Republic Of Yemen

Public Electricity Corporation

132 KV OHL Rehabilitation at Costal Areas

Al-fush, Raskat, Mukha

Technical Specifications for 132 kv O.H.L Rehabilitation Tender

Part 1 :- Technical specifications for supply of materials

1.0 – General

This Tender Specification hereunder consists of two parts (lots) they are :-

- Part1 " supply of materials.
- Part2 "errection of materials" where these tender's specification are prepared for the purpose of replacement of the existing heavily corroded towers with Transmission line in many parts of coastal areas in Yemen (Al-fush , Raskat , Mukha).The tenderer / contractor must satisfy himself about general circumstances of all required works or supply of materials technical data attached in this tender document for the offer to be technically accepted .

2.0 - Background

Most of 132 kV transmission line towers employed in Many parts of Yemen specifically Hodiedah Region, Mukha region, and Alfeush region which are located at the coastal areas of Red Sea and Arabian Sea.
These O.H.L lines were installed in 1980, 1984, and 1986 by Hyundai Construction Co. LTD and SAE S.P.A Milano Italy. These areas well known of severe environmental conditions of high temperature, high relative humidity, prevailing wind full of marine sand and industrial pollution which resulted in severe rust to O.H.L towers insulator's metal, parts, fittings and connections. Where the steel Tower members bars are extremely affected by corrosion. All section routes are located in the areas shown in appendix (1M) :-

3 - Standard

The materials and work under this contract shall be complying with international standards and codes of practice to ensure higher quality of the materials and work.
The contractor shall mentioned the international standards for each martial / work offered and shall provide three copies in English of this standards when so requested.
Any deviations from the international standards and code of practice should be mentioned in the deviation list attached .

4. Scope Supply Of Materials

4.1 – General

According to the status of the existing 132kv O.H.L sections which are affected by corrosion in the coastal areas as mentioned in forgoing items and according to the need in order to keep the existing circuits at the coastal areas in operation .
P.E.C has prepared the following technical specifications for the rehabilitation of 132 kv O.H.L sections by replacing the corroded towers with new double circuit towers as mentioned in background item taking in to consideration the existing design tower parameters and data such as line clearance distance , outline and loading schedules , loading diagram and tower foundations drawings according previous soil investigation for tower types (DA ,DG ,DH ,DEF, ST ,AT1). Appendix (3) and Appendix (4) .
In order to facilitate the process of manufacture , installation and integration with the new section length towers with the existing transmission lines. PEC propose the use of DEF type

tower (for either terminal towers (0□-45□) or angle tower (60□-90□) and to use DG(0°-20□)type tower to be used either suspension or tension tower .
Any alternative type of towers, insulators , coneductors and fittings, can be offered will be considered in condition that it will meet all conditions and design parameters mentioned above in order to fulfill the integration with the existing towers, all calculations, and design parameters shall be submitted to prove the integration with the existing towers .
As an option the tenderers can offer a single circuit towers to split the existing circuit in the terminal points between the new sections and the existing sections.For this option a complete proposal and calculations to be submitted with this option.

- The Contract shall comprise the manufacture, supplier, delivery to site, loading, and unloading, transport from docks to stores, including manufacturer's type and prototype testing for towers also ,shuttering , template and routin test for condactors , insulators and fittings .

4.2 - Tower Design Data

The contractor shall consider that all supports shall be lattice steel, self-supporting towers. They will accommodate the double circuit with Body and leg extensions above standard height tower shall be provided as mentioned in the tower design data Appendix (8) .
The manufacturing of towers shall be in accordance with attached fabrication drawings for DEF and DG towers Appendix (1) & (2) .
For alternative types of towers the tenderes shall submit all technical particulars and design drawing as an options.

4.3- Drawings to be submitted by the supplier

After the contract has been awarded the supplier shall submit the following drawings for approval as set out below :-

4.3.1- For Design Approval

Tower Design calculations, loading schedules, panel assembly (fabrication drawings), schedules of foundation loads, foundation design calculations and wire clearance diagrams for each type of support including all extensions to the basic body to be supplied by the manufacturer.

4.3.2 - Before Manufacturing

Tower material lists and type, tower steel work masses, tower template, foundation shuttering details, insulator and shield wire attachments, tower testing programme and loading procedures.

4.3.3 - Before Erection

Stub-setting diagrams, foundation installation procedures, tower erecting drawing and erection procedures.
Preliminary tower / support schedules and profiles.
Conductor stating arrangements
Foundation testing programme and loading procedures.

Technical Specifications for 132 kv O.H.L Rehabilitation Tender

5 . SITE PARTICULARS

5.1 - Local Conditions

The Site conditions shall be assumed to be as follows for the purpose of Tendering. ALFEUSH MOKA RAS-KATHIB HODEIDAH .

		ALFUOCH	MOKA	RAS-KATHIB	HODEIDAH
(a) Altitude	m	10	5	5	5
(b) Maximum Ambient temperatur	º C	45	45	45	45
(c) Minimum Ambient temperatur	º C	15	15	15	15
(d) Everyday Temperatur	º C	29	29	29	29
(e) Maximum 3 second gust speed with one-in 50 year return period	m/s	45	45	45	45
(f) Seismic Acceleration g	g	0.12	0.12	0.12	0.12
(g) Isokeraunic level		10	10	10	10
(h) Relative humidity :-					
Max	%	100	100	100	100
Min	%	30	30	30	30
(j) Annual rainfull (i)	mm	50-297	50-298	50-299	50-300

Under storm condition the maximum precipitation of 50 mm. Hour shall be assumed and rainfall varies considerably from year to year.

6 - Ports and Transport Facilities

The main sea ports for the Republic of Yemen are Hodiedah and Aden. The locations of new transmission line from those sea ports are as follows :-

-Alfeush area is located 30 km from Aden Sea part
- Ras-Katnib area is located 30 km from Hodiedah sea port

Hodiedah site for new sections areas are located 5 km from Hodiedah sea port
Mukha area is located 230 km from Hodiedah sea port

Technical Specifications for 132 kv O.H.L Rehabilitation Tender

7 – Technical Specifications

7.1 - Technical Specifications for Fabrication of Towers

The towers shall be manufactured according to the attached drawings (out line drawing, fabrication drawings and loading diagram of the towers types DG and DEF(Appendices 1,2,3 and 4).

7.1.1 - List of References

The following international standards are recommended for tower fabrication:

EN 10020-1995	- Definition and classification of grades of steel
ISO 657-1/89	- Equal-leg angles
BS EN 10056-/98	- Structural steel equal – leg angles tolerances on shape and Dimensions
BS EN 10027-1/92	- Design systems for steel
BS 10025:1993	- Specification for hot rolled products on non-alloy structural Steel and their technical delivery conditions
BS EN 10029/1991	- Specification for tolerances on dimensions, shape and mass For hot – rolled steel plates 3mm thick and above.
EN 10137	- Plates and wide flats made of high yield strength structural Steel
IS 808/76	- Hot rolled steel sections (India)
GOST 8509-93	- Hot rolled steel equal – leg angles. Dimensions.
DIN 267	- Fasteners
DIN 799	- Steel Hexagon Head Bolts for structural steel.
BS 4190	- Specification for ISO metric black hexagon bolts, screws and Nuts - Specification
IEC 60652/1979	- Loading test on overhead line towers
BS 729/1971 (1986)	- Specification for Hot Dip Galvanized Coatings on iron and Steel Articles
BS EN ISO 1461	- Specification for Hot Dip Galvanized of structural steel
BS 7361-6	- Coatings on Metal Fasteners – Part 6 – Specification for Hot Dipped Galvanized Coatings
ISO 1459/1973	- Metal Coatings – Protection against corrosion by hot dip Galvanizing
EN ISO 1461/1973	- Hot dip galvanized coatings on fabricated ferrous products – Requirements
BS 4360:1990	- Specifications for weldable structural steels
BS 5135: 1984	- Specification for arc welding of carbon and carbon Manganese steels
BS EN - 288: 1992	- Specification and approval of welding procedures for Metallic materials (Part 1, 2, 3)
BS EN 499:1995	- Welding consumable
BS EN 970:1997	- Non – destructive examination of fusion welds – visual Examination
ISO 9000:1987	- Quality management and quality assurance standards- Guidelines for selection and use.
ISO 9002:1987	- Quality system – model for quality assurance in production and Installation
ISO 9003:1987	- Quality system – model for quality assurance in final Inspection and tests

Technical Specifications for 132 kv O.H.L Rehabilitation Tender

7.1.2 – Manufacturer's Experience

The Manufacturer shall have at least 10 years experience in the detailing and manufacturing of transmission towers. Furthermore, evidence should be submitted to demonstrate the above experience.

