NEPAL ELECTRICITY AUTHORITY

(An Undertaking of Government of Nepal)

Bidding Documents for **Procurement** of Plant

Design, Supply and Installation of

Lekhnath Damauli 220 kV **Transmission Line Project**
Package A: Transmission Lines

Single-Stage: **Two-Envelope**
Bidding Procedure

KfW Development Bank

September 2022

ENGINEERING CONSULTING

Procurement of Plant

Design, Supply, and Installation

Single-Stage: Two-Envelope
Bidding Procedure

Bidding Document
for

Lekhnath Damauli 220 kV Transmission Line Project

Package A: Transmission Lines

(Lekhnath to Damauli 220kV Double Circuit OHL)

Issued on	**:**	**09 September 2022**
Invitation for Bids No.	:	**ICB/NEA/LD220KVTLP/Package-A**
ICB No.	:	**ICB/NEA/LD220KVTLP/Package-A**
Employer	:	**Nepal Electricity Authority**
Country	:	**Nepal**

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PART 2 – EMPLOYER’S REQUIREMENTS

PART 2 - Employer’s Requirements

VII-1

Project Description and Scope of Works

Table of Contents

1 Project Participation

1.1 The Employer

NEPAL ELECTRICITY AUTHORITY (NEA)

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Kathmandu,

Nepal

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2 Project Description

2.1 Background and Objective

The Nepalese Ministry of Population and Environment, under their Energy Policy, promoted the implementation of "Efficient Transmission of Electricity from Renewable Energy Sources in Nepal", which contributes to the overall development objective: "Contribute to the sustainable economic and social development of Nepal and to improve living conditions through a reliable, sustainable and climate-friendly power supply, and contribute to poverty reduction and the fight against climate change."

The efficient transmission of electricity from renewable energy sources is pursued by expanding the network infrastructure, which also implies the improvement of the line voltage, the reduction of the technical grid losses and the enhancement of the reliability of the electricity supply.

The "Lekhnath-Damauli 220 kV Transmission Line Project" is part of the mentioned Energy Policy, and it aims at evacuating the climate-friendly electricity generated by hydropower plants (HPP) in the Seti-Madi River basin through a newly constructed 220 kV Transmission System comprising an approximately 45 km double-circuit transmission line between Lekhnath and Damauli, as well as two substations at the termination locations - one in Lekhnath and one in Damauli.

2.2 Overview

The overall project scope consists of two packages:

Package A - Transmission Lines

Package A comprises the following basic components:

- construction of the 220 kV Double Circuit Transmission Line from Lekhnath Substation to New Damauli Substation
- Loop-in/Loop-out (LI-LO) connection of 220 kV Tanahu Hydro OHL into New Damauli Substation (OHL is under-construction under separate project)
- LI-LO connection of existing 132 kV Damauli - Bharatpur OHL into New Damauli Substation.

Package B - Substations

Package B comprises the following basic components:

- extension of existing 132 kV Substation Lekhnath and construction of new 220 kV GIS
- construction of the new 220/132/11 kV GIS Substation at Damauli.

This document together with associated documents listed in Chapter 3 forms the Employer's Requirements (as defined by the Clause 1.1.1.5 of the General Conditions of Contract for Plant and Design-Build first edition) for Package A - Transmission Lines. All further instances of the terms 'Project' and 'Contract' within these Employer's Requirements shall be understood as related to Package A - Transmission Lines only.

3 Intention of the Employer's Requirements

The intention of the PART II, Employer's Requirements is to set out the minimum requirements according to which all works relevant to the Project shall be performed.

The following Sub-Sections of PART II collectively form the Employer's Requirements:

Sub-Section VII-1:	Project Description and Scope of Works
Sub-Section VII-2:	Project Procedures
Sub-Section VII-3:	General Technical Requirements
Sub-Section VII-4:	Particular Technical Requirements
Sub-Section VII-5:	Environmental and Social Requirements
Sub-Section VII-6:	Technical Data Sheets
Sub-Section VII-7:	Annexes

Without restricting anything else set forth elsewhere in the Contract, all work, equipment, material and services required to be provided by the Contractor shall be designed, constructed, and operated, at a minimum, to meet the Employer's Requirements and all applicable laws, including applicable standards, guidelines, codes and regulations governing any of the foregoing including, but not limited to, those standards specifically listed in other sections of the Employer's Requirements and the Contract.

In the event of conflicts between the requirements of any portion of the Contract and any of the standards listed, the more stringent requirement shall apply, unless otherwise agreed to in writing by the Employer/Engineer.

4 Locations, Environmental Data, Site Access, and Transportation

The information provided in this chapter does not release the Contractor from his obligation to perform all necessary studies and investigations regarding the locations, the environmental conditions, site access and transportation facilities. The information provided shall be considered on a purely informative basis.

4.1.1 Locations

Lekhnath and Damauli are located in the Gandaki province, in the Kaski and Tanahun district respectively. The distance from the capital city Kathmandu is approximately 135 km (Lekhnath) and 105 km (Damauli) in northwest direction.

Table 4-1: Terminal tower Locations

Coordinate System WGS 1984 UTM Zone 45N	Terminal tower at Lekhnath SS	Terminal towers at New Damauli SS
Coordinates (approx.)	Easting (m): 211056.8 Northing (m): 3120700.6	Lekhnath 1&2 Easting (m): 233601.4 Northing (m): 3096470.6 Tanahu HPP 1&2 Easting (m): 233644.5 Northing (m): 3096417.8 Bharatpur 1&2 Easting (m): 233668.4 Northing (m): 3096460.7
Province	Gandaki	Gandaki
District	Kaski	Tanahun
Nearest city or village	Pokhara	Damauli
Linear distance from Kathmandu	135 km Northwest	105 km Northwest

4.1.2 Environmental and climatic data

The main climate data for Lekhnath and Damauli are shown below.

Table 4-2: Main climatic data

Description	Unit	Lekhnath	Damauli
Climate type		Sub-tropical	Tropical
Altitude above sea level	m	745	381
Air temperature, max.	°C	40	50
Air temperature, min.	°C	0	0
Annual average temperature	°C	22	32
Maximum relative air humidity	%	100	100
Average relative air humidity	%	80.9	83.8
Annual average precipitation	mm	3665.66	1459.67
Max. wind speed	m/s	50	50
Max. snow cover	cm	N/A	N/A
Number of foggy days	days /year	40	40
Isokeraunic level / thunderstorm days	days /year	60	60
Atmospheric pollution		Light	Light

4.1.3 Site access

Permanent permission to enter the sites shall be provided with the work (construction) permit. Temporary permission shall be given following a specific agreement with the Employer.

Agreements with the concerned landowners to obtain temporary permission to access the sites fall within the responsibility of the Contractor. As per sub-clause 2.1 “Particular Condition of Contract”, the Contractor shall bear all related costs.

However, construction works at the site shall commence only after completion of the design and granting of permits for construction by the relevant local authorities.

The Contractor shall consider and outline this requirement in the Time Schedule. For planning purpose of the site works, the Contractor shall also account for typical weather conditions in Nepal, in particular the monsoon season (June - September).

5 Scope of Works

The main Scope of Works is related to design and construction of a 220 kV double circuit overhead line between Lekhnath substation and the future New Damauli substation.

The overhead transmission line route length is approximately 45.0 km, and is equipped with phase conductor, OPGW and earthwire and insulator sets as per Sub-Section VII-6, Technical Data Sheets.

Sections of the OHL route are passing through very difficult, mountainous, terrain with steep slopes. These sections of the route are generally difficult to access, and slopes are often covered by dense vegetation.

Part of the section AP58 to AP61 passes through potential flood plain of the Sange river. Contractor shall perform hydrological study to provide reliable estimate of the flood level with 1% annual exceedance probability in this area. The cost of this study is considered to be included in the cost of geotechnical investigations.

It is assumed that foundations with up to 1m chimney extensions shall be sufficient to raise the towers above the 1% annual exceedance probability flood level. Design and installation of described chimney extensions shall be deemed included in the Contract price. In case the above assumption is incorrect, the Contractor shall propose modification of this part of the route as may be necessary to raise the towers above the flood level utilising 1m chimney extensions.

To reduce environmental impact and minimise the geotechnical risks potentially associated with removal of vegetation and slope disturbance, the Contractor is required to:

- minimise the length of necessary access tracks by creating short ‘finger’ roads from existing tracks to tower locations
- consider the viability of potential mitigation measures (e. g. possibility of site restoration and re-vegetation or application of suitable geotechnical measures against long-term degradation)
- use alternative means of transport (e. g. aerial, cable or animal) where the above is not viable or residual environmental impact is deemed to be excessive

As part of the Project Resettlement Policy Framework (RPF) for land acquisition and management of social impact on Project Affected Persons (PAP) shall be implemented. The Contractor is required to diligently implement all tasks and measures defined as the responsibility of the Contractor within the RPF. Tasks and measures defined in RPF with shared responsibility of the Employer and the Contractor require Contractor’s full cooperation and assistance to the Employer.

Additional items in the Scope of Works include design and construction of Loop-in / Loop-out (LI-LO) connections of the 220 kV Tanahu Hydro OHL (currently under construction) and also LI-LO of existing 132 kV Damauli - Bharatpur OHL into the New Damauli substation, which is planned to be built as part of the Scope of Work included in Package B.

5.1 220 kV Tanahu Hydro LI-LO

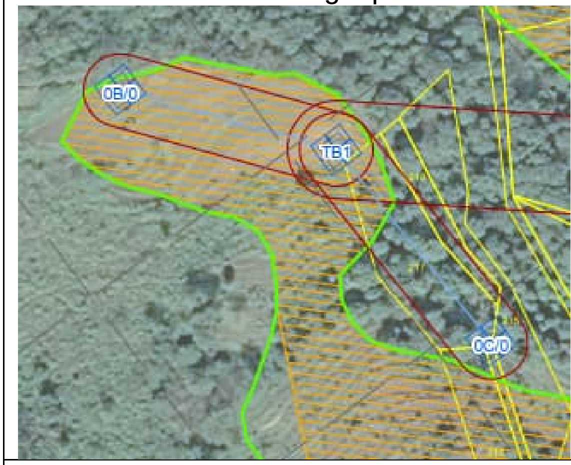
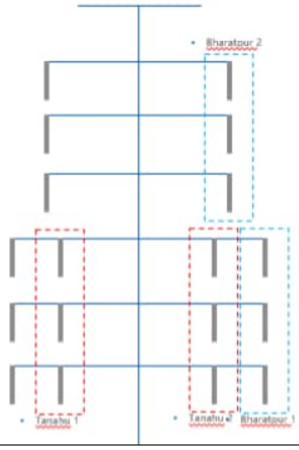
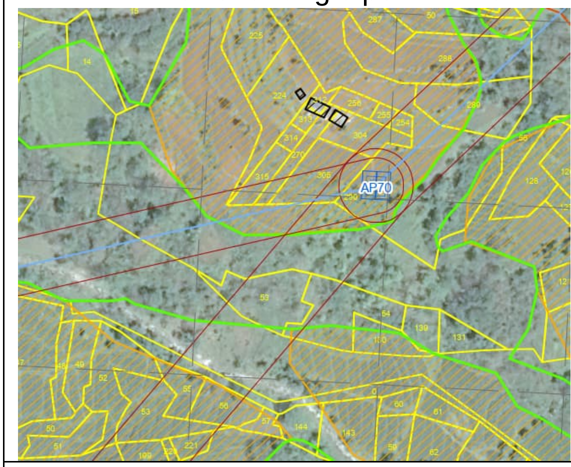
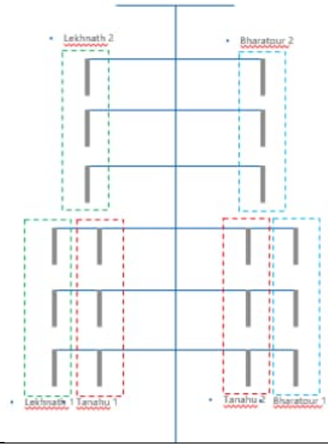
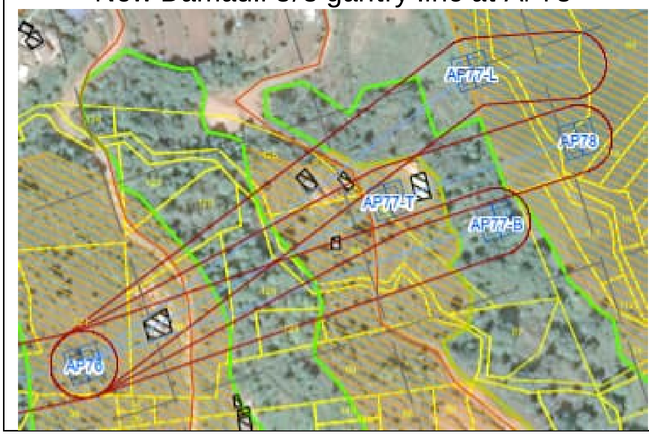
Due to limited space available on the approach to the New Damauli substation it is envisaged that the LI-LO for Tanahu Hydro 220 kV OHL and the final part of the Lekhnath - Damauli OHL shall be placed on the same structures, on six-circuit towers.

