Site and Erection Works (TS-2)

KENYA - UGANDA - INTERCONNECTION

400 kV DOUBLE CIRCUIT – LINE OPERATED AS A 220 kV
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1 General Works

1.1 Obtaining Right-Of-Way and Compensation

1. Prior to starting and during the construction work, the Employer shall obtain and compensate for the following:

a. Right of constructing the transmission line along the selected line route;
b. Acquisition of tower sites, as located by the Contractor;
c. Right of using a strip of land of 60m long within the right-of-way along the selected line route and;
d. Removal of houses and other properties, which are to be removed from the right-of-way.

2. The Contractor shall be responsible for the following, but not being limited to, and shall pay at his expense for all necessary costs for:

a. Compensation for damages to trees, vegetation, crops and the like during the works up to taking over;
b. Land for storing the plant materials and the Contractor's equipment, and for camps, offices and Works outside the area specified in the above (1) (a) to (c) except as specified in the Conditions of Particular Application;
c. Construction and removal of temporary access to site and use of private roads, access, and bridges and;
d. Repair and restoration of public or private roads, access and bridges damaged by the Contractor.

3. The Contractor shall submit five (5) copies of access maps showing the locations of proposed access at least two (2) weeks prior to the commencement of the works to the Employer.

If any difficulty or trouble should arise in using the lands and the right-of-way arranged by the Employer, the Contractor shall without any delay inform the Employer of the fact.

4. The Contractor shall also be responsible for giving occupiers of land adequate notice of the commencement of the work before the work commences.

The Contractor shall take all precautions to avoid damage to land, properties, roads, field drains, fences, gates, walls, trees, hedges, crops and the like and shall ensure that the work is adequately supervised so that damage is to be limited to the minimum.

5. In case the Contractor does not disburse duly the compensation, which he is obligated, the Employer is entitled to pay the unsettled compensation and deduct the corresponding sums from the payments to the Contractor.

6. Measurement for Payment

There shall be no separate measurement for payment for the works described in this Clause.

1.2 Survey

1.2.1 Scope

The line route survey shall include, but not being limited to, the following tasks:

1. The actual line route survey;
2. Map and profile;
3. Land schedule;
4. Mapping of access roads;

5. Preliminary soil investigation;


1.2.2 Line route

The line route has been marked on the maps attached hereby in drawing # TLUK-017 (will be provided later), which shall be followed generally. However, the scale of the available maps is not suitable for specifying the line route in details. The surveyor shall follow the route considering the requirements of every single tower location, especially, when locating the route angle points.

If the route on the map cannot be surveyed as a straight line, the line should be drawn smoothly using angles up to 15 degrees to left and right as needed. Greater angles can be used if necessary.

At the Kenya/Uganda border, it is the Contractor’s responsibility to ensure that the last section of the Kenya/Uganda line is compatible with the alignment of the last section of the Kenya/Uganda line.

1.2.3 Survey Work

1.2.3.1 Line survey

The line survey shall be done in accordance with the described line route and marked on the maps attached hereby in drawing # TLUK-017 (will be provided later).

The surveyed line route shall be clearly marked by concrete or wooden posts or plastic tubes so that the line route can be identified in every section of the line. All route angles shall also be marked by the posts.

All buildings, overhead lines, cables, pipelines, roads, walls, fences, tanks and other firm obstacles, which differ from the general shape of the ground, reaching to the right-of-way area, shall be measured by location, length, height, level and slope and drawn on the line route map. The ground level and slope shall be determined by adequate intervals (20 m) and where the ground slope changes. If the ground slope across the line exceeds 1:25, the level of ground left and right of the centre line shall be recorded at the horizontal distances of 6 and 12 m.

The boundaries of plots of land shall be also mapped up to an offset distance of 16 m on both sides of the centre line.

The line route shall be mapped to the distance of 60 m on both sides of the centre line.

The following levels of objects are to be measured:

1. Roads

2. Crossing of overhead lines and towers

3. Water levels (actual water level with date and time and HW-level)

4. Buildings, tanks

5. Fences and walls, etc.

Water levels in and near waterways at flood stage shall be determined by statistics or approximation by landmarks.

The accuracy of survey shall be such that the vertical tolerance between levels forming the profile and actual ground level shall not exceed 30 cm and the horizontal distance to the accuracy of not more than 0.2%.
1.2.3.2 Map and Profile

After the survey, the map and profile of the line route shall be produced. The right-of-way shall be shown on the map in scale 1:2000 reaching 50 m on both sides of centre line.

The profile of the centre line shall be drawn in horizontal scale 1:2000 and in vertical scale 1:500 (1:200). If the ground slope across the line route exceeds 1:25 the contour of the ground left and right of the centre line shall be shown at distance of 6 m.

All vertical 0.5 m transition points shall be shown on the profile and also the levels the following objects:

1. Roads
2. Crossing of overhead lines and towers
3. Water levels
4. Buildings
5. Fences and walls, etc.

1.2.3.3 Land Schedule

The land schedule of the line route shall be made, showing sheet number, plot numbers, name of owner, area on the line route up to an offset distance of 16 m of the line on both sides of the centre line, particulars of permanent structures and obstructions including major trees, bushes, if there are any on plots of land along the route of transmission line up to an offset distance of 16 m of the line on both sides of centre line.

All trees and bushes which must be cut, shall be marked in this schedule, as well as all buildings, which shall be pulled down.

1.2.3.4 Access Roads

All the existing access roads on the line route area shall be marked on the route map. The existing roads from main road to the line route if any shall be listed with description of condition. The possible routes for necessary access roads shall be looked for and described.

1.2.4 Preliminary Soil Investigation

The bearing capacity of soil and soil type shall be estimated visually at adequate intervals and soft soil areas on the right-of-way shall be mapped in order to avoid tower setting at these areas.

The areas, where there is risk of landslides above or below the tower shall be mapped as well as the areas of exposed to erosion.

1.2.5 Soil Resistivity Measurement

The soil resistivity shall be measured at 500 m intervals for characteristics of soil changes. The results shall be recorded in the report mentioning the exact distance from the starting point of the line and the measurement result as well as the soil type.

1.2.6 Estimation of Environmental Impacts

In addition to items mentioned above concerning the environmental impacts as the land use, housing, cutting of trees on the right-of-way, the risk of erosion and landslides, the following areas shall be recorded:

1. Ecologically sensitive areas on the right-of-way or in the vicinity of the line.
2. List of historical and cultural sites with location and description recorded.
3. Settlements, being in the vicinity of the line.
4. List and locations of the bird migration routes, such as valleys crossing with the line.

1.2.7 Route Clearing

During the survey work the bush clearing must be kept as minimum as possible, only such clearing shall be done which is necessary in performing the survey.

1.2.8 Measurement for Payment

Payment for survey work shall be based on the unit prices stated in the Schedule of Prices (will be provided later).

1.3 Transmission Line Design

1.3.1 Tower Plotting

Tower plotting shall be started immediately after the Employer’s approval of map and profile drawings. Tower plotting shall be done either by using approved sag templates or by using PC and approved plotting program.

1.3.2 Tower List

After tower plotting the tower list shall be furnished. The tower list shall include at least the following information:

- Tower number
- Survey number
- Chainage
- Span (tower-to-tower)
- Ruling span
- Horizontal angle
- Wind span
- Weight span
- EDS
- Tower type
- Body extension
- Leg extensions
- Foundation type
- Foundation protection
- Insulator string data (suspension s/d, tension s/d, normal/inverted, jumper support and counter weight)
- Support level
- Support difference
- Span slope: \( h_1/S_1, h_2/S_2 \) and \( \Sigma h/S \)

- Minimum clearance: ground, river, power/telecommunication line, road and other

- Remarks: crossing type and land item.

Plotted map and profile drawings and tower lists shall be submitted to the Employer for approval.

### 1.3.3 Tower Spotting

Immediately after approval of plotted map and profile drawings the Contractor shall start tower spotting. One concrete centre peg shall be located at the station of the proposed tower location.

In addition to two reference pegs shall be located so that centre of tower can be found and re-pegged in the case that original centre peg has been moved or destroyed. The size of centre peg shall be 10 cm x 10 cm x 45 cm. The reference pegs can be concrete, wood or steel.

