switchgear (at 50Hz and 60Hz), LV Distribution Panels, DC battery charger, SFC auxiliaries and control panels, shore to ship control panel, HVAC Panels, Building Services boards, and all safety equipment to complete the substation. It must be tested and validated in the supplier's factory with witnessed functional tests before shipment. Battery backup is envisaged for substation HT/LT control panels, protection systems supply, emergency lighting etc. with minimum 3 HRS back UP.

2. GENERAL TECHNICAL SPECIFICATIONS OF ELECTRICAL WORKS

1) GENERAL TECHNICAL PARTICULARS.

i) General specification

Fault level at W/Island at 11 KV	: 25 KA
Anticipated Max. fault level	: 50 KA
Rated system voltage	: 11 KV
Rated frequency	: 50 Hz
Neutral earthing	: effectively earthed.
Installation of cable	: Underground burial.
Rated short circuit current at 11 KV side	: 25 KA
Proximity of extraneous heat source	: Nil
Max. Permissible operating temp. of conductor under normal Operation	: 90^{0} C
Under short circuit	: 250^{0} C
Ground temperature	: 40^{0} C
Type of installation	: Earthed
Maximum temperature of air	: 45 degree C
Minimum temperature of air	: 22 degree C
Maximum relative humidity	: 95%
Minimum relative humidity	: 10%
Average No. Of thunderstorm days	: 40 days
Average number of rainy days per annum	: 90 days

2) Type of soil along the cable route

General condition of the earth is soft marshy. Some portions are tarred with rubble soling. However Contractor shall conduct route survey before submitting their quotes.

3) General conditions

In addition to the above, the scope intends to cover but not restrict to the following activities, services and works.

(i) Complete design and engineering of all the systems, sub-systems, equipment, material and services.

(ii) Providing engineering data, drawing and O&M manuals for Employer's review, approval and records.

(iii) Supply, testing, packing transportation and insurance the equipments from the manufacturer's work to the site.

(iv) Receipt, storage, insurance, preservation and conservation of equipment at the site.

(v) Fabrication, pre-assembly (if any), erection, testing and putting into satisfactory operation of all the equipment/ material including statutory clearances & successful commissioning.

(vi) In addition to the requirements indicated in Technical Specifications, all the requirements as stated in relevant regulations stipulated for successful commissioning of the installation also be considered as a part of this specification and Contractor is bound for compliance the same.

(vii) The Contractor shall be responsible for providing all material, equipment and services specified or otherwise which are required to fulfill the intent of ensuring

operability, maintainability and the reliability of the complete work covered under this specification.

(viii) For individual equipment specifications reference shall be made to the relevant Technical Specification of the equipment as per contract condition

(ix) The Contractor shall be responsible for the overall management and supervision of works. He shall provide experienced, skilled, knowledgeable and competent personnel for all phases of the project, so as to provide the Employer with a high quality system.

(x) A project execution schedule called Master Network (MNW) in the form of PERT /Gant chart/ network and based on 'Work break down structure' shall be prepared by the Contractor for Employer's approval. The MNW shall identify milestones of key events for each work/ component in the areas of engineering, procurement, manufacture, dispatch, erection & commissioning.

4) PROJECT MANAGEMENT & SITE SUPERVISION

a) Testing and commissioning

The scope includes testing and commissioning of all equipment, sub-systems and systems of the project and putting them into successful commercial operation. The scope shall include but not limited to the requirements given elsewhere in the specification. The Contractor shall be responsible to provide all necessary testing and commissioning personal, tools and plant, test equipment etc.

The Contractor shall identify all interface issues with Employer and other agencies, and shall be responsible for each interfacing, coordination and exchange of all necessary information.

The Contractor shall submit to the Employer all drawings for review. He shall list out the detailed requirements of interface between Contractor's work and the material and services to be supplied by Employer.

The interpretation of the Employer in respect of the scope, details and services to be performed by the Contractor shall be binding, unless specifically clarified otherwise by the Employer in writing before the award of the contract.

The drawings(enclosed), forming a part of the specification shall supplement the requirements specified herein. These are preliminary/ tentative drawings for bidding purpose only and are subject to changes that may be necessary during detailed engineering after award keeping the basic parameters as specified.

Failure of any equipment to meet the specified requirements of tests carried out at works or at site shall be sufficient cause for rejection of the equipment. Rejection of any equipment will not be held as a valid reason for delay in the completion of the works as per schedule. Contractor shall be responsible for removing all deficiencies and supplying the equipment that meet the requirement after furnishing of necessary fresh type test report, as per relevant ISS Standard from NABL Accredited Laboratory.

b) Compliance Of Electricity Act, Regulations, Etc.

Contractor is required to follow statutory regulations stipulated in Electricity Act 2003, Indian telegraph act 1889, Electricity (Supply) Act 1948, Indian Electricity Rules 1956, CEA (Regulation relating to safety of electrical installation) regulation 2010, with all amendments till date and other local rules and regulation referred in this specifications.

The Contractor shall comply with all the statutory rules and regulations prevailing in the

state of Kerala including those related to safety of equipment and human beings.

The successful Contractor (individual) or any of the partner of joint venture who has qualified, should obtain "A" class electrical license from Electrical inspectorate of Govt. of Kerala/GoI/ any other state/ Union territory etc. before award of contract and to be kept valid till such time all the erected work as per scope of the award is taken over by the Employer.

The Contractor shall do complete coordination with all local and statutory agencies for execution of complete works including obtaining clearance for energizing of the HT system upon completion of entire works. The Contractor shall obtain approvals & clearances and right of way from all agencies involved. All cable routes shall generally be routed through public land/ along the road. Necessary statuary fees if any shall be paid by the User/ Cochin Port. land belonging to CoPA and hence no permission is required from any other authorities.

The Contractor shall be responsible for transportation to site all the materials to be provided by the Contractor as well as proper storage and preservation of the same at his own cost, till such time the erected installation is taken over by the Employer.

c) **Safety Codes and Labour Regulations**

In respect of all labour employed directly or indirectly on the work, the tenderer, here in after called the contractor, at his own expense will arrange for the safety provision outlined in safety manual to comply with the statuary regulations, ISI recommendations and other codes.

In case of default, the department shall be at liberty to make arrangements and provide facilities as aforesaid and recover the cost from the contractor.

The contractor shall provide necessary barriers warning signals and other safety measures to avoid accidents. He shall also indemnify CoPT against claims for compensation arising out of negligence in this respect.

Nothing in these specifications shall be construed to relieve the contractor of his responsibility for the design, manufacture and installation of the equipment with all accessories in accordance with applicable statutory regulations and safety codes in force from the safety angle.

d) Works To Be Done By The Contractor

In addition to supply, installation, testing and commissioning of all equipments as per schedule of work, the following work shall be deemed to be included within the scope of work, to be executed by the contractor.

(i) All minor building works, such as equipments foundation if required cutting and making good holes, grouting of channels belts as required. Cutting and making good damages etc.
(ii) Provision of supports / clamps for equipments, cables etc. wherever required.
(iii) Small wiring, inter-connection etc. inclusive of all materials and accessories, necessary to comply with the regulations as well as proper and trouble free operation of the equipment.
(iv) Closing of the cable entry points in sub-station/ switching stations against seepage of water, rod ends etc.
(v) Tools and tackles required for handling and installation.
(vi) Necessary testing equipments for commissioning.
(vii) Watch and Ward of materials and/or installation and equipments till their handing over to the department

e) Extent Of Works.

The scope of work shall consist of cost of all materials, labour supervision, installation, calibration, adjustments as required for commissioning of the sub-station. The term complete installation shall mean, not only, major item of the plant and the equipments

covered by these specifications, but also, incidental sundry components necessary for complete execution and satisfactory performance of installation with all labour charges, whether or not specifically mentioned in the tender documents, which shall be provided by the contractor at no extra cost.

f) Completeness Of Tender.

All fittings, unit assemblies accessories, hardware foundation bolts, terminals blocks for connections, cable glands and miscellaneous materials and accessories of items of work which are useful and necessary for efficient assembly and working of the equipment shall be deemed to have been included within the scope of the work in the tender and within the overall details for complete item whether they have been specifically mentioned or not

g) Data Manual And Drawings To Be Furnished By The Contractor.

(a) After award of work.

The contractor shall submit the following drawing within a fortnight of the award of the work or as specified in tender document which shall prevail, for approval by the department.

i) General arrangement or location drawing of the equipment complete with dimensions and clearances.
ii) General arrangement drawing of H.V. Panel, M.V. panels, Earthing, Cable route etc. including details of grouting of channels / bolts of various equipments.
iii) All panels' schematics & wiring diagram including control wiring.
iv) Bar chart indicating general programme for supply, installation, testing and commissioning and handing over.
v) Any other drawing or data that may be necessary for the job

(b) Before energizing the installation

The contractor shall also furnish 3 copies of detailed installation, operation and maintenance manuals of manufacturers for all items of equipment together with all relevant data sheet, spare parts catalogues, repairs, assembly and adjustment procedure etc., in triplicate.

h) Final Inspection And Testing

When the installation is complete, the contractor shall arrange for inspection and testing of the installation. Test results obtained shall be recorded. The installation shall not be accepted until it complies with the requirement of these Specifications. The installation shall be got inspected by the contractor from local licensee and/or CEA and their clearance taken before energizing the installation. All the observations/ deficiencies pointed out by the inspecting authorities shall be complied with by the contractor on priority. The final payment shall be released only after the installation is accepted by the engineer in charge after it is approved by the CEA and its successful commissioning and taken over.

i) Date Of Acceptance.

The contractor shall operate the installation for a period of at least 3 days after it is energized. The date of taking over of the installation shall be reckoned after its trouble free operation during the running in period. If the installation is not able to operate or to commission due to the reasons beyond the control of the contractor, the taking over date shall be reckoned as date of approval of the installation by CEA. The guarantee period shall commence from the date of approval of CEA and commissioning the installation.

j) Methodology Of Procurement

All equipments/material shall be sourced from reputed manufacturers only. All equipment/ material offered shall be of reputed manufacturers only as per the list of approved make mentioned in the tender document and who have designed, manufactured,

completely tested for relevant Indian Standards and supplied the equipment/ material to various State Electricity Boards or other reputed utilities which are in trouble free services at least two different locations for a period of more than two (2) years or as mentioned in the tender as on the date of bid opening.

k) Quality Assurance, Inspection And Tests.

