

- c. content of aggressive carbon dioxide, mg/l;
- d. content of magnesia salts, mg/l, recalculated in terms of ions, Mg^{+2} ;
- e. content of ammonia salts, mg/l, recalculated in terms of ions, NH_4^{+} ;
- f. content of caustic alkalis, mg/l, recalculated in terms of ions, Na^{+} and K^{+} ;
- g. contents of chlorides, mg/l recalculated in terms of ions, Cl^{-} ;
- h. contents of sulphates, mg/l, recalculated in terms of ions, SO_4^{-2} ;
- i. aggregate content of chlorides, sulphates, nitrates, carbonates and other salts, mg/l.

6.8 Morphological Study of Rivers

Morphological study should be conducted for the rivers which are crossed by transmission line or the rivers that run parallel/close to transmission line. The study shall be carried out by a specialist firm/person appointed by the Contractor in consultation with the Employer's Engineer. Duely sealed and signed study report shall be submitted by the Contractor for Employer's review and approval.

The study report shall include the following:

- a. Geological information of the study area including geomorphology, geological structure.
- b. Observations and data regarding historical channel and bank line movement for the river/ change of course of river;
- c. Prediction about possible future development of the river.
- d. Design discharge, maximum velocity, scour depths, slit factor, etc., and history of flood details for mid-stream and river bank locations.

6.9 Rates and Measurements

6.9.1 Rates

The Contractor's quoted rates shall be inclusive of making observations, establishing the ground level and coordinates at the location of each borehole, test pit etc. No extra payments shall be made for standard penetration test, collecting, packing, transporting of all samples and cores, recording and submittal of results on approved formats and conducting morphological study of rivers.

6.10 Field Quality Plan

A standard field quality plan is given in **Annex 3-5** of this document as a minimum requirement. Bidders are requested to convey their acceptance of the same along with their offer.

6.11 Foundation Setting Level Diagrams

Where specified foundation setting level diagrams shall be prepared for specific tower positions. At a scale of 1:200 (horizontally and vertically) the foundation excavation and setting levels on the two diagonals (drawn separately) shall be shown, together with a record of the applicable foundation design, leg and body extensions and tower centre-pegcoordinates.



The contractor shall confirm the water level and adjust the foundation setting level to meet the requirement. Such foundation site shall be dewatered by pumping or other approved means during excavation, all other necessary arrangements to perform the foundation work in water-logged condition, concrete works and backfilling works. Those costs shall be deemed to be considered in the Contractor's expense.

If raised chimney is required at any location, stubs required for that raised chimney will have to be designed by the contractor subject to approval by the Employer. Such costs shall be deemed to be included in the contract price.

Depending on the highest flood level, raised chimney may vary from 1m to 6m in one meter increment. The Contractor shall submit his proposed method of installation and Q.C. procedures to the Engineer prior to commencing his design. This is a **Hold Point**.

7.1.4.5 Rigid Frame Foundation

Rigid framed foundation, which is adopted at high water level area, shall be consisted of rigid frame and pile.

As for foundation design, foundation shall be designed as a rigid frame to withstand against uplift load, compression load and horizontal load. The Contractor will consider friction between pile and soil against uplift load and against compression load, displacement of pile against horizontal load respectively. Individual footings shall be interconnected by tie beams, which shall be adequate to resist lateral forces and hydrostatic pressure exerted by the flood water. Allowances shall be made in the foundation design for hydrostatic pressure and the effects of seasonal rains, and scour.

In flooding area, the top of chimney concrete of the foundation shall be above the highest flood level. The Contractor shall confirm the water level and adjust the foundation setting level to meet the requirement. Such foundation site shall be dewatered by pumping or other approved means during excavation all other necessary arrangements to perform the foundation work in water logged condition, concrete works and backfilling works. Those costs shall be deemed to be considered in the Contractor's rates.

Depending on the water height, rigid frame foundation may vary from 2m to 6m. The Contractor shall submit his proposed method of installation and Q.C. procedures to the Engineer prior to commencing his design. **This is a Hold Point.**

7.1.4.6 River Crossing Foundations

The location of both river crossing tower and anchor tower should be finalized based on hydro and geomorphological study of the river. Foundations of both river crossing tower and anchor tower shall be treated as foundations on midstream of river. If any other type of tower/towers is/are require to be spotted near/parallel to any river, then base on morphological study foundation of those tower/towers shall be treated same as described above.