If proposed tower location as plotted in the profile drawing is not suitable by reason of topographical, geological or any other affecting conditions, the Contractor shall be required to recommend the proper location of tower to the Employer for consideration. The Contractor shall carry on the work in accordance with the Employer's decision.

Tower spotting and measuring of levels shall be performed by the qualified and experienced personnel and supervised by the qualified surveyor. Not less than 15 days prior to the commencement of work, the Contractor shall submit qualification of surveyor(s), work program and list of survey equipment for approval of the Employer.

During tower spotting the Contractor shall also make soil investigations at every tower location by using approved method.

In addition to, the Contractor shall measure the earth resistivity at every tower location by using approved method.

All the works concerning this chapter should be carried out under strict supervision and coordination of the Employer.

### 1.3.4 Measurement for Payment

There will be no separate measurement for payment for transmission line design. Payment for transmission line design shall be included in the unit prices of the survey work stated in the Schedule of Prices (will be provided later).

### 1.4 Right-Of-Way Clearance and Access Tracks

#### 1.4.1 Right-of Way Clearance

Clearing shall consist of cutting at the approved or specified heights and disposing of all trees, bush and other vegetation within areas to be cleared, reference to the drawing TLUK-007 (will be provided later).

Clearing of trees and shrubs in the area of right-of-way shall be carried out in compliance with the local applicable laws, rules and regulations, and Employer’s practice.

In addition to the above, all tall trees or other obstructions outside the right-of-way which may fall down within 3.5 m of any line conductor under still air or which will likely interfere with the operation of the transmission line (called as danger trees) shall be checked by the Contractor and to be trimmed, cut down or dismantled by the Contractor upon direction by the Employer.

For spans across deep valleys, the right-of-way need not be cleared for the bottom of the valley but must be cleared for a distance of 8 m from any tower leg.

Clearing shall be completed (final clearing) by the Contractor one month before starting of operation of the
transmission line and the Employer will compensate for trees to be cut in the right-of-way.

1.4.2 Access Tracks

The Contractor shall construct, maintain and demolish the temporary access tracks for approaching the construction sites. The route and construction programme for temporary access tracks including associated drainage, stream crossing facilities, bridges, etc., to and around the working sites; and the construction schedules shall be submitted by the Contractor to the Employer for his approval.

The Contractor shall adhere strictly to AfDB’s Environmental Assessment Guidelines, local environmental regulations, the Employer’s practice and stipulations in Scope of Supply, Clause 2 when constructing the temporary access tracks. The most salient principles of the Environmental Management are, but not being limited to, such as:

- Minimize the need to construct of new access tracks wherever possible;
- Employment of existing access roads and tracks wherever available;
- Decommission additional temporary access tracks at end of construction; and
- Where access is required across agriculture lands use temporary access paths during dry season involving placement of geotextile over which aggregates shall be placed.

1.4.3 Measurement for Payment

There will be no separate measurement for payment for temporary access tracks.

Payment for right-of-way clearance work shall be based on the unit prices stated in the Schedule of Prices (will be provided later).

2 Foundation Works

2.1 Soil Test

2.1.1 Scope

This specification covers all the work required for geotechnical investigations at tower locations and laboratory soil tests. The work includes all necessary equipment and labour required for carrying out the soil investigation as specified hereafter. The work includes a detailed report on soil investigations and laboratory tests. The methods and the amount of soil tests shall be described herein.

The purpose of the soil test is to determine and verify the soil parameters used in foundation design. The subsoil conditions shall be determined at each tower location by using light static dynamic sounding method (LSD-sounding). At a certain number of tower locations additional and more detail soil tests shall be carried out with standard penetration test (SPT-probing) and laboratory analysis.

2.1.2 Codes and Standards

All work shall be carried out in accordance with the relevant international standards such as BS, DIN, ANSI etc. Preferably British Standard shall be used whenever practical.

2.1.3 Field Work

2.1.3.1 General

The survey and mapping team will be accompanied by a soil investigation team (LSD sounding team). This will comprise of a supervisor and the necessary number of assistants. The supervisor shall be a qualified and experienced engineer, geologist or similar. The SPT tests shall be taken at a certain number of locations as agreed upon with the Employer. The SPT tests and laboratory tests shall be carried out by a qualified company and testing laboratory.

The details for LSD-soundings and SPT-tests shall be subject to approval by the Employer.
2.1.3.2 Method of Drilling

Drilling or augering in soil shall be done according to instructions and standards regarding the probing method. Dynamic methods (hammering, hitting, Dynamic cone penetration) may be used when hard soil strata is met and hand augering is no longer possible. The drilling log diagrams, SPT N-values or LSD blow counts, ground water table observations, soil description and thickness of different soil strata shall be reported at each investigation point. The drill hole depth is usually 6 metres, minimum depth being 3 metres in case of very hard soil stratum that contains big stones, cobbles or boulders. In case of very soft clay or clayey soil the drilling shall be continued up to one metre depth inside the hard soil stratum. The maximum drilling depth for SPT in this case may be about 20 metres.

2.1.3.3 Soil Sampling

Sampling shall be done according to BS or other equivalent standards. Disturbed soil samples may be taken with the split spoon sampler of the SPT test equipment and the samples shall be securely sealed and systematically labelled in plastic bags. The number of disturbed soil samples to be taken will be determined at the time of the detailed soil investigations. Undisturbed soil samples for in-situ density, unconfined compression and consolidation tests shall be collected by means of an open tube sampler. The number of undisturbed soil samples will depend on the occurrence of the cohesive soil or very soft clay at the actual tower location. Undisturbed soil samples shall be taken sufficiently to define the required soil properties by laboratory analysis. Numbering and labelling of all soil samples shall be clear and unambiguous. The samples shall be properly packed and securely transported to the testing laboratory.

2.1.3.4 LSD Soundings

The light static dynamic soundings shall be carried out at each tower location according to the detailed description, which shall be given for review and approval by the Employer.

2.1.3.5 Standard Penetration Test (SPT)

Standard penetration tests shall be carried out at one-metre intervals according to BS or other equivalent standards. The number of blows (N-values) for every 150 mm penetration shall be recorded.

2.1.4 Laboratory Tests

All the laboratory tests shall be done in proper soil testing facilities and shall be performed by qualified and experienced personnel. The tests shall be carried out according to the BS standards or equivalent. The final number and quality of laboratory testing shall be subject to approval by the Employer. The scope of laboratory tests together with SPT tests include:

a. tests for determining the physical properties of the soil such as moisture contents, specific gravity, grain size distribution etc. (sufficiently per each SPT investigation point)

b. unconfined compression tests for cohesive undisturbed soil samples (two to four tests for the length of the transmission line)

c. direct shear tests for non cohesive soils (one or two tests per each SPT investigation point).

The quantity of laboratory tests to be performed shall be limited to those mentioned in parentheses above.

2.1.5 Formal Report of the Test Results

The Contractor shall draw up and submit a full test report of the soil tests for review and approval by the Employer. The report shall contain test results and observations as well as recommendations for foundation types to be used. The report shall also contain a brief geological description of the line route, history for regional seismic...
activities, recommendations for types of foundations to be used, soil bearing capacities and considerations for deleterious effects of the soil (soil aggressivity) for concrete foundation structures.

2.1.6 Measurement of Ground Resistance

The Contractor is required to perform ground resistance tests at every support location. Methods of measurement, tools and instruments shall be submitted to the Employer for approval.

2.1.7 Measurement of Payment

There will be no separate measurement for payment for soil tests. Payment for the soil tests shall be included in the unit prices of the survey work stated in the Schedule of Prices (will be provided later).

2.2 Earthworks, Excavation and Backfilling

2.2.1 General

This specification covers the requirements for all necessary earthworks for tower foundations, grounding, foundation protection work, and possible access roads. Excavation and backfilling and other related earthworks including dewatering and shoring the excavation pit, removal, storage and stockpiling of the soil are also specified herein.

The Contractor shall furnish all tools, equipment, machines, labour, and supervisory personnel to perform the work as specified herein.

The Contractor shall carry out a check survey of the site before excavation and properly set all lines and levels for foundations.