220 kV Tanahu Hydro LI-LO connection is envisaged as follows, and also refer to route layout drawings in Sub-Section VII-7, Annexes:

- Both circuits of Tanahu Hydro OHL shall be diverted to tower located at TB1. Diversion shall be made from towers located at angle points 0B/0 and 0C/0.
- Twin ACSR Bison phase conductor shall be strung in span 0B/0-TB1 and in span 0C/0-TB1. The Contractor shall verify the possibility of using existing conductor and insulator sets.
- Between angle points TB1 and AP70 four circuits shall be strung.
- All four LI-LO circuits, Tanahu 1&2 circuits and Bharatpur 1&2 circuits, shall be strung with twin ACSR Bison conductor.
- Existing 24 fibres OPGW between 0B/0 and 0C/0 shall be diverted onto tower TB1 and connected, via joint box, to a single 48 optical fibres OPGW.
- 48 fibres OPGW shall be strung between tower at TB1 and New Damauli substation. This 48 fibres OPGW shall be of similar performance characteristics and construction as the existing 24 fibre OPGW strung on Tanahu HPP line.
- Between tower TB1 and AP70 a second earthwire ACS 93 will be installed.
- At angle point AP70 both circuits of Lekhnath - Damauli OHL shall be also connected to the same six-circuit structure.
- All six circuits shall be strung on common structures between angle points AP70 and AP76. Lekhnath 1&2 circuits shall be strung using same phase conductor and OPGW as on the main line.
- The last of the six-circuit structures shall be placed at AP76. From this tower circuits shall be separated onto three individual double circuit terminal towers located in front of New Damauli substation, at locations AP77-L, AP77-T and AP77-B.

Schematic diagram and the circuit configuration of the Tanahu Hydro LI-LO are shown in the table below. Further details are available in Annexes.

Table 5-1.- Proposed circuit configuration on the approach to New Damauli S/S

<table>
<tr><td>Tower at angle point TB1

</td><td>Circuit arrangement at tower TB1

</td></tr>
<tr><td>Tower at angle point AP70

</td><td>Circuit arrangement at tower AP70

</td></tr>
<tr><td>Dead-end towers at AP77-L, AP77-T & AP77-B
New Damauli S/S gantry line at AP78

</td><td>Circuit arrangement at new Damauli s/s

</td></tr>
</table>

Locations AP77-L, AP77-T and AP77-B correspond to the terminal towers of Lekhnath 1&2, Tanahu HPP 1&2 and Bharatpur 1&2 circuits respectively and are located in front of the 6 circuit 220 kV gantry line in New Damauli Substation.

Contractor shall plan the works so the main section of the 220 kV LI-LO, between substation gantry and tower located at TB2 as well as the foundations at location TB1, are built while the 220 kV Tanahu-Bharatpur OHL is in operation in order to reduce as much as possible outages of the line. In such a way, power transmission could be quickly restored as soon as tower erection and conductor connection works are carried out at TB1.

The Contractor shall bear sole responsibility for coordination with NEA and Tanahu - Bharatpur OHL owners regarding line outages or any other requirements necessary for execution of the works. Outage duration and dates shall be included in the Contractor’s time schedule and confirmed in writing by NEA and Tanahu - Bharatpur line owners. In addition, the Contractor shall provide notification to both mentioned parties and the Engineer about planned outages three months before scheduled execution of the works.

5.2 132 kV Damauli-Bharatpur LI-LO

The scope of works of the project includes the LI-LO connection of the existing 132 kV Damauli - Bharatpur OHL into the New Damauli substation.

132 kV LI-LO connection is envisaged as follows, also refer route layout drawings in Sub-Section VII-7, Annex A-1

- The tower designs developed for the main 220 kV Lekhnath - Damauli overhead line are anticipated to be used for the 132 kV LI-LO.
- Proposed connection point of the 132 kV LI-LO is at DB1, located as close as possible to existing tower 141.
- A new double circuit tension tower, capable of 132 kV single circuit junction arrangement shall be installed at DB1.
- Existing conductor and earthwire are to be cut and transferred onto the new tower at DB1. Existing conductor is ACSR Wolf type.
- The existing conductor and earthwire in spans either side of tower at DB1 shall be sagged to match the existing tension, i.e.: insulator sets on adjacent suspension towers shall be plumbed.
- New insulator sets and hardware and conductor fittings compatible with existing conductors are required at DB1
- Single ACSR Wolf phase conductor shall be strung between New Damauli Substation and tower DB1
- A 96 optical fibres OPGW shall be strung between New Damauli Substation and tower DB1. A conventional earthwire 66-A20SA shall also be strung between New Damauli Substation and tower DB1
- Both, OPGW and earthwire, shall be compatible with system requirements at 132 kV New Damauli substation and the mechanical performance shall be compatible with phase conductor ACSR Wolf

- A 3-way OPGW termination box shall be supplied and installed at the base tower DB1. OPGW strung between New Damauli and tower DB1 shall be terminated at tower DB1 and earthwire shall be connected (via slack span) to the nearest tower on the existing OHL
- The existing suspension tower located near DB1 shall be dismantled and transferred to designated storage yard
- Foundations of the existing suspension tower shall be demolished up to 1.0m below ground level

The 220 kV Tower crossarms shall be adapted to fulfil the following requirements:

- Horizontal phase to phase distance, according to EN50341:2012.
- Right of Way of 18 m

Contractor shall plan the works so the main section of the 132 kV LI-LO, between substation gantry and tower located at location DB2 as well as foundations at location DB1, are built while the existing 132 kV OHL is in operation in order to reduce as much a possible line outages and power supply disruptions. In such a way, power transmission could be quickly restored as soon as tower erection and conductor connection works are carried out at DB1.

5.3 132 kV OHL Tower Inside Lekhnath Substation

For 132kV OHL tower connecting 132kV gantry and autotransformer gantry inside the Lekhnath substation (see Annex A-2), The Contractor shall propose suitable existing tower and foundation design for Employer’s approval. Design suitability shall be demonstrated in detailed design stage by verification of external and internal clearances as well as tower and foundation structural capacity considering climatic data specified in Employer’s requirements and the results of geotechnical investigations. Verification shall be done in accordance with requirements of EN 50341-1 or other international OHL design standard approved by the Employer. Tower clearance and loading diagram as well as foundation outline drawing shall be submitted with the Bid.

Tower shall be of double circuit ‘pine’ type strung with twin ACSR Moose and single earthwire Conductor tensions shall be kept as low as possible whilst maintaining

5.4 General

The contract scope includes design, engineering, manufacturing as well as transportation to site, unloading, temporary storage, installation, and commissioning of Overhead Transmission Lines (OHL) described in Chapter 5. The OHLs shall be designed and built according to the latest version of European Norms (EN) and International Electrotechnical Commission (IEC) standards.

In case discrepancies between the items of scope of supply and services stated hereby and the ones derived from the respective annexes (as per Sub-Section VII-7: Annexes) and in case certain items of scope of supply are identified hereby but not in the respective annexes or vice versa, the

Contractor is required to interpret the Project requirements by considering this document and the annexes in conjunction and collectively. The most stringent requirements shall apply in case of deviations.

The Contract includes the following works:

- surveys
- design
- supply
- installation
- testing
- commissioning
- trial operation
- site restoration
- all other works not explicitly mentioned but necessary for provision of a fully working plant.

The scope of supply and services includes, but is not limited to, the following activities:

- familiarization with local conditions, and project environmental and social requirements and limitations as detailed in ESIA report
- Preparation and implementation of detailed Contractor's Construction Environmental and Social Management Plan (CCESMP) based on ESIA report requirements. CCESMP shall contain specific measures aimed at reducing biodiversity, social and environmental impact of the OHL route.
- verification and adjustment, if required, of the proposed line routes. The Contractor is required to verify suitability of all tower locations for construction during survey and detailed design stage (tower spotting). It is anticipated that related activities shall require multiple site visits.
- LiDAR survey and high-resolution aerial imagery of overhead line route corridor; including additional buffer area to allow potential adjustment of tower locations. Line route survey shall include all existing power lines, pipelines, cables, gas pipelines, telecommunication cables, roads, railways, etc.
- line design, including towers spotting, line profiles, clearance report; clearance drawings
- geotechnical investigation at tower locations and any other local investigation, including hydrological study described above, required to determine tower site protection measures, site stabilization works required and foundation design; including preparation of reports as required
- site specific investigation in areas of confined space due to terrain morphology or proximity to existing overhead lines
- the integral design of all OHL components required to construct a functional overhead line. The studies shall include (but are not limited to) electrical, mechanical, and civil works design. As a minimum it includes preparation, submission and obtaining Employer/Engineer approval

of all relevant design documents (main design, detailed design, fabrication drawings, as-built records), such as:

- site area polygon drawing at all proposed tower locations
- area polygons of cadastral data and ownership titles for identification of PAPs in digital georeferenced file, such as shape file (for affected tower locations, all affected private properties in the overhead line right of way and ancillary working areas, such as access roads, laydown areas, etc)
- schedule PAPs and related cadastral area polygon(-s), including its identification number/code and relevant information
- where line runs parallel to another transmission line, minimum clearance between adjacent overhead lines shall be investigated and proved by calculation
- sag-tension calculations, including calculation of and allowance for, conductor long term creep
- structural design and detailing of towers
- strength check of existing structures related to project works
- design of foundations
- insulator sets and fittings - component definition including electrical and mechanical verifications
- conductor and OPGW system, including joints and fittings - electrical and mechanical calculations, stress verification
- earthing detailing
- construction methodology and design - stringing positions, stability verifications, sag-tension tables, site specific installation methodology

- line components: manufacture or procurement, factory testing, packing, insurance, shipment, custom clearance, unloading, storage, local transportation, delivery to site and site storage
- planning, design, construction, and restoration of access tracks as per provisions of the Contract
- all required civil works:
  - site preparation (access tracks, storage yards, work areas)
  - excavations and backfill
  - protection for tower locations and access tracks (including as appropriate: retaining walls, slope stabilization measures, erosion protection, drainage) as per Employer's Requirements
  - reinstatement of tower locations, work areas, and access tracks during construction and upon completion of works as per Employer's Requirements
  - installation of long-term erosion protective measures in accordance with Employer's Requirements
- dismantling works of existing power lines, where required by project scope; including transportation to designated warehouse(s)
- supply of specific tools and equipment required for erection, tests, and commissioning

- installation of foundations
- erection of towers
- installation of all required fittings, spacers, dampers, insulator sets, stringing of conductors, OPGW and installation of earthing system and all specified tower furniture and signage. Following the assembly of the different overhead line components, the Contractor shall allow for the Employer/Engineer check prior to final installation.
- installation of aircraft warning system and tower painting in line with national aviation authority requirements
- connection to substation gantries, optical fibre connections to junction and termination boxes
- site tests required for line commissioning
- supply of spare parts and maintenance tools, including submission of main equipment manuals in English language
- operation and maintenance training of Employer's personnel
- submission of documentation (test reports, equipment, and material certificates, "As-built" final documentation)
- final site restoration, removal of all storage yards, debris, and leftover construction materials. Additional works as required to leave the site clean and restored to original condition as much as possible.