The Contractor shall offer proven and type tested equipment for the project. The type test Certificates shall be complete as per the relevant I.S., carried out by NABL, CPRI or any other statutory bodies responsible for testing of equipment and it shall not be older than 5 years.

If required, Sub-vendor's credentials, copies of valid BIS license, past supply& performance certificates as per requirement will also be required for sub-vender's approval, if not already approved for a specific item.

In case during post award detail engineering stage, if any equipment is found to be not type tested or partially type tested, as per I.S., the Contractor shall carry out complete type test for the items at his own cost.

The Contractor shall arrange all type, routine and acceptance tests at manufacturer's works as per approved Material Quality Programme with CoPT's officer. **Any expenditure in connection with deputing CoPT's representative to the manufacturer's work site will be borne by Copt.** The Contractor shall arrange the inspection program in consultation with engineer-in-charge to give sufficient advance intimation of the manufacturing and testing schedules to facilitate timely inspection of the equipments by CoPT. Fake inspection call will attract penalty as per the discretion of the employer. The Contractor shall provide one set of tests reports to Employer on successful completion of the tests.

5) Technical Specifications

a. **General Technical Specifications - Supply Of Materials**

All materials required to complete the work as per given specifications & drawings etc, must be manufactured and supplied using fresh raw materials. Re-moulded, re-circulated materials are not acceptable. The procurement of materials must be made directly from manufacturer or through authorized dealer / distributors. Documentary evidences to this effect are to be made available to the engineer-in-charge for necessary checks / verification of source of supply of materials. Second hand materials / partial used materials / used materials would not be acceptable. The offer should be as per Technical Specification without any deviation. But any deviation felt necessary to improve performance, efficiency and utility of equipment must be mentioned in the Deviation Schedule with reasons duly supported by documentary evidences during pre bid meeting. Such deviations suggested may or may not be accepted by the employer. Any deviations projected after the pre bid meeting shall not be entertained at any cost.

b. **General Technical Specification - Installation Of Equipments**

(i) Scope

This specification covers the engineering requirements for erection/installation, testing and commissioning of equipment/items and its associated works.

(ii) Standards

Erection, testing and commissioning of the equipments covered shall be done as per standard codes of practice and shall comply with requirements of following Indian Standards and other relevant standards, Indian Electricity Rules and acts and also to the regulations that are in force at the place of installation.

IS: 1255	:	Code of practice for installation and maintenance of power cables upto and including 33 kV rating.
IS : 5216	:	Guide for safety procedures and practices in Electrical work.

IS 100118	:	Code of practice for selection, installation and maintenance for Switchgear and control gear-Part-III Installation.
IS : 13408	:	Code of practice for the selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres (other than mining application of explosives processing and manufacture).
IS: 3043/87	:	Code of practice for installation and maintenance of earthing of installation.

(iii) Reference

Following documents shall be read in conjunction with this specification

(i) Scope of work and special requirements
(ii) Schedule of items of work
(iii) Engineering Specification and Data sheet of General requirements of Electrical system.

c. General Conditions For Installation Of Equipments

(i) The erection/installation, testing and commissioning shall be carried out in accordance with specification, data sheets, drawings, manufacturer's recommendations, and relevant standards or as directed by owner/Engineer-In-Charge. Requirements regarding erection/installation, testing and commissioning of switchboards, cables, etc, are generally explained here in. It is the responsibility of the contractor to supply all equipment, items, accessories, materials, tools, tackles, transporting, and lifting vehicles, consumables etc. required for unpacking, checking, transportation, storage, safe custody, installation, erection, testing, commissioning, return of unused equipment/items which are supplied from owner's stores and handing over of the installation to the entire satisfaction of owner.

(ii) The erection scope shall include supply of all hardwares and accessories such as bolts, nuts, washers, gaskets, cable termination accessories, lugs, paint, primer, sand etc. required for completeness of the work. All consumable materials such as insulation, tape, cleaning and paint brushes, welding electrodes, rust preventive materials, jute, cotton waste, hack saw blades, bolts, nuts, inhibitive grease, fuel, lubricants, etc, and any other material required in carrying out the work but not for incorporation in to the permanent work, shall also be included in the scope of contractor.

(iii) The equipment/items to be erected shall be handled with care by experienced workers under the guidance of the competent supervisor. Proper handling and transporting equipments are to be used and dragging is to be avoided.

(iv) The equipment/items supplied by the owner, shall normally be kept at their stores. The contractor shall inspect these items at the stores by unpacking the containers, if necessary. Responsibility of safe custody of materials after delivery and till handing over shall rest with the contractor. Unused materials and containers shall be returned to the stores. The items supplied by the owner shall be transported from the point of storage to the point of erection / installation using proper capacity transporting vehicles. The scope shall include unpacking the containers, assembling parts, fixing loose items, components, etc. Materials supplied by the contractor or issued by the owner shall be given suitable protection against weather, dust and vermin. In storage places, equipments shall be placed over wooden sleepers to keep them above ground. Before carrying out erection/installation works of any item, proper care regarding leveling, alignment, access to working parts, facilities for removing the items for repair, statutory clearance, etc. shall be taken.

(v) Foundation bolts, nuts, lock nuts, washers, etc. will normally be supplied by the equipment supplier. Any further requirement of these items shall be under the scope of contractor. The equipment shall be installed on the foundation bolts firmly such that there will not be any vibration during operations. For mounting of equipment/items on the walls/ columns / supports, suitable MS/GI brackets shall be fixed / grouted.

(vi) Electrical connections shall be done with great care using spring washers, bimetallic strips, conducting grease, etc. wherever required to ensure good contact without creating undue stresses. Copper bus bar joints shall be made after tinning the contact area. Supply of all required accessories or electrical connections shall be included in the contractor's scope. Discrepancies if any found between drawings/statutory requirements and actual conditions at the site, shall be immediately brought to the attention of owners representative. If any modification is found required in the writing or to suit site condition the same shall be carried out as per the instruction of the Engineer-In-Charge without any extra cost.

(vii) All equipments under erection shall be kept properly cleaned and free of dust, vermin, moisture, etc. After erection, it shall be ensure that non-foreign materials, tools or tackles are left in the equipment. All unused cable entries, cutouts, etc. shall be sealed properly. For hazardous area, blanking plugs suitable for the area classification applicable shall be used.

(viii) All tests shall be carried out in the presence of owner's representative and test shall be recorded on an approved proforma duly certified. The records of all tests shall be submitted to the purchaser's representatives. All interconnected wiring shall be checked thoroughly for correct connection with the wiring and schematic drawings of the manufacturer and the drawings supplied by owner before energizing.

(ix) All power and bus bar connection shall also be thoroughly inspected and checked for connections, foreign materials, tightness, etc. before energizing the equipment. All components within the main equipment shall be tested for proper performance and correct operation before commissioning the equipment.

(x) All labeling shall be checked for correctness. All nuts, bolts, clamps, joints, connections, etc. shall be checked for tightness and tightened wherever required. All moving parts shall be checked for its correct movement and proper lubrication. Apply lubrication wherever required. All equipment containing liquid shall be checked for correct quantity filling and all gaskets, walls, etc, shall be checked for leak proof. Oil filling, if found required, shall be done with dry and clean oil. Gaskets shall be replaced if found required. It shall be ensured that all CT leads are loaded or shorted prior to testing and commissioning. Insulation tests shall be carried on all electrical devices, whether specifically mentioned or not, as per this work after properly cleaning these devices.

(xi) All the relays and its settings after commissioning shall be furnished to owner detailing relay type number, panel number etc. In case of any component of an equipment supplied by the owner is found to faulty/ unsuitable, the same shall be replaced by the new one issued by owner. All relays, before installation, the rating, range and auxiliary supply voltages for the relay should be checked against drawings/ schematic/ schedule.

d. Civil and structural works

(i) Miscellaneous civil works associated with the erection/installation such as excavation, dewatering and refilling of earth work for earth pits and cable trench, chipping, grouting, small cutting, etc. on floors/ walls/ columns / structures and bringing back the same to original finish, grouting of supports, providing suitable fixing arrangements for cables, push button stations, DBs etc. shall be included in the rates quoted for erection of the respective items, unless specifically excluded in the "Schedule of Items of Work". All structural works associated with cabling, earthing, equipment erection and supporting arrangements shall be included in the scope of the contractor. All the welding and cutting works shall be carried out by certified welders. Painting shall be done on all MS materials provided, by the contractor such as base channels, frames, supports, pedestals, cable trays/racks/risers, enclosures, boxes, conduits, chequered plates etc. Before painting, the surface should be thoroughly scraped and cleaned to remove dust, grease, plaster or any other foreign materials. It is the responsibility of the contractor to supply and install all the required materials for painting including paint. Cement concrete footing shall be provided

for, cable trays/racks/risers, pedestals, supports, etc. Footing shall be provided using 1:2:4 PCC with 20mm broken stone. It is responsibility of the contractor to supply and install all materials such as river sand, reinforcement rods, 20mm broken stone, etc. without any extra cost to owner. All concrete works and grouting shall be cured for a minimum period of 48 hours.

(ii) Chipping, grouting, etc as recommended shall be done for completion and installation work on the finished floor, wall, roof, etc. It is the responsibility of the contractor to supply all necessary materials and to bring the disturbed surface to the original finish. Touch painting of scratches found on equipment, other painted metallic surfaces, galvanized etc. associated with this work is also included in the scope of contractor without any extra cost. Base steel structures shall be painted with 2 coats of epoxy primer and 2 coats of epoxy paint.

(iii)Standard requirements for testing and commissioning

a) The standard requirements for testing and commissioning are furnished below.

b) All tests shall be carried out in the presence of Owner's representative and tests shall be recorded on an approved format duly certified. The records of all tests shall be submitted to the purchaser’s representative.

c) All interconnected wiring shall be checked thoroughly for correct connections with the wiring and schematic drawings of the manufacturer before energizing. All Power and bus bar connections shall also be thoroughly inspected and checked for correctness, foreign materials, tightness, etc. before energising the equipment.

d) All components within the main equipment shall be tested for proper performance and correct operation before commissioning the equipment. All labeling and nameplates shall be checked for correctness. All nuts, bolts, clamps, joints, connections, etc shall be checked for tightness and tightened wherever required. All moving parts shall be checked for its correct movement and proper lubrication. Apply lubrication wherever required. All equipment containing liquid shall be checked for correct quantity filling and all gaskets, valves, etc. shall be checked for leak proofness. Oil filling if found required shall be done with dry & clean oil. Gaskets shall be replaced if found required. The condition of oil shall be tested in accordance with IS-335.