2.2.2 Excavation and Backfilling

The soil types encountered on this line route are specified in Foundation Application Schedule (will be provided later). Soil is defined as material, which can be removed and excavated by shovels and pick axes. Excavated material suitable for backfilling the foundations shall be stockpiled for later use. Unsuitable material shall be disposed. The stockpiles should be sloped and protected from rainfall.

Rock excavation shall mean excavation made in "hard rock" as specified. Definition for "hard rock" shall mean hard stratum, which in excavation requires to be loosened by blasting or pneumatic tools or if by hand, by wedges and sledge hammers. Rock excavation shall also include loosening, stripping and excavating large embedded boulders, which are larger than 500mm in any direction. Also loose or semi detached rock boulders close to the excavation may need to be removed. The volume of this rock excavation shall be measured or estimated from the drawings, and the payment shall be based on the volume of the excavated rock and the unit price as given in the Schedule of Prices (will be provided later) for "Rock Excavation".

Excavation for foundations shall conform to the dimensions and elevations as shown in the approved design drawings. When foundations are built directly on the excavated soil, special care shall be taken not to disturb the bottom of the excavation pit.

All excavation work, shoring of the excavation and stockpiling of the excavated soil shall be done in such a manner to ensure the safety of site personnel or any other person.

The clearing of the tower site is specified elsewhere in this specification. However, when roots or stumps of trees are met during the excavation they shall be removed, if necessary.

All gold, silver, oil, mineral, coins, and other precious objects or archaeological findings, which may be found at tower sites or during excavation, shall be the property of the Employer.

For excavations where the base is unstable or very soft and/or lies below the groundwater level, shall be covered with a compacted layer of gravel, select borrow or crushed stones, if found necessary for carrying out the work as specified and approved by the Employer. Blinding concrete C10 of 10-15 cm in thickness may also be used. The payment of this soil strengthening shall be based on the volumes measured at site or estimated from the design drawings. The unit price for this work shall be given in the Schedule of Prices (will be provided later).
later) for "Blinding concrete C10" or "Compacted gravel".

At the nominal excavation depth for the foundation as stated in the approved design drawings, the bottom of the excavation shall be graded and examined by the Contractor and the final determination of the applied foundation type shall be done. The Employer shall verify the final foundation type at site by signature.

Backfill shall be placed in layers not exceeding 300 mm in thickness before compaction. The compaction shall be done by mechanical or pneumatic equipment or by other appropriate means approved by the Employer. Large stones, trash, wood, roots or other organic materials may not be used in backfill. Rock particles larger than 100 mm may be used in backfilling, if they are not in direct contact with the foundation.

No separate payment will be made to the Contractor for excavation and backfilling of the tower foundation. All costs incurred in connection therewith shall be included in the unit price for the construction of the various foundation types.

The following, however, shall be priced separately:

a. Soil strengthening by blinding concrete C10 and/or compacted gravel
b. Excavation and backfilling for foundation protection

2.2.3 Dewatering

All excavations shall be kept free of water, if found necessary for carrying out the foundation construction work as specified.

The Contractor shall remove by pumping or by other proper means all rainwater or ground water accumulated in the excavation pit, in case the water may disturb the soil in the excavation pit or harm the foundation work. Suitable pumping equipment shall be provided and used for dewatering so that all installation work and backfilling can be performed in a dry state. The method of pumping shall be adequate to ensure proper construction work and subject to approval by the Employer.

No separate payment will be made to the Contractor for dewatering the tower foundation. All costs incurred in connection with dewatering shall be included in the unit price for excavation.

2.2.4 Timber Shoring

Timber shoring may have to be used in open excavations for foundations.

Timber shoring, when constructed, shall be built strong and safe to prevent the sides of the excavation from collapsing. Depending on the soil type and the depth of the excavation, the shoring shall be of closed or open type. Closed timbering is used to cover the excavation walls completely leaving no gaps in between adjacent timber boards. The type of timber shoring shall be subject to approval by the Employer.

No separate payment will be made to the Contractor for timber shoring. All costs incurred in connection with timber shoring shall be included in the unit price for the construction of the various foundation types.

2.3 Foundation Construction

2.3.1 General Requirement

The Contractor shall furnish all material and labour required for the construction of foundations.

a. The Contractor will be required to remove and replace at his expense any material incorporated in the work that does not conform to these specifications.

b. The Contractor shall furnish the Employer without any extra cost all materials required for testing. The scope and amount of testing will be specified here in this specification. The cost of specified tests shall be borne by the Contractor.

c. The preliminary selection of the foundation type to be actually constructed will be done by the Contractor
after the soil test and shall be subject to the approval of the Employer. The final selection of the type of foundation is done at the tower location after excavation.

### 2.3.2 Measurement for Foundation Payment

Measurement for payment for the Contract item "Foundations" shall be on the basis of the actual number of each type of structure foundations constructed by the Contractor.

### 2.3.3 Payment

Payment for the contract item "Foundations" will be made at the unit price per tower foundation type. The unit prices for each different foundation type are given in the Schedule of Prices (will be provided later). The unit price for "Foundations" includes:

a. Strength calculations, detailed foundation design and construction drawings of the foundation types listed in the Schedule of Prices (will be provided later).

b. Supply and transporting of all foundation materials to the tower site.

c. Foundation orientation.

d. All equipment and labour required for completing the specified work.

e. Excavation, dewatering and timber shoring when necessary, and backfilling for the foundation.

f. Concreting and reinforcement including all material and work.

g. Stub setting.

h. All other foundation works specified here in this specification.

i. The following, however, shall be priced separately:

j. Blinding concrete C10 and compacted gravel

k. Additional concrete C20 and reinforcement

l. Special Foundation types

These items will be paid by quantities measured at site or calculated from the drawings and the corresponding unit price given in the Schedule of Prices (will be provided later).

### 2.3.4 Standard Specifications

In general, all international standards, BS, ACI, ASTM, DIN or equivalent shall be used to perform the required construction works. Preferably British Standards (BS) shall be applied whenever practical. All materials and workmanship shall also comply with the local applicable laws, rules and regulations.

### 2.3.5 Concrete

The Contractor shall design concrete mixes to meet the strength requirements for Grade C20 concrete according to BS 8110 and BS 5328: Part 1. The characteristic compressive cubic strength shall be $f_{cu} = 20 \text{ N/mm}^2$ at 28 days. The minimum cement content of concrete shall be 300 kg/m$^3$.

Prior to start of construction work, the Contractor shall be responsible of selecting and testing the concrete mix proportions in laboratory conditions to achieve the required concrete strength and other requirements. The test cube set consists of three 150 mm test cubes, and the laboratory testing shall be done using two different water/cement-ratios. The test cubes shall be made and tested in accordance with the applicable standards (for instance: test cubes and testing methods according to BS 1881: Part 108 and Part 116 and the test results according to BS 5328: Part 4).
After the laboratory tests the Contractor shall submit the test results for review and approval to the Employer. The Employer shall notify the Contractor within 14 days of the acceptance of the test results and design mixes.

The concrete may be ready-mixed, site-mixed or hand-mixed concrete. The concrete shall be composed of cement, fine and coarse aggregates and water. Only approved admixtures are allowed being used, if found necessary. The fresh concrete shall be well mixed at site to make a homogenous and plastic paste, which workability suits the methods of transport and placing.

The water/cement ratio shall be maintained.

When placing concrete in hot weather the recommendations of the ACI publication "Hot Weather Concreting" (ACI 305) or equivalent shall be followed. The temperature for the fresh concrete at placing should not exceed 35 degrees centigrade.

Concrete to be placed under water (submerged concrete) shall be deposited by tremie, when no other means cannot practically and reliably be used. Normally, the water should be pumped out from the pit before concreting.

2.3.6 Cement and Aggregates

In locations where conditions do not require high sulphate resistance, cement shall conform to the requirements of BS 12 Portland Cement (or ASTM C150 type I, type T or type V).

At least compressive strength and setting times of the cement shall be tested initially, and the cement manufacturer's test certificates (delivery tickets) are required. The cement used shall be subject for the approval of the Employer.

Fine aggregates (sand) and coarse aggregates shall be clean, natural or crushed material.

Maximum particle size for fine aggregate shall be 5 mm. Coarse aggregate shall have particle sizes between 5 - 40 mm. Each source of the fine and coarse aggregate shall be tested initially.