The Contractor shall also perform a study to determine electrical and magnetic fields strength and audible noise level along the overhead line Right of Way corridor. The aim of this study shall be to demonstrate compliance with Employer's Requirements. Study shall be performed in line with good international industry practice and shall be submitted to Employer/Engineer for review and approval.

The following activities are also deemed to be part of the scope and shall be provided without additional costs to the Employer:

- services related to procurement of material and equipment: manufacture, factory testing, packing, insurance, transportation, shipment, custom clearance, unloading, storage and supply to the site
- support in getting all work permits from authorities and landowners for all site activities required as per local regulations, including submission of detail design, detailed drawings, etc. also in Nepali language if requested by the Employer.
- In order to obtain the Construction Permit, the Contractor will prepare the application according to Nepali legislation.
- negotiations with landowners and authorities regarding land usage for access roads/tracks, store yards, tower locations and line corridor
- access to site as per Particular Conditions of Contract
- support in getting approval and work permit for all overhead line crossings, such as roads, power lines, gas pipelines, roads, telecommunication lines, etc. Including submission of

crossing detail design, detailed outage schedule, detailed works plan, scaffolding location, etc. and all documentation required as per local regulations. Outage schedule of existing lines shall be incorporated into overall project schedule.

- During stringing works, the Contractor is responsible for providing a temporary bypass/connection for existing distribution lines for which an outage, either longer than 24 hours or more than 3 days with evening energization, is required.
- In the event of resettlement of existing properties, demolition of all affected existing buildings and structures (i.e.: houses, fences, shelters, sheds, etc.) within RoW corridor shall be in line with requirements.
- installation and testing of all equipment and materials as required
- supply of specific tools and equipment required for erection, tests and commissioning, including submission of main equipment manuals in English language
- accessories for the main components - e. g. joint material and clamps for conductors, connection equipment, fixing material including screws, bolts, washers, and nuts.

The Contractor is deemed to have carefully examined the Contract documents and all conditions affecting the execution of the Works and to have evaluated all available and required facilities.

All materials, designs, details, fabrication, and tests shall comply with the Employer's Requirements. However, this does not limit the responsibility of the Contractor to perform all design and works and to supply all accessories required to deliver the Overhead Line(s) complete, safe, and ready for operation.

No omission or ambiguity in these Employer's Requirements shall relieve the Contractor from the responsibility for furnishing the quality design, materials, and workmanship.

All designs and details shall be subject to approval by the Employer/ Engineer. The Engineer reserves the right to request the Contractor, without incurring additional costs for the Employer, for adjustments in design and details as deemed necessary to fully conform to the Contract requirements. The Contractor shall assume full responsibility for the adequacy and accuracy of the work, which is required to be provided. The Contractor remains responsible for providing all necessary interface data.

The Contractor shall offer quantities according to the Price Schedules. These quantities were estimated for bidding purposes only. They are not valid for the Contractor's material ordering, for which purpose the Contractor shall establish the necessary quantities based on approved detailed design.

The Contractor is required to provide complete works and equipment to fulfil the purpose of the Project even if the equipment or services are not mentioned specifically in the Employer's Requirements.

Any quantities set out in a Price Schedule or in the description of the Scope of Works are estimated and shall not be considered as the actual and correct quantities of the works. Actual quantities shall be determined by the Contractor based on approved detailed design and Price Schedules updated accordingly.

All temporary works and equipment, necessary during the execution of the works, are deemed to be included in the scope of supply.

The Contractor shall provide all necessary documentation required for obtaining the construction license/work permit.

The Contractor shall be responsible for liaising and operating with the Employer's operations and maintenance personnel and for always providing them with free and uninterrupted access to those areas of the site required for their operations. The Contractor who shall be wholly responsible for ensuring that all materials used comply with the approved standards (latest edition), and that all processes of workmanship are carried out with a high degree of efficiency, in accordance with an approved program and in compliance with the Employer's Requirements.

The technical features, functionality, outfits, data, and further details shall be according to technical requirements, equipment specifications and Technical Data Sheets.

5.5 Interfaces and Limit of Supply with Substation

The following interfaces are included in the scope of works:

- interface between the overhead line and the substation works are the substation gantries
- Phase conductors, earthwire and OPGWs shall be terminated at these gantry structures. Gantry structures are not part of the scope.

The limit of supply of the OHL Contractor shall include:

- Downlead conductors and tension insulator strings shall be supplied and installed at the substation gantries.
- Phase conductor jumper loop at the substation gantry shall have sufficient length to enable Substation Contractor connection with the line entry equipment.
- OPGW termination splicing boxes shall be supplied and installed at the base of the substation gantry structure.
- OPGW droppers shall be installed down to the splicing box.
- OPGW splicing works and end-to-end testing of the fibre optic link, between termination splicing boxes
- Existing overhead lines: interface between existing equipment and new equipment shall be at the nearest existing tension tower either side of location where works are to be carried out.

The OHL Contractor shall coordinate and interface with the substation Contractor(s) for “end to end” protection and telecommunication tests. OHL Contractor shall also coordinate the access to Lekhnath and Damauli substations, as required for execution of works, with the Employer and respective substation Contractors. Compliance with any particular safety and environmental requirements within substation sites set by the Employer or substation Contractors is the sole responsibility of the OHL Contractor.

Limit of supply and interfaces between transmission lines and substations are presented in Annexes.

6 OHL route description

Due to extensive references to angle points this section should be read in conjunction with the OHL route layout drawings, presented in Sub-Section VII-7, Annexes.

The 220 kV Lekhnath-Damauli Transmission Line project located in Kaski & Tanahaun district of Gandaki Province which is the western part of Nepal. The proposed route alignment has encompassed the two Nepal districts, namely Kaski & Tanahun.

Proposed Lekhnath Substation is situated at the Pokhara Municipality (Lekhnath), Kaski & Damauli substation has been situated at Byas Municipality Damauli, Tanahun Nepal.

Pokhara the headquarters of the Kaski district, is the nearest city from project area Lekhnath substation site & the ‘Damauli’ is the headquarters of Tanahun District Nepal which is nearest city from the Damauli substation site.

Proposed project area of Transmission line route moves through Pokhara municipality of Kaski Lekhnath, Gandaki province of Nepal to Byas Municipality Tanahun district, Gandaki province of Nepal. There is a road connecting Kathmandu to Pokhara Lekhnath substation & Damauli substation through via Prithivi Highway. Damauli substation location can be reached through Prithivi Highway by 4 hrs drive which is approximately 152 km distance from Kathmandu Nepal & the Lekhnath substation can be reached through this highway by 6 hours’ drive which is approximately 200 km distance from Kathmandu.

Alternatively, the project area at Lekhnath substation site can be reached following 25 minutes’ flight from Tribhuvan International Airport Kathmandu to Pokhara Airport Kaski which is nearest airport from the project area.

From Lekhnath S/S the proposed line route follows E-NE direction crossing a hilly area up to AP10 near the village Syangkhudi. In this section the line route crosses several times the Kabi Shiromani Lekhnath Marga Road.

Between angle points AP1 and AP2 proposed line is crossing over the future 132kV New Modi line (currently under construction) and between AP2 and AP4 is crossing under the existing 132kV Upper Madi transmission line.

Starting at AP10 till line route reaches AP14, proposed line route is located along the mountain ridge line and through a forest area. Special measures for bird protection, i.e.: earthwire equipped with bird flight diverters, shall be installed in this section of the line.

From AP10 and AP24 the line route follows East direction along the mountain ridge, reaching up to 1,180 m altitude. The line route passes near populated areas, crosses a valley North from Talbeshi village, turning then in the South direction near Sirkutan village (AP26). In this section the line route crosses Doman River and several roads (Begnas Bhorletar, Vhirchowk Mohoriya).

From AP37 the line route continues in South direction in parallel with Midim Khola River up to AP54, crossing a relatively flat area. The surrounding area is sparsely populated, and land is use mainly for crops.

Onwards, the line route goes along a wide valley crossing the Damauli-Sanghe Road, passes near a densely populated area and crop fields parallel to the road and turns S-E up to AP65.

Between AP62 - AP63 the line route is crossing the Prithvi Highway (H04), a major road connection between Pokhara and Kathmandu, an existing HV overhead line, a 33 kV distribution line and the existing 132 kV Lekhnath-Damauli transmission line.

Between AP65 and AP66 the line route crosses the Seti River. After it, the line route goes along the river and crosses again between AP68 and AP69.

At AP70 the proposed 220 kV line route joins the four circuit 220 kV Tanahu LI-LO and continues as a six-circuit line up to AP76.

Between AP70 and AP76 area is hilly, with steep slopes, and there are scattered houses.

Three dead-end towers, labelled AP77-L, AP77-T, AP77-B, are anticipated in front of Damauli 220 kV Gantries.

6.1 220 kV Tanahu Hydro LI-LO

The approximately route length of the 220 kV Tanahu Hydro LI-LO is:

- 4 circuit section, between TB1 and AP70: approx. 1.00 km
- 6 circuit section, between AP70 and 220 kV gantry line at New Damauli S/S: 1.80 km

Angle points along 220 kV LI-LO route are located in general on terraced agricultural fields or in the vicinity of them. Access to the tower locations is deemed to be complicated and challenging, particularly for heavy equipment and machinery.

Tower location TB1 is approximately 50 m from the 220 kV Tanahu-Bharatpur OHTL, which is under construction.

Last 6 circuit tower is located at AP76. Then, three dead-end towers, labelled AP77-L, AP77-T, AP77-B, are anticipated in front of Damauli 220 kV gantry line. Construction of the tower foundations shall be closely coordinated with substation contractor, in particular regarding the river training works, and taking into account the final New Damauli substation ground level.

6.2 132 kV Damauli-Bharatpur LI-LO

The route length of the 132 kV Damauli-Bharatpur LI-LO is approximately 400 m, between angle point DB1 and the 132 kV gantry inside New Damauli substation.

Terrain is flat and with no major obstacles. Angle points are located in agricultural fields with relatively easy access. Existing 132 kV suspension tower near DB1 is located around 35 m from an existing road.

Tower location DB3 is approximately 40 m from the future 132 kV gantry. Construction of the tower foundation shall be closely coordinated with substation contractor, in particular regarding the river training works, and taking into account the final New Damauli substation ground level.

6.3 Crossing of existing OHLs

The proposed 220 kV OHL route is crossing with a number of existing overhead transmission lines as described hereafter.

In addition to crossings described hereafter, which are with main existing transmission and distribution overhead lines, there is a number of HV and LV power distribution and telecommunication overhead lines present along the proposed OHL route, in particular where the line route is passing in the vicinity of populated areas and settlements, such as in the approach to both end substations, between AP38 and AP42, or at AP55.

132 kV New Modi and 132 kV Upper Madi

Proposed 220 kV OHL is starting at angle point AP1, located in front of 220 kV Lekhnath Substation Gantry, where a dead-end tower type will be located.