3. TECHNICAL SPECIFICATION FOR SUPPLY & INSTALLATION OF ITEMS

1) The HVSC System consists of the hardware components in the Shore Side as Follows:

A. Main Power System in 110 KV Main Receiving Station

a) Bay Extension in the existing 11kV HT switchgear at the 110kV Receiving station.
b) Installation of Circuit breakers and associated cabling in HT.
c) Metering, Monitoring & Protection system and associated Cabling in LT.

B. Cabling from 110 KV Main Receiving Station to the proposed Substation near International Cruise Terminal with 3 runs of 11 KV HT Cables.

C. Shore Supply Distribution System:

a) Construction of Substation near International Cruise Terminal
b) Installation of Ring Main Units, H.V Circuit breakers, distribution system etc..
c) Civil work relative at the New Substation, Existing Substation and Cable duct routing.

D. High Voltage Shore Connection System

a) Installation of Power Transformers.
b) The Power Convertors
c) Shore- Side Protection Relaying
d) Shore-side circuit-breaker and earth switch
e) Control system of shore connection
f) Shore-to-ship connection and interface equipment
g) Communication equipments

E. Substation equipments and others

a) Installation of No. 1 (one) 24VDC Battery Charger and Distribution board;
b) Installation of No. 1 (one) 24VDC Battery Bank with Cabinet;
c) Installation of No. 1 (one) Transformer 11/.433, 50hz for Substation use
d) Installation of No. 1 (one) LV Distribution Board for Building services;

F. Fire & Safety equipments

2) System Description and scope of work:

1. The complete system shall include the following:-

a) Main Power System in 110 KV Main Receiving Station

Bay Extension in the existing 11kV HT Panels at the 110kV Receiving station, Installation of 3 nos. of Circuit breaker Panels and associated cabling in HT including Metering, Monitoring & Protection system integrated to the existing panels and associated Cabling in LT auxiliary and control power supply.

b) Cabling from 110 KV Main Receiving Station to the proposed Substation

SITC of the following:

(i) 4.5kM length of Cabling through open trench/ HDPE Pipe etc. from 110KV Main Receiving Station to the proposed Substation near International Cruise Terminal with 3 runs of 3 x 400 sq.mm 11 KV grade (E)XLPE UG Cables.

(ii) Jointing &Terminations at both ends of each cable

c) Power Supply Distribution System:

Design and provide Power Supply Distribution System consisting of the following items:

(a) Construction of Substation near International Cruise Terminal including all civil works involved.

(ii) Installation of Ring Main Units, H.V Circuit breakers VCB's, transformers, distribution system, earthing etc.. as per IEC 61936-1 etc., VCB panels shall be installed as per the contract requirement.

(iii) Providing necessary battery backup for the station control system and LT works etc. for the functioning of the system.

d) High Voltage Shore Connection System in accordance with the Standard IEC/IEEE 80005, the General requirements IEC/IEEE 80005-1 *'Utility connections in port – Part 1: High voltage shore connection (HVSC) systems'*. Design and Provide High Voltage Shore Connection System to provide Shore connections to the vessels in 11 KV and 6.6 KV Voltage levels in both 50 Hz & 60 Hz frequencies as per the standard IEC/ISO/IEEE 80005-1consists of the following items:

(i) Installation of HT/LT switchgears.
(ii) Installation of Power Transformers with OLTC.
(iii) The Static Power Convertors (Frequency converter).
(iv) Shore- Side Protection Relaying.
(v) Shore-side circuit-breaker and earth switch.
(vi) Control system of shore connection.
(vii) Shore-to-ship connection and interface equipment including Cable Management System and Connectors.
(viii) Communication equipments.
(ix) Providing shore power connection in 440V System both in 50 Hz & 60 Hz frequencies with capacity of 1 MVA
(x) The Data Communication between shore power system and ship shall be in accordance with IEC/IEEE 80005-2.
(xi) SCADA system at the proposed substation connecting shore power substation equipments, shore power system and onboard power equipments for monitoring and control.

A. Main Power System in 110 KV Main Receiving Station

(Main Power System in 110 KV Main Receiving Station

Main 110kV receiving station has 2nos. of Power Transformers of 110kV/11kV, each of 12MVA capacity, feeding to 11kV substation separated with coupler.

- Bay Extension in the existing 11kV HT switchgear at the 110kV Receiving station

i) On one side of coupler required bay extension to facilitate 2nos. of breaker units and on the other side required bay extension to facilitate one no. of breaker.
(ii) Installation of 3nos. of HT 11kV Circuit breakers in the extended bays and associated cabling/ trunking, earthing etc..
(iii) Metering, Monitoring & Protection system and associated Cabling.

B. H.T. Cabling from 110 KV Main Receiving Station

The brief scope of work is as shown below:.

a) Supply, laying, testing and commissioning of 3 Runs of approximately 4.5 Km of 3C x 400 sq.mm, 11KV XLPE cable from 110 KV Main Receiving Station of CoPA to the proposed substation at Ernakulam Wharf by open trench/HDD/through HDPE pipes by clamping/ fixing with GI post supports in the ground, inside the road kerb areas/ through HDPE/ GI pipes below the surface.

b) Supply and providing end termination for HT cables.

c) **Civil works**

Scope of civil works including covered housing for placing the equipments at near the jetty area for the shore supply systems. The Contractor shall design the foundation for the equipments, housing for equipments to prevent the equipments from weather conditions, anti rusting roofing with steel structures, providing Epoxy painting etc. The housing/room shall withstand the weather conditions such as wind speed etc. and same to be designed accordingly to the location. Design for the civil works shall be get approved by the CoPA civil department and TPIA. UPVC door and frames are preferred for the works.

1) **XLPE 11KV GRADE CABLE**

1.1Application

The 11 KV cable is intended for use on Distribution network, outdoor application for flexibility with connected to RMU and switchgear.

1.2 Codes & standards

All standards, specifications and codes of practice referred to herein 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 those (IS: codes, standards, etc.) referred to herein, the former shall prevail. All the cables shall conform to the requirements of the following standards and codes:

IS: 7089(Part-II) Specification for Cross linked polyethylene insulated PVC sheathed cable :For working voltages from 3.3 KV upto and including 33 KV

IS:3975	Low Carbon Galvanized steel wires, formed wires & tapes for armouring of cable
IS:4905	Methods for random sampling.
IS:5831	PVC insulation and sheath of electrical cables.
IS:8130	Conductors for insulated electrical cables and flexible cords.
IS:10418	Specification for drums for electric cables.
IS:10810	Methods of tests for cables.
IS:1255	Code of Practice for installation and Maintenance of power cable up to an Edition 3.1including 33 KV Rating.
ASTM-D-2843	Standard test method for density of smoke from the burning or decomposition of plastics.
IEC-754(Part-1)	Tests on gases evolved during combustion of electric cables.
IEC-332	Test on electric cables under fire conditions. Part-3: Tests on bunched wires or cables (Category-B).

1.3 Technical requirements

The cables shall be suitable for laying on racks, in ducts, trenches, conduits and underground (buried) installation with chances of flooding by water. Cables shall be designed to withstand all mechanical, electrical and thermal stresses developed under steady state and transient operating conditions as specified elsewhere in this specification. XLPE insulation shall be suitable for continuous conductor temperature of 90 deg. C and short circuit conductor temperature of 250 deg C. The aluminium used for armouring shall be of H4 grade as per IS: 8130 with maximum resistivity of 0.028264 ohm-sq.mm / mtr at 20 deg. C. The gap between armour wires / formed wires shall not exceed one armour wire / formed wire space and there shall be no cross over / over-riding of armour wires / formed wires. The minimum area of coverage of armouring shall be 90%. The breaking load of armour joint shall not be less than 95% of that of armour wire / formed wire. Zinc rich paint shall be applied on armour joint surface of GS wires / formed wires. Outer sheath shall be of PVC black in colour. In addition to meeting all the requirements of Indian standards referred to, outer sheath of all the cables shall have the following FRLS properties:

a) Oxygen index of min. 29 (Test method as per IS 10810 Part-58)
b) Acid gas emission of max. 20% as per IEC – 754(Part-I)
c) Smoke density rating shall not be more than 60% during Smoke Density Test as per ASTMD-2843.

Cores of three core cables shall be identified by colouring of insulation or by providing coloured tapes helically over the cores, with Red, Yellow & Blue colours. In addition to manufacturer's identification on cables as per IS, following marking shall also be provided over outer sheath:

a) Cable size and voltage grade-To be embossed

b) Word ‘FRLS’ at every 5 meter To be embossed
c) Sequential marking of length of the cable in meters at every one meter To be embossed / printed

The embossing / printing shall be progressive, automatic, in line and marking shall be legible. Allowable tolerances on the overall diameter of the cables shall be +/-2 mm maximum over the declared value in the technical data sheets. In plant repairs to the cables shall not be accepted. Pimples, fish eye, blow holes etc. are not acceptable. The cross-sectional area of the metallic screen strip/tape/wires shall be considered in sizing calculations.

The technical specification of the cable shall satisfy the IS for 11 KV grade 3C x 400 sqmm (E) XLPE Aluminium cable only.

1.4 Constructional features

Cables shall conform to IS 7098 Part-II. These cables shall be multi-stranded, compacted Aluminium conductor, XLPE-insulated, metallic screened suitable for carrying the system earth fault current. The conductor screen and insulation screen shall both be of extruded semiconducting compound and shall be applied along with the XLPE insulation in a single operation of triple extrusion process so as to obtain continuously smooth interfaces. Method of curing for 11 KV Cables shall be “dry curing/ gas curing” For the single core armoured cables; the armouring shall constitute the metallic part of the screening.

1.5 Tests

1.5.1 Type Tests

All Types and sizes of cables being supplied shall be subjected to type tests, routine tests and acceptance tests as specified below and according to relevant standards.

Type Test	**Remarks/Standards Code**
Conductor resistance test	
For Armour Wires/Formed Wires	As per IS 8130 (cl:63)
Measurement of Dimensions	
Tensile Test	
Elongation test	
Torsion test	For round wires only
Wrapping test	
Resistance test	
Mass & uniformity of Zinc	
Coating tests	For GS wires/formed wires only
Adhesion test	For GS wires/formed wires only
Test for thickness	For XLPE insulation & PVC Sheath
Tensile strength and elongation Test	before ageing and after ageing in air oven
Loss of mass test	For PVC Outer sheath only.
Hot deformation test	For PVC Outer sheath only.
Heat shock test	For PVC Outer sheath only.
Shrinkage test	
Thermal stability test	For PVC Outer sheath only.
Hot set test	For XLPE Outer sheath only.
Water absorption test	For XLPE Outer sheath only.
Oxygen index test	For PVC Outer sheath only.
Smoke density test	For PV C Outer sheath only.