The following tests shall be carried out:

a. sieve analysis according to BS 882 or US Standard sieve analysis according to ASTM C 33;

b. the amount of fines (passing 75 mm sieve, should not exceed 2-4 %) according to BS 882;

c. water absorption test (BS 812 Part 2: should not exceed 3 %);

d. mechanical strength by Los Angeles abrasion test by ASTM C 131, limits given in ASTM C 33 or alternatively by ten per cent value test according to BS 812: Part 111, limits given in BS 882;

e. specific gravity ;

f. chemical analysis showing the mica content and for finding out if the aggregates contain any deleterious organic impurities.

2.3.7 Water and Slump

The water used for mixing concrete may be obtained from locally available sources and should be clean, potable water. The water shall be free of harmful quantities of organic material such as sugar, oil, silt, humus, alkali, sulphates or acids. The water cement ratio of the concrete should be kept as low as possible (maximum free water cement ratio w/c = 0.60), especially when using hand mixing. The main effort shall be put on achieving workable and homogenous concrete paste. Recommendations for different water cement ratios are specified for instance in BS 5328.

The slump, measured in laboratory conditions only for design mix, should be between 50 - 125mm. The slump for hand mix concrete is not an essential factor to be tested in field conditions.

The slump for ready-mixed concrete or site mixed concrete by batch mixer shall be controlled and maintained...
between the above values.

### 2.3.8 Storage of Material

Cement and aggregates shall be stored at site in such manner as to prevent deterioration or intrusion of foreign matter. Special care shall be taken in storing cement to keep the cement thoroughly dry at all times.

Cement should not be kept in storage for more than three months. When pressed between fingers the cement is usable if it powders easily.

The reinforcing steel shall be protected in order to prevent excessive rust development. Excessive rust shall be removed before usage.

### 2.3.9 Concrete Mixing and Placing

Prior to any concreting work the Contractor shall do the following checks:

a. Before any concrete mixing is begun, all equipment for mixing and transporting shall be cleaned of all dirt and debris.

b. All mechanical equipment shall be checked to be in good operating condition before any concreting work is begun.

c. The stock of construction material (cement, sand, coarse aggregate, and water) shall be checked to ascertain their sufficient quantities.

d. The Contractor shall notify the Employer when the foundation location is ready for concreting and the Employer shall give the permission to start concreting by signature.

e. The Contractor shall ensure that the excavation pit is free of water, mud and debris, the excavation bottom is well levelled and compacted, the reinforcement is properly installed, the formwork is properly braced and the stub angles are securely fixed at the correct level and location.

All concrete components shall be accurately measured. Measuring on a weight basis is preferred, however, measuring on a volume basis will be allowed if careful controls are maintained.

Normally, the concrete is mixed manually (hand-mix). The mixing shall continue as long as it is required to make a homogenous, plastic and workable concrete paste. When using mechanically operating batch mixer, the mixing shall be continued for at least one and half minutes. Fresh concrete should not be kept in the mixer for more than thirty minutes before placing. Fresh concrete shall be placed, compacted and finished as quickly as possible.

When concrete is to be placed on hard rock or hardened concrete, the existing surface shall be properly wet. The first batch of concrete shall be a grout made of cement, sand and water only.

The concrete should not be placed dropping more than two meters.

The concrete shall be compacted during and after placing by vibration. The concrete vibrators shall be efficient enough for the purpose and shall be kept in good operating condition at the location of the work.

### 2.3.10 Concrete Test Cubes

The Contractor shall make one set of test cubes (one set = three cubes) for each tower place until satisfactory quality of concrete is proven by repeatedly passing test results. Thereafter the Employer can accept a reduced number of test cubes. The test cubes shall be made and tested in accordance with the relevant BS standards as directed in the other parts of this specification. The costs for the concrete compressive strength tests shall be borne by the Contractor. Tests shall be witnessed by the Employer.

The standard methods for making, handling and testing of the test cubes are described in detail in BS 1881: Part 101, Part 108 and Part 116. The test results shall meet the requirements given in BS 5328: Part 4. Two of the test cubes shall be tested at 28 day of age and the remaining one cube shall be tested at 90 day only if the...
first two cubes fail to fulfill the specified 28 day strength requirements.

Should the 90 day test fail to produce specified results additional tests such as the Swiss hammer or testing of the core drilling samples from the ready, hardened structure shall be made to prove the strength of concrete. Whenever the quality of the concrete becomes under suspicion the Employer shall immediately make a written site note for the Contractor.

2.3.11 Concrete Formwork

Formwork shall be strong and rigid enough to withstand the pressure resulting from placing and vibrating the concrete. Forms shall be tight enough to prevent loss of mortar from the concrete.

All permanently exposed concrete corners (above ground level) shall be chamfered.

Templates made of mild steel can be used to hold the stub angles at their correct position during the concreting work. Other sufficient means of assuring the accurate stub location may also be used. Also the lowest part of the tower body may be used for bracing and supporting the stub angles at their correct position.

The material used for formwork may be steel, timber, plywood or wood. Before concrete is placed, the surfaces of all forms shall be oiled with suitable form oil.

Forms shall be removed only when sufficient strength of the concrete is achieved. As a rule, the forms shall not be removed until 48 hours after concreting. Any concrete damaged by form removal shall be repaired.

The tolerances for stub setting dimensions, foundation dimensions etc. shall be subject to the Employer’s approval and stated in the assembly/design drawings.

2.3.12 Concrete Finishing and Curing

The exposed top surfaces of all concrete foundation piers shall be wood floated and steel trowelled and shall be slightly sloped to prevent the accumulation of water.

After the removal of forms, the holes left by form tie rod fasteners shall be filled with mortar and all damaged or defective concrete shall be repaired or removed and replaced. Improperly consolidated concrete shall be chipped off and the remaining openings or recesses shall be carefully filled with patching material. Dry pack mortar is recommended in patching concrete voids.

To ensure proper curing, the concrete shall be kept moist for a period of at least 7 days. Burlap, other equivalent material or frequent watering shall be applied over exposed concrete surfaces. The burlap (or foundation top) shall be kept moist at all times. If the foundation is backfilled before the week’s (7 days) curing time has elapsed, the burlap (watering) protection shall remain on the exposed projection.

The foundation shall not be backfilled before the possible defects and voids are identified and properly repaired. The foundation shall not be subjected to any additional loads from the tower until the curing period has elapsed.

2.3.13 Payment

No separate or direct payment will be made to the Contractor for the concrete of foundation. All costs incurred in connection therewith shall be included in the unit price for the construction of the various foundation types. All exceptions to this are mentioned elsewhere in this Specification, especially the items that will be paid by measured quantities and corresponding unit price. However, the concrete used in protection works for foundation will be made at unit price.

2.3.14 Steel Reinforcement

Steel reinforcement shall be deformed, high yield (fy ≥ 400 N/mm²) steel bars conforming to the requirements of international standards such as BS 4449 or equivalent. The Contractor shall obtain the Employer’s approval for the supplier and quality of the steel reinforcement.

Mill scale, loose rust, oil, mud or other harmful substances shall be removed before reinforcing steel is placed.
All reinforcement shall have a protective concrete cover of not less than 80 mm on the bottoms of the footings and 50 mm on the vertical faces of the excavation pit, formwork and foundation top.

Steel reinforcement bars shall be securely and accurately placed at their correct position. Reinforcement bar intersection points and splices shall be tied together with annealed wire or suitable clips. Concrete blocks shall be used at the bottom of the foundation to support the reinforcing steel. Proper means shall be used to ensure the required concrete cover between the forms and the reinforcing bars.

2.3.15 Payment

No separate or direct payment will be made to the Contractor for the steel reinforcement of foundation. All costs incurred in connection therewith shall be included in the unit price for the construction of the various foundation types. All exceptions to this are mentioned elsewhere in this specification, especially the items that will be paid by measured quantities and corresponding unit price.

However, the reinforcement steel used in protection works for foundation will be made at unit price.

2.4 Foundation Protection Work

Structure foundations located near river banks or at steep hillsides or ridges or other required places shall be protected by gabion or stone masonry walls. The tower locations, which require protection work, shall be determined during the execution of foundations and are subject to approval by the Employer. The final number of towers to be protected and the quantity of protection will be defined only after completion of the foundation work.