Between AP1 and AP4, the line is crossing with two 132 kV lines, namely New Modi Line (currently under construction) and the existing Upper Madi.

Proposed 220 kV overhead line is crossing over the 132 kV New Modi in the span between angle points AP1 and AP2. A relatively tall tower, equipped with longest body extension, is anticipated at AP2

Proposed 220 kV overhead line is crossing under the existing 132 kV Upper Madi, which is located on the ridge line, in the spans between angle points AP2 and AP4. A portal type of structure is anticipated at AP3 in order to facilitate the under-crossing of the proposed 220 kV line.

Ahead of AP4, proposed 220 kV line is crossing over an existing 11kV and 33kV distribution lines located along the eastern shoulder of the existing road.

During construction works, Contractor shall stablish a close liaison and coordination with NEA in order to coordinate the necessary line outages required for the stringing works.

132 kV Lekhnath - Damauli

Proposed OHTL route is crossing with the existing 132 kV Lekhnath - Damauli overhead line towards the end of the line.

The crossing point is located between AP62 and AP63, approx. 45 m back from AP63. Due to the orography of the area, proposed 220 kV line will be crossing under the existing 132 kV Lekhnath - Damauli line.

Proposed 220 kV Line is crossing over highway H04 and over an existing 33 kV distribution overhead line in the same span, located along the northern shoulder of the highway.

Highway H04 is the main road connecting Pokhara and Kathmandu, and it is heavily congested throughout the day. Traffic management measures and road traffic protection measures, such as hurdles, shall be implemented by Contractor in order to reduce as far as possible any disruption to the road traffic during conductor stringing works.

Additionally, Contractor shall relocate the existing 33 kV line along the southern shoulder of the H04 in order to enable the construction of the future 220 kV OHTL.

During construction works, Contractor shall stablish a close liaison and coordination with NEA and the Nepalis roads authority in order to coordinate the necessary line outages and traffic management measures required during the stringing works.

7 Right of Way and Land Take

Preliminary Right of Way (RoW) corridor considered is as follows:

- 220 kV Lekhnath - Damauli OHL: 30 m
- 220 kV Tanahu-Bharatpur LI-LO section: 30 m
- 132 kV TanahuOld Damauli-Bhratpur LI-LO section: 18 m

The Contractor shall be responsible for all vegetation clearing within the RoW corridor, including removal from site and appropriate disposal of all tree-cutting remains, branches, scrubs, bushes, etc. Vegetation clearing works shall be carried out as prescribed in Project Environmental and Social Management Plan (ESMP). Vegetation clearance outside of RoW corridor, if required for site access, also falls under Contractor's responsibility.

In-span land plots within the RoW corridor can still be used by the landowners but under restrictions regarding plantation's growth height. The locations where towers are located will not be available for use by the landowners, and consequently the area being permanently occupied by tower structures shall be bought by the power utility.

During the line construction some temporary land access may be required for site access, in-transit storage of material and temporary placement of line erection equipment (construction equipment yard). Access to such sites shall be as per Particular Conditions of Contract.

8 Environmental, Social, Health and Safety (ESHS) Management

In conjunction with the works and services described herein, the Contractor shall plan, execute, and document construction works as specified in Construction Contractor’s Environmental and Social Management Plan (CCESMP) approved by the Employer/Engineer. This document shall be prepared considering requirements of ESIA report included in the Contract.

9 Other Items of Supply and Services

The below mentioned items of supply and services regard all transmission lines (existing and new) affected by the Project and are an integral part of the overall scope of the Project.

9.1 Document Preparation and Submission for Permits

The Contractor shall prepare and submit to the Employer all necessary documents required for obtaining all necessary permits from the relevant authorities for the execution of works included in the Project.

The Contractor shall ensure that all documents for approval are provided with appropriate time consideration for examination by the authorities. Documents shall be submitted early enough to allow amendments to be made and resubmission for approval can be conducted without delay in the delivery and installation program or the guaranteed completion dates of the works.

All drawings shall be plotted and shall show the scales of the metric system, and all descriptive wording shall be in both English and Nepali language.

All relevant costs shall be borne by the Contractor.

9.2 Communication and Visibility

The Contractor shall ensure compliance with the Project communication and visibility requirements and guidelines by placing display panels at defined locations.

The purpose of the display panels is to inform about the major features of the project and the work in progress. A display panel shall be placed by preference at a spot were many people pass by e.g., near a road. Therefore, the panel must be readable from a distance, accounting for the speed of vehicles and people passing by.

9.2.1 Display panel requirements

The panels shall contain (as a minimum) the following:

- the logos of the funding institutions displayed according to the specific requirements: German Cooperation, KfW and EU
- the name of the Project
- the name of the Sub-project (Lot) - if applicable
- completion month/year
- name and logo of the Employer
- name and logo of the Contractor
- name and logo of the Engineer.

Photography using the whole width of the panel can be used.

Typography: a sans-serif font shall be used.

A minimum of 3 panels shall be placed at appropriate locations.

The dimensions of the panels shall be 5.00 m x 3.00 m unless otherwise agreed with the Employer.

The panels, printed on an environmentally friendly material, shall be placed on a safe and solid frame designed to withstand local climatic conditions.

Procedure

For each sub-project the final number of display panels shall be established in consultation with the client.

The contractor is responsible for producing and placing the panels.

The marketing and communication company selected by the client shall provide the design (lay-out file - certified pdf, approved by the client) to the contractor.

The contractor sends the certified panel layout (pdf-file) to the display supplier, selected by the contractor.

The contractor has the construction boards produced according to the material specifications.

The contractor pays the costs of the design and the production and placement of the display panels.

9.3 Spare Parts and Tools

For all transmission lines spare parts and tools are included in Contractor’s scope in quantities indicated in document Price Schedules.

Spare parts and tools are divided in two categories, i.e., the mandatory spare parts and tools and recommended ones.

For both categories of spare parts, brochures and catalogues shall be provided along with the Bids.

9.3.1 Mandatory spare parts and tools

Mandatory spare parts and tools are included in Contractor's scope. The type and quantity of these spare parts are listed in the Price Schedules.

9.3.2 Recommended spare parts and tools

In addition, the lists of recommended spare parts, equipment, tools, and instruments for maintenance of Overhead Line(s) shall be included in the Bid. This applies to all spare parts and tools which are not listed as mandatory spare parts and tools but are considered by the Contractor as necessary.

It is noted that the cost of these recommended items of supply will be reviewed and considered during the bid evaluation process but shall not be part of the evaluated price. They shall serve as basis of a potential order of the respective equipment and tools -or part thereof- which may be placed at the Employer's discretion.

9.4 Training of Employer's Staff

During erection, commissioning and trial operation, the Employer's selected operating personnel shall be familiarized with the functions of the Transmission Lines. The Contractor shall arrange appropriate training in the erection, operation, and maintenance of the equipment for the Employer's personnel at site as well as training at a designated training centre.

The training shall be performed in accordance with the following schedule:

1. Training on-site

For installation, operation, testing and maintenance of the newly installed equipment, the Contractor shall perform training on site for 7 Employer´s representatives for a minimum of 7 days during installation phase.

The Contractor shall submit for approval of Employer/Engineer a comprehensive on-site training program focused on general and basic structure of the system, safety procedures and measures during construction, installation and erection works methodology as well as on the technical characteristics of the different line components and its maintenance and repair works.

On-site training program shall be structured in various sessions considering the availability of the Employer's shift personnel.

The training on-site shall comprise the following:

- 220 kV overhead line works
- training on OPGW technology, fibre splicing, joint boxes assembly, testing and maintenance

2. Training at Contractors' or Manufacturers' premises

The following training modules shall be provided at contractor´s main office/manufacturing premises:

- lattice steel tower design using PLS-TOWER
- tower foundation design.

For both on-site and at Contractor's/Manufacturer's premises training, the Contractor shall submit a tentative training program, subject to the approval of the Employer/Engineer. Training shall be arranged for two (2) persons over ten (10) working days.

The Contractor shall undertake all costs related to the above-mentioned training, including air travel, hotel accommodation, 50.00USD daily allowance for Employer's staff, and local transportation (when the training is not performed in the Employer's country).

All training sessions shall be conducted in English language.

All training material shall be submitted in both English and Nepali languages.

9.5 Participation of the Employer's staff in FATs

Employer's engineers shall participate in factory acceptance tests (FAT) for the following equipment:

- participation in FAT for towers in manufacturing factories for 20 man-days and 5 trips
- participation in FAT for OPGW equipment in factories for 10 man-days and 2 trips
- participation in FAT for conductors/earthwires in factories for 10 man-days and 2 trips
- participation in FAT for insulator strings in factories for 10 man-days and 2 trips.

The arrival/departure of the Employer's personnel shall be scheduled for one day before/after the respective test(s).

The Contractor shall, if requested by the Employer, aid in arranging air travel (including visas if necessary), hotel accommodation and local transportation. Associated costs shall be borne by the Employer.

9.6 Participation of the Employer's staff in Type Tests

The Employer's engineers shall participate in the type tests for newly designed towers. Number of tests and tower types are specified in Sub-Section VII-4.

For these type tests, 20 man-days and 5 trips shall be foreseen.

The arrival/departure of the Employer's personnel at the towers' testing station will be scheduled for one day before/after the respective test(s).

The Contractor shall, if requested by the Employer, aid in arranging air travel (including visas if necessary), hotel accommodation and local transportation. Associated costs shall be borne by the Employer.

9.7 Site facilities of the Employer and Engineer

Contractor shall provide, in addition to other facilities and accommodations for Contractor's own staff, separate accommodation facilities on site for the Employer and the Engineer.

Therefore, the below mentioned items of supply shall be provided:

- one (1) Employer's office containers
- one (1) Engineer's office containers
- one (1) Employer's/Engineer's meeting room containers.

These containers shall be installed at locations to be indicated by the Employer/Engineer. The Contractor shall maintain them throughout the Project period and shall -upon request- remove them after the completion of works.

The afore-mentioned temporary site facilities shall be structurally sound and compatible with the weather conditions on the site, including at least the following rooms:

Office container

- two (2) main (office) rooms, each equipped for 2-3 persons
- two (2) toilet rooms, one for men and one for ladies
- one (1) small kitchen.

Meeting room container

- one (1) room for holding meetings for at least 10 – 12 persons (of -as a minimum- 32 m²)
- two (2) toilet rooms, one for men and one for ladies
- one (1) small kitchen.

All the above-mentioned containers shall be provided with appropriate furniture to fulfil their purpose. In addition, they shall be equipped with heating and air-conditioning systems.

All containers shall be provided with an internet connection. The Contractor shall install a communication system on the Employer's/Engineer's containers independent of the one installed for his own containers. All the relevant costs throughout the Project implementation shall be borne by the Contractor.

The facilities shall be provided along with the services necessary for their operation, such as electrical energy, potable water supply, sewers, drainage system, fire extinguishing system, regular cleaning, etc. All the relevant costs throughout the Project implementation shall burden the Contractor.

The Contractor shall submit for approval all drawings and details for the buildings, services and equipment intended to be used before starting with the execution works on the site.

VII-2

Project Procedures

Table of Contents

1 Project organisation, administration, and meetings

1.1 General

During the tendering phase of the Project, along with his bid, the Contractor shall submit the Project organization chart clearly identifying the Project team, their responsibilities, communication, and reporting lines.

Close cooperation shall be established between the Employer/Engineer and the Contractor throughout the Project.

Document submission, meetings and other administrative aspects shall be handled as outlined below.

1.2 Correspondence and document submission

The Contractor shall address all formal correspondence (letters etc.) to the Employer and provide a copy to the Engineer.

Each correspondence shall carry the Project title, Project number, date, correspondence number etc.