Acid gas generation test	For PV C Outer sheath only.
Flammability test as perIEC-332 Part-3 (Category-B)	For completed cable only.

The following type tests shall be carried out on the cable:

Insulation resistance test (Volume Resistivity method)
High Voltage test
Partial discharge test
Bending test
Dielectric power factor test
As a function of voltage
As a function of temperature
Heating cycle test
Impulse withstand test
High voltage test
Partial discharge test
Acceptance Tests

1.5.2 Acceptance tests

Following acceptance tests shall be carried out for each type and size of the cables on the cable drums selected at random as per sampling plan mentioned in is: 7098 part 1

a) For Conductor

Tensile Test
Wrapping Test
Resistance Test
For Armour Wires/Formed Wires (If applicable)
Measurement of Dimensions
Tensile Tests
Elongation Test
Torsion Test — For Round wires only
Wrapping Test
Resistance Test
Mass of Zinc coating test — For G S wires/Formed wires only
Uniformity of Zinc coating — For G S wires/Formed wires only
Adhesion test — For G S wires/Formed wires only
Freedom from defects

b) For XLPE Insulation & PVC Sheath

Test for thickness
Tensile strength & Elongation before ageing
Hot set test (For XLPE insulation)

c) **For completed cables**

Insulation resistance test (Volume resistivity method)
High Voltage test
Partial discharge test(for 6.35/11 KV grade of above rating of cables).

Test certificates for the cable shall be submitted during delivery of the cable

2) **HT, 11 KV CABLE END TERMINATION & STRAIGHT THROUGH JOINT KITS**

2.1 Scope

This specification provides for delivery of 11 KV grade outdoor type End termination, open joint & straight through joint kits suitable for installation in 50Hz 11KV distribution system.

All the materials required for doing over head open joints shall be supplied by the Contractor.

2.2 Application

The 11 KV cable end termination & straight through joint kits are intended for use on Distribution net work, outdoor application for terminating / jointing the 11 KV grade Cables for better distribution network.

2.3 Codes & Standards

All standards, specifications and codes of practice referred to herein 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 those (IS: codes, standards, etc.) referred to herein, the former shall prevail. All the cable end terminations & straight through joint kits shall conform to the requirements of the following standards and codes:

2.4 Technical requirements

a) The Kits are to be used for 11KV XLPE type Power Cables.
b) The Kits to be supplied must have manufactured as per latest IS and the reference there of be given with the offer.
c) The literature for the cable jointing kits are to be used by the contractor must be supplied along with delivery of materials.
d) The Kits shall be suitable for storage without deterioration at a temperature up to 45 0 C and unlimited self life.
e) The contractor shall offer one year warranty after commissioning against defective design and for material / terminations and joints and for bad workmanship etc.
f) For carrying out all the joint of the kit tenderer has to depute his representative with man and material without any extra charges.
g) The cable termination shall be class-I termination as defined in IEEE standard 48-1975.
h) The termination kits shall be tested as per IS-13573 with latest amendment from I & II. The test reports are to be submitted.
i) The kits offered should have satisfactory working performance in Indian atmospheric condition.

2.5 General requirements of joints and terminations

The installed joints and terminations must provide the following:

a) Complete external leakage insulation between the high voltage conductor and earth potential using anti-track heat shrink material.
b) Electrical stress control using semi-conducting heat shrinkable tubing over the cores and by the insertion of high di-electric strength insulating material into the crutch of the termination such that electrical discharge activity does not occur in the termination after it has been energised at its rated voltage.
c) Hermetic sealing of the interfaces between heat shrinkable materials and cable surfaces, bushings or cable lugs by use of track resistant hot melt adhesive which can accommodate the creep and relaxations that may occur with recovered heat shrink materials. This sealant shall be pre-coated inside the heat shrinkable components and activated by the heat applied to shrink the components which shall be in excess of 125 Deg.C.
d) Uniform adhesive flow from the adhered heat shrink component into the adjoining surfaces will be used as an indicator that shrinking is complete, and therefore, the adhesive must be suitable for this purpose.

e) Outdoor terminations shall incorporate a design feature to prevent flexing of the terminated cores under short circuit conditions.
f) Joints and terminations must be insensitive to cable manufacturers tolerances allowed under BSS 6480-1969.
g) The length of core insulation required is 450 mm per phase.
h) Copper braid should be provided to connect the metal shield of XLPE cable and to make electrical contact with the outer screen of the joint for transition joints.

3) **HDPE (HIGH DENSITY POLYETHYLENE) PIPE**

HDPE pipe shall be provided for laying the HT cable at road crossing/hard surfaces.The HDPE pipes shall be 110 mm. dia: with thickness of not less than 5 mm. The HDPE pipe shall be made from high-density polyethylene (HDPE) resins meeting the following requirements:

The HDPE material supplied under this specification shall be high density, high molecular weight conforming to relevant IEC/BIS. The HDPE material shall conform to IS 14930/IS 4984/ASTM D 3350. Suitable size PVC flexible pipe with collar shall be provided for the end portion of HDPE pipe.

4) **LAYING OF CABLE THROUGH TRENCHES**

4.1 Excavation of Trenches

HT cable shall be laid along the open trench/ pipes/ the excavated trench/clamping through cable tray etc. as per IS. Necessary material such as brick/ loose earth /concrete slab, fastening materials etc., if required, shall also be supplied by the contractor.
Contractor shall construct the cable trenches required for directly buried cables. The scope of work for construction of cable trenches shall include excavation, preparation of loose earth bedding, loose earth cover, supply and installation of brick or concrete protective covers, back filling and reaming, supply and installation of route markers and joint markers. The bidder shall ascertain the soil parameters prevailing at site, before quoting the unit rates. The trenches after that shall be excavated manually/by using JCB and utmost care shall be taken while excavating the trenches. The trenches shall be excavated with 50 cm width and 100 cm depth from the ground level. The trenches shall be resurfaced and provide the compaction after laying the cable.

4.2 Installation of cables

Cable drums shall be checked for any damage in transit. Insulation test of the cable shall be carried out between phases and phase to earth before unwinding the drum.
Cables shall be laid direct in ground, masonry trench, pipes/closed ducts, open ducts or on racks as per requirement. When the cable has been properly straightened, the cores are tested for continuity and insulation resistance and the cable is then measured. In case of PVC cables, suitable moisture seal tape shall be used for this purpose.

4.3 Loose soil / earth cushion

When the cable has been properly straightened the trench shall be covered with 100 mm thick layer of good quality clean loose earth, then the cables shall be lifted and placed over this loose soil / earth cushion. Again, another layer of good quality clean loose earth 100mm thick should be laid and gently pulled on to the top of the cable to form a depth of 100mm from the top of the cable. The minimum envelop cushion around the cable shall not be less than 200 mm. Sufficient loose soil / earth shall be supplied by the contractor.
The cables shall be protected by precast plain RCC slab of size 20 cm x 50 cm. x 5 cm. (W x L x T) with Fe steel rods, The protection slabs placed on top of the loose earth shall be laid breadth wise for the full length of the cable. This protective covering shall cover all the

cables and project at least 50 mm over the sides of end cables. The trenches shall be then backfilled with excavated earth free from stone or other debris and shall be rammed, watered if necessary, in successive layers, unless otherwise specified a crown of earth shall be formed to allow for subsidence.

Where road or lawns are cut or curb stone displaced, these shall be made good, and all excess earth removed from site.

4.4 LAYING OF CABLE THROUGH HDPE PIPE

For road, entry into buildings and paved areas cables shall be drawn through HDPE pipes. Pipe shall be of 110 mm dia. and wall thickness not less than 5mm . Top of pipe shall be not less than 750 mm from the top surface... All pipes shall be provided with a fish wire. Where cables have been drawn the ends shall be plugged with bituminized tape over the cables for water proofing. For longer distances and at bends draw-pits of adequate size shall be provided to facilitate drawing in of cable, if necessary. The HDPE pipes shall be joined together, if necessary with PVC/ HDPE coupling or through the Butt joint. Supply of the jointing material shall also be borne by the contractor. Laying of cables shall be carried out by skilled and experienced labourers using adequate rollers to minimize stretching of the cable/external damage to cables. Cables shall not be bent below the minimum permissible limit. The permissible limits are as follows :

Type of cable & voltage grade	Minimum bending radius
Power cable	12 D
Control cables	10 D

Where D is overall diameter of cable.

In each cable run some extra length shall be kept at a suitable point to enable one (for LT Cables) or two (for H.T cables) straight through joints to be made, should the cable develop fault at a later date. Metal screen and armour of the cable shall be bonded to the earthing system of the station on the receiving and the sending end. The erection work shall be carried out in a neat workman like manner and the areas of work shall be cleaned of all scrap materials, etc. after the completion of work in each area every day. In case the outer sheath of a cable is damaged during handling/installation, the Contractor shall repair it at his own cost, and to the satisfaction of the Engineer-in-Charge. In case any other part of a cable is damaged, the same shall be replaced by a healthy cable, at no extra cost i.e. the Contractor shall not be paid for installation and removal of the damaged cable. All cable terminations shall be appropriately tightened to ensure secure and reliable connections. The Contractor shall cover the exposed part of all cable lugs with insulating tape, sleeve or paint.

4.5 DRAWING OF CABLE BY HDD

Cable shall be drawn through road crossings / hard surfaced areas by horizontal direct drilling at a minimum depth of not less than 3 m except at both ends. The length of the route for providing HDD shall be minimum possible and shall be finalized after the approval of Engineer in charge.

HDD shall be done with 110 mm HDPE pipe having thickness of not less than 5 mm.

4.5.1 Method of drilling

The pipe shall be pulled through the borehole of sufficient depth & size after successfully reaming the borehole. Once pull back operations have commenced, the operation must continue without interruption until the pipe is completely pulled through the reamed hole.

The Contractor shall take all care and necessary precautions to protect existing structures, utilities and services in planning and execution of the Works for which the contractor shall carry out proper sounding before starting the HDD work. Any damage to adjacent

properties that are not part of this work shall be repaired and restored to its original condition at the Contractor's expense. The Contractor shall be responsible for the identification and protection of services where these are crossed by construction activities. Where crossing of roadways and railways are involved, the Contractor shall be required to record and report any ground settlement to the satisfaction of the controlling agencies. Where utilities and pipelines are involved the Contractor shall monitor ground settlement or heave directly above and 3 m before and after the utility or pipeline intersection. The Contractor shall cease operations when monitoring points indicate any surface disruption. Necessary clearances from the concerned authority shall be obtained by the contractor.