The evidence for satisfactory manufacturing and field experience should be for substantial number of projects and for substantial quantities per project in comparison with those included in this Tender for them to be considered acceptable.

7.1.3 - Quality assurance

The Manufacturer shall submit for approval all internal quality control procedures and quality plan before commencing the fabrication. The manufacturer shall have properly documented and fully implemented quality system in accordance with ISO 9002, 9003 and 9004: 1987. The application of quality system shall be exceeded to sub-suppliers and sub-contractors.

On commencement of the contract, the manufacturer shall present the list of all documents to be used to manage and control the quality of the products, works and services to be provided within the contract. This list shall include suppliers and sub-contractors documents.

The manufacturer shall also submit to the Owner a Quality plan produced in accordance with the above standards.

7.1.4 - Inspection and testing

All towers structural steel shall be accompanied by a manufacturer / suppliers certificate, which demonstrates compliance with the requirements of the specified standards.

All manufactured materials of the towers are subjected to inspection and tests at the manufacturer_s facilities. Two PEC engineer s and Inspectors shall attend the tests for each lot of deliveries. Business class flight tickets and full board accommodation for two owner's engineer, one inspector and design engineer, and all cost will be borne by the manufacturer. The manufacturer shall provide all required equipment and instruments for these inspections. If required by Owner's inspector, specimen welds shall be prepared and tested in accordance with relevant standards. Test samples shall be cut from manufactured members. The manufacturer shall submit two samples of each type of bolt, nut and washer for approval before issuing the sub-order.

The Owner's inspector will reject bolk consignments that fall in any respect below the standard of submitted approved samples.

Spring washer shall be such that they return to their uncompressed form after loosening of the nut.

7.1.5 - Lattice Steel Towers

Material

The materials used for fabrication of the existing towers members at the sections A1 ,A2, E1, F1 and B1 are comply with Japanese standard SS55 : JIS G 3101 for the high tensile steel members and SS41 : JIS G 3101 for mild steel members .

The materials to be used for fabrication of the new towers members shall comply with latest issued of approved international standards which shall be equivalent to Japanese standards mentioned above. The contractor shall submit one grade of mild steel and one grade of high tensile steel certified mill test reports as evidence of mechanical features of the steel. The steel shall be free from lamination defects, blisters etc.

The gusset plates shall be manufactured from mild or high steel as specified on the drawings. The high tensile steel is specified on the drawings by the letter H to the end of the number erection work and mild steel is specified by the letter M. High tensile steel stock shall be marked distinctively prior to fabrication by an approved method of identification.
Nuts and head of bolts shall be of the hexagonal type. Spring washer shall be rectangular section to the DIN 127. Bolt thread profile shall be of ISO form and shall be manufactured according to grad mentioned in the fabrication drawing with suitable grade for towers. Taking in to consideration the connection bolts used in the existing towers are made according to JIS B 1180, 5T for all connection bolts and 4T for step bolts or equivalent standard.

7.1.6 - Fabrication of Tower Members

All members shall be carefully cut and the holes shall be accurately located so that when members are in the position all bolts can pass through the holes freely. Individual members shall be true to shape and fully interchangeable with members bearing the same erection mark. Mild steel members up to 16mm thickness and high yield steel up to 14 mm thickness may be sheared to length. Ends of members must be true to angle and from burrs and notches.
The bolts, nuts and washers shall comply with drawings indications and relevant standards specified above. All bolts shall be one grade of steel corresponding to suitable grade number the bolt hole diameter in the ungalvanised state shall not be more than 1.5 mm larger than the corresponding bolt diameter.
The drilling, punching cutting and bending of members shall prevent any difficulties when the towers are erected. The punching of holes is permitted for thickness less then 16 mm on meld steel. Where the thickness of the member is larger than the holes_ diameter, the holes shall be performed by drilling .Any hole adjacent to a bend line or near the weld must partially, be refilled by welding or plugging.
All bends over 5°C on high tensile steel shall be formed hot (as defined by standard specifications). For thickness less than 12 mm the preferred temperature is 650° C and above this thickness the temperature shall be 850 ° C-950 ° C
The use of welding shall be subjected to approval prior to fabrication and shall comply with approved standard specifications. All shop welds shall be carried out by welders qualified for the work under proper supervision and in accordance with BS 5135. Machine welding should be used whenever possible.
BS 4872 or equivalent standard specification shall be applied for welding.
The size of erection mark shall have numbers and letters [at least 16 mm and shall be clearly legible after galvanizing. the erection mark shall use the bar code from the drawings including M for mild steel and H for High tensile steel.
All members shall be assembled with bolts and nuts with single spring washers.

7.1.7 - Design of Towers

7.1.7.1 _ Form of construction

All supports shall be lattice steel, self-supporting towers. They will accommodate the double circuit with Body and leg extensions, single 400 mm2 (ACSR) conductor and one 7/8 AWG aluminum clad steel earthwire for section A1,A2,E1and F1, and single 300 mm2 (AAAC) conductor and one 7/8 AWG aluminum clad steel earthwire for section B1 .

Technical Specifications for 132 kv O.H.L Rehabilitation Tender

7.1.7.2 - Span length

Basic span length, equivalent span length, wind span, used for design of the existing DEF and DG towers as shown in the line data sheet and out line and loading schedule (attached Appendix (4) and Appendix (9) .

7.1.7.3 – Design Span and types of towers

a) for Raskat, Mukha and Hodiedah areas.

Tower Type		DA Straight line	DG 20 ° Straight line/Angle	DH 60° Angle	DEF 90 ° Angle	DEF 45 ° Terminal
Condition Basic Span	M	350	350	350	350	350
Angle of Deviation	Degrees	0	0-20	20-60	60-90	0-45
Maximum Sum of Adjacent Spans	M	770	770	770	770	-
Maximum Single Span	m	595	595	595	595	595
Maximum wind span	m	385	385	385	385	290
Maximum weight span	m	700	1050	700	700	525
Minimum weight span	m	245	-500	-500	-500	-375

Note:-

Maximum and Minimum Weight spans shall apply under MWT Conditions as indicated at the outline and loading scheduale for towers type DA,DG,DH,DEF.

7.1.7.4 _ Conductor and earthwire spacing and clearances

For all towers, the clearances from conductors, arc jumper loops and all live metal to steelwork shall not be less than those specified here in out line drawing and loading schedule drawings attached Appendix (4) .

7.1.7.5 _ Clearance to Ground

The clearance between the line conductors and the ground in still air under the maximum specified temperature final conductor tension shall not be less than 7.5 m.

7.1.7.6 - Temperatures for conductor & Tower Design

- minimum temperature for which the conductor tensions are considered + 15 C˚
- maximum conductor temperature for which the maximum sag for tower +75 C˚ height is considered .
- Every day conductor temperature 30 C˚ .

Technical Specifications for 132 kv O.H.L Rehabilitation Tender

7.1.7.7 – Wind Loading

The basic wind pressure q10 adopted for the design :-

Tower Types	Basic wind pressure q10 kgf / m^2		
	Case 1	Case 2	Case 3
All	156	132	95

The totale wind on the panel is calculated from the expression :

$$Tw = 4.3 \times q_{10} \times \left(\frac{(H)}{(10)}\right)^{.087} \times (1 - 1.16 S_r) \times (\zeta) \times w_a$$

Between limits $0.05 < S_r < 0.45$

Where

H = is the height above ground level in metres to the top of the panel being considered

S_r = is the solidity ratio of the panel .

Tw = is the calculated wind load

W_a = projected area of exposed members on the windward face .

ζ = is an additional shielding factor when considering multi-panel frames .

7.1.7.8 _ Combination of Loads

Under normal working conditions tower designs will cater for the simultaneous action of ultimate maximum or minimum vertical loads, maximum transverse wind loading, loads resulted from minimum and maximum angles of deviation, and the longitudinal loads imposed by differential conductor tensions at tension tower.

Under broken wire conditions the simultaneous actions of the above loads derived from the intact conductors together with the longitudinal and tensional effects of broken conductors. In addition the transverse loading resulting from the broken wire wind span will be applied for each conductor considered broken.

Longitudinal loads from broken conductors will be equal to the actual working tension of the conductors or earth wire broken. In case of suspension towers the applied load resulting from a broken phase conductor can be reduced to 70% of the maximum working tension-due accent being taken of the swing of the suspension set and the slip of the broken conductor the clamp.