The Contractor shall track all correspondence in a Correspondence Log which shall be added to a Monthly Progress Report.

Documents shall be submitted using Document Transmittal Sheets (DTS) and as outlined in this document.

Further details will be discussed during the kick-off meeting.

1.3 Meetings

1.3.1 Kick-off meeting

A kick-off meeting will be held at the Employer’s offices in Nepal to discuss the Contract framework, Time Schedule, administrative aspects, organization, and other Project specifics.

The meeting shall be organized as soon as practical following the Commencement Date.

1.3.2 Progress meetings

Progress meetings shall take place in Employer’s offices on a regular (usually monthly) basis following the commencement of the Contract.

The main topics of these meetings shall be:

- work progress review (previous month)
- Time Schedule review
- work forecasted
- open topics, unresolved issues etc.
- review of DTS and Communication Logs
- review of Project finances.

Any other topics based on the Monthly Progress Report submitted by the Contractor ahead of the progress meeting and as outlined further below may also be discussed.

The relevant Minutes of Meetings shall be signed by all parties.

1.3.3 Site meetings

During construction, installation and commissioning, site meetings shall be held on a regular basis (at least weekly) and/or as needed in accordance with the progress and situation at site.

The meetings shall take place at the site office unless otherwise required by the Employer/Engineer.

The main topics of these meetings shall be:

- progress review and forecast
- construction schedule review
- equipment and material delivery status
- environmental and social review, including RAP implementation review
- review of QA/QC topics
- ESHS review and analysis
- administrational matters.

Design-related topics may also be discussed; however, such discussions shall not be deemed to comprise any design approval action.

The relevant Minutes of Meetings shall be signed by all parties.

1.3.4 Other meetings

Each party may request a meeting at any time required.

Such request shall be in writing (accompanied by an agenda) and shall be submitted at least 5 working days prior to the meeting.

During Factory Acceptance Testing (FAT), inspections and commissioning tests, meetings shall be held as follows:

- a kick-off meeting at the beginning of each session to discuss the scope, procedures, criteria, environment, expected results etc.
- a meeting at the end of each test session, to discuss the results and potential mitigation measures (if required).

The relevant Minutes of Meetings shall be signed by all parties.

1.4 Reporting

1.4.1 General

The reporting activities shall mainly cover the following:

- monthly progress reporting
- reporting on FAT
- reporting on inspections and tests
- project completion
- environmental and social performance reporting
- other reports as required.

Details and requirements regarding the layout and contents of above reports shall be discussed during the kick-off meeting.

1.4.2 Monthly progress report

Monthly Progress Reports shall be prepared by the Contractor and submitted to the Employer and to the Engineer.

The following items shall be considered in addition to the items required in PART III, Sub-Clause GC 4.21:

- executive summary
- financial summary and details "Detailed cash flow estimates of all payments to which the Contractor will be entitled under the Contract"
- main issues and events
- updated Time Schedule. The Contractor shall describe major adjustments and deviations between the updated Time Schedule and the Base Line Schedule. Further planned and actual disbursement schedules of the Project (S-graph) shall be provided.
- updated FAT schedule
- updated Disbursement Schedule
- updated Correspondence and DTS Logs
- coordination with other Contractors of SS Lots and/or Transmission Line Lots etc.
- matters requested under the ESMP

- QA/QC and HSE matters
- implementation of CESMP and RAP (overall performance and progress)
- Further items shall be considered if instructed by the Engineer.

The detailed layout and content of the Monthly Progress Report including appendices required shall be discussed during the kick-off meeting.

1.4.3 Special reports

Throughout the Project but especially during installation and commissioning and until the end of the Defects Notification Period, the Contractor shall prepare special reports covering (as a minimum) the following:

- test reports (FAT and other type test and routine test reports)
- transport of (main) equipment like transformers etc.
- inspections and tests during installation
- pre-commissioning tests
- site tests
- commissioning tests
- trial operation
- equipment failures, damages (especially during transport), testing, trail operation, warranty etc.

These reports shall be submitted to the Employer/Engineer as reasonably possible but the latest within 28 days following the occurrence of the subject, completion of the test etc.

Details and requirements regarding the layout and content of the above-mentioned reports will be discussed during the kick-off meeting.

The Contractor shall promptly, but the latest within 2 workdays after the occurrence of any of the following events set out below, provide to the Employer/Engineer the detailed report regarding:

- any incident of an environmental or occupational health and safety nature (including without limitation any explosion, spill or workplace accident which results in death, serious or multiple injuries or material environmental contamination)
- any incident of a social nature (including without limitation any labour strike or violent labour unrest or dispute with local communities/community protests), occurring on or nearby any site, plant, equipment or facility of the Employer which has or is reasonably likely to have a material negative impact on the environment, the health, safety and security situation, or the social and cultural context, together with, in each case, a specification of the nature of the incident or accident and the on-site and off-site effects of such events
- any actions by the competent authorities / regulators leading to partial or complete stoppage of project activities, and

- any action the Contractor proposes to take to remedy the effects of these events. The Contractor shall by regular (weekly, unless otherwise agreed) updates keep the Employer informed about the progress in respect of such remedial action.

1.4.4 Project completion report

The Contractor shall prepare and submit the Project Completion Report not later than 1 month after the Taking-over Certificate for the works has been issued.

The report shall contain (as a minimum):

- project definition, objectives etc.
- Contractor's scope of work
- financial summary (including all amendments and change orders)
- schedule comparison (base line and schedule at completion)
- summary of incidents etc. occurred during Project execution including description of mitigation measures etc.
- Contractor's organization charts
- installation and commissioning report
- test certificates and reports
- inspection certificates
- acceptance certificates
- analysis of environmental and social compliance
- analysis of health and safety performance.

Details and requirements regarding the layout and content of above report will be discussed during the completion phase of the Project.

2 Project documentation

2.1 General

All documents shall comply with international standards and shall be easy to be identified including their revisions and amendments.

As a minimum, documents shall show the Project title, Project number, date, unique identification reference (number) and other details agreed during the kick-off meeting.

In preparation of and during the kick-off meeting the Contractor shall introduce its documentation/document management system (structure, document tree etc.) and shall submit a preliminary Document Schedule for review and discussion ahead of the meeting.

Documents (studies, specifications, reports, drawings etc.) shall be submitted in accordance with the Document Schedule.

Documentation in electronic format shall be in Microsoft Office 2010 format.

All documentation (except where otherwise required for permitting purposes) shall be in English language. To the degree necessary for permitting purposes, the Contractor shall prepare all necessary documentation also in Nepali language.

2.2 Document schedule

The Contractor shall prepare and submit a Document Schedule (in accordance with the Time Schedule) which shall list all Project Documents including:

- project organization and chart
- method statements
- inventory
- spare parts
- system studies
- design studies
- equipment specifications
- design calculations
- drawings
- manuals
- inspection and test plans, test programs
- test protocols
- Quality Management System
- HSE management/OHS Management Plan (final version to be completed prior to start of construction activities)
- Environmental and Social Management Plan
- environmental and social permits/approvals.

The Contractors shall include other documents, reports etc. necessary to execute the Contract, meet performance criteria and other obligation etc. in compliance with the Contract requirements.

The Document Schedule shall indicate the dates the Contractor intents to submit the documents for information, review and/or approval and the as built versions.

An updated version of the Document Schedule shall be provided with the Monthly Progress Report.

A preliminary version of the Document Schedule shall be submitted before the kick-off meeting for review and discussion during the meeting.

2.3 Documents for approval

As a minimum the Contractor shall submit the following documents for approval through DTSs:

- final time schedule to be frozen
- project organization and chart
- site organization and chart
- method statement for civil construction
- method statement for electrical installations
- single line diagrams
- system studies
- design studies
- equipment specifications
- design calculations
- list of manufacturers and subcontractors
- equipment outlines drawings
- layout drawings
- earthing system drawings and calculation
- civil drawings
- steel work drawings
- inspection and test plans
- earthing system drawings and calculation
- pre-commissioning tests report
- commissioning tests report
- trial operation report
- training program and schedule
- operation & maintenance manuals
- spare parts list
- as built documentation.
- CESMP and OHS Plan.

2.4 Documents for information

As a minimum the Contractor shall submit the following documents for information through DTSs:

- survey reports
- weekly plans
- inspection and test programmes
- test reports
- training manuals
- monthly progress reports.

2.5 Calculations, drawings, and tests required for permitting

The Contractor shall prepare and submit for approval to the relevant state building permit authority all necessary documents (including calculations, designs, drawings etc.) to obtain permits for the execution of works included in the Project.

The Contractor shall ensure that all documents for approval are forwarded to the authority for approval in such a way as to allow sufficient time for their examination. The Contractor shall also ensure that documents are submitted early enough to allow amendments to be made and that resubmission for approval is conducted without delay in the delivery and installation program or the guaranteed completion dates of the works.

All drawings shall be plotted and shall show the scales of the metric system, and all descriptive wording shall be in both English and Nepali language.

All relevant costs shall be borne by the Contractor.

2.6 Operation and maintenance manual

The Contractor shall provide the following documents in both English and Nepali languages:

- operation & maintenance manuals for the equipment and auxiliary systems supplied
- health & safety manual
- environmental and social management manual
- training manual
- maintenance plan/schedule for recommended (preventive) maintenance
- spare parts list (incl. ordering and delivery specific information) and storage plan.

2.6.1 Equipment operation and maintenance manual

- The operation and maintenance manuals shall contain the following:
- safety instructions
- manufacturer’s contact information
- component and material descriptions
- outline and assembly drawings
- connection and wiring diagrams
- installation (assembly) instructions
- operation instructions
- maintenance instructions
- maintenance schedule
- troubleshooting instructions
- spare parts list
- list of tools and consumables.

The Contractor shall include other necessary information to maintain the equipment on a regular basis, exchange components, handle trouble shooting, contact manufacturer’s service personnel etc.

The maintenance instructions shall be divided into sections describing in detail the preventive maintenance and the troubleshooting procedures (instructions and recommendations).

2.6.2 Health and safety manual

The Contractor shall prepare a Project specific Occupational Health and Safety Management Plan, including a health & safety manual and submit for review and approval.

The OHS Management Plan and - manual and the procedures etc. described shall comply with applicable national codes and standards as well as with the EHS Guidelines of the World Bank Group and with the provisions set in the overall ESMP for the Project as well as with any additional specifics outlined in the Contract.

2.6.3 Training manual

The Contractor shall provide training manuals for all equipment, auxiliary systems, services etc. included in the scope and in accordance with the Contract requirements.

Along with the manuals the Contractor shall provide a training schedule including classroom training and training during factory testing, installation, and commissioning.

2.6.4 Maintenance plan/schedule

The Contractor shall provide a maintenance plan/schedule, describing scheduled and preventive maintenance.

It shall include requirements and instructions regarding health & safety, shut down of systems and equipment, shut down periods and other information required to effectively plan, schedule and perform preventive maintenance.

2.6.5 Spare parts list and storage plan

The Contractor shall provide the Spare Parts List and Storage Plan including the following information:

- list of all spare parts including storage locations
- list of all consumables including storage information
- list of (special) tools
- ordering and delivery specific information regarding all spare parts and consumables.

2.7 As-built documentation

As-built documentation shall be submitted by the Contractor, as agreed in the latest version of the Document Schedule.

During the preparation of the as built versions the Contractor shall keep one original of “red-lines” available on site.

All as-built documentation shall be submitted in both English and Nepali language and in electronic format (i.e.: .doc; AUTOCAD, etc.).

2.8 Document submission

The following documents and information shall be provided by the Contractor.