The design of the gabion walls or stone masonry walls shall be done by the Contractor and shall be included in the unit prices of these items in the Schedule of Prices (will be provided later). The design shall be completed in detail at the tower location by taking into account the surrounding terrain and other conditions.

2.4.1 Gabion Walls

The standard type gabion shall be made of hot dip galvanized steel wire mesh. The steel wire shall be at least 3 mm thick and the size of the mesh shall not be more than one third of the smallest stone filled in the gabion. Locally available mild steel wire mesh and mesh sizes may be used. The standard gabion box dimensions are: length 2.0 m, width 1.0 m and height 0.5 m. If needed, the size of the gabion wall boxes may vary from the standard dimensions. Usually, the gabion boxes are buried at least 0.4 m in the surrounding ground.

All edges of the gabion shall be mechanically selvedged to prevent unravelling of the mesh. The wire used for the selvedge shall be of greater diameter than the original mesh wire. The adjacent gabions shall be tied together with sufficient quantity of lacing and connecting wire.

The stones for filling in the gabion mesh shall be taken from the river deposit material if not otherwise agreed with the Employer. The stones shall be strong and solid having no visible cracks or holes or loose rock material or laminations. The stone blocks shall be of natural irregular cubical shape. Thin sliced stone blocks shall not be accepted. The size of the stone shall be at least 10 cm.

2.4.2 Stone Masonry Walls

The stones shall be hand placed with uncoursed close joints to the lines and grades as designed. The rubble stone shall be placed with 1:3 cement mortar after having joints thoroughly moistened. The surface joints shall be finished with 1:3 cement mortar. After completion of the masonry wall, it shall be cured with water for more than 10 hours. The top of the masonry wall shall be capped with smooth layer of concrete.

The width to height ratio for stone masonry structures shall be 0.6.

Weep holes for drainage shall be perforated PVC pipes of diameter not less than 5 cm. The pipes shall be buried in the stone masonry wall at two metres intervals with a 10 % slope. Vertical drainage ducts of size 0.2 m x 0.4 m shall be made of graveling to allow drainage water to flow into the pipes.

In cases where stone masonry is used for upper foundation legs, there may be a need of stone masonry water ditches, which shall be designed in a way the water flows away from the lower foundation legs. Stone masonry
water ditches may have to be designed and constructed whenever there is a need to control water flow at tower
locations.

2.4.3 Measurement for Payment

Measurement for payment of gabion walls shall be based on the constructed volume of gabions in cubic meters. The corresponding unit price for "Gabion Wall" is given in the Schedule of Prices (will be provided later). The unit price shall include all labour, tools and equipment, material, transporting and placing, and all other costs necessary for completion of the gabion walls.

Measurement for payment of stone masonry shall be based on the constructed volume of stone masonry in cubic meters. The corresponding unit price for "Stone Masonry" is given in the Schedule of Prices (will be provided later). The unit price shall include all labour, tools and equipment, material, transporting and placing, and all other costs necessary for completion of the stone masonry.

2.4.4 P.C.C. works

P.C.C. works (plain concrete) used for foundations of gabion walls or stone masonry works shall be of grade C10 plain concrete.

2.4.5 Excavation and Backfilling

The scope of excavation and backfilling as stated herein shall cover the excavation and backfilling works for:

a. foundations for gabion walls or stone masonry works or
b. cutting of earth in places where sufficient ground clearance of the line is not available or
c. levelling at the tower location to fit the foundation tower leg height differences.

2.4.6 Reinforcement

The additional reinforcement used for gabion or stone masonry wall foundations shall be covered here.

The detail specification for the reinforcement bars (rebars) shall be the same as in the tower foundation works.

2.4.7 Measurement for Payment

Payment for the contract items P.C.C. works, excavation and backfilling and re-bars used for foundation protection works will be made at the unit price. Therefore the unit price given in the Schedule of Prices (will be provided later) shall include full compensation for all costs incurred in furnishing all materials and labour.

3 Erection of Towers

3.1 Erection Work

At least two months prior to commencement of erection work the Contractor shall submit to the Employer for approval his method of tower erection and particulars and quantities of main tools and equipment.

No tower shall be erected until 7 days after placing of the foundation concrete and before proper backfill and compaction without the Employer's approval.

If shop errors in the steel members are discovered, the Contractor shall notify the Employer who will decide whether the errors may be corrected in the field, or the members returned to the Manufacturer for correction or replacement at the Contractor's expense.

Erection/assembly of towers shall be carried out in strict accordance with the Erection Drawings and the Tower List approved by the Employer and the conditions stated hereinafter.
On the occasion of assembling the joining parts of the posts of each section, all bolts to be applied for the section shall be inserted by hanging up the posts, and at least four (4) pieces of bolts for upper and lower positions and both sides shall be completely finish-fastened.

Bracing materials shall be attached to each section, and finish fastening shall be carried out so that no torsion of whole of the steel tower or no gap between each part is produced.

Tower members shall not be strained or bent during erection. No gin poles or wire ropes shall be directly mounted on tower members without adequate protection with burlap. Contact surface of joints shall be cleaned and cleared of foreign material and dirt before assembly.

Reaming or drilling of bolt holes to enable connection to be made at the site shall not be permitted without approval by the Employer. Such drilling or reaming if approved shall be repainted with zinc rich paint as directed by the Employer.

All bolts shall be so installed that their heads are in the "down and in" position. The Contractor shall verify the propriety of tightness of bolts with calibrated torque wrenches with the Employer's witness. The required tightening torque is shown in the table of Clause 8.8. Wrenches used for bolt tightening shall be subjected to the approval of the Employer. The use of any wrench which may deform the nut/bolt head or cut or flake the galvanizing will not be permitted.

Damage to galvanized surface shall be brushed out, washed off and painted with two coats of zinc rich paint without extra cost.

Members that are bent, twisted or otherwise deformed in storage, transportation, handling or erecting operations shall be straightened or replaced by the Contractor. Straightening shall be done only by the use of methods that will not injure the galvanized coating. The method of straightening shall be approved by the Employer. Tolerances for lateral variations of straightened members shall be as follows:

<table>
<thead>
<tr>
<th>Member Type</th>
<th>Tolerances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compression Members</td>
<td>2/1000</td>
</tr>
<tr>
<td>Tension-only Members</td>
<td>6/1000</td>
</tr>
</tbody>
</table>

Number plates, danger plates, phase indication and circuit plates shall be fixed on front and back faces of each tower at height of approximately 3.0 m from the ground as indicated in the Erection Drawings.

Anti-climbing devices shall be fitted at a height of 3m to 5 m above the highest ground level at tower location as instructed by the Employer.

After erection, all towers shall be cleaned of all foreign materials and dirt. Climbing step bolts below the anti-climbing devices shall be removed immediately after the stringing work is completed and they shall be returned to the Employer before the completion of the line.

For threads of all bolts below anti-climbing device shall be punched or jagged as to render the removal of nuts almost impossible and as measure against vandals and shall be coated with zinc rich paint after punched or jagged.

In case that the leg extensions are provided, cost for erection of such extended portions shall be deemed to be included in the prices for erection of tower.

### 3.2 Grounding of Tower

All towers shall be grounded by means of grounding device on two diagonal legs, see drawing TLUK-010 (will be provided later). Refer to Scope of Supply, Clause 3.6.12.

### 3.3 Measurement for Payment

Payment for tower erection work shall be based on counting the number of towers completed at the unit prices stated in the Schedule of Prices (will be provided later).
Payment for supply and installation of notice plates and anti-climbing devices shall be based on the unit prices stated in the Schedule of Prices (will be provided later).

4 Stringing Work

4.1 General

Conductor erection shall be carried out entirely by approved methods keeping conductor off the ground at all times when the conductor is in motion.

At least two months before stringing commences the Contractor shall submit to the Employer for approval comprehensive work proposal (stringing schedule) that shall include, but not being limited to, the following:

1. Methods for stringing and details of stringing equipment
2. Location of conductor drums and stringing equipment
3. Temporary stay arrangements and temporary support strengthening
4. Scaffolding positions and types
5. Position of mid span joints
6. Procedures and methods for making joints and dead-end clamps
7. Schedule of conductor accessories to be fitted
8. Sag and tension charts

4.2 Tension Stringing Equipment

Tensioning bull wheels shall have a minimum diameter of 35 times the outside diameter of the conductor and will have multiple grooves lined with neoprene. Brakes and controls shall be hydraulically operated to minimize danger or brake failure. The tensioner design shall be such that once the required tension is obtained, the conductor will remain at that tension so long as the brake setting remains unchained.