Under cascade condition the simultaneous actions of vertical loads together with loadings from conductor tensions at minimum temperature still air , in case of suspension the applied load resulting from the breakage of all conductors reduced to 70 % of the working tension due account being taken of the swing of suspension sets and the slip of broken conductors through the clamps.

7.1.7.9 - Factors of Safety

For wind blowing on structure and for loads applied on towers from wind on conductors and earth wire a factor of safety of 2.22 shall be applied irrespective the case, normal or unbalanced loadings.

For vertical loads it is considered a factor of safety of 1.27 for normal working cases and 1.1 for unbalanced cases.

For loads derived from conductor considered a factor of 1.65 should be applied for normal working cases and 1.1 for unbalanced loading cases.

Technical Specifications for 132 kv O.H.L Rehabilitation Tender

7.1.8 - Galvanizing of Tower Members

All tower members shall be galvanized by the hot dip process according to standard specification(BS 729).The galvanized process and the preparations for galvanizing shall not have any adversely affect on the physical and mechanical features of the coated material.
All drilling,punching, bending and welding of members shall be completed and all burrs removed before galvanization.The black members shall be pickled in dilute hydrochloric acid or blast cleaned and flash pickled in dilute hydrochloric acid, then washed, fluxed and stove and coated with zinc by means of dipping in a bath of molten zinc.
The tower members shall be immersed in the bath only for the time sufficient to attain the temperature of the bath and shall be withdrawn at such speed to achieve a coating of 915 g/m2.
The zinc coating shall be smooth, clean and of uniform thickness and free from defects.
The members on which galvanizing was damaged shall be re-dipped.
The control and tests of the galvanizing shall fully comply with relevant international standards. Thickness of zinc coating shall be assessed as the mean of several measurements by magnetic means on 1 % of samples selected from inspected delivery.
Peirce test shall be performed in order to check the uniformity of the zinc coating as required by the Owners inspectors. Six dips of one minute each without deposit of metallic copper will be required in order to check the uniformity of the zinc coating.
Selected samples shall be subjected to hammer test in the presence of Owner's inspector .if any sample fails to these tested, at least a further 1% shall be selected for re-testing the material. If any of these further batches fails, the whole of consignment shall be rejected and the members from the respective delivery lot shall be re-galvanized and re-inspected.
All bolts and screwed rods shall be galvanized including the threaded part to a minimum average coating weight of 305 g/m2. All nuts shall be galvanized with the exception of the threads that shall be oiled.
To avoid the white rust during transportation an approved inhibitor shall be applied according to instructions of the producer. The protection solution against white rust shall be submitted for approval before fabrication.

7.1.9 - Towers Earthing

7.1.9.1) Scope

Towers complete with all nuts , bolts, cross arms, number plates, circuit danger and aerial number identification plates as specified , flag brackets, anti-climbing devices , earthing and shieldwire bonding

7.1.9.2) Materials

The earthing of galvanized lattice steel towers shall be realized by means of buried copper strip to BS 2870" Schedule of rolled copper and copper alloys". Sheet strip and fail Grade C101 or C 102 shall be used and may include copper earth rods to BS 2874 "Schedule of Copper and Copper Alloys".
Rods and Sections shall be Grade C101 or 102 _ PA2.

Technical Specifications for 132 kv O.H.L Rehabilitation Tender

The minimum dimension of the cross-section of the earthling conductor shall be equivalent to 20 mmx3mm.Earth rods shall be 12 mm diameter.Connection to the tower shall be by bolting of an approved compression lug to the tower leg by an M 10 bolt. Connection between portions of copper conductor shall be by on approved thermo-weld joint.

7.1.10 - climbing Facilities and Anti-climbing Devices

7.1.10.1 - Step Bolts

Two diagonally opposite legs (on right side facing transverse face of each tower) shall be provided with step bolts of approved type at not more than 450 mm centers starting as near as practical to the base and continuing to 1 meter below the top of the tower.

The bolts shall have a shoulder, shall not be less than 16 mm in diameter, project not less than 150m, and be fixed with nut, washer and nut.

7.1.10.2 – Anti- climbing Device

Each structure shall be fitted with anti-climbing device of the spiked type as per the drawings. A side ward opening gate shall be fitted in the anti-climbing device of the step leg of the tower and provision made for looking the gate, with a bolt, nut and locknut.

7.1.11 - Shop Assembly

All towers shall be shop assembly checked in the presence of two PEC engineers and one inspector designer. The rates shall include all expenses for two PEC engineers and one inspector designer for business class flights tickets and full board accommodation. During check assembly, member must not be forced into position in such manner that deformation or unacceptable stresses occur. Tower steelwork may be galvanized or in the black for assembly test. Assembly test may be on vertical or horizontal position. If the tower is assembled horizontally, an adequate support shall be provided in order to ensure proper fit; the assembly shall be carried out without forcing the pieces into position and to align easily the bolt holes. Bolt holes shall not be enlarged or reamed during assembly test.

At least 1% of the members shall be presented for inspection from each type of structure, selector at random and assembled to from complete structure, in the presence of owner’s inspector at the fabricator’s works.

7.1.12 - Full Scale Load Type Test

7.1.12.1 - General

One tower of each type shall be assembled at the fabricator’s works or other approved place and shall be erected on a rigid test foundation .The tower submitted for test shall be galvanized and shall have the maximum height. The tower shall be tested in accordance with IEC 60652/2002.Testing procedure for each type of tower to be tested shall be submitted by the contractor for approval within 10 days prior to the test.

All test loads shall be removed completely before the loads for the next test are applied.

The tested towers shall be subjected to the following:-

Normal conditions.

Unbalanced conditions / broken conductors and shield wire conditions.

Such combination of broken conductors and shield wire as mentioned in the loading diagram (attached)

The tower subject to type testing shall not be used subsequently in the construction of the line.

Technical Specifications for 132 kv O.H.L Rehabilitation Tender

The manufacturer shall furnish the test towers, testing facilities, rigging and all instrumentation , computer facilities included as may be required and shall perform all work specified or implied.
Any failure of loadings or the use of incorrect grade of steel shall be considered a defect so the contractor shall correct the defect and repeat the test loadings at his own expense.

7.1.13 - Packing of Towers

The whole of the plant shall be packed where necessary in non-returnable cases or otherwise prepared for overseas shipment to tropical country without sustaining damage.
All packing shall become the property of the purchaser .The contractor is to arrange for the protection, against corrosion and mechanical during shipment.
Bundles of steel angle section shall be properly tied together by an approved method and care taking shall become they robust and not of excessive length for handling during shipment. Bundles shall be as large as possible to provide stiffness and resistance to careless handling.
The tower steel work shall be bundled into individual tower units and each consignment must consist of complete towers, extensions or sets of foundations steel works.
Unless the Manufacturer can offer an equally acceptable method bundles of angles shall be arranged in rectangular formation with notched outer stout wooden battens to locate the angles, the battens being compressed on the bundles by outside tie bolts, the above binders, being located at sufficiently close intervals to form a strong and homogeneous element.
The contents of packing cases shall be securely bolted or fastened in position with struts or cross batten. Cross battens supporting weight in any direction shall not rely for their support on nails or screws driven lengthwise into the wood, but shall be supported by cleats secured from the inside.
Bolts and nuts shall be double bagged and crated for shipment. Crating together of components of dissimilar metals shall be avoided. Nuts shall be finger tight on the delivered bolts and will be rejected if they are considered to have an excessively loose or tight fit. Bolts with re-died after galvanizing will be rejected.
Particular attention shall be given to strutting before packing cases are fastened down. Cases shall be up-ended after packing to prove that there is on movement of the contents.
Timber wedges or chocks shall be firmly fastened in place to prevent their displacement when the timber shrinks.
The Manufacturer shall be required to suitably protect all steelwork before shipment to prevent damage to galvanized surfaces by white rust.
All stencil marks on the outside of casings shall be either of a waterproof material protected by shellac or varnish to prevent obliteration in transit.
Wood wool shall be avoided as far as possible
Each crate or package shall contain a packing list in a waterproof envelope and copies in triplicate shall be forwarded to the purchaser prior to dispatch. All items of materials shall be clearly marked for easy identification against the packing list.
All cases, packed etc. shall be clearly marked on the outside with a shipping mark to indicate the total weight, to show where the weight is bearing and the correct position of the slings and shall bear an identification mark relating them to the appropriate shipping documents.
The owner can ask to inspect and approve the packing before the items are dispatched but the Manufacturer shall be entirely responsible for ensuring that the packing is suitable for transit

and such inspection will not exonerate the manufacturer from any loss or damage due to faulty packing.