4.5.2 Precautions to be taken

All necessary measures must be taken to ensure that excavations are left in a safe condition, including the erection of suitable hard barricades, warning signs and hazard lights. The earthworks shall be set out in accordance with the design drawings. All excavations shall be made to the depth and extent as shown on the Drawings with proper allowance for fill, additional cover (where required) and formwork. The excavations shall be kept free and clear of loose materials, water and rubbish. After satisfactory completing, excavated materials for the HDD operations shall be removed, the Contractor shall prepare the bottom of all pits to the same specification as required for the pipe foundation. The Contractor shall ensure that the terminal sections of pipe that are joined are connected with Central Plastics Electrofusion Couplings or connectors with tensile strength equivalent to that of the pipe being joined.

4.5.3 Safety

The Contractor shall undertake works in accordance with appropriate safety requirements by local & state regulations. Safety measures shall include, but not be limited to, personal protective equipments, operating of machinery within job site, and storage and transportation of materials and equipments.

After the HDD work, the HT cable shall be drawn through the pipe as per the schedule. Due Care shall be taken not to damage the cable while drawing.

4.5.4 Cable tags and marker

Each cable and conduit run shall be tagged with numbers that appear in the cable and conduit schedule. The tag shall be of aluminum 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. Alternately, the contractor may provide cable tags made up of nylon, cable marking ties of 'TY-CAB' or equivalent type with cable number heat stamped on the cable tags. Location of cables laid directly underground shall be clearly indicated with cable marker made of galvanized iron plate. Location of underground cable joints shall be indicated with cable marker with an additional inscription "Cable joint". The marker shall project 150mm above ground and shall be spaced at an interval 100 meters and at every change in direction. They shall be located on both sides of road and drain crossings. 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. Cable tags shall be provided inside the switchgear, motor control centers, control and relay panels etc., wherever required for cable identification, such as where a number of cables enter together through a gland plate. The price of cable tags and markers shall be included in the installation rates for cables /conduits quoted by the Contractor. Specific requirements for cabling, wiring ferrules as covered in respective equipment section shall also be complied with.

4.6 CABLE ROUTE MARKER

(a) Route markers shall be provided along the runs of cables at locations approved by the

Engineer in charge and generally at interval as suggested by Engineer in Charge. Markers shall also be provided to identify change in the direction of the cable route and at locations of underground joints. Route markers shall be fixed firmly with cement concrete.

(b) Route identifiers shall be made out of RCC in 1:2:4 (cement: 2coarse sand: 4graded stone aggregate of 20mm in size) of size 75 cm x 30 cm x 10 cm shall be laid and centered over the cable. The concrete markers, shall project over the surrounding surface so as to make the cable route easily identifiable. The reinforcement shall be with Fe rod.

(c) The words **'CoPA 11 KV CABLE/2023"** as the case may be, shall be engraved / inscribed on the marker.

C. Shore Supply Distribution System

Typical distribution systems inside the proposed substation at Ernakulam wharf, where power is received from the 110kV main receiving station through 3nos. of power cables as specified in item (B) above. The distribution system includes breakers, isolator switches, power interconnections, earth switches etc. as per the requirement of the standard IEC 61936-1.
(Details to be furnished as per the design by the bidder).
The soil bearing capacity (SBC) of the Berth wherein HVSC substation is proposed to be built may be considered as 5.0Ton/SqMtr.
Civil drawing of Ernakulam Wharf Q8 and Q9 Wharf diagram is uploaded to show the Cable Trench available in this area.

D. HV Shore Connection System

The High Voltage Shore Power System Shall be in accordance with the Standard IEC/IEEE 80005. The General requirements are as per IEC/IEEE 80005-1 *'Utility connections in port – Part 1: High voltage shore connection (HVSC) systems'*, describes high-voltage shore connection (HVSC) systems, onboard the ship and on shore, to supply the ship with electrical power from shore. The Standard is applicable to the design, installation and testing of HVSC systems and addresses the following aspects:

- HV shore distribution systems,
- Shore-to-ship connection and interface equipment,
- Transformers/reactors,
- Semiconductor frequency convertors,
- Ship distribution systems, and
- Control, monitoring, interlocking and power management systems.

The typical HVSC System as per the standard IEC/IEEE 80005-1 is described in the Block Diagram attached as **Figure 1**, consisting of the following components:

a. Shore Side Components

i. Shore supply system
ii. Shore-side transformer
iii. Shore-side protection relaying
iv. Shore-side circuit-breaker and earth switch
v. Control shore
vi. Shore-to-ship connection and interface equipment

b. Ship Side Components

i. Control ship
ii. On-board protection relaying
iii. On-board shore connection switchboard
iv.On-board transformer (where applicable)
v. On-board receiving switchboard

The General System Diagram is attached as **Figure -2**.
The Functional Diagram of Cruise Ship HVSC System is attached as **Figure –3**

D.1 Design requirements

i. General

Protection and safety systems shall be designed based on the fail-safe principle, hard wired. Suitable warning notices shall be provided at locations along connection-equipment routes, including connection locations.

Effective means shall be provided to prevent accumulation of moisture and condensation, even if equipment is idle for appreciable periods.

Equipment shall be suitable for the environment conditions in the space(s) where it is expected to operate. Ship equipment shall comply with the applicable requirements of IEC 60092-101 and IEC 60092-503.

HVSC equipment shall be installed in access-controlled spaces.

Personnel safety measures, such as physical barriers to prevent unauthorized personnel from accessing the HVSC equipment or the cable management equipment.

When determining the connection point of the HVSC system, all tidal conditions and ship operations affecting the ship's free board shall be considered.

ii. System study and calculations

The shore-connected electrical system shall be evaluated. The system study and calculations shall determine the following:

a) The electrical load during shore connection;

b) The short circuit current calculations as per IEC 61363-1 shall be performed in order to take into account the prospective contribution of the shore supply and the ship's installations. The short circuit current rating is 25 KA as per COPA level and contractor shall design as per IEEE 80005-1-2-3 standards for HVSC.

The following ratings shall be defined and used in these calculations:

1) For shore supply installations, a maximum and minimum prospective short-circuit current for visiting ships;
2) For ships, a maximum and minimum prospective short-circuit current for visited shore supply installations.

c) The calculations may take into account any arrangements that

1) Prevent parallel connection of HV shore supplies with ship sources of electrical power, and/or
2) Restrict the number of ship generators operating during parallel connection to transfer load, and
3) Restrict load to be connected.

d) System-charging (capacitive) current for shore and ship; this system-charging current calculation shall consider the shore power system and the expected ship power system including the on-line generator(s);

e) Shore power transformer neutral earthing resistor analysis;

f) Transient overvoltage protection analysis;

g) Fail-safe principle for cables/connectors operation.

These calculated values shall be used to select suitably rated shore connection equipment and to allow the selection and setting of protective devices so that successful discriminatory fault clearance is achieved for the largest on-board load while connected.

The system study shall be made available to all involved parties.

iii. Electrical requirements:

The HVSC system shall be rated for 6 MVA at nominal ship system voltages of 11 kV AC and/or 6.6 kV AC.

Consideration may be given to an HVSC system with a lower rating where only ships with lower power demands will be required to connect.

Measures shall be taken so that ships with power demands higher than the HVSC system rating

will reduce their power demand prior to connecting.

Designers may give consideration to rating connection equipment for 6.6 kV AC HVSC systems for 11 kV AC characteristics where inadvertent connection of the ship socket-outlet and connection switchboard to an 11 kV AC shore supply is considered to be reasonably foreseeable.

The prospective short-circuit contribution level from the HV shore distribution system shall be limited by the shore-sided system to 25 kA RMS.

The prospective short-circuit contribution level from the onboard running induction motors and the generators in operation shall be limited to a short-circuit current of 25 kA RMS.

iv. Emergency shutdown including emergency-stop facilities

Emergency shutdown facilities shall be provided. When activated, they will instantaneously open shore connection circuit-breakers onshore and onboard ship.

Fail-safe, hard-wired circuits (safety circuits) shall be used for emergency shut-down. This does not preclude emergency shut-down activation commands from programmable electronic equipment, for example programmable protection relays.

The relay contacts of the safety circuit shall be designed in accordance with IEC 60947-5-1and for a rated insulation voltage of Ui = 300 V, AC 5 A, DC 1 A.

Minimum current value in the safety circuits shall be 50 mA.

To address the potential hazard to personnel of access to high-voltage connection cables that have not been discharged, the high-voltage power connections shall be either

a) Automatically earthed so that they are safe to touch immediately following the isolation from ship and shore electrical power supplies, or
b) Arranged for manual earthing and routed and located such that personnel are prevented from access to live connection cables and live connection points by barriers and/or adequate distance(s) under normal operational conditions.

   Barriers and/or adequate distance(s) shall be satisfied with operational procedures established to
c) Restrict un-authorized access to HVSC spaces,
d) Control personnel access to HVSC spaces and areas when the HV connection is live;locking arrangements may be considered, and
e) Arrange for the safe discharge of HV conductors.

The emergency shutdown facilities shall be activated in the event of:

a) Loss of equi-potential bonding, via the equi-potential bond monitoring devices (where utilized)
b) Over tension on the flexible cable (mechanical stress)
c) Remaining cable length is too low
d) Loss of any safety circuit,
e) Activation of any manual emergency-stop,
f) Activation of protection relays provided to detect faults on the HV connection cable or Connectors, and
g) Disengaging of power plugs from socket-outlets while HV connections are live before the necessary degree of protection is no longer achieved.

Emergency-stop push buttons, activating emergency shutdown facilities, shall be provided at each of the following locations:

a) an attended onboard ship control station during HVSC;
b) In the vicinity of the socket-outlet;
c) At active cable management system control locations; and
d) At the shore side and ship circuit-breaker locations.

Additional emergency push buttons may also be provided at other locations, where considered necessary. The means of activation shall be visible and prominent, prevent inadvertent operation and require a manual action to reset.

Opening of safety loop shall cause the automatic opening of ship and shore HVSC circuit breakers in a maximum time of 200 ms.

An alarm to indicate activation of the emergency shutdown shall be provided to adviserelevant duty personnel when connected to HV shore supply.