Conductor stringing pulleys shall be so designed as to allow conductors to be pulled out smoothly and shall have a minimum diameter of 35 cm. Stringing pulleys will be of low friction and the pulleys groove shall be lined with neoprene. Pulleys are to be designed so that the pilot wire does not damage the neoprene lining during conductor running. Pulleys shall be inspected daily for proper operation. The use of defective pulleys shall not be permitted.

4.3 Stringing Procedure

The Contractor shall string and sag the conductors and the ground wires in accordance with the Drawings and Specifications. After sagging, the point of attachment shall be marked on each conductor in a manner satisfactory to the Employer. The insulator assemblies shall be attached to the conductors at the points marked on the conductors.

Care shall be taken during handling and storage to prevent abrasion or other damage to the cables. Prior to installation, reels of conductor shall be stored blocked-up off the ground and adequately supported so as to avoid damage to reel, lagging and conductor. Cables and reels shall be kept free of standing water, dust and mud.

Lagging or other protective covering shall be removed at the job site and the outside layer of each reel shall be examined by the Contractor and the Employer to ensure that the cables are in good condition and that no nails, staples or other sharp objects, which would damage the cables during unreeling, protrude on the inside of the reel heads. At no time shall the cables be dragged over the ground or any other rough surface.
4.4 Stay and Scaffolding

1. All such towers which may be subjected to excessive loading during stringing and sagging of the conductor and ground wires shall be reinforced with backstays in an approved manner.

2. Such cross arms as may be subject to heavy vertical loading shall be reinforced with armtie guy wires. Methods of stringing and sagging procedure as may be subject to unbalanced loading and torsional force on both sides of arms shall be avoided whenever possible. The Contractor shall submit for approval to the Employer his proposed practice of stay-wire when he submits his detailed account of stringing procedure.

3. The Contractor shall provide, at his own expenses, suitable scaffolding during the stringing work where the line crosses over national roads, local roads, power lines, telephone lines, etc., which the Employer considers to be protected.

4. The height of scaffolding shall be such that the clearance of conductor may not be less than 7 meters to road, 1.5 meter to 20 kV power lines, 1 m to 6.6 kV lines and 0.6 meter to low voltage lines and telephone lines. No part of the scaffolding shall approach power or telephone lines within the distance aforementioned. The cost for the scaffolding and preliminary works shall be included in the rate of appropriate stringing works.

5. The Contractor shall be responsible for giving necessary notice to and obtaining the approval from the related authorities prior to the erection of such scaffolding. Two (2) copies each of such notice and approval shall be submitted to the Employer.

4.5 Stringing of Conductors and Ground Wires

Conductors shall be pulled out and strung by an approved tension stringing method. Cables shall, as a principle, never be allowed to touch ground.

The Contractor shall submit in writing, for the approval of the Employer, a complete and detailed description of the stringing equipment and the stringing and sagging procedure intended for use.

Not later than 2 months before commencing the cables installation work, the Contractor shall submit a general stringing plan to the Employer, for approval. The plan shall describe the Contractor’s proposed work schedule, method of stringing, temporary guying, scaffolding, personnel required in performing the work and a list of tools, communication equipment and stringing equipment to be employed.

In addition, not later than 2 weeks before commencing stringing work in any section of the line, the Contractor shall submit details of the unreeling section, location of reels, pullers, tensioners, snubs and temporary guying, scaffolding, splices and lengths of cables to be strung to the Employer for approval.


Unless otherwise approved by the Employer, the tension stringing procedure shall be in strict conformity with the recommendations of the manufacturer of the stringing equipment. Only specially trained linesmen who are well acquainted with the handling and running of the particular equipment to be used shall be employed.

Reliable means of instantaneous two-way communication shall be available between the pulling and the braking crews, and between these crews and any observation posts that may be placed along the stringing section.

The stringing equipment shall be set up so as not to cause excessive vertical loads on the towers. The distance to the nearest tower through which the cables are being strung shall be selected with due regard to the relative levels of the pulleys on the tower and the stringing equipment. A reasonable allowance should also be made for possible accidental over-tensioning of the cables.

Stringing pulleys shall preferably be located at approximately the same levels as that which the conductors and the galvanized steel ground wire will occupy when installed.

At all times during stringing, the conductors shall be handled and protected so as not to be scratched,
nicked, abraded, kinked or otherwise damaged. If during stringing it should prove inevitable to lower the conductors to the ground, suitable non-metallic lagging shall be placed underneath.

Stringing pulleys shall have adequate strength and shall be of approved design. They shall be equipped with ball or roller bearings. The sheave diameter measure at the bottom of the groove shall not be less than 15 times the outside diameter of the conductor or galvanized steel ground wire. The groove shall be wide enough for the passage of compression joints. Stringing pulleys for the conductors shall have the sheave grooves lined with electrically conductive neoprene or equivalent.

Pulleys shall be inspected daily for proper operation. The use of defective pulleys will not be permitted.

Cables, which have been subject to bird-caging during stringing, will not be accepted. Stringing tensions shall, at no times, exceed corresponding sagging tensions by more than 20%.

Clamps for attaching the conductors to the hauling device shall be of approved design and shall prevent relative movements of strand or layers of the conductors or galvanized steel ground wires. Freely rotating ball bearing swivels shall be used for each cable to be strung.

If, for any reason, stringing operations in progress must be interrupted, the conductors may be left in the stringing pulleys, but their tension shall be reduced as far as possible. In all cases, however, the cables must be kept completely clear of the ground, by approximately 2 m, and sufficiently far from any obstacles, which might cause abrasion of the cables, if touched by them.

If the interruption lasts for more than 40 hours, or if stormy weather has prevailed, the cables shall be closely inspected for damage. Such inspection applies particularly to the suspension points where the cables have been resting in the pulleys sheaves.

At all times during stringing, sagging and clamping operations, the conductors, reels and hauling equipment shall be effectively grounded.

The Contractor shall make suitable arrangements for temporary staying of towers, where necessary. Suitable plates (detachable or otherwise) shall be provided on the towers for attachment of any temporary stays.

4.6 Insulators

Insulators shall be packed in wooden crates and shall be delivered to the job sites in their original containers. They shall not be unpacked until their utilization.

All insulators shall be inspected before their assembly in accordance with the required number to form the appropriate sets. The Contractor shall ensure that the insulating material, the caps and pins are free from any defects.

All damaged insulators shall be rejected, whatever damage it may be, and whether it is on the insulating material, the metal parts or the galvanized coating.

Prior to installation and immediately before hanging, the insulators shall be thoroughly cleaned and all cotter pins shall be checked for correct positioning and freedom from defects.

Insulator strings shall be carefully lifted into position without undue strain being imposed on any part by using suitable lifting equipment.

4.7 Suspension and Dead-end Accessories

Suspension and dead-end hardware for conductor shall be handled in such a manner that it shall not be broken, scratched or damaged.

All accessories shall be installed in the location and in the manner shown on the assembly drawings. All nuts, lock nuts, washers, cotter pins, etc., supplied with the accessories, shall be installed in the correct order and location. No substitutes or omission will be permitted without the specific approval of the Employer.
All accessories found to be incorrectly assembled or placed, shall be reassembled correctly or changed by the Contractor at his expense, and the Contractor shall be fully responsible for any damages resulting from this incorrect installation.

4.8 Joints

1. Compression joints and dead-end fittings shall be installed in accordance with the manufacturer’s recommendation. The Contractor shall submit detailed written instructions for the complete installation procedure for the approval of the Employer. The fullest possible use of maximum conductor length shall be made so as to hold the number of joints to a minimum. Joints shall in no case be installed closer than 15 m to the centre of suspension clamps or closer than 50 m to dead-end fittings. There shall not be more than one joint per conductor or ground wire in any one span.

2. No joints shall be made in spans, which cross main roads, power lines, or in the major river crossings, nor, whenever conductor drum lengths permit, in spans immediately adjacent thereto.