All tower members are to be stamped up to eighth distinguishing numbers and/or letters corresponding to those on the approved drawings and material lists. These erection marks shall be impressed before galvanizing and are to be clearly readable afterwards.

7.1.14 - Documentation to be submitted with the tender for towers

- Quality assurance certificates
- List of References
- Evidences from End Users
- Full Scale Test Report for towers of equal or higher voltage compared with those required by this Tender
- Galvanization Test certificate covering the manufacture of similar towers with zinc coating of not less than 915 g/m2
- Technical leaflets and catalogues

7.1.15 - Documents to be submitted with Tender for tower earthing

- Detailed Drawings for All Components
- Conductor Drum Drawing
- Reference List
- Technical leaflets, Catalogues

Quality Assurance Certificates

7.2 - Technical Specifications of Towers foundation

- **Tower Foundation General**

- Ras-Katnib area sections A1, A2 and B1

The new sections of the transmission lines will be installed at Ras-Katnib area for sections A1, A2 and Alfeush area B1 near to the existing line the soil investigation has been carried out for the existing lines at that area, all foundation drawing of the existing towers DEF, DG are attached in Appendix (5) .

The new towers will be located in the same soil types as following:-

a) The first tower terminal towers double circuit type DEF up to the sixth tension tower type DG will be located at soil type (2); therefore the contractor shall consider the type of foundation design as the drawings attached Appendix (5) .

b) The seventh tower up to the ninth or twelve towers (remaining towers for section A1 and A2) will be located at soil type (1) therefore the contractor shall consider the type of foundations design for soil type (1) as the drawings attached Appendix (5) .

c) All the towers which will be installed in section B1 at Al-fush area will be located at soil type (1) therefore the supplier shall consider soil type (1) for foundation design as the drawings attached Appendix (5) .

- Mukha area sections E1 and F1

The new sections of the transmission lines will be installed at Mukha area for sections E1, and F1 near to the existing line the soil investigation has been carried out for the existing lines at that area and the new towers will be located in the same soil types as following :-

Technical Specifications for 132 kv O.H.L Rehabilitation Tender

a) The first tower terminal towers double circuit type DEF up to the third suspension tower type DG will be located at soil type (4); therefore the supplier shall consider the type of foundation design as the drawing attached Appendix (6) .
b) The fourth tower up to the ninth towers will be located at soil type (1) therefore the supplier shall consider the type of foundations design for soil type (1) as the drawings attached Appendix (5) .

7.2.1 - Design principles

Foundation design loadings: Foundations are designed for maximum ultimate loads increased by a supplementary loss factor of 1.24.
The depth to width ratio of the pad and chimney foundation is always less than 2.
Foundations for angle towers were designed to be identical for compressed and uplifted legs.
The use special concrete protection (soleplate resisting cement, increase of concrete cover etc.) has to be decided before erection of the foundations based on chemical analysis of soil and water on the location were the technical supervision team has suspicions about soil or water aggressiveness.

7.2.2 Standards

The following international standards and codes of practice were considered for the design of foundations:

-DIN 4020- 1990	-Geotechnical investigations for civil engineering purposes
-DIN 4022:1987	-Subsoil and ground water; classification and descriptions of soil and rock types samples
-BS 4449-1988	-Specification for scheduling, dimensioning, bending and cutting of steel reinforcement for concrete.
-BS 5075	- Concrete admixtures.
-BS 5328-1997	-Guide to practice for site investigations
- BS 5930-1981	-Code of practice for site investigations
-BS 8004-1986	-Code of practice of concrete
-BS 8110-1985	-Structural use of concrete
-ASTM D2487-90	- Standard test method for classification of soils for engineering purposes
-ASTM 2488-90	- Standard recommended practice for description of soil, visual-manual procedures
-ACI standard 305R	- Hot weather concreting
-IEEE 979-91	-IEEE Guide to installation of Foundations for Transmission line Structures.

Technical Specifications for 132 kv O.H.L Rehabilitation Tender

7.2.3 - Foundation design parameters

Foundation design parameters for all type of structures are based upon the assumptions set out in the following table:-

Foundation	
1. Concrete Block Foundation	
Maximum angle between base and side of concrete foundation block to allow for uplift condition … … degrees	70
Assumed depth of point of application of resultant lateral earth pressure below ground level, when H is the depth from ground level to top of foundtion block (for parallel sided chimneys only) . ….. …… ….. ….	0.67 H H<5.3 m
The lateral earth pressure acting against the foundtion is assumed to vary linearly with depth from zero at 300 mm below ground level to maximum at the top of the foundtion block provided this is not greater than 5.3 m below ground level . for depths below ground 5 m a constant value equal to the maximum value at 5 m shall be considered .	
2. Ultimate Design stresses	
a) Ultimate stresses used in the design of concrete foundations :	
Bond between galvanised steel and concrete …. ..… kg/cm^2	10
Bearing – type A Concrete …… …… … ……. ……... kg/cm^2	240
– type B Concrete …… …… ……. …... kg/cm^2	190
Punching shear …….. ……. …….. …. … ….. kg/cm^2	70
Diagonal shear ……. .. ……. …… … ……... kg/cm^2	44
Tensile stress in bending …. …….. …… …… …….	ZERO
b)Ultimate stresses used in the design of steel re-inforcement :-	
Where FY is the guaranteed yield or proof stress in ….. kg/cm^2	
Hot Rolled mild steel	
Nominal size …… ……. ……. …… …… …….	All Diameters
Specified characteristic strength …… …… …… ….. kg/cm^2	2500 = Fy
Tensile stress except in shear re-inforcement ……. ……. ……	0.87 Fy
Tensile stress in shear re-iforcement …… ……. …… ……	0.87 Fy
Compressive stress …….. …… …… …… ……..	0.87 Fy
Hot rolled high yield steel	
Nominal size …… ……. ……. …… …… ……..	All Diameters
Specified characteristic strength …… …… …… …..	4120 = Fy
Tensile stress except in shear re-inforcement ……. ……. …….	0.87 Fy
Tensile stress in shear re-iforcement …… ……. …… ……	0.87 Fy
Compressive stress …….. …… ……	0.87 Fy
Cold worked high yield steel	
Specified characteristic strength :	
Up to and including 16 mm …. ….. …… ……. kg/cm^2	4700 = Fy
Over 16 mm …… …… …… ……. …. kg/cm^2	4330 = Fy
Tensile stress except in shear re-inforcement	
Shear re-inforcement …….. …… kg/cm^2	0.87 Fy
Tensile stress in shear re-inforcement …… …….. ……	0.87 Fy
Compressive stress …… ….. ……. …… ……..	0.87 Fy

Technical Specifications for 132 kv O.H.L Rehabilitation Tender

Soi1 Classification

PRESUMED SOIL PARAMETERS

Soil C1ass	Permissib1e Foundation Arrangement	oi1 Classification	Concrete Density kg / Cu.m	Soi1 Density kg / Cu .m	Frustrum Angle Degrees º vertical	Bearing Pressure kN/ sq.m/m	Lateral Pressure kN/ sq.m/m Depth	Water Level Upper Limit	SPT N Count Per 300mm
Class 1 (Normal Soi1)	Anchor Auger, Conc. pad/Chimney	Rock Cohesive	parameters to be based on test results					B below base of foundation	
		Non- Cohesive	2400	1700	25	300	300		30
Class 2 (Weak Soil)	Auger , Conc. (Weak Soil)	Cohesive Non- Cohesive	2400	1600	20	175	225	0.5 m below base of 20	20
Class 3 (Loose Sand)	Conc. pad/Chimney	Non- Cohesive	2400	1500	10	125	150	B below base of foundation	10
Class 4 (Special)	Raft Piling	Dependent upon special investigation							>2

Notes:

1- Sub-soil investation limits based upon standard penetration equipment.

2-bearing pressures shown are ultimate nott allowable pressures.

3-Lateral earth pressure/metre of depth to be considerd, ignoring initial 300 mm below ground level. Below a depth of 5 m lateral earth pressure is to be assumed constant .

4- in case the soil characteristics are found to be lower than specified for class 2 soil, the difference in cost of such special foundations shall be paid for according to the method of measurement and payment given in Volume 2 , Clause 8.2.3.

5- water levels shown are nominal for concrete block foundations only . + B = base with of concrete block foundation .