For reliable operation of safety circuits, the pilot cable length and cross section shall be considered.

v. HV shore supply system requirements

i. Voltages and frequencies

HV shore connections shall be provided with a nominal voltage of 6.6 kV AC and/or 11 kV AC galvanically separated from the shore distribution system.

The operating frequencies (Hz) of the ship and shore electrical systems shall match by using frequency convertors.

At the connection point, looking at the socket-outlet/ship connector face, the phase sequence shall be L1-L2-L3 or A-B-C or R-S-T, counter clockwise. A phase sequence indicator shall indicate correct sequence prior to energizing or paralleling HVSC

ii. Quality of HV shore supply

The HV shore supply system shall have a documented voltage supply quality specification, which should be in line with IEC/IEEE standards. Electrical equipment of ships shall only be connected to shore supplies that will be able to maintain the distribution system voltage, frequency and total harmonic distortion characteristics given below. For compliance, the compatibility assessment referred to in the Standard shall include verification of the following:

a) Voltage and frequency tolerances (continuous):

1) The frequency shall not exceed the continuous tolerances ±5 % between no-load and nominal rating;
2) For no-load conditions, the voltage at the supply point shall not exceed a voltage increase of 6 % of nominal voltage;
3) For rated load conditions, the voltage at the supply point shall not exceed a voltage drop of −3.5 % of nominal voltage.

b) Voltage and frequency transients:

1) The response of the voltage and frequency at the shore connection when subjected to an appropriate range of step changes in load shall be defined and documented for each HV shore supply installation;
2) The maximum step change in load expected when connected to a HV shore supply shall be defined and documented for each ship. The part of the system subjected to the largest voltage dip or peak in the event of the maximum step load being connected or disconnected shall be identified;
3) comparison of 1) and 2) shall be done to verify that the voltage transients limits of voltage +20 % and −15 % and the frequency transients limits of ±10 % will not be exceeded.

c) Harmonic distortion: for no-load conditions, voltage harmonic distortion limits shall not exceed 3 % for single harmonics and 5 % for total harmonic distortion. Single Harmonic distortion limits above 25^{th} harmonics are indicated as per the graph diagram **(Figure 4).**

The above parameters shall be measured at the supply point.

The HV shore supply shall include appropriate rated surge arrestors to protect against fast transient overvoltage surges (e.g. spikes caused by lightning strikes or switching surges).

Different voltage and frequency tolerances may be imposed by the authorities responsible for the shore supply system and these shall be considered as part of the compatibility assessment to verify the effect on the connected ship load is acceptable.

Where the possible loading conditions of a ship when connected to a HV shore supply would result in a quality of the supply different from that specified in IEC 60092101: 1994/AMD1:1995, 2.8, due regard shall be given to the effect this may have on the performance of equipment.

Installation Requirements

General

Shore connection equipment and installations shall be in accordance with IEC 61936-1.

The rating of the HVSC system shall be adequate for the required electrical load as calculated as per the System study and calculations sl.no. D1(ii)above.

The shore-side electrical system shall ensure that each connected ship is galvanically isolated from other connected ships and consumers.

The use of HVSC system shall not compromise the electrical protection selectivity of the largest on-board load (as per the definition in IEC 60050-151:2001, 151-15-15) while connected.

D.2. System component requirements

i. Circuit-breaker, disconnector and earthing switch:

In order to have the installation isolated before it is earthed, the circuit-breaker, disconnector and earthing switch shall be interlocked in accordance with IEC 62271200.

The rated making capacity of the circuit breaker and the earthing switch shall not be less than the prospective peak value of the short-circuit current (**I**P) calculated in accordance with IEC 61363-1.

The rated short-circuit breaking capacity of the circuit-breaker shall not be less than the maximum prospective symmetrical short-circuit current (IAC (0.5T)) calculated in accordance with IEC 61363-1.

(*NOTE The short circuit contribution from the shore side can be calculated using IEC 60909*.)

An automatically operated circuit-breaker shall be provided.

ii. **Shore Side Transformer:**

In the event adjustments are required to maintain the HV supply voltage within tolerances under load, then these adjustments shall be automatically controlled as required in sl.no. V (ii) Quality of HV shore supply.

The shore side transformers shall be with input and output voltage ratings of 440 or 690Volts according to the 3 MVA SFC's input and output voltages.

Energy efficiency level shall be level 2 or as per latest IS standard.

Transformers shall be of the separate winding type for primary and secondary side. The transformer with Dyn type which shall have Delta connected primary winding, star connected secondary winding, with provision to connect to the neutral point.

The temperature of supply-transformer windings shall be monitored.

In the event of over-temperature, an alarm signal shall be transmitted to the ship using the data-communication link, if such data-communication link is installed. The alarm signal shall activate an alarm onboard to warn relevant duty personnel.

Short-circuit protection for each supply transformer shall be provided by circuit-breakers or fuses in the primary circuit and by a circuit breaker in the secondary. In addition, overload protection shall be provided for the primary and secondary circuit.

iii. **Neutral earthing resistor/** Neutral Grounding Resistance (NGR)

The shore-side transformer star point shall be earthed, through a neutral grounding resistance of 540 ohms, and connected only to the ship-side (see Figure 3.1) during ship operation. When a ship is not connected, it shall be connected to earth. NGR (Neutral Grounding Resistance) shall be designed as per standards.

(Note: Typical cruise ship HV distribution systems are earthed via high-resistance earthing resistors that are installed on each of the ship's generators' star point to earth connections. By using this earthing system on eachgenerator, the earth fault current can be limited according to the size of the resistor, while, on the shore, HV earth fault current can range from a minimum value that exceeds the rating of the ship HV installation.)

The neutral earthing resistor rating in amperes shall not be less than 1,25 times theprospective system charging current. The rating shall be minimum 25 A, 5 s.The continuity of the neutral earthing resistor shall be continuously monitored. In the event ofloss of continuity, the shore-side circuit breaker shall be tripped.

An earth fault shall not create a step or touch voltage exceeding 30 V at any location in theshore-to-ship power system.

iv. Equipment-earthing conductor bonding

A system earthing conductor shall connect the neutral earthing resistor's earthing connectionto a nearby system-earthing electrode. An additional system-bonding conductor shall connect the neutral earthing resistor's earthing connection to the earthing bus of the primary shore power switchboard. Bonding shall be in accordance with 8.2.3 of IEC 60204-11:2000.Equipment-earthing conductors terminated at the shore's three-phase socket-outlets shall be connected to the ship and continued to the ship to create an equipotential bond between theshore and ship. This shall require bonding to the ship's switchgear earthing bus and/orbonding to the ship's hull.

V. Shore-to-ship electrical protection system

The HV circuit breaker on the secondary side of the transformer shall open all insulated poles in the event of the following conditions:

a) Over current including short-circuit;
b) Over-voltage/under-voltage;
c) Reverse power;
d) Earth fault;
e) Unbalanced cable protection

To satisfy this requirement, at least the following protective devices, or equivalent protective measures, shall be provided:

a) Synchro check (25) or voltage sensing device (for dead bus verification);
b) Under voltage (27);
c) Reverse power (32);
d) Negative phase sequence over current (46);
e) Instantaneous over current (50);
f) AC inverse time over current (51);
g) Earth fault over current (51G or 51N);
h) Overvoltage (59);
i) AC directional over current (67);

(Numbers in brackets refer to standard device designation numbers as per IEEE Standard C37.2)

Alarms shall be communicated to the ship as common alarm, using the data-communication link, if such data-communication link is installed.

The protection systems shall be provided with battery back-up adequate for at least 30 minutes. Upon failure of the battery charging or activation of the back-up system, an alarm shall be communicated to the ship.

vi. **High Voltage interlocking**

Operating personnel shall be protected from electrical hazard by an interlocking arrangement during connection and disconnection of High Voltage connectors. Operational procedures and interlocking to verify that non-fixed high-voltage cables are discharged before disconnection shall be established.

Arrangements shall be provided so that the circuit breakers cannot be closed when any of the following conditions exist:

a) One of the earthing switches is closed (shore-side/ship-side);
b) The safety circuit is not established;
c) Emergency-stop facilities are activated;
d) Ship or shore control, alarm or safety system self-monitoring diagnostics detect an error that would affect safe connection;
e) The data-communication link between shore and ship is not operational,
f) The permission from the ship is not activated;
g) The HV supply is not present;
h) Equipotential bonding is not established (via equipotential bond monitoring devices where utilized, or via manual override).

Arrangements shall be provided so that the disconnector cannot be closed, or the circuit breaker cannot be racked into the service position, when any of the following conditions exist:

a) One of the earthing switches is closed (shore-side/ship-side);
b) The safety circuit is not established;
c) The communication link between shore and ship is not operational, where applicable;
d) Equipotential bonding is not established (via equipotential bond monitoring devices where utilized, or via manual override).

Arrangements shall be provided so that the earthing switches can only be opened when all the conditions in the interlocking of earth switches of ship are fulfilled.

vii. The Converter

Semiconductor convertors for connecting HV shore supplies to a ship electrical distribution system shall be constructed in accordance with IEC 60146-1 (all parts)

The effect of harmonic distortion and power factor shall be considered in the assignment of a required power rating. The use of frequency convertors shall not compromise the electrical protection selectivity of the largest on-board load (as per the definition in IEC 60050-151:2001, 151-15-15) while connected.
The protection for electrical equipment shall be in accordance with IEC 61936-1, as applicable. Where forced or closed-circuit cooling is used, whether by air or with liquid, an alarm shall be initiated when the cooling medium exceeds a predetermined temperature and/or flow limits.

Semiconductor frequency convertor equipment shall be so arranged that it cannot remain loaded unless effective cooling is maintained. Alternatively, the load may be automatically reduced to a level compatible with the cooling available.

The convertor temperatures shall be monitored and an alarm shall be activated to warn relevant duty personnel if the temperature exceeds a predetermined safe value. Liquid-cooled frequency convertor equipment shall be provided with leakage alarms. A suitable means shall be provided to contain any liquid which may leak from the cooling system so

that it does not cause an electrical failure of the equipment.

In the event of overload, an alarm signal shall be activated to warn relevant duty personnel. The alarm shall be activated at a lower overload level than that of the circuit-breaker protection.

Alarms from the onshore protection equipment shall be transmitted to the ship using the data communication link

Shore connection and interface equipment

Ship-to-shore connection cable extensions shall not be permitted.