Table 2-1: Documentation following Letter of Acceptance

Title / Description	Preliminary	Final
Time Schedule for monthly progress report	before kick-off meeting	updated monthly
List of Standards	4 weeks	8 weeks
Document Schedule	4 weeks	updated monthly
HSE Policy & Plan	4 weeks	8 weeks
Contract Documents	-	4 weeks
Contract Documents (A5)	-	8 weeks

Table 2-2: Documentation following Commencement date

Title / Description	Preliminary	Final
Monthly Progress Reports	-	monthly
Standards (2 sets)	-	12 weeks
Factory Acceptance Test Programme	12 weeks	updated monthly
List of Manufacturers, Subcontractors and Suppliers	4 weeks	12 weeks
Time schedule to be frozen	before kick-off meeting	2 weeks after kick-off meeting
Project organization and chart	before kick-off meeting	2 weeks after kick-off meeting
Site organization and chart	12 weeks	20 weeks
Method statements (see 5.8 for details)	12 weeks	3 months before scheduled start of site works
H&S Management Plan	4 weeks	12 weeks
Quality Assurance Programme	4 weeks	12 weeks
Quality Assurance Plan	4 weeks	12 weeks
CESMP	4 weeks	12 weeks
On-Site Inspection programme	12 weeks	updated monthly
Commissioning Test Program	12 weeks	3 months prior to commissioning
Training Program/Schedule	12 weeks	updated monthly
Training Material	4 weeks	2 weeks
Operation & Maintenance Manuals	prior to factory tests	prior to shipment
As built Documentation	-	prior to Taking Over
Completion Report	1 month after Taking Over	prior to Performance Certificate

All other documents shall be submitted in accordance with the Document Schedule.

2.9 Document distribution

The Contractor shall submit/distribute documents as follows:

Table 2-3: Document distribution requirements

Item	Employer		Engineer		Total
	H.O.	Site	H.O.	Site	
Contract Documents	3	2	1	2	8
Contract Documents (A5)	5	2	3	2	12
Correspondence	1	-	1	-	2
Documents for Approval	2	-	2	-	4
Progress Reports	1	-	1	-	2
Special Reports	1	-	1	-	2
Operation & Maintenance Manuals	1	2	1	2	6
As built Documentation	1	2	1	2	6
Other Reports and Submittals	1	-	1	-	2
Completion Report	1	-	1	-	2

In addition, all correspondence, documentation, reports etc. shall be submitted by e-mail.

Soft copies on CD/DVD/USB stick shall be submitted for manuals and the as built Documentation.

All submissions shall be free of charge for the Employer/Engineer and shall be included in the Contract price.

3 Time Schedule

The Contractor shall prepare and submit the Time Schedule which shall be developed and maintained using the standard scheduling tool/software of Microsoft Project.

The Project Schedule shall be developed as a Level IV schedule divided into the following Project specific main tasks and milestones:

- Contract milestones
- scheduled payment milestones
- design & engineering
- manufacturing & testing
- transportation
- training
- permitting

- construction/civil works
- installation
- checks after erection
- pre-commissioning
- commissioning
- trial operation.

Updates, analysis, and forecasts shall be included in the Monthly Progress Report and shall be performed in relation to the Base Line Schedule which will be discussed during the kick-off meeting.

The updated schedule shall show the base line (time schedule frozen) and the actual scheduled tasks in one document.

Submission of documents as outlined in the Document Schedule shall be in accordance with the Time Schedule.

The Contractor shall take note of the relevant activities and shall be prepared to coordinate his Time Schedule with the Contractor(s) of the connected Substations as far as necessary and to the degree requested by the Employer/Engineer.

Especially regarding the required availability of the connected transmission lines, shutdowns and energization requirements coordination and early planning with the Employer/Engineer as well as the Substations Contractor(s) are required as early as possible. This shall be a major coordination topic during the monthly progress meetings and Time Schedule updates. It is the entire responsibility of the Contractor to plan and coordinate the necessary commissioning activities and requirements as early as possible to avoid any delays and influences on his own Time Schedule and the schedule of other contractors.

This topic shall be further discussed during the kick-off meeting.

4 Approval procedures

4.1 General

The Contractor shall (as a minimum) submit for approval the documents specifically listed in this document.

The timing of the submissions shall be in accordance with the updated version of the Document Schedule.

Submissions shall be accompanied by a DTS, clearly marked and as outlined further below.

The Employer/Engineer reserves 28 days to review/approve/comment the submittals. Should it be found at any time after approval has been given to any documents submitted by the Contractor that the said documents do not comply with the terms and conditions of the Contract or that the details do not comply with any documents submitted previously, such alternations and additions, as may be deemed necessary by the Engineer, shall be made therein by the Contractor and the work shall be carried out accordingly without extra payment to the Contractor thereof.

The entire procedure shall be discussed in detail during the kick-off meeting.

4.2 Document Transmittal Sheet (DTS)

Each formal submission of documents shall be accompanied by a DTS clearly indicating the purpose of the submission:

- for information (FI)
- for approval (FA).

Each DTS shall be clearly identifiable by a DTS number, date, and title.

The DTS shall list all documents (drawings etc.) included in the submission.

The detailed layout and content of the DTS, the DTS Log (which shall be used to keep track of all DTS) and the handling procedure shall be discussed during the kick-off meeting.

4.3 Submission and response procedure

Each submittal shall contain the following:

- covering letter
- DTS (stamped and signed by the Contractor's Authorised Representative)
- 2 hardcopies of the documents (report, drawings, specification etc.) included in the submittal.

The original including the hardcopies shall be sent by courier to the Employer/Engineer. In parallel a copy of the entire submittal shall be sent by e-mail.

For larger submissions (10 MB and beyond) a transfer server etc. shall be arranged.

The Employer/Engineer will stamp and sign the submittal on arrival to commence the contractual review time and return a copy of the stamped and signed DTS to the Contractor (by E-Mail).

The Employer/Engineer's response shall contain:

- covering letter
- DTS (stamped and signed)
- one set of the original hardcopy of the document (stamped and signed) indicating the status of each document.

The covering letter will detail the status, conditions, and comments applicable for each document submitted.

4.4 Approval categories

Approval categories shall be as follows:

- "Approved" - AP
- "Approved on Condition" - AC
- "Not Approved" – NA

"Approved" authorizes the Contractor to commence manufacturing or to proceed with further activities in accordance with the Time Schedule related to the approved scope.

"Approved on Condition" authorizes the Contractor to commence manufacturing or to proceed with further activities in accordance with the Time Schedule related to the approved scope and based on the conditions.

The Contractor shall re-submit the entire submission (including the corrected documents) within 28 days for Approval.

The Contractor is required to implement the approval procedure in the Time Schedule as required.

No impact/delay to the Time Schedule is accepted due to Not Approved documents.

5 Quality assurance

5.1 General

The Contractor shall comply with the quality requirements of ISO 9000 suite of Standards.

The Contractor shall prepare and submit a Project specific Quality Assurance Programme and Quality Assurance Plan based on ISO 9001 and ISO 9002, as applicable, describing the quality related activities, procedures, steps, and measures (including Project organization, qualifications and expertise, documents control, quality audits, testing procedures etc.) implemented throughout the Project.

The same shall apply for any Subcontractor, supplier, or manufacturer.

5.2 Quality Assurance System

The Contractor shall provide and operate a quality assurance system both in his facilities and the facilities of his sub-Contractors and at site capable of producing objective evidence that the material and equipment meet the Contract quality requirements. The system shall be in accordance with ISO 9000 suite of standards.

Detailed inspection plan(s) shall be submitted to the Employer/ Engineer for approval. Plan(s) shall describe the facilities and site inspection for each major component and for the finally assembled equipment and shall include the following:

- a schedule or flow chart indicating each inspection and the stages in the manufacturing and erection process when the Contractor proposes inspection shall be carried out
- written description of the method for each inspection
- standards of acceptance, with references to Employer’s Requirements, and/or International Standards or Codes as applicable.

The Contractor is responsible for ensuring the quality of items of equipment supplied under the Contract and remains accountable when manufacture or erection is subcontracted. It is therefore a requirement that works are only subcontracted to companies with effective Quality Assurance (QA) organization and that the Contractor monitors the quality control by the attendance at tests of experienced inspectors employed by the Contractor.

Timely notice shall be provided when the equipment is ready for inspection or test and every facility shall be provided by the Contractor and his Subcontractors to enable the Employer/Engineer to carry out the necessary inspection of the plant.

A detailed record of the results of all tests and inspections shall be maintained by the Contractor and copies provided to the Employer/Engineer within a reasonable time, but no later than 21 days after the tests.

5.2.1 Quality Assurance Programme

The Quality Assurance Programme shall give a description of the quality system for the Works and shall include the following details:

- the structure of the Contractor's organisation
- the duties and responsibilities of staff assigned to ensure quality of the work
- the system for purchasing, taking delivery and verification of materials
- the system for ensuring quality of workmanship
- the system for control of documentation
- the system for retention of records
- the arrangements for the Contractor’s auditing
- a list of the administrative and work procedures required to achieve and verify the Contract's Quality requirements. These procedures shall be made readily available to the Employer/Engineer for inspection on request.

The Quality Assurance Programme for the Works shall be submitted to the Engineer for approval in accordance with the timelines specified in Table 2-2.

5.3 Quality assurance plan

The systems and procedures which the Contractor will use to ensure that the project works comply with the project requirements shall be defined in the Contractor’s quality plan for the project works.

Each quality plan shall set out activities in a logical sequence and shall consider the following:

- an outline of the proposed work and programme sequence
- the structure of the organisation for the contract, both at the head office and at any other centres responsible for part of the work
- the duties and responsibilities assigned to staff ensuring quality of the work
- submission of engineering documents as required
- the inspection of materials and components on receipt
- reference to the quality assurance procedures appropriate to each activity
- inspection during manufacture and/or construction
- final inspection and testing.

The Contractors’ quality assurance plan shall be submitted to the Engineer/Employer for approval in accordance with the timelines specified in Table 2-2.

5.4 Related standards

The Contractors and/or Suppliers are responsible for ensuring they are in possession of the latest edition, including all amendments of the specified standards, together with other documents referred to in the Employer's Requirements.

The Contractor and/or Supplier shall bring to the attention of the Employer/Engineer any inconsistencies between the requirements of these Standards and the Employer's Requirements.

5.5 Quality control

5.5.1 Inspection and testing

The prime responsibility for inspection and testing rests with Contractor. The inspection and approval/acceptance of drawings, materials and workmanship, or the waiver of inspection by the Employer/Engineer does not relieve the Contractor of any obligations or responsibilities to carry out the work in accordance with the Contract. The inspection and testing shall be documented such that is possible to verify that it was undertaken. Records of inspection shall include as a minimum the contract identity, the name of the inspector / tester, date of inspection / test, operation / inspection technique used, acceptance standard and acceptability.

5.5.2 Factory and on-site testing

In line with the timelines specified in Table 2-2 the Contractor shall submit the following:

a) Factory Acceptance Test Programme containing detailed schedule for:
   - type tests
   - sample tests
   - routine tests
   - any other Factory Acceptance Tests
b) On-Site Inspection Programme containing detailed schedule for:
   - on-site tests and regular joint site inspections during construction
   - final installation & pre-commissioning tests
c) Commissioning Test Programme containing detailed schedule for:
   - commissioning tests
   - trial operation preparation, execution, and monitoring activities.

The Contractor shall also include other tests, inspections, and quality arrangements the Contractor deems necessary based on the scope, design, and other Project specifics to demonstrate compliance with the Contract requirements.

The tests etc. shall be conducted in accordance with relevant international standards as per Employer's Requirements. In case of omission of requirements for any test, the Contractor shall propose suitable international standard for approval by the Employer/Engineer.

A minimum of 30 days ahead of each test to be performed at the Contractor's facilities the Contractor shall provide final notification regarding the test schedule, commencement, arrangement, scheduled completion etc.