6- * Allowable toe pressures for grillage Foundations may be 25 % higher than specified B.P.'s shown.

Technical Specifications for 132 kv O.H.L Rehabilitation Tender

8.Towers shutterings General

This specification is providing technical information for the manufacture of shutterings to be used for installation of the foundations on 132kV OHTL

The shuttering shall be provided for each type of towers.

The types of shuttering shall be manufactured according to the tower foundations drawings attached in Annex (5)&(6).

The height of forms for chimney of the foundation is variable according to the design of the foundations.

The manufacturing drawings will provide complete detailing for each shutterings element and will be delivered on both hard and electronic copies.

The fabrication of the shutterings shall follow the requirements of the international standards recommended below or other international/national standards with equal requirements:

BS EN 10025:1993 – Specifications for hot rolled products on non-alloy structural steel and their technical delivery conditions

ISO 657-/89 – Equal–leg angles

GOST 8509-93 – Hot rolled steel equal–leg angles. Dimensions.

IS 808/76 – Hot Rolled Steel Sections (India)

DIN 267 – Fasteners

DIN 7990 – Steel Hexagon Head Bolts for Structural Steel

BS 4190 – Specifications for ISO metric black hexagon bolts, screws and nuts – Specifications

BS 4360:1990 – Specifications for Weldable structural steels

BS 5135:1984 – Specifications for arc welding of carbon and carbon manganese steels

BS EN 288:1992 – Specifications and approval of welding procedures for metallic materials (Part 1,2,3)

EN 10137 – Plates and wide flats made of high yield strength structural steel

BS EN 499:1995 – Welding consumable

BS EN 970:1997 – Non–destructive examination of fusion welds – visual examination

BS 729/1971 (1986) – Specification for Hot Dip Galvanised Coatings on Iron and Steel Articles

ISO 9002:1987 – Quality systems – Model for quality assurance in production and installation

Technical Specifications for 132 kv O.H.L Rehabilitation Tender

8.1 -Materials

The material to be used for fabrication of the shutterings shall comply with an international or national standard. The shutterings elements shall be manufactured from mild steel as specified by designation S235JR from BS EN 10025 or equal quality.

The gusset plates shall be manufactured from mild or high steel as specified on the fabrication drawings. The high tensile steel is specified on the drawings by the letter H to the end of the number erection work and mild steel is specified by the letter M.

Nuts and head of bolts shall be of the hexagonal type. The washer shall comply with DIN 127. Bolt thread profile shall be of ISO form and shall be manufactured from one steel grade: DIN 267 grade 4.6.

8.2 Fabrication

All members shall be carefully cut and the holes shall be accurately located so that when members are in the position all bolts can pass through the holes freely. Individual members shall be true to shape and fully interchangeable with members bearing the same erection mark. Ends of members must be true to angle and free from burrs and notches.

The bolts and nuts and washers shall comply with drawings indications and relevant standards specified above. The bolts shall be of one grade of steel corresponding to grade 4.6. Any hole adjacent to a bend line or near the weld must be drilled after bending/welding. All bolts shall be galvanised including the threaded part. All nuts shall be galvanised with the exception of the threads that shall be oiled.

All bends over 5° on high tensile steel shall be formed hot (as defined by standard specifications). The welding shall comply with approved standard specifications. All shop welds shall be carried out by welders qualified for the work under proper supervision and in accordance with BS 5135.Machine welding should be used whenever possible. BS 4872 or equivalent standard specification shall be applied for welding.

The size of erection mark shall have numbers and letters at list of 16 mm and shall be assembled with bolts and nuts with flat washers.

The shutterings shall be protected against corrosion on the external face only with an approved paint.

8.3-Inspection of manufactured material

The shutterings shall be shop assembled in the presence of Owner's inspector. During check assembly, members must not be forced into position in such manner that deformation occurs.

All materials shall be accompanied by a manufacturer/suppliers certificate, which demonstrate compliance with the requirements of the specified standards.

The Owner's inspectors may ask to attend the assembly tests for deliveries. Business class flight tickets and full board accommodation for two Owner's Inspectors will be borne by the Manufacturer. The manufacturer shall provide all required equipment and instruments for these inspections. If required by Owner's inspectors, specimen welds shall be prepared and tested in accordance with relevant standards.

Technical Specifications for 132 kv O.H.L Rehabilitation Tender

8.4-Packing

The whole of the plant shall be packed where necessary in non-returnable cases or otherwise prepared for overseas shipment to a tropical country without sustaining damage. All packing shall become the property of the Purchaser. The Contractor is to arrange for the protection, against corrosion and mechanical damage during shipment.

Bundles of steel angle sections shall be properly tied together by an approved method and care taken to ensure that they are robust and not of excessive length for handling during shipment

The contents of packing cases shall be securely bolted or fastened in position with struts or cross battens.

Bolts and nuts shall be double bagged and crated for shipment.

Cases shall be up-ended after packing to prove that there is no movement of the contents.

Timber wedges or chocks shall be firmly fastened in place to prevent their displacement when the timber shrinks.

The Manufacturer shall be required to suitably protect all steelwork before shipment to prevent damage.

All stencil marks on the outside of casings shall be either of a waterproof material or protected by shellac or varnish to prevent obliteration in transit.

Each crate or package shall contain a packing list in a waterproof envelope and copies in triplicate shall be forwarded to the Purchaser prior to dispatch. All items of materials shall be clearly marked for easy identification against the packing list.

All cases, packages, etc., shall be clearly marked on the outside with a shipping mark to indicate the total weight, to show where the weight is bearing and the correct position of the slings and shall bear an identification mark relating them to the appropriate shipping documents.

The Owner can ask to inspect and approve the packing before the items are dispatched but the Manufacturer shall be entirely responsible for ensuring that the packing is suitable for transit and such inspection will not exonerate the Manufacturer from any loss or damage due to faulty packing.

8.5 -Quality Control Procedures

The manufacturer shall submit for approval all internal quality control procedures and quality plan before commencing the fabrication. The manufacturer shall have properly documented and fully implemented Quality System in accordance with ISO 9002,9003 and 9004:1987.

On commencement of the contract, the manufacturer shall present the list of all documents to be used to manage and control the quality of the products, works and services to be provided within the contract. This list shall include suppliers and sub-contractors documents.

Technical Specifications for 132 kv O.H.L Rehabilitation Tender

9. Towers Template General

This specification is designed to provide the technical information for fabrication of the templates to be used for installation of towers on 132kV OHTL

The templates shall be provided for each type of towers(DEF&DG) and shall allow fixing the correct position of the stub angles for each tower type and for each height of respective tower.

The types of templates shall be manufactured according to template drawings attached in Annex (1),(2),(5) & (6).

The manufacturer drawings shall provide complete detailing for each templates element and will be delivered on both hard and electronic copies.

The fabrication of the templates shall follow the requirements of the international standards recommended below or other international/national standards with equal requirements:

BS 10025:1993 – Specifications for hot rolled products on non-alloy structural steel and their technical delivery conditions

EN 10137 – Plates and wide flats made of high yield strength structural steel

ISO 657-1/89 – Equal–leg angles

GOST 8509-93 – Hot rolled steel equal – leg angles. Dimensions.

IS 808/76 – Hot Rolled Steel Sections (India)

DIN 267 – Fasteners

DIN 7990 – Steel Hexagon Head Bolts for Structural Steel

BS EN 10029-/1991 – Specification for tolerances on dimensions, shape and mass for hot – rolled steel plates 3mm thick on above

BS 4190 – Specifications for ISO metric black hexagon bolts, screws and nuts – Specifications

BS 5135:1984 – Specifications for arc welding of carbon and carbon manganese steels

BS 729/1971 (1986) – Specification for Hot Dip Galvanised Coatings on Iron and Steel Articles

ISO 9002:1987 – Quality systems – Model for quality assurance in production and installation

9.1- Materials

The material to be used for fabrication of the templates shall comply with international or national standards. The elements shall be manufactured from mild steel as specified by designation S235JR from EN 10025 or higher quality.

The gusset plates shall be manufactured from mild or high steel as specified on the shopping drawings. The high tensile steel (to be marked on the templates members) is specified on the drawings by the letter H to the end of the number erection work and mild steel is specified by the letter M.

Technical Specifications for 132 kv O.H.L Rehabilitation Tender

Nuts and head of bolts shall be of the hexagonal type. The washer shall comply with DIN 127. Bolt thread profile shall be of ISO form and shall be manufactured from one steel grade: DIN 267 grade 4.6.