Foundation of these types of tower shall be pile supported. The pile shall be designed considering an unsupported height equal to depth of river bed plus allowance for scour depth. If permanent casing is required for pile casting upto any depth, the contractor shall considered its cost within the quoted price. Lacey's formula may be applicable for calculating scour depth. All required data to calculate the scour depth shall be collected and managed by bidder themselves. Skin friction for unsupported height shall be considered zero in calculating the pile capacity in this regard.

Top of chimney of this type of tower shall be at least 450mm above highest flood level. The Contractor has to assess the river erosion and has to perform the foundation works within the quoted price even if the tower location found under water during execution stage.



11. Conductors

11.1 Scope

11.1.1 Types and Uses

The type and configuration of the phase conductor and earthwire shall be in accordance with the requirement of this specification. For types of conductor reference should be made to **Annex 11-1**.

11.1.2 Definition

The following definitions are used throughout this specification:

ACCC	Aluminium Conductor Composite Core
AAC	All Aluminium Conductor
AAAC	All Aluminium Alloy Conductors
ACSR	Aluminium Conductor Steel Reinforced
ACAR	Aluminium Conductor Alloy Reinforced
AACSR	Aluminium Alloy Conductor Steel Reinforced
ACSR/AW	Aluminium Conductor Aluminium clad steel reinforced
S	Galvanised Steel Conductor
SA	Aluminium clad steel conductor

11.1.3 Sub-conductor Configuration

For details of sub-conductor configuration and spacing reference should be made to **Annex 11-2**.

11.1.4 Optical Fibre Cable

For details of embedded optical fibre cable reference should be made to Section 14 of this specification.

11.1.5 Special Warranty for ACCC Conductor-Not Applicable

The Contractor shall submit warranty certificate for ACCC conductor to the Employer within 30 days of the date of sale of the ACCC Conductor. The warranty shall valid for three years and shall start from the date mentioned in Conditions of Contract, Volume 1 of the bidding document. Scope of warranty shall be as below:

The ACCC® Conductor O.E.M. Warranty covers ACCC® Conductor and Connector failure due to:

1. Sag, Thermal Elongation & Creep: This Plan will repair or replace any covered Line that Creeps or Sags more than 5% of its measured and documented installation sag.



11.7.5 Type Tests

The following tests shall be conducted once on sample/samples of conductor from each manufacturing facility:

(a) ACCC Conductor-**Not Applicable.**

(1)	On complete Conductor	
i)	DC resistance test on stranded conductor	: As per Annex 11.4
ii)	UTS test on stranded conductor	: As per Annex 11.4
iii)	Stress- Strain test on stranded conductor and core at room temperature	: IEC 61089
iv)	Sheaves Test	: As per Annex 11.4
v)	Axial Impact Test	: As per Annex 11.4
vi)	Radial Crush Test	: As per Annex 11.4
vii)	Torsional Ductility Test	: As per Annex 11.4
viii)	Aeolian Vibration Test	: As per Annex 11.4
(2)	On Conductor Strand/core	: As per Annex 11.4
i)		: As per Annex 11.4
ii)	Coefficient of linear expansion on composite core	: As per Annex 11.4
iii)	Bending test on composite core	: As per ASTM B987
iv)	Brittle Fracture Test	: As per Annex 11.4
Type tests specified shall require to be submitted in the bid for the ACCC Conductor. Report shall be considered valid if the tests conducted within the past 5 years as on the date of bid opening at an accredited ISO/IEC 17025 third party laboratory or at manufacturer's own laboratory witnessed by the representative(s) of a utility or witnessed by a representative of an ISO/IEC 17025 accredited laboratory. In the case of composite core conductors, the tests specified shall be carried out before stranding on as-manufactured samples. The ACCC conductor, to be used in the transmission line, must be type tested. If the bidder does not submit above satisfactory type test reports for the offered type ACCC conductor with their bid, then the type tests as per above requirements must be conducted during contract execution stage in presence of Employer Engineers within the Contract price.		