Test reports shall be submitted by the Contractor in as soon as practicable, but no later than 21 days following the test execution.

Travelling costs etc. of the Employer to participate in the tests at the Contractors facilities shall be included in the Contract as outlined in Section B1. Scope of Supply and Services.

5.5.3 Type, sample, and routine tests

Type, sample, and routine tests shall be undertaken as appropriate on all components supplied and/or installed under this contract, in accordance with the Technical Requirements and relevant standards.

The Employer/Engineer may, at their discretion, waive the requirements for type tests on the submission by the Contractor of test certificates either certified by an independent quality assurance organisation, or undertaken by an internationally acknowledged independent testing organisation, showing that the component had successfully passed the type tests specified in the Technical Requirements.

5.6 Monitoring of quality assurance arrangements

Monitoring of the Quality Assurance arrangements shall be undertaken by the Employer/Engineer during the contract. This may take the form of surveillance of the activities at work locations and/or by formal audits of the Contractor's and/or Supplier's systems and procedures which constitute his Quality Assurance arrangements.

Corrective actions shall be agreed and implemented in respect of any deficiencies. The Contractor and/or Supplier shall provide all facilities including access (including his suppliers or sub-contractors), which may be required by the Employer/Engineer for monitoring activities. Upon request of the Employer/Engineer the Contractor shall also provide other support such as providing supporting documentation for visa applications, or assistance with travelling and lodging reservations.

5.7 Suppliers and Subcontractors

The Contractor shall ensure that any supplier or subcontractor appointed by them under the Contract shall conform to the requirements of the Contract. Prior to the appointment of any supplier or subcontractor the Contractor and/or Supplier shall ensure that their Quality Assurance arrangements comply with the requirements of ISO 9001 and/or ISO 9002, as applicable, and the Project Specification.

The Contractor's and/or Supplier's auditing of their Supplier's or Subcontractor's Quality Assurance arrangements shall be documented to demonstrate to the Employer/Engineer their extent and effectiveness.

5.8 Method statements

The Contractor shall submit Method Statements in accordance with the timelines specified in Table 2-2 for Employer's/Engineer's approval. Following documents shall be submitted:

- Method statement for Topographical Survey
- Method Statement for Geotechnical Investigations
- Method Statement for Access Roads and Earthworks
- Method Statement for Tower Foundations
- Method Statement for Earthing Installation
- Method Statement for Tower Erection
- Method Statement for Stringing Operations
- Method Statement for OPGW Installation.

When requested by the Employer/Engineer, additional method statements related to specific items of work (e.g. significant obstacle crossings) shall be provided by the Contractor.

6 Appendices

Appendix VII-2 - 1 Contractor’s Monthly Report - Format

Appendix VII-2 - 2 Document Transmittal Sheet (DTS)

Appendix VII-2-1

Contractor’s Monthly Report - Format

1. Executive Summary

1.1. Overall progress

The overall progress shall include a brief description of progress work and a summary table which shall be prepared take in consideration the table below:

Subject	Planned total progress [%]	Actual total progress [%]	Weighting [%]	Weighted progress [%]
Lekhnath - Damauli 220kV double circuit OHL				
Tanahu - Bharatpur 220kV four circuit LILO				
Old Damauli - Bharatpur 132kV double circuit LILO				
Total	-	-	-	

1.2. Progress during this reporting period

[Description in text form about overall progress and main topics during this reporting period]

1.3. Difficulties & recommendations

2. Introduction

2.1. General

2.2. Project Office Directory

2.3. Financial Institute

2.4. Project Executing Authority (Employer)

2.5. Engineer

2.6. Contractor

3. Project Progress / Developments

3.1. Phase A: Preconstruction Phase (Design and Procurement)

3.2. Phase B: Construction Phase

3.2.1. Overall progress summary

3.2.2. Status of key project elements

3.2.3. Meetings

3.2.4. Main project events

3.2.5. Environmental, Social, Health and Safety and issues

3.2.6. ESIA and ESMP (and eventually RAP) implementation

3.2.7. Communication and Visibility Actions

3.3. Next Reporting Period Activities

4. Overview of Project Costs

4.1. The Contractor

4.2. Overall Project Costs

5. Time schedule, milestones, outage schedule

[Separate for each plant]

No.	Description	Scheduled date *[to be frozen]*	Actual date
…			
…			
…			
…			

6. Two-month activity forecast

[Separate for each plant]

No.	Description	Date	Remark
…			
…			

7. Concerns / recommendations

[Separate for each plant]

No.	Description	Recommendations
…		
…		

8. Annexes

8.1. Disbursement schedule, cash-flow chart

Invoice No.	Type	Date of invoice	Invoiced amount	Amount received	Date received	Deductions	Remarks
…							
…							

8.2. Time schedule(s) (master schedule, current schedule)

8.3. Outage schedule(s)

8.4. Progress tables

8.5. Progress S-curves (separate for each plant)

8.6. Actions follow-up

8.6.1. List of finished actions

8.6.2. List of actions under progress

8.7. Drawing list

8.8. FAT list (scheduled/performed)

8.9. Correspondence logs

8.9.1. from Contractor to EMPLOYER/Engineer

8.9.2. from EMPLOYER/Engineer

8.10.List of variations, claim notices

8.11.Records as per General Conditions of Contract, sub-clause 6.10

8.12.Photo report

8.13.Other Annexes for the relevant reporting period, if any.

Appendix VII-2-2

Document Transmittal Sheet (DTS)

DOCUMENT TRANSMITTAL SHEET

Document Distribution

NEA: Nepal Electricity Authority *(number of documents)*

FCE_HO: Fichtner Head Office *(number of documents)*

FCE_SO: Fichtner Site Office *(number of documents)*

DTS ref.:
Date:
Signature:
____
Stamp:

Received date:

The following documents are enclosed with corresponding action:

FI - for Information only	FA - for Approval
RET - approved document returned to EMPLOYER/Engineer with “Approved” stamp on it	

Title	**Reference number**	**FI**	**FA**	**RET**	**Status**			
					NA	**AC**	**AP**	**IN**
		date	***date***	***date***				
		date	***date***	***date***				
		date	***date***	***date***				
		date	***date***	***date***				
		date	***date***	***date***				
		date	***date***	***date***				

Comments:

Status signatures

Employer’s signature and stamp

Engineer’s signature and stamp

VII-3

General Technical Requirements

Table of Contents

Sub-Section VII-3: General Technical Requirements

The following directions, information and technical requirements for design, engineering, layout, manufacturing, erection, installation, and testing shall be observed as far as they are applicable for the equipment to be delivered. The requirements stated in this part of the Employer's Requirements are valid unless superseded by the requirements specified within the Sub-Section VII-4.

The Contractor shall be responsible for all related engineering and technical documentation. Any changes on the design of any part of the Plant, which may become necessary after signing of the Contract, shall be submitted by the Contractor in writing to the Employer/Engineer for approval, with adequate justification and substantiation.

1. General Requirements

1.1 Units of Measurement

The Contract shall be conducted in the Système International d'Unités (SI) in accordance with the provisions of ISO 31 and ISO 1000.

1.2 Materials

Asbestos or materials containing asbestos shall not be used. Likewise, it is not permissible to use mercury or oils containing Polychlorinated Biphenyl (PCB).

No welding, fitting, or plugging of defective parts shall be permitted without permission in writing of the Employer/Engineer.

Further requirements for various OHL components are specified in relevant sections of Employer's Requirements.

1.3 Guaranteed Values

The Contractor shall guarantee that the data provided in the Data Sheets and specified on the name plate of the equipment will not deteriorate during the life of the equipment under the specified operating and maintenance conditions.

1.4 Standards and Codes

The work is to be performed according to the most recent relevant codes, standards, accident prevention regulations and legal regulations at the signing of the contract.

Within this document references to industry standards / norms do not include the year of issue of the current version (at the time of writing) of each document. It shall be understood that intention of these Employer’s Requirements is the usage of the latest version of the industry standards / norms. Compliance with this intention is responsibility of the Contractor.

All materials and equipment supplied, and all work carried out as well as calculation sheets, drawings, quality and class of goods, methods of inspection, constructional peculiarities of equipment and parts and acceptance of partial plants, as far as these are beyond the special requirements of partial plants and as far as they are beyond the particular requirements of the technical requirements, shall comply in every respect with relevant ISO, EN and IEC standards and recommendations.

Contractor, subcontractors, and suppliers shall be certified according to ISO 9000.

In case materials specified in Employer’s Requirements cannot be locally sourced or specified tests cannot be performed in local quality control laboratories the Contractor may propose the alternative standard for Employer’s/Engineer’s approval. It is Contractor’s responsibility to provide sufficient evidence that any alternative standard the Contractor proposes ensures an equivalent or higher quality.

1.5 Marking, Labelling and Packing

Before being packed for shipment to the site, all items of the equipment shall be carefully numbered and marked so that they can be readily assembled and erected in the correct relative positions at the site.

Packing shall be done in convenient sections, so that the weight and size of sections are suitable for transport to the site and for handling at the site under the special conditions applicable there.

All individual pieces shall be marked with the plant identification number and the correct designation shown on the Contractor's detailed drawings and on other documents like packing lists, spare parts lists, operation, and maintenance instructions, etc.

All parts shall be suitably protected against corrosion, water, sand, heat, any adverse atmospheric conditions, shocks, impact, vibrations, etc. for later transport and storage.

Spare parts shall be packed for long term storage.

Each crate or package shall contain a packing list placed in a waterproof envelope. All items of the crate or package shall be clearly marked for easy identification against the packing list.

All cases, crates, packages, etc. shall be clearly marked on the outside to indicate the total weight, the position of the centre of gravity and the correct position of the slings and shall bear an identification mark relating them to the appropriate shipping documents.

All packings shall be included in the scope of delivery and the cost be included in the prices. The packing materials remain the property of the Employer.

Prior to shipment the Contractor shall furnish the shipping documents to the Employer/Engineer. Details and format shall be agreed upon during the Kick-Off Meeting.

When actual transport has been completed, the Employer/Engineer shall be so notified.

1.6 Pre-Service Cleaning and Protection of Plant Equipment

Cleaning of fabricated component items shall be carried out after fabrication and final heat treatment, or welding shall take place only at manufacturers' workshop.

In the event of the surfaces not being cleaned to the Employer's/Engineer's satisfaction, such parts of the cleaning procedures or agreed alternatives as deemed necessary to overcome the deficiencies shall be carried out at the Contractor's sole expense.

Mechanical cleaning as opposed to alternative chemical cleaning is the preferred method for workshop cleaning except where this is precluded by design or access considerations.

The Contractor shall take all necessary precautions to ensure that all plant surfaces of are kept clean and free from harmful edges or particles during erection works.

All necessary equipment, provisions, chemicals etc. are to be provided by the Contractor.

Additionally, Contractor shall take over all responsibility for the treatment and disposal of waste according to the local law, Project ESIA, and to the satisfaction of the Employer/Engineer.

2. Quality assurance

2.1 Standards

ISO 9001 Model for quality assurance in design, development, production, installation, and servicing

ISO 9002 Model for quality assurance in production, installation, and servicing

2.2 Quality Assurance System

For detailed Quality Assurance System Requirements reference shall be made to Sub-Section VII-2.

3 Topographical Survey

The Contractor shall employ modern survey techniques such as electronic total stations, aerial LiDAR, satellite positioning systems or a combination of listed methods.

3.1 Width of survey swathe

Minimum width of survey swathe is defined in Sub-Section VII-4.

3.2 Planimetric information

The following general categories of detail shall be surveyed:

- buildings/structures including temporary/mobile buildings
- visible boundary features: walls, fences, hedges
- roads, tracks, railways
- street furniture and surface markers for main underground services
- isolated trees/wooded areas
- water features
- earth works
- industrial features
- overhead cables and transmission lines.