9.2-Fabrication

All members shall be carefully cut and the holes shall be accurately located so that when members are in the position all bolts can pass through the holes freely. Individual members shall be true to shape and fully interchangeable with members bearing the same erection mark. Ends of members must be true to angle and free from burrs and notches.

The bolts and nuts and washers shall comply with drawings indications and relevant standards specified above. The bolts shall be of one grade of steel corresponding to grade 4.6. Any hole adjacent to a bend line or near the weld must be drilled after bending/welding.

All the supplied threaded part of the bolts shall be galvanised to a minimum average coating weight of 305 g/m^2. All nuts shall be galvanised with the exception of the threads that shall be oiled.

All bends over 5° on high tensile steel shall be formed hot (as defined by standard specifications). The welding shall comply with approved standard specifications. All shop welds shall be carried out by welders qualified for the work under proper supervision and in accordance with BS 5135.

The size of erection mark shall have numbers and letters at list of 16 mm and shall be assembled with bolts and nuts with single spring washers.

9.3-Galvanising of Template Members

All template members shall be galvanised by the hot dip process according to standard specifications (BS 729). The galvanisation process and the preparations for galvanising shall not have any adversely effect on the physical and mechanical features of the coated material.

All drilling, punching, cutting, bending and welding of members shall be completed and all burrs removed before galvanisation. The black members shall be pickled in dilute hydrochloric acid or blast cleaned and flash pickled in dilute hydrochloric acid, than washed, fluxed and stoved and coated with zinc by means of dipping in a bath of moulted zinc.

The template members shall be immersed in the bath only for the time sufficient to attain the temperature of the bath and shall be withdrawn at such speed to achieve a coating of 610 g/m^2.

The zinc coating shall be smooth, clean and of uniform thickness and free from defects. The members on which galvanising was damaged shall be re-dipped.

The control and tests of the galvanising shall fully comply with relevant international standards. Thickness of zinc coating shall be assessed as the mean of several measurements by magnetic means on 1% of samples selected from inspected delivery. Preece test shall be performed in order to check the uniformity of the zinc coating as required by the Owner's Inspectors. Six dips of one minute each without deposit of metallic copper will be required in order to test the adhesion and brittleness of the zinc coating. Selected samples shall be subjected to hammer test in the presence of Owner's inspector. If any sample fails to these tests, at least a further 1% shall be selected for re-testing the material. If any of these further batches fails, the whole of consignment shall be rejected and the members from the respective delivery lot shall be re-galvanised and re-inspected.

All bolts and screwed rods shall be galvanised including the threaded part to a minimum average coating weight of 305 g/m^2. All nuts shall be galvanised with the exception of the threads that shall be oiled.

To avoid the white rust during transportation an approved inhibitor shall be applied according to instructions of the producer. The protection solution against white rust shall be submitted for approval before fabrication.

9.4. Inspection of manufactured material

The templates shall be shop assembled in the presence of Owner's inspector. During check assembly, members must not be forced into position in such manner that deformation occurs.

All materials shall be accompanied by a manufacturer/suppliers certificate, which demonstrate compliance with the requirements of the specified standards.

The Owner's inspectors may ask to attend the tests for deliveries. Business class flight tickets and full board accommodation for two Owner's Inspectors will be borne by the Manufacturer. The manufacturer shall provide all required equipment and instruments for these inspections. The manufacturer shall submit two samples of each type of bolt, nut and washer for approval before issuing the sub-order.

9.5. Packing

Bundles of steel sections shall be properly tied together by an approved method and care taken to ensure that they are robust and not of excessive length for handling during shipment.

The whole of the plant shall be packed where necessary in non-returnable cases or otherwise prepared for overseas shipment to a tropical country without sustaining damage. All packing shall become the property of the Purchaser. The Contractor is to arrange for the protection, against corrosion and mechanical damage during shipment.

The contents of packing cases shall be securely bolted or fastened in position with struts or cross battens.

Bolts and nuts shall be double bagged and crated for shipment. Cases shall be up-ended after packing to prove that there is no movement of the contents.

Timber wedges or chocks shall be firmly fastened in place to prevent their displacement when the timber shrinks.

The Manufacturer shall be required to suitably protect all steelwork before shipment to prevent damage.

All stencil marks on the outside of casings shall be either of a waterproof material or protected by shellac or varnish to prevent obliteration in transit.

Each crate or package shall contain a packing list in a waterproof envelope and copies in triplicate shall be forwarded to the Purchaser prior to dispatch. All items of materials shall be clearly marked for easy identification against the packing list.

All cases, packages etc., shall be clearly marked on the outside with a shipping mark to indicate the total weight, to show where the weight is bearing and the correct position of the slings and shall bear an identification mark relating them to the appropriate shipping documents.

The Owner can ask to inspect and approve the packing before the items are dispatched but the Manufacturer shall be entirely responsible for ensuring that the packing is suitable for transit and such inspection will not exonerate the Manufacturer from any loss or damage due to faulty packing.

9.6.Quality Control Procedures

The manufacturer shall submit for approval all internal quality control procedures and quality plan before commencing the fabrication. The manufacturer shall have properly documented and fully implemented Quality System in accordance with ISO 9002,9003 and 9004:1987.

On commencement of the contract, the manufacturer shall present the list of all documents to be used to manage and control the quality of the products, works and services to be provided within the contract. This list shall include suppliers and sub-contractors documents.

9.7. Documents to be Submitted with Tender

Quality Assurance Certificates

Reference List

9.8. Schedule of Technical Particulars for Templates

(to be confirmed by Tenderer/manufacturer)

Item	***Description***	***Details***	
		Required	***Offered***
1.	Mild tensile steel for angles and plates according to BS EN 10025		
2.	Equal–leg angles		
3.	Bolts and nuts		
4.	Welding		

9.9.Schedule of Departure from the Requirements of the Specifications

e No.	s

Republic Of Yemen

Public Electricity Corporation

132 KV OHL Rehabilitation at Costal Areas

Al-fush, Raskat, Mukha

Technical Specifications for 132 kv O.H.L Rehabilitation Tender

Item No.	Description	Template Weight – Black [kg]	Reference Drawing no.
1			
2			
3			
4			
5			
6			

Technical Specifications for 132 kv O.H.L Rehabilitation Tender

10 - Technical Specifications of Polymer Insulator

10.1) Electrical and mechanical Characteristics :-

The electrical and mechanical Characteristics of 132 kv insulators which is avilable P.E.C for rehabilition the sections mentioned above are manufactered according to Appendix (7.0) with the following specification :-

Describtion	Suspension String	Tension String
Overall Leakage Path [mm]	7250	7250
Min. Electromechanical Failing Loss [kN]	120	210
Withstand Voltage-wet [kv]	600	820
Dry Lightning Impulse		
Withstand Voltage [kv]	1000	1000

10.2) System Voltage

System Highest Voltage [kv] 145 (System presently operates at 143 kv during the system peak .The supplier shall account in his design the operating voltage as 145 kv)

System nominal Voltage [kv] 132

10.3 - Materials

10.3.1) Marking of Insulators:-

Each insulator shall have marked upon it the manufacturer's name, the date of manufacture, the guaranteed electromechanical strength, etc.

10.3.2) Insulator:-

Composite insulators shall comprise an electrical corrosion resistance (ECR) type pultruded glass fiber reinforced epoxy core, which shall be enclosed within a silicon rubber seamless weatherproof sheath.

The sheath with sheds shall be fabricated from silicon rubber with a uniform diameter. Where the sheds are fitted separate to the sheath, the sheds shall be fitted by using High Temperature Vulcanization method.

Single shot High pressure injection molding is the preferred method of assembly.

10.3.3) Insulator Caps:-

The caps of insulator units shall be of hot dip galvanized min 120 micron malleable cast iron steel hot dip galvanized of 120 micron .

The design of the unit shall be such that the stresses due to expansion and contraction of any part of the insulator shall not lead to deterioration.

For composite insulators a seal is required against moisture penetration at the end fittings. The shed interface shall be provided, capable of accommodating movement due to thermal expansion and contraction and resisting insulator washing under live line conditions .

Technical Specifications for 132 kv O.H.L Rehabilitation Tender

10.4. Tests

10.4.1) Testing _ General:-

Type, sample and routine tests on individual insulator units shall be carried out in accordance with either IEC1109 or DIN 57 441 Part 2 and DIN 57 441 Part 1.

10.4.2) Insulation Withstand Test Required:-

Test on complete insulator strings shall carried out in accordance with IEC 60 to prove the required parameters.
Proposed test arrangements and procedures for Impulse Voltage Tests, Power Frequency Tests, insulator Flashover Tests shall be approved.