3. Cutting of layers of aluminium strands shall be so made that underlying steel strands are not damaged.

4. The Contractor shall follow a detailed account of joints given by the Employer including the practice of jointing, the dimensions before and after compression, device for centering the sleeves, the methods of impregnation of anti-corrosion coating, checking gauges for dimensions after compression, cleaning, compressing pressure and practice, etc.

5. Joints made at the drum site shall be protected for passing through the pulleys during stringing with approved protectors of suitable design.

4.9 Sagging

The Contractor shall submit, for the approval of the Employer, sag and tension charts for use during erection, which shall be established with due regard to the specific stringing and sagging methods to be employed so that remaining creep after clamping may be assessed and taken into account with reasonable accuracy.

Erection sagging charts or tables shall display sag in still air against span length for temperatures between 15 °C and 60 °C in increments of 5 °C.

Sagging temperature shall be read from a certified thermometer, the bulb of which has been inserted in an approximately 50 cm long piece of conductor with the inner layers removed. The thermometer so equipped shall be freely suspended in the air without any shielding and not less than 3 m above ground. Temperature readings will be taken only after 20 minutes’ exposure.

After finishing stringing operations, the conductors shall be sagged in accordance with agreed sagging procedure and relevant erection sagging chart or table. It is essential that prescribed hold periods before definite sagging are rigorously observed.

Immediately after conductors have been regulated and clamped in, the mean sag of the conductors shall not deviate from the correct erection sag by more than plus or minus 2 per cent. In addition, the sag of anyone line conductor in a span shall not deviate by more than 15 cm from the mean sag of the line conductors in the same span.

The Contractor shall check the sag of each conductor of a sagging section in at least one span of approximate average length. The sags shall also be checked in all spans exceeding 600 m and in spans on each side of angle structures and sharp breaks in profile. Intermediate spans shall be inspected for uniform sag.

If the Employer wishes to check the sag at any locations, the Contractor shall furnish such assistance in equipment and personnel as may be required for this purpose.

Sagging sections shall be limited to such length as can be sagged satisfactorily but shall not be in excess of 15 spans or 6 km, whichever is less.

Work shall be planned so that cables can be pulled and sagged as specified within 24 hours period.
Conductor tension shall be equalized between sagging sections so that the insulator strings will assume the proper position when successive sagging sections have been clamped in.

The contractor shall keep a record on approved schedules of the particulars of the sagging of conductors and galvanized steel ground wires on each sagging section.

4.10 Clamping in

1. After the conductors or ground wires have been finally tensioned to their correct sags, the position of tension clamps shall be carefully marked. Compression type tension clamps shall be compressed on the conductors in a similar manner to midspan tension joints. Bolt type tension clamp shall be bolted tightly in a proper manner. Tightening torque of clamp bolts shall be as recommended by the Manufacturer.

2. Clamping in shall be done within 48 hours after completion of sagging unless otherwise agreed but cables shall hang in the stringing blocks for a minimum of two (2) hours before the clipping operation is started.

3. When fitting the tension clamp to insulator set or tower, care shall be taken so that no excessive stress may be given to tower members.

4. All markings of the conductors, e.g. for the centering of clamps or armour rods, shall be done with tape or other inoffensive means. Scratch marks or similar must not be permitted.

5. Temporary short and grounding arrangement shall be installed on each of conductors at interval not exceeding 3 km. A report of each grounding arrangement installed shall be made to the Employer in writing, giving the tower number and date of installation. Such temporary shorts or grounds shall be removed before testing of the complete line.

6. The Contractor shall ensure that the suspension clamps are properly assembled over the armour rods in such a manner as the insulator set being hung vertically. Armour rods shall be installed in accordance with the Manufacturer's instruction. They shall be centered within plus or minus 5 cm. When installed, the difference between the ends of rods shall not exceed 5 mm.

7. Suspension insulators shall be plumbed longitudinally within plus or minus 30 mm.

8. All split pins of insulators, hardware and clamps shall be faced toward the centre of the tower and upward.

9. Immediately after clamping-in, sag tolerances shall be plus or minus 2% of specified sag, provided that specified clearance to ground will be obtained.

4.11 Jumpering

Jumper conductor shall be provided in such a manner as forming a smooth ellipse and providing necessary clearance to tower members, which shall be checked after installation of each jumper.

Where instructed by the Employer, the jumper shall be supported by a jumper support insulator set. The designer has the liberty to decide the jumper support insulator set to be used.

4.12 Vibration Dampers

Vibration dampers shall be installed immediately following the clamping in of a section.

Before installation, all dampers shall be thoroughly cleaned and inspected. Damaged dampers shall not be installed.

Vibration dampers for conductor or ground wire shall be fitted as specified below in Tables 4-1 and 4-2.
Table 4-1  Number of dampers per conductor or ground wire in one span

<table>
<thead>
<tr>
<th>Span length L (m)</th>
<th>Number of vibration damper (pcs/phase/span)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L ≤ 150</td>
<td>2</td>
</tr>
<tr>
<td>150 &lt; L ≤ 300</td>
<td>2</td>
</tr>
<tr>
<td>300 &lt; L ≤ 600</td>
<td>4</td>
</tr>
<tr>
<td>L &gt; 600</td>
<td>6</td>
</tr>
</tbody>
</table>

Table 4-2  Distance from a suspension or tension clamp

<table>
<thead>
<tr>
<th></th>
<th>1st damper</th>
<th>2nd damper</th>
<th>3rd damper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conductor</td>
<td>1.3 m</td>
<td>2.6 m</td>
<td>3.9 m</td>
</tr>
<tr>
<td>Ground wire</td>
<td>0.5 m</td>
<td>1.0 m</td>
<td>1.5 m</td>
</tr>
</tbody>
</table>

Double torsional type vibration dampers shall be mounted so as to maintain their damper weights horizontally and incline their clamp axis at an angle of 60 degrees to the horizontal plane. The first damper for each phase conductor shall be mounted so as to strengthen the twist of the outermost layer of the conductor, and the second damper, if any, to loosen the twist.

4.13  Repair Sleeve

In case of damage to the conductor aluminium strand, approved type of repair sleeve shall be installed provided the damage consists of not more than the following limits. Wherever damage exceeds the following limits for ACSR, the damaged portion shall be replaced:

1. Damage is restricted to the outer layer of aluminium strand.
2. The steel core is undamaged.
3. The number of damaged aluminium strands is less than one quarter (1/4) of the number of outer layer aluminium strands.

Repair sleeve shall be installed in the presence of the Employer.

4.14  Communications

The Contractor shall maintain good communications between personnel at the tensioner end, the puller end and intermediate points at all times during stringing operations. Running boards shall be observed as they pass through each traveller. The running board observers shall have reliable communications with both pulling and tensioning ends. Dual systems of communication shall be available during stringing in case one system fails.

4.15  Measurement for Payment

Payment for stringing work shall be based on the length of the transmission line route, measured in horizontal plane, at the unit prices stated in the Schedule of Prices (will be provided later).

Payment for stringing work shall be included in the erection prices of conductor and ground wire stated in the Schedule of Prices (will be provided later).

5  Stringing of Optical Ground Wire (OPGW)

5.1  General

This Specification sets out installation parameters, which are specific to OPGW. These are additional to the requirements of Scope of Supply, Clause 3.2.3.
Care shall be taken to avoid damaging the OPGW during handling and stringing operations. The Contractor shall avoid sharp bends to the cable and take precautions to prevent crushing the OPGW during placement. To avoid degradation of the transmission quality of the optical fibres, the Contractor shall not subject the OPGW to excessive pulling tensions or excessively small bend diameters.

OPGW cable reels shall always be transported and handled in an upright position. Reels of OPGW cable shall not be laid on its side.

5.2 Stringing

OPGW shall be pulled out and strung by an approved tension stringing method. The Contractor shall submit in writing, for the approval of the Employer, a complete and detailed description of the stringing equipment and the stringing and sagging procedure intended for use. This procedure shall be approved by the OPGW’s manufacturer.