The suitability of connectors with regard to peak short-circuit withstand capability shall be verified during the compatibility assessment.

viii. Ship-to-shore connection cable

(i) General:

Cables shall be at least of a flame-retardant type in accordance with IEC 60332-1-2. The outer sheath shall be oil-resistant and resistant to sea air, sea water, solar radiation (UV) and shall be non-hygroscopic. The temperature class shall be at least 90 °C. Correction factor for ambient air temperatures above 45 °C shall be taken into account according to IEC 60092-201:1994, Table 7. The maximum operating temperature shall not exceed 95 °C, taking into account any heating effects as a result of cable coiling. Due consideration should be given to requirements for smoke emission, acid gas evolution and halogen content for cables installed or stored in accommodation spaces and passenger areas.

The cables should be constituted as follows: power cores with copper conductors, conductor screen, insulation, insulation screen. The power cores should be laid up with earth cores with copper conductor and semi conducting layer. Pilot and fibre-optic elements, if specified in the applicable ship annexes, should be laid up in the interstices of the power cores. A metallic shield shall be installed at least on the power cores or a common shield on pilot wires.
(IEC 60092-350:2008, 4.6, provides further information regarding the use of inner coverings.;IEC 60092-350:2008, 4.7, provides further information regarding the use of inner sheathing).
The neutral cables are constituted as follows: core with copper conductor, insulation and outer sheath.

(ii) Conductors

All conductors should be flexible (class 5 of IEC 60228 or Table 11 of IEEE Std 1580-2010).
The conductors should be plain or metal-coated copper conductors.

(iii) Insulation of power cores and neutral core

The insulating compounds should be extruded cross-linked solid dielectric designated as EPR, HF EPR, HEPR or HF HEPR in IEC 60092-360 or equivalent of EPR, HF EPR, HEPR orHF HEPR in IEEE Std 1580

Electrical and non-electrical characteristics of the insulation system should be as specified in IEC 60092-360 or IEEE Std 1580 for the type of insulating compound used. Insulation thickness should be in accordance with IEC 60092-354, or IEEE Std 1580 for the standard rated voltages. Insulation thickness for the neutral core should be in accordance with IEC 60092-353 for the standard rated voltages.

(iv) Screening

Screening of individual power cores should consist of a conductor screen and an insulation screen. The conductor screen should be non-metallic and should consist of an extruded semiconducting compound or a combination of an extruded semi-conducting compound and a semi-conducting tape. The conductor screen should be firmly bonded to the insulation.

The insulation screen should consist of a non-metallic semi-conducting layer and, if necessary to fulfill the cable test requirements within Annex A, in combination with a metallic layer. The metallic layer, where required, should be applied over the individual cores and should comply with the requirements of 5.5 of IEC 60092-354:2014, or IEEE Std 1580.

(v) Earth conductors

Earth conductors should be flexible copper conductors in accordance with class 5 of IEC 60228 or Table 11 of IEEE Std 1580™-2010 forming together at least 50 % of the power core cross-section.

The conductor screen, when used, should be non-metallic and should consist of an extruded semi-conducting compound, in accordance with IEC 60092-354 or IEEE Std 1580.

The standard rated voltages

The standard rated voltages *U*0/*U* (*U*m) of the cables considered are as follows:

*U*0/*U* (*U*m) = 6/10 (12) kV RMS

The standard rated voltages *U*0/*U* (*U*m) of the neutral cables considered are as follows:

*U*0/*U* (*U*m) = 1,8/3 (3,6) kV RMS

where

*U*0 is the rated voltage between phase conductor and earth or metallic screen for which the cable is designed;

U is the rated frequency voltage between phase conductors for which the cable is designed;

*U*m is the maximum value of the highest system voltage that may be sustained under normal operating conditions at any time and at any point in the system. It excludes transient voltage conditions and rapid disconnection of loads.

(vi) Pilot conductors:

Pilot conductors should be flexible, plain or metal-coated copper conductors in accordance with class 5 of IEC 60228 or Table 11 of IEEE Std 1580™-2010, with a minimum nominal cross-sectional area of 1.5 mm 2.The insulation of pilot conductors should be extruded cross-linked solid dielectric of one of the types indicated in vii.(iii)Electrical and non-electrical characteristics of the insulation system should be as specified in IEC 60092-360 or IEEE Std 1580 for the relevant type of insulating compound used. Thickness of insulation should be in accordance with IEC 60092-376 or IEEE Std 1580 for the relevant insulation type. A wrapped covering with tapes or an extruded covering is permitted over the cores. Screening is optional.

Pilot element with rated voltage *U*0/*U* (*U*m) = 150/250 (300) V

(vii) Optical fibres

Optical fibres shall consist of a minimum number of six 62.5/125 gradient fibres. Optical fibres should be in accordance with IEC 60793-2-10, product specification. There should be no breakage of the optical fibres after conclusion of the mechanical bending test of the cable.

(viii) Cabling

The three power cores, the earth core(s), the pilot element and the optical fibres should be

laid up.

(ix) Separator tape

If separator tape is used, it should be wrapped around the assembled cores and should consist of a suitable, non-hygroscopic material.

(x) Outer sheath

The outer sheathing material should have a high level of mechanical properties as per IEC 60092-360 or IEEE Std 1580™. Thermoplastic polyurethane (TPU) in accordance with EN 50363-10-2 is also an acceptable material. For all sheath materials, the minimum tensile strength should be 12,5 N/mm2. Minimum elongation at break should be 300 %. The minimum thickness at any point of the extruded outer sheath should be 6 mm for high-voltage cables and 2,5 mm for separate neutral cable.

Markings

Cable sheaths should be permanently marked repeatedly throughout their length with an indication of origin with the manufacturer's name and/or registered trademark, rated voltage(*U*0/*U*), construction (number of cores and cross-sectional area of power conductors, earth conductors, pilots and fibre type of fibre optics) and the relevant standard.

Durability should be in accordance with IEC 60092-354 (IEC 60092-353, for neutral cable) or IEEE Std 1580. Continuity should be in accordance with IEC 60092-354 (IEC 60092-353, for neutral cable) or IEEE Std 1580.Legibility should be in accordance with IEC 60092-354 (IEC 60092-353, for neutral cable) or IEEE Std 1580.

Tests on complete cables:

For these tests, reference is made to the relevant clauses of IEC 60092-350 or IEEE Std 1580.

For test methods for insulation and sheaths, reference should be made to the appropriate part of IEC 60811 (all parts).

Routine tests, special tests and type tests should be conducted in accordance with IEC 60092-354 or IEEE Std 1580 with the following additions or modifications.

a) Bending test (see Figure 7):

1) The test should consist of 5 000 cycles of operation.
2) After 2 500 cycles, the cable should be rotated 180 degrees.

b) The diameter of the bending reels should be 10 D with a tolerance of ±5 %;
where:

1) D is the actual external diameter of the cable sample, in millimetres;
2) tensile force should be 15 N/mm2 of power cores;
3) maximum % of broken wires for each conductor and metallic screen, if required, should not exceed 20 %;
4) maximum % of broken optical fibres to be 0 %.

On completion of this test, the sample should be subjected to a partial discharge measurement. The magnitude of discharges at 1,73U0 should not be higher than 10 pC.

c) Sunlight-resistance test on outer sheath (duration of test 720 h):

1) The test should be performed in accordance with ISO 4892-2:2013, Table 3, test method A, cycle no. 1.
2) Maximum permissible change: tensile strength ±40 %, and elongation at break ±40 %.

d) Abrasion test on outer sheath:

1) The test should be performed in accordance with ISO 4649:2010, test method A.
2) Relative volume loss, ΔVrel: max 300 mm3.

e) Flame propagation test:
The test should be performed in accordance with IEC 60332-1-2 and should at least satisfy the recommended requirements of Annex A of this document.

f) Behaviour of completed cable at low temperatures:
The test should be performed in accordance with IEC 60092-350:2008, 8.9.1, 8.9.2, and Annex E, or IEEE Std 1580. The test should be conducted at −40 °C ± 2 °C.

g) Resistance between earth conductor and semi-conductive layer:
The resistance between earth conductor and semi-conductive layer should be maximum 500 ohms before and after bending test.

ix. Control and monitoring cable

Control and monitoring cables shall be at least of a flame-retardant type in accordance with IEC 60332-1-2 and independent of the power cable assembly. The environmental requirements for the sheath shall be the same as described for the ship-to-shore connection cable ~~in 7.5~~.
The control and monitoring cables, if integrated with the power cable assembly, shall be able to withstand internal and external short-circuits.
For details and further guidance, see Annex A.

x. Connectors

General

Connectors shall be in accordance with IEC 62613-1.
Handling of connectors shall be possible only when the associated earthing switch is closed. Connections shall be made in areas where personnel will be protected in the event of an arcflash as a result of an internal fault in the connectors by barrier and access control measures. These measures shall be supported by access control procedures. Each connector shall be fitted with pilot contacts for continuity verification of the safety circuit.

For single connector connections, a minimum of five pilots is required. If more than one cable is installed, an interlock shall be used so that no cable remains unused.
Contact sequence shall be in the following order for Connection Process
1) Earth contact;
2) Power contacts;
3) Pilot contacts.

Contact sequence shall be in the following order for Disconnection Process:
1) Pilot contacts;
2) Power contacts;
3) Earth contact.
The general arrangement of the ship connector located ashore shall be in accordance with Figure 5.1&2.

Each 3-phase HV connector or inlet shall have
a) Three-phase current carrying contacts, (L1, L2, L3),

b) One earth contact (see Figure 5.1), and

c) One pilot contact for continuity-check monitoring.

The general arrangement of the power connector and inlet shall be in accordance with IEC 62613-2:2016, Figure 5.1. The neutral connector and inlet shall be in accordance with IEC 62613-2:2016

Cruise ships shall utilize two power 3-phase connectors, each rated 500 A and one neutral single pole connector rated 250 A.

The short-circuit withstand current is 25 kA for 1 s and a maximum peak short-circuit current of 63 kA.

In addition, the ship inlets as well as the neutral ship inlet shall be fitted with fail-safe limit switches that are activated only when the connector and inlet are properly mated (see Figure 5.2).

These fail-safe limit switches shall be part of, and activate the emergency shutdown, if the connector is moved from the mated position while live

Support arrangements are required so that the weight of connected cable is not borne by anyplug or ship connector termination or connection.

Pilot contacts

Pilot contact connections shall open before the necessary degree of protection is no longer achieved during the removal of an HV-plug or connector. Pilot contacts are part of the safety circuit.

Earth contact

The current-carrying capacity of the earth contact shall be at least equal to the rated current of the other main contacts.