10.4.3) Design test:-

Design test on the insulator units shall have been previously undertaken in full accordance with the requirement of IEC 1109 and all amendments thereto, including the ageing tests under operation voltages and simulated weather conditions Annex C (IEC 1109). These tests should have been certified by an independent quality assurance organization, and the test certificates to be submitted with the offer.

10.4.4) Samples:-

Part of silicon rubber insulators should be submitted with the offer .

10.5. Design of Insulators , conductor and sheild wire Fittings :-

The contactor shall offer all fittings of the insulators , conductor according to Appendix (7.0) Appendix (10) and to the techincal requirment of the line connected to the towers to Appendix (8)

10.5.1) General:-

Insulator Fittings shall comply with DIN/VDE, BS or such other equivalent standard as may be approved.
The design of adjacent metal parts and mating surfaces shall be such as to prevent corrosion of the contact surfaces and to maintain good electrical contact under service conditions.
All clamps shall be as light as possible and shall be designed to avoid any possibility of deforming the stranded conductors and separating the individual strands.
Tension insulator sets shall incorporate devices for adjusting the conductor sag the total range of linear adjustment of the sag adjusters shall be not less than plus or minus 150 mm in steps of not more than 6 mm. The sag adjusters shall be placed at the earthed end of the string.
Suspension strings shall be terminating in trunnion type suspension clamps, which shall be corona free.
Protective Devices: The design of the protective fittings shall comply with the following requirements:-
- Shall effectively protect the insulator units and fittings form damage caused by power arcs ,
- Shall effectively improves the voltage distribution along the insulator string;
- Shall resist to force of 1 KN applied at a point of maximum leverage.

All ferrous metal parts except those of stainless steel shall be hot dip galvanized to give an average coating of zinc of 750g/m2 (107 microns) and shall be carried out according to BS 729 . White rust fermentation must be inhibited leading to rejection of the affected material.

Technical Specifications for 132 kv O.H.L Rehabilitation Tender

10.5.2) Electrical and Mechanical Characteristics

10.5.2.1) Fittings

Suspension insulator sets shall terminate in aluminium alloy trunnion type suspension clamps, which shall be corona free.

Tension insulator sets shall terminate in dead-end anchor clamps of the compression type, which shall include bolted jumper terminals. The plate which will receive the jumper terminals shall have an angle of 15 _ 25 ° to the vertical.

Adequate clearing area between fittings shall be provided and point and line contacts shall be avoided.

All split pins for securing attachment of fittings of insulator sets shall be backed by washers.

All bolts and nuts on insulator strings fittings shall be galvanized as specified and locked in an approved manner.

10.5.2.2)Arc/corona rings

Fittings shall make provision for arc rings to be attached at the line and earth end of individual composite sets.

The mechanical strength of arc rings shall resist to a force of 1 KN applied at a point of maximum leverage

10.6) Tests

Type tests on complete insulator strings shall be carried out in accordance with IEC standards to prove the required parameters in the Specifications .The Following parameters shall be obtained for each type of strings :-

- Dry lighting Impulse withstand Test _ 750 kv
- One Minute wet power Frequency Withstand Test _ 325 kv

Proposed test arrangement shall be submitted for PEC approval a minimum six week prior to commencement of the tests.

Corona Tests shall be carried out on one insulator string of each type to be supplied the insulator string complete with vibration dampers

A voltage of 10 % in excess of the nominal phase to earth voltage shall be applied to the phase conductor and following parameters shall not be exceeded, under the specified conditions:

Limit Voltage of a string measured in dB/1 micro V/300 Ohm

- Wet conditions – 55 dB @ 84 kv
- Dry conditions – 45 dB @ 84 kv

Test procedure shall be in accordance with IEC 437. The voltage measured at 0.5 MHz, at the above, a visual corona test shall be undertaken. Visible corona formation shall not occur at voltage less than 10 % in excess of the nominal phase to earth Voltage .

Sample and Routine Test shall be carried out according to BS 3288 Part 1.

10.6.1-Test Certificates

All metallic materials used in manufacture shall be covered by test certificates stating their mechanical, chemical and where specified impact properties and clearly showing the cast numbers to prove compliance with the requirements of this Specification

Tests of galvanized items shall be carried out at the works to ensure compliance with the requirements of BS 729 or approved equivalent. Details or the test results shall be made available upon request

Technical Specifications for 132 kv O.H.L Rehabilitation Tender

10.6.2-Cost of the Tests

Cost of the test as well as all traveling expenses for two P.E.C engineers and one consulting engineer, who will attend the tests, shall be borne by the Manufacturer of the fittings as an option .

10.6.3-Qualification

Only manufacturers which proven performance of at least 15 years in similar conditions shall be qualified. The tenderer shall submit the offer drawings and technical performance of the goods as well as tests intends to carry out to prove strict compliance with this specification.
Prior to start manufacturer and the Contractor shall get approval of the drawings test procedure.
All drawings of the existing insulators and insulator fittings are attached in appendix (7) .

11 - Technical Specifications of Conductors and conductors fittings

11.1 – Design – (ACSR and Aluminium conductors)

11.1.1 – Loading Conditions

The line and shieldwire conductors shall be strung so that under the assumed loading conditions (given in the table below) the stated conductor tensions are not exceeded

Loadind	**ZEBRA**	**7/8 AWG Shieldwire**
Erection Condition		
Maximum Tension (Still Air , No Ice) kgf	4000	4000
Temperature	-15	-5
Maximum working Tension Condition		
Maximum tension kgf	6400	2900
Temperature C°	5	5
Wind Pressure * kgf / sq.m	110	110
Everyday Condition		
Maximum Tension (Still Air, No Ice) kgf	3200	1400
Temperature C°	25	25

Note :-

* This value is to be applied to the full projected area of the conductors .

Temperature Limits	
Assumed Minimum Temperature	
All sections	15 C°
Maximum Conductor Temperature	
All sections	70 C °

11.2 - GENERAL

The line and shieldwire conductors and conduuctor fittings shall comply in all respect with the requirements as set out in this specification and otherwise with IEC publication No 209, ASTM-B416 or BS 125 as appropriate or such other standard as may be approved .

11.3 - Line conductors - General

Line conductors for sections(A1 ,A2 , E1 and F1) shall be of ACSR 400 mm^2 , and Line conductors for section (B1) shall be of AAAC 300 mm^2 with one conductor only per phase .

Technical Specifications for 132 kv O.H.L Rehabilitation Tender

11.4 - Conductor characteristic

The conductors shall have the following characteristics :-

- International code name	ZEBRA
- Type	ACSR
- Nominal Aluminium Area sq.mm	400
-Total Area	484.5
-Weight (without grease) kg / km	1621
Stranding :-	
(No .	54
Aluminium / Copper (	
(Dia mm	3.18
(No .	7
Steel (	
(Dia mm	3.18
Contd / …..	ZEBRA
Overall Diameter mm	28.62
Minimum Breaking	
strength kg	13450
Maximum d.c.	
Reistance at ohm / km 20° C	0.0674

12 - Technical Specifications of Shieldwire and shieldwire fittings

The shieldwire shall have the following characteristics :

		All Sections
Number of strands		7
Nominal diameter of strands	AWG	8
-ditto -	mm	3.26
Nominal Overall diameter of shieldwire	mm	9.78
Conted / ….		
Minimum ultimate tensile strength		
Aluminium Covered	Kg	6000
Copper Covered	Kg	6000
Weight :		
Aluminium Covered	Kg / km	389
Copper Covered	Kg / km	482

12.1 Joints and Clamps for conductor and sheildwire

The following types of joints and clamps can be offered :-

Mid-span tension joint	Compression type
Mid-span repair sleeves (non tension	Compression or preformed type
Tee connectors (3-way non – tension)	Compression or Bolted type
Deadend (tension)	Compression type with flag for removble jumper terminals
Jumper terminals (non – tension)	Compression type with flag for connection to deadend
Aluminium to copper connectors (bi-metal, non-tension)	Bolted
Suspension clamps	Aluminium alloy trunnion type