The Contractor shall make sure that:

1. The pulling line shall have the same direction lay as the OPGW to help resist the tendency to rotate under stringing load.
2. The stringing block shall have neoprene lined grooves.
3. The tensioner and puller shall be positioned for a 3:1 ratio to the stringing block on the first structure adjacent to the equipment.
4. An anti-torsion device shall be installed between the OPGW and the pulling line.
5. The OPGW shall not be cut with ratchet cutters or other type of tools which could crush the aluminum pipe.
6. The following values shall be followed in order to prevent damage to the OPGW: Minimum Bull Wheel Diameter 70 x D (OPGW)

Recommended Block Diameter 40 x D (OPGW)

Permanent Bend Radius (no tension) 15 x D (OPGW)

Maximum Stringing Tension 20 % of the OPGW Rated Breaking Strength

5.3 Sagging and Clamping in

The Contractor shall submit for approval the sag and tension data provided by the OPGW’s manufacturer.

Sagging and clamping in procedures shall be such as described in Clauses 4.9 and 4.10, respectively.

A temporary grip shall be installed on the OPGW for tensioning. The grip shall be designed to hold the OPGW without damage, and in particular not pinch the cable or crush the aluminum pipe.

5.4 Dead-Ending and Clipping In

Dead-ends shall be installed on OPGW spans which terminate at splicing towers or ends of the system. Dead-ends shall also be used at angle structures when the angles are too great to use suspension clamps. Suspension clamps are normally used at the remaining towers.

The OPGW shall not be allowed to lay in the stringing blocks for more than 48 hours after being sagged.

To lift the OPGW from the stringing blocks in order to install the hardware, comealongs or preformed wire grips shall be attached on both sides of the block and a coffin hoist shall be placed over the tower arm. The hooks of the coffin hoist shall be attached to the comealongs and jacked up to form a small loop in the OPGW. The block shall then be removed and the armour rods can be placed on the OPGW then attached to
the structure.

5.5 Splice Points

Splice points shall be located at the beginning and end of each OPGW reel. After completion of sagging and clipping, the surplus OPGW shall be coiled and attached temporarily to the tower. Coils shall be approximately 1 to 1.5 meter in diameter. The coils shall be fixed on the tower to prevent any damage to the OPGW prior to splicing.

The exposed ends of the OPGW shall be re-sealed to prevent moisture from entering the aluminum pipe.

The OPGW shall be trained down the tower and to the ground for splicing. The excess length of the OPGW shall not be cut off at this time. To facilitate splicing, the OPGW shall extend a minimum of 20 meters beyond the bottom of the tower. The length of OPGW running down the tower shall be attached to the structure using appropriate guide clamps, spaced every 1.5 to 2.5 meters of running length.

The splice enclosure shall be installed above the anti-climbing device in such way that this will allow the splice box (joint box) to be removed and lowered to the ground if necessary.

5.6 Measurement for Payment

Measurement for payment for work of this Clause shall be on the same basis as stated in Part TS1, Clause 3.2.

Payment shall be included in the erection prices of optical ground wire stated in the Schedule of Prices (will be provided later).

6 Testing, Final Inspection and Commissioning

6.1 General

Completion of the transmission line work shall be followed immediately by a clean-up and a final inspection, including outstanding remedial work, the repair of damages and testing in accordance with the Specifications.

6.2 Inspection and Test

On request by the Employer, the following inspections and tests shall be carried out by the Contractor. The inspections and tests shall cover all necessary transport, materials, tools, instruments required, etc., and the record of inspections and tests shall be submitted to the Employer.

1. Survey
   a. Inspection on check surveys from time to time.

2. Foundation work
   a. Inspection of dimensions of excavated pits and stub setting.
   b. Screen test of sand and coarse aggregate before work commencement and periodic tests throughout work execution.
   c. Concrete mixture test before work commencement.
   d. Inspection of concrete mixers before work commencement and periodic tests through work execution.
   e. Concrete slump tests and sample moulding.
   f. Inspection of arrangement of reinforcing bars in foundations before concreting.
g. Inspection of concrete curing and hardness test of concrete.

h. Inspection of backfilling of foundations and density test of backfilled soil.

i. Inspection on land formation.

j. Inspection of excavation and installation of counterpoise before backfilling.

3. Tower erection

a. Inspection of size, direction, length, torque etc., of members, bolts and fillers.

b. Grounding resistance test on the towers selected at random in accordance with the record submitted by the Contractor.

4. Stringing

a. Inspection of stringing tools, equipment and machines before work commencement and periodically.

b. Inspection of scaffolding, guys and stay wires before and during stringing.

c. Inspection of construction, perpendicularity, cleaning and arcing horn gaps of insulator sets and/or ground wire sets.

d. Inspection of surface conditions of conductors and ground wires during stringing and tensioning.

e. Compression test on samples of tension joints and tension clamps before work commencement.

f. Inspection of tension joints, repair sleeves and tension clamps.

g. Inspection of sags of conductors and ground wires during tensioning at spans selected at random.

5. Safety measures

a. Inspection of measures related to all required work.

In addition to the inspections and tests specified herein or elsewhere in the Particular Technical Specifications, the Contractor shall, upon order by the Employer, undertake any engineering test necessary to satisfy the acceptability of all electrical work covered in this Contract.

6.3 Clean-up

1. The Contractor shall remove from the vicinity of the work, all plant, building, equipment, rubbish, concrete forms and other like materials. Unused materials shall be incinerated or disposed of at places which will not be unsightly or objectionable to the inhabitants of the area and as approved by the Employer.

2. The Contractor shall restore:

a. all irrigation facilities to the condition existing before arrival on site;

b. natural drainage in areas where temporary facilities have been made for construction purposes;

c. any fences, gates, etc., which have been damaged during construction;

d. access roads to their original condition.

6.4 Final Inspection
The Contractor shall carry out a final inspection of the completed work in the presence of the Employer prior to tests or completion.

During this inspection, the Contractor shall remedy all defects immediately, and in particular, ensure the following:

1. Requirements for footings on sloping ground, disposal of excess earth, etc., have been completed.
2. Concrete protruding above ground is correctly shaped, finished and sealed.
3. Bitumastic painting has been correctly applied.
4. Towers are true to line and are vertically acceptable.
5. Tower accessories and signs are complete and correctly fitted.
6. Tower framework is free of all foreign matter.
7. Scratches or like damage to galvanizing has been carefully repaired to the Employer’s approval.
8. Insulators are free from conspicuous foreign material, and all units are undamaged.
9. Conductor and galvanized steel ground wire have been erected in accordance with the drawings and are complete, and line conductor and galvanized steel ground wire are correctly clamped.
10. All conductor stringing pulleys, hooks and other equipment has been removed from the line.
11. All bolts, nuts and cotter pins, washers and split pins on all fittings are properly fitted, tightened and locked.
12. Conductors and galvanized steel ground wires are clean, without strand damage and free of foliage, loose wires, etc. The sag of all cables is in accordance with sagging documents and clearances are correct.

6.5 Records and As-Built Drawings

Upon successful completion of electrical integrity test, the Contractor shall submit to the Employer the following records and drawings for provisional acceptance and subsequent maintenance of the transmission line:

1. As-built drawings and inspection/test records as requested by the Employer.
2. Other construction records particularly requested by the employer.

6.6 Taking Over

The following steps shall be taken before and as leading to the Taking Over:

1. The appearance of constructed facilities and a clearance check of the cleared site shall be examined by the Employer.
2. The Contractor shall carry out line parameter measurements to each line section separately in order to determine positive, negative and zero sequence impedances of the line sections.
3. The Contractor shall carry out electrical integrity test on the whole or part of the transmission line by using a 500 volt or 1000 volt megger in the presence of the Employer, and shall report the test results to the Employer.
4. The line shall be energized successfully for 24 hours with the operation voltage before Taking Over.
5. The arrangement for this and other tests that the Employer may desire to make on the completed line shall be assisted by the Contractor who shall provide such labour, transport and other
assistance as is required without extra charge. Apparatus for such tests shall be provided by the Contractor.

6. All records of the tests shall be detailed in an approved manner. Sample log sheets, charts, etc., shall be submitted to the Employer for approval.

7. All data shall be submitted to the Employer in triplicate copies upon satisfactory conclusion of the tests.

8. Upon successful tests under this section and receipt of records thereof, the Employer will issue the Taking Over Certificate to the Contractor as stipulated in the General Technical Requirements.

6.7 Measurement for Payment

Payment for testing, final inspection and commissioning shall be made under the lump sum price for the relevant items in the Schedule of Prices (will be provided later).