(a) ACSR Conductor



The following tests shall be conducted once on a sample of conductor for each type of conductor for manufacturing facility:

i)	DC resistance test on stranded conductor	: As per Annex 11.4a
ii)	UTS test on stranded conductor	: As per Annex 11.4a

11.7.6 Acceptance Tests

(a) ACCC Conductor-Not Applicable.		
i)	Visual and dimensional check on drum	: As per Annex 11.4
ii)	Visual check for joints scratches etc. and length measurement of conductor by rewinding	: As per Annex 11.4
iii)	Dimensional check on core/core strands and Aluminium or Aluminium Alloy strands	: As per Annex 11.4
iv)	Check for lay-ratios of various layers	: As per Annex 11.4
v)	Breaking load test on core/core strands and aluminium/Aluminium alloy strands	: As per Annex 11.4
vi)	Minimum conductivity test on Aluminium/thermal resistant Aluminium Alloy strands	: As per IEC 60889
vii)	Procedure qualification test on welded joint of Aluminium/ Aluminium Alloy strands	: As per Annex 11.4
viii)	Heat resistant test on Aluminium Alloy strands	: As per Annex 11.4
ix)	Glass transition temperature test for composite core	: As per Annex 11.4
x)	Galvanic layer thickness test for composite core	: As per Annex 11.4
xi)	DC resistance test on aluminium/Aluminium alloy strands	: As per Annex 11.4
xii)	Bending test on composite core	: As per Annex 11.4
All the tests to be performed on composite core shall be carried out in as manufactured conditions before dispatch of composite core. Two engineers of PGCB will carry out the witnessing of these tests on 5% reels of each lot/shipment. Bidders are requested to refer to clause 18.1.11.1 in this regard. All costs of such tests and witness shall deem to be included in the contract price. All acceptance tests of Conductor as mentioned above to be carried out on 10 % of conductor drums.		

(b) ACSR Conductor/Galvanized Steel Earthwire		
i)	Visual and dimensional check on drum	: As per Annex 11.4a



Annex 11-4: Test Procedures of Conductor

Annex 11-4(1): Tests on ACCC Conductor –Not Applicable.

1.1 UTS Test on Stranded Conductor

Circles perpendicular to the axis of the conductor shall be marked at two places on a sample of conductor of minimum 5 m length between fixing arrangement suitably fixed by appropriate fittings on a tensile testing machine. The load shall be increased at a steady rate up to 50% of minimum specified UTS and held for one minute. The circles drawn shall not be distorted due to relative movement of strands. Thereafter the load shall be increased at steady rate to minimum UTS and held for one minute. The Conductor sample shall not fail during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

1.2 Corona Extinction Voltage Test (Not applicable)

The sample of the conductor of 5 m length shall be strung at a height not exceeding 7.01 m above ground. The sample assembly when subjected to power frequency voltage shall have a corona extinction voltage of not less than 154kV (rms) line to ground under dry condition. There shall be no evidence of corona on any part of the samples. The test should be conducted without corona control rings. However, small corona control rings may be used to prevent corona in the end fittings. The voltage should be corrected for standard atmospheric conditions.

1.3 Radio Interference Voltage Test (Not applicable)

Under the conditions as specified under (1.2) above, the conductor samples shall have radio interference voltage level below 1000 microvolts at one MHz when subjected to 50 Hz AC voltage of 154 kV line to ground under dry conditions. This test may be carried out with corona control rings and arcing horns.

1.4 D.C. Resistance Test on Stranded Conductor

On a conductor sample of minimum 5m length two contact-clamps shall be fixed with a predetermined bolt torque. The resistance shall be measured by a Kelvin double bridge by placing the clamps initially zero metre and subsequently one metre apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20°C as per relevant IEC/BS/equivalent standard. The resistance corrected at 20°C shall conform to the requirements indicated in the STP.

1.5 High Temperature endurance & creep test

Two conductor samples of length equal to at least $100 \times d + 2 \times a$ (where, d is the conductor diameter and a is the distance between the end fitting and the gauge length) shall be strung at tension equal to 25 % of conductor UTS. The distance, a, shall be at least 25 % of the gauge length or 2 m whichever is the smaller. The conductor samples shall be subjected to tests as indicated below:

(i) On one of the conductor samples, the conductor temperature shall be maintained at 20 deg C for 1000 hours. The elongation/creep strain of the conductor during this period shall be measured and recorded at end of 1 hour, 10 hour, 100 hour and subsequently every 100 hour upto 1000 hours time period.