13 . Drawings Lists for the Project :-

13.1 - Designation of structures

The designation of structures will be as follows

Tower Designation	Description	Type of insulator	Reference Drawing
DA	Straight line (intermediate)	Suspension	3YE8/1006
DG	0°-20° Angle of deviation or straight line section	Tension	3YE8/1007
DH	20°-60° Angle of deviation	Tension	3YE8/1008
DEF	60°-90° Angle of deviation or 0°-45° Angle of entry for terminal positions	Tension	3YE8/1009
SJF	0°-90° Angle of deviation or 0°-45° Angle of entry for terminal positions	Tension	3YE8/1010
SX	0°-10° Angle of deviation or 0°-5° Angle of entry for terminal positions	Tension	3YE8/1014
ST	Straight line (intermediate)	Suspension	P. 105462 c
AT1	0°-10° Angle of deviation or straight line section	Tension	P. 106769 a

13.2 - Fabrication drawing of tower type DG \ See Appendix (1)

	Title	DG type Dr.No
1.	Index Drawing for fabrication	YEM008/4- 122ABC
2.	Outline Drawing	YEM008/4- 103AB
3.	Tower peak and top conductor Arm	YEM008/4- 123ABC
4.	Upper part and middle conductor Arm	YEM008/4- 124ABC
5.	Upper part and bottom conductor Arm	YEM008/4- 125ABC
6.	Basic body 13 m 160	YEM008/4- 126AB
7.	4.5 m body ext (17m 660)	YEM008/4- 127ABC
8.	9.0 m body ext (22m 160)	YEM008/4- 128ABC
9.	1.5 m 3.0 m and 4.5 m leg ext	YEM008/4- 129A
10.	6.0 m and 7.5 leg ext	YEM008/4- 130A
11.	Ant1 climbing Device	YEM008/4- 131AB
12.	Stub and cleat	YEM008/4- 132A
13.	Stub setting	YEM008/4- 133AB
14.	Stub setting	YEM008/4- 134AB
15.	Stub setting	YEM008/4- 135AB
16.	Stub setting	YEM008/4- 136AB
17.	Setting template	YEM008/4- 137AB
18.	Top conductor Arm	YEM008/4- 141A
19.	Upper part and middle conductor Arm	YEM008/4- 142A
20	Upper part and bottom conductor Arm	YEM008/4- 143A
21.	Stub setting	YEM008/4- 145AB

Technical Specifications for 132 kv O.H.L Rehabilitation Tender

13.3 - Fabrication drawing of tower type DEF \ See Appendix (2)

	Title	DEF type Dr . No
1.	Index Drawing for fabrication	YEM008/4-
2.	Outline Drawing	YEM008/4-303ABC
3.	Top conductor Arm	YEM008/4-326A
4.	Top conductor Arm Detail	YEM008/4-327A
5.	Upper part and middle conductor Arm	YEM008/4-328AB
6.	Detail of middle conductor Arm	YEM008/4-329AB
7.	Upper part and bottom conductor Arm	YEM008/4-330AB
8.	Bottom conductor Arm(Auxiliary Arm)	YEM008/4-331A
9.	Basic body (13 m 160)	YEM008/4-332A
10.	9.0 m body ext (22m 160)	YEM008/4-334A
11.	4.5 m body ext (17m 660)	YEM008/4-333A
12.	1.5 m 3.0 m and 4.5 m leg ext	YEM008/4-335A
13.	6.0 m and 7.5 leg ext	YEM008/4-336A
14.	Ant1 climbing Device	YEM008/4-337
15.	Stub and cleat	YEM008/4- 338A
16.	Stub setting	YEM008/4-339AB
17.	Stub setting	YEM008/4-341AB
18.	Stub setting	YEM008/4-342AB
19.	Stub setting	YEM008/4-344A
20.	Setting template	YEM008/4-345AB
21.	Stub setting	YEM008/4-

13.4 - Loading Diagram for existing and new towers \ See Appendix (3)

	Loading Diagram	Tower type	Dr . No
1	Loading Diagram	DA	YT-70/5-002
2	Loading Diagram	DG	YT-80/4-102
3	Loading Diagram	DH	YT-70/5-202
4	Loading Diagram	DEF	YT-70/5-302
5	Loading Diagram	SJF	YT-70/5-402

Technical Specifications for 132 kv O.H.L Rehabilitation Tender

13.5 - Out Line and Loading Schedule for existing and new towers \ See Appendix (4)

	Loading Schedule	Tower type	Dr . No
1	Out Line and Loading schedule for existing and new towers	DA	3YE8/1006
2	Out Line and Loading schedule for existing and new towers	DG	3YE8/1007
3	Out Line and Loading schedule for existing and new towers	DH	3YE8/1008
4	Out Line and Loading schedule for existing and new towers	DEF	3YE8/1009
5	Out Line and Loading schedule for existing and new towers	SJF	3YE8/1010
6	Out Line and Loading schedule for existing and new towers	ST	P. 105462 c
7	Out Line and Loading schedule for existing and new towers	AT1	P. 105788 a
8	Typicl ARRANGEMNT OF ANTI – CLIMBING DEVICE AND DANGER	All	3YE 8 / 1011

13.6 - Foundation drawings of tower type DEF and DG \ See Appendix (5)

	Title	DG type DEF Dr . No
1.	Concrete block foundation	YEM008/1- 001-00
2.	Typical arrangement of foundation & earthing arrangement for soil classes 1&2	3YE8/1004
3.	Stub setting details DG type tower	YEM008/4- 136AB
4.	Stub setting details DG type tower (soil class 2)	YEM008/4- 134AB
5.	Stub setting detail for DEF type tower of belled caisson	YEM008/4- 345AB
6.	Stub setting details DEF type tower	YEM008/4- 339AB
7.	Stub setting details DG type tower (soil class 1)	YEM008/4- 133AB

13.7- Special foundation drawing for soil type 4 SJF towers \ See Appendix (6)

Tower Type	Drawing No
SJF	YT-70/3-108
	YT-70/3-107

Technical Specifications for 132 kv O.H.L Rehabilitation Tender

13.8 - Insulators and insulator fittings \ See Appendix (7)

Total existing towers weight for rehabilitation project

No	Section Name	NO of towers required (73)							
		DEF type				DG type			
		Terminal	NO Tension Insulator string	Angle.	NO Tension Insulator String	tension	NO Tension Insulator string	Suspension	NO Suspension Insulator string
1	Section E1	1.0	12	—	—	3.0	36	6.0	36
2	Section A1	1.0	12	—	—	5.0	60	4.0	24
3	Section A2-1	1.0	12	1.0	12	5.0	60	5.0	30
4	Section A2-2	1.0	12	—	—	2.0	24	6.0	36
5	Section F1 new	1.0	12	1.o	12	3.0	36	4.0	24
6	Section B1	0.0	—	1.0	12	2.0	24	15.0	90
7	Spare towers	1.0	—	1.0	—	1.0	—	2.0	00
	Total	6.0	60	4.0	36	21.0	240	42	240

Total of suspension insulator string = 240 unit
Total of tension insulator string = 336 uni

13.9 – Existing and new Sections Routes Schedules \ See Appendix (8)

Section NO	circuits	Description	Reference Drawing
A1	Ras.Kat – to Bajel	9 Towers to be located beside the exsiting at Ras.Kat area	3Y/1A1
A2-1	Ras.Kat – to Hodiudah	12 Towers to be located beside the exsiting at Ras.Kat side	3Y/1A2-1
A2-2	Ras.Kat – to Hodiudah	8 Towers to be located beside the exsiting at Hodiudah side	3Y/1A2-2
B1	Hiswa – to Jear	18 Towers to be located beside the exsiting at Al.Fush area	3Y/1B1
E1	Mukha – to Barh	9 Towers to be located beside the exsiting at Mukha area	3Y/1E1
F1	Mukha – to Jarahi	7 Towers to be located beside the exsiting at Mukha area	3Y/1F1

Technical Specifications for 132 kv O.H.L Rehabilitation Tender

13.10 - Existing Section Record line data \ See Appendix (9)

Section NO	circuits	Description	No of Sheets
A1	Ras.Kat – to Bajel	line data from tower No (101 B) to tower No (122)	5 Sheets
A2-1	Ras.Kat – to Hodiudah	line data from tower No (1A) to tower No (23)	11 Sheets
A2-2	Ras.Kat – to Hodiudah	line data from tower No (55) to tower No (61)	
B1	Hiswa – to Jear	line data from tower No (79) to tower No (106)	3 Sheets
E1	Mukha – to Barh	line data from tower No (1R) to tower No (9)	7 Sheets
F1	Mukha – to Jarahi	line data from tower No (401L) to tower No (8)	7 Sheets

13.11 - Suspention and Tension Set for sheild wire \ See Appendix (10)

1.	- Suspention Set for sheild wire
2.	- Tension Set for sheild wire