Fibre-optic connection

An optical fibre socket-outlet, shall be installed on the connector or plug as per Annexure Figure 6. Fibre-optic cable, terminated with a fibre-optic plug, shall be mounted on the stationary side, adjacent to the three-phase inlet or socket outlet. The fibre-optic receptacle shall have 4 optical terminals with 2.5 mm ceramic ferrules and configuration in accordance with Figure 6. Pin 1 will be used for TX transmission and pin 2 for RX transmission.

XI. Cable management system

General:

Only one cable Management system is envisaged and supply shall be given to one ship at a time, conforming to IEEE 80005-1,2,3 / IEC standards.

The cable management system shall:

a) Be capable of moving the ship-to-shore connection cable, enabling the cable to reach between the supply point and the receiving point. The trailing cable used shall be of UV resistant, oil and chemical resistant, flexible, polychloroprene rubber based compound for sheath, insulation HEPR compound. Conductor shall be tinned copper, flexible specially for mobile application.

b) Be capable of maintaining an optimum length of cable which minimizes slack cable, and prevents the tension limits from being exceeded.

c) Be equipped with a device (e.g. limit switches), independent of its control system, to monitor maximum cable tension and maximum cable pay-out.

d) Address the risk of submersion by prevention or through the equipment's design;

e) Be positioned to prevent interference with ship berthing and mooring systems, including the systems of ships that do not connect to shore power while berthed at the facility;

f) Maintain the bending radius of cables above the minimum bending radius recommended by the manufacturer during deployment, in steady-state operation and when stowed;

g) Be capable of supporting the cables over the entire range of ship draughts and tidal ranges;
h) Be capable of retrieving and stowing the cables once operations are complete.

Where the cable management system employs cable reel(s), the HVSC system rated power shall be based on the operating condition with the maximum number of wraps of cable stowed on the reel that is encountered during normal operations. Where applicable, the cable sizing shall include appropriate de-rating factors.

Moving arrangement of the cable management system

CMS shall be tyre mounted and cable drum shall also be mounted on movable CMS system with sufficient length of cable. Auxiliary supply arrangements for movement of CMS required shall be made available by EPC contractor from new Substation or nearby location from nearest tapping point including cables. CMS shall be equipped with telescope type of jib for facilitating the cable connection to the vessel's socket.

Monitoring of cable mechanical tension

The cable management system shall not permit the cable tension to exceed the permitted design value. A means to detect maximum cable tension shall be provided, or where an active cable management system that limits cable tension is provided, means to detect the shortage of available cable length shall be provided with threshold limits provided in two stages:

Stage 1: alarm;

Stage 2: activation of emergency shutdown facilities.

Monitoring of the cable length

Length of the moving cables shall be minimum 60 meters, considered as per the location of the ship and location of shore panels near berth. The cable management system shall enable the cables to follow the ships' movements over the entire range of the ships' draughts and tidal ranges, and the maximum range of allowable motion forward, aft or outward from the dock.

Where the cable length may vary, the remaining cable length shall be monitored, and threshold limits are to be arranged in two stages:

Stage 1: alarm;

Stage 2: activation of emergency shutdown facilities.

Consideration may be given to equivalent alternative measures (automatic break-away release, connectors with shear bolts and pilot lines, connection with ship/shore emergency shutdown system, etc.).

Connectors protection

The ship and shore HV circuit-breakers shall be arranged to open all insulated poles in the event of a damaging current unbalance between multiple phase conductors (separate, parallel power cables and connectors).

Protective devices to satisfy this requirement shall be installed ashore to isolate the connection in the event of damaging unbalance detection.

Equipotential bond monitoring

The equipotential bond monitoring device, where utilized, shall be installed either ashore or onboard where the cable management system is installed. Equipotential bond monitoring termination devices, where utilized, shall be installed on the other side.

Slip ring units

Slip ring units shall be tested in accordance with IEC 62271-200 (excluding non-applicable tests) for:

a) HV tests,
b) Impulse-voltage withstand tests,
c) Insulation resistance measurements,
d) Heat run test with nominal currents,
e) Short-circuit withstand tests,

f) Arc test, if accessible under energized conditions, and

g) Ingress protection tests (IP rating).

Other testing standards may be considered.

Interlocking of earthing switches

Interlocking shall be hardwired.

The earthing switches shall remain closed until

a) All connections are made and the pilot contact circuit is closed,

b) No emergency-stop switch is activated,

c) The communication link between shore and ship is operational,

d) Ship or shore control, alarm or safety system self-monitoring properties detects that nofailure would affect the safety of connections

e) The permission from ship and shore is activated.

Data communication

The data-communication link between ship and shore arrangements shall be used for communicating the following information:

a) Shore transformer high-temperature alarm

b) HV shore supply circuit-breaker protection activation

c) Permission to operate HV circuit-breakers for HV ship to shore connection

d) If ship or shore control, alarm or safety system self-monitoring properties detect an error that would affect safety of connection

e) Indication of emergency-stop activation

f) Where provided, shore control functions in accordance with Load transfer via automatic synchronization procedure.

g) Indication of emergency disconnection of the shore supply; and

h) Failure of the battery's charging or activation of the back-up system

The communication protocol for communication link between HVSC and ship shall be in accordance with IEC/IEEE 80005-2.

HVSC system control and monitoring

Ship equipment shall be protected and controlled by the ship's own protection and control systems. If the shore supply fails for any reason, supply by the ship's own generators is permitted, after disconnecting the shore supply. Load transfer shall be provided via blackout or automatic synchronization.

Load transfer via blackout

Interlocking means shall be provided so that the shore supply can only be connected to a dead switchboard. The interlocking means shall be arranged to prevent connection to a live switchboard when operating normally or in the event of a fault, for example a fault in the blackout monitoring circuit.

The simultaneous connection of an HV shore supply and a ship's source of electrical power tothe same dead section of the electrical system shall be prevented (see 8.5.3 and 8.5.4).

Load transfer via automatic synchronization

General

The HV shore supply and the ship's source(s) of electrical power temporarily in parallel shall be in accordance with the following:

a) Load shall be automatically synchronized and transferred between the HV shore supply and the ship's source(s) of electrical power following their connection in parallel;

b) The load transfer shall be completed in the shortest time practical without causing machinery or equipment failure or operation of protective devices, and this time shall be used as the basis for defining the transfer time limit;

c) Any system or function used for paralleling or controlling the shore connection shall have no influence on the ship's electrical system, when there is no shore connection.The transfer time limit shall be defined and made available to the personnel responsible. Where the transfer time limit is adjustable to match the ability of an external source of electrical power to accept and shed load, the procedure for setting this limit shall be addressed in operating instructions. Where operation of only designated or a restricted number of ship source(s) of electrical power is required to permit the safe transfer of load between an HV shore supply and ship source(s) of electrical power, the arrangements shall fulfill this requirement before and during parallel connection.

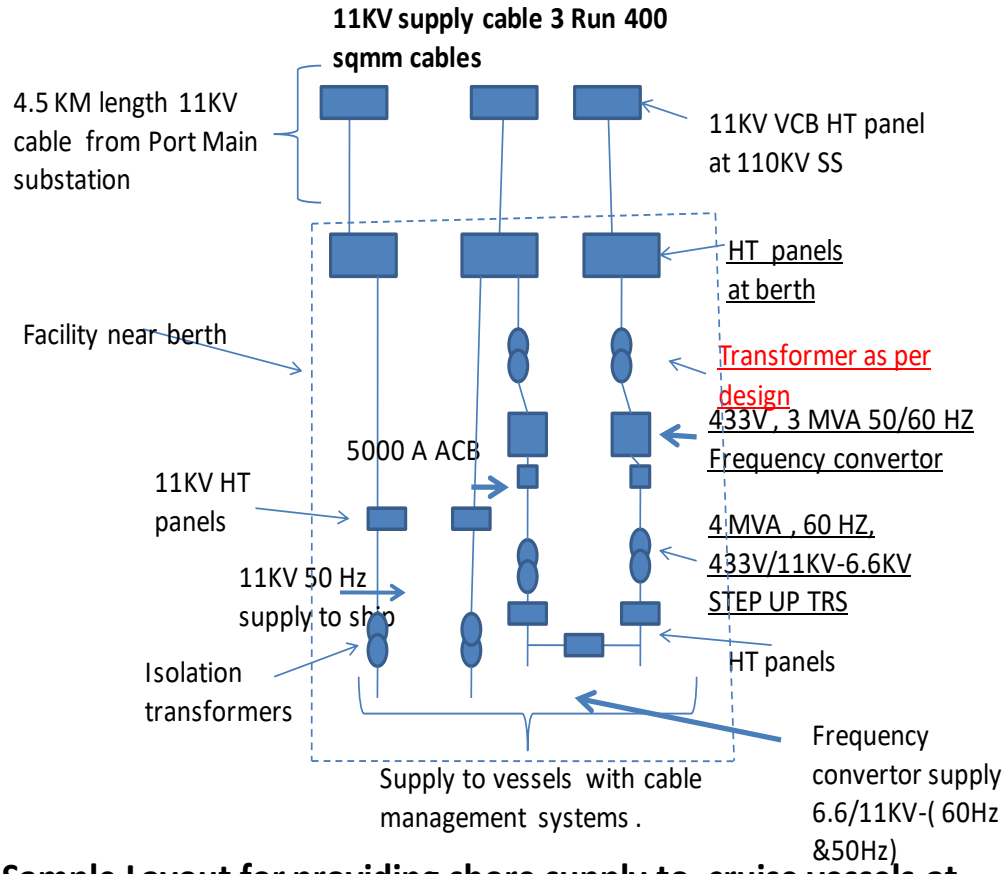
The instrumentation and protection requirements contained in 8.5.3 and 8.5.4 shall be met for parallel transfer.

Protection

If the defined transfer time limit (see 9.3.1) for transferring of load between HV-shore supply and ship source(s) of electrical power is exceeded, one of the sources shall be disconnected automatically by the ship, and an alarm shall be provided to advise relevant duty personnel.Special care shall be taken not to exceed the maximum permissible load steps of thegenerator sets in accordance with IEC 60092-301.Where load reductions are required to transfer load, this shall not result in loss of essential services for the ship's safety.

Tailor-made Cable Management and CRD System

A customized CRD system is recommended, which is mounted on a trolley arrangement and can be moved across the berth to connect the SFC junction box to the vessel, depending on the positioning of the Vessel at berth.



Sample Layout for providing shore supply to cruise vessels at Harbour