In addition, the visual nature of the ground, whether cultivated, woodland etc. shall be recorded.

The accuracy of planimetric detail shall be such that the plan position of any well-defined point of detail shall be correct to within 300 mm Root Mean Square Error (RMSE) when checked from the nearest permanent control station.

3.3 Height information

Height information shall be surveyed to enable a digital terrain model to be constructed. Sufficient levels shall be surveyed such that the ground configuration, including all discontinuities greater than 300 mm, is represented in the model and on subsequently generated sections.

3.3.1 Spot heights

The maximum distance between adjacent spot levels along the line of the route shall be 50 m, with a median distance not exceeding 30 m. Across the swathe the spacing shall not exceed 1.5 times the nominal offset. Ground survey spot levels on hard surfaces shall be correct to ±30 mm RMSE and on soft surfaces to ±100 mm RMSE.

3.3.2 Obstruction heights

Features rising above the general ground level shall have indicative heights recorded to enable their inclusion in the terrain model. In the case of buildings and other tall obstructions the heights shall be recorded to the same accuracy as spot heights. Any such buildings and other obstructions, which are positioned up to 15 m outside the swathe width, shall also be surveyed. For buildings the limit of land ownership adjacent to the swathe shall be surveyed, where such boundaries are obvious.

Any power line passing within 50 m of the centre of the swathe shall be surveyed. When an existing line crosses the swathe then the support points to either side shall also be located.

3.4 Survey method

3.4.1 Traditional ground survey

Existing structures shall have the following features surveyed:

- top of structure – pole, lattice tower, etc.
- base of structure – pole, base plate, each lattice tower leg, etc.
- wire attachment points – point where the wire and the insulator (or clamp) meet
- insulator attachment points –point where the insulator meets the structure
- structure attachment points – point where items like crossarms, x-braces, and guys are attached to the structure.

All existing shield wires and transmission, distribution, and communication conductors are to be surveyed. All wires survey should include a minimum of five (5) locations per span, including the mid-span (low-point) of conductors. Any equipment on the wires shall also be surveyed and photographed.

All underground facilities shall be located and captured.

The existing terrain shall be surveyed such that a representative ground profile can be determined. A minimum of one point every 5m along the centreline shall be collected. In addition, the Contractor shall collect enough points to the left and right of the centreline, within the Right-of Way corridor, to enable reliable clearance verification. All ground slope changes shall be identified and recorded. The Contractor shall differentiate between ground and farm fields, roadways, sidewalks, water bodies, streams, drainage ditches, culverts, top of slope, and toe of slope features.

3.4.2 Ground survey control

For all surveys there is a requirement to place permanent control stations that will enable future surveys to be related to the work being undertaken under this project. The survey should also be related to the national survey grid so that existing mapping can be used in conjunction with the new survey.

3.4.3 Control network

The Contractor shall:

a) Establish plan controls at a density sufficient to achieve the specified accuracies
b) In all cases control stations shall be positioned such that at least two (2) reference points can be sighted
c) The control network shall be sufficient to enable the complete survey to be coordinated accurately onto a single grid system.

3.4.4 Permanent survey control stations

The main survey stations shall be of stable construction. In all cases the markers used, shall be of a type suitable to remain in position for at least five (5) years after completion of the survey. The maximum error between adjacent permanent survey control stations or their reference points shall not exceed 1 part in 20 000.

3.4.5 Temporary ground markers

Pegs placed to mark the route line or support positions and intended for use as markers for construction alignments shall be driven flush to the ground, or 50 mm below ground in areas where livestock are likely to be present.

3.4.6 Height control

Height control may be established by levelling, trigonometrical heighting or by satellite positioning observations. The Contractor must clearly demonstrate that the chosen method has achieved the required accuracy. The Contractor shall establish vertical control at a density sufficient to achieve the specified accuracies. All levels shall be related to the national datum checking the selected datum benchmark against at least one other existing benchmark. Benchmarks adjacent to the route shall all be checked where possible and be used to adjust the height control when appropriate. The height difference between any two (2) points used as permanent benchmarks shall not be in error by more than ±12 x k mm, where k is the square root of the distance in kilometres between the points being considered.

3.4.7 Equipment calibration

The Contractor is required to demonstrate that the equipment used for the survey is in correct adjustment and consistently accurate.

3.4.8 Total stations

All electronic measuring instruments used for surveying control or for conductor observations shall have been calibrated within the previous twelve (12) months over distances equivalent to those to be observed in the field. A copy of the calibration certificate must be supplied prior to commencement of the work.

If the calibration has been by comparison with a certified instrument, then the calibration must have been affected within the past year. Check adjustments should be carried out in accordance with the manufacturer's instructions upon arrival on site and prior to commencing survey work.

3.4.9 Satellite positioning systems

Each pair of satellite positioning system instruments shall be checked over a short level baseline not exceeding 5m, immediately before and after each survey.

3.4.10 Optical measuring instruments

All optical measuring instruments used for surveying control or for conductor observations shall be adjusted in accordance with the manufacturer's instructions upon arrival on site and prior to commencing survey work. Where significant adjustment is required then subsequent checks shall be carried out to ensure that the instrument remains in good adjustment.

3.5 Aerial LiDAR

All LiDAR-derived coordinates shall be three-dimensional with a sufficient density to satisfy the requirements of this document. Sufficient density shall also constitute the ability to develop a detailed surface model of the ground surface over the entire width of the surveyed corridor. The Contractor shall extract coordinates from all topographical features, above ground obstacles, and features which would impact the design or analysis of transmission lines. The Contractor shall ensure the accuracy of his work so that extensive ground verification shall not be required.

All LIDAR-derived coordinates shall be referenced using the coordinate system specified in Sub-Section VII-4.

All LIDAR-derived coordinates shall be assigned feature codes according to the feature code table proposed by the Contractor and approved by the Employer/Engineer.

Following requirements apply for the LiDAR data acquisition:

- Point Densities shall be a minimum of 15 points per square meter.
- Frequency shall be a minimum of 50 kHz.
- Up to four (4) return values per pulse. No first or last pulse only systems are to be used.
- Statistics on the data shall be collected, including average point density, frequency, pulse rate, satellite coverage, and meteorological information as per 3.6.

3.5.1.1 Aerial LiDAR equipment

The Contractor shall submit a full description of the LIDAR unit to be used, along with certificates of calibration. The LIDAR system shall be capable of collecting four (4) coordinate points from each laser pulse.

3.5.1.2 LiDAR ground control

The Contractor shall provide adequate GPS base stations along the right of way to support the LIDAR data accuracy requirements. GPS base stations shall not be placed at excessive intervals resulting in gap areas and shall always have adequate overlap between stations.

The Contractor shall provide a Ground Control Report(s) outlining all ground control points used during the survey. Reports shall be generated for each line surveyed.

The Contractor shall field-verify LiDAR data by collecting ground data along the surveyed corridor on surfaces considered permanent and/or semi-permanent. The Contractor shall prepare ground survey variance reports that calculate and check the achieved accuracy of the laser scan by comparing, as applicable in a selected area, the locations of 20 ground survey points along pavement, 20 ground survey points along a grassy area, 20 ground survey points along a brush area, and 20 ground survey points along a forested area of the transmission line with LIDAR (laser scan) points in the same locations. An accuracy check shall be made at least every 10km along a right-of-way. At least two accuracy checks shall be made for each transmission line.

The ground survey variance report shall, as a minimum, include the following:

- average statistical deviations of vertical data
- minimum and maximum statistical deviation of vertical data
- statistical verification of confidence levels.

3.6 Meteorological data

The Contractor shall collect the following data to obtain an accurate representation of weather conditions throughout the duration of the survey:

- date
- time
- ambient air temperature (°C)
- wind speed (m/s)
- wind direction
- sky conditions
- solar radiation (W/m^2).

The type and number of weather stations shall be detailed in the Contractor’s work plan and approved by the project engineer.

The Contractor shall space their weather stations no more than 15km apart. In mountainous terrain, the Contractor shall place their weather stations such that each major valley has at least one weather station. This may require that weather stations be spaced significantly less than 15km apart.

Data shall be collected, at a minimum, of every five minutes for LiDAR survey and at every instance of overhead wire data collection for Traditional Ground survey.

The weather stations shall have a minimum accuracy of:

- ambient air temperature: 0.5°C
- temperature range: -30°C to 60°C
- wind threshold speed: 0.1m/s
- wind speed accuracy range: 0.1m/s to 60m/s
- wind direction: 10°.

3.7 Existing obstructions and features

All aerial and ground obstructions shall be captured. This includes, but is not limited, to the following:

- guy wires
- anchors
- equipment
- buildings – residential, commercial, storage, etc.
- roof peaks and edges
- fences
- streetlights
- pools
- playgrounds
- wells
- outline of signs and billboards
- irrigation systems
- bridges
- railroad tracks
- railroad appurtenances (e.g., crossing arms, connection points, lights, etc.)
- fuel tanks
- silos and other farming facilities
- any other relevant clearance obstructions.

3.8 Plan and Profile Drawings

The Contractor shall prepare plan & profile drawings with tower positions plotted on. Drawings are subject to approval by the Employer/Engineer.

Profiles shall be produced based on a precision ground or aerial survey. The vertical tolerance between levels forming the profile and actual ground (or obstacles) level shall not exceed 300 mm. The horizontal position of surveyed objects (points) shall have an accuracy tolerance of no more than 400 mm. The angular measurements accuracy tolerance shall not exceed the angle of 1 minute of a degree.

The digital line model (including tower models) shall be used for optimal tower spotting, structural verification, and analysis of towers at each location, production of longitudinal profiles, generation of forces acting on foundations and the verification of stress in conductors, insulators, and fittings.

Profile plans including a tower list of the final line route shall be submitted to the Employer/Engineer for approval. The following principles and conditions shall be taken into consideration:

- Where ground slope across the line route exceeds 1 in 25, the level of ground left and right of the centre line shall be recorded up to a minimum distance of ±10 m at tower locations and ±25 m in mid-span. These levels shall be indicated on the profile as broken and/or chain lines, with the distances stated.
- All ground features such as hedges, fences, graves, ditches, roads, railways, rivers, buildings, channels, telecommunication, and all power lines shall be recorded and shown.
- Road numbers or designations or road destination shall be stated. Road crossings shall be performed as close to right angle as possible.
- The voltage level for power lines shall be indicated.
- All buildings or obstructions within 60 m each side of the centre line shall be shown dotted at their measured height with the distance left or right of the line indicated.
- Along the bottom of the profile sheet a route map shall be drawn, to the same scale as the horizontal scale of the profile showing all relevant details, within minimum 40m of each side of the route centre line.
- Clearance lines shall be shown on the profiles. The proposal for resolution of eventual clearance breaches shall be submitted to Employer/Engineer for approval.
- Tower numbers, types, elevations, level differences, UTM (Universal Transverse Mercator) coordinates, horizontal and vertical coordinates of all features affecting the line construction shall be indicated on the profile.
- Line profile shall display the bottom conductor catenary line at the maximum operating temperature (hot curve) together with the ground or special clearance curves, as well as at the minimum operating temperature (cold curve).
- In-span clearance verification shall be presented in a clearance report.

- Clearance report shall include all crossings and obstacles as per their respective classifications - roads, railways, rivers, power, and telecommunication lines, etc.
- If the required clearance is not met under most detrimental conditions, the rectification measure shall be proposed by the Contractor and submitted to Employer/Engineer for approval.
- Special attention shall be dedicated to populated areas or in proximity to the roads, or where the OHL is to be parallel with other existing OHL. The location of the existing OHL towers shall be clearly marked on the drawings.
- Unless otherwise agreed, the scale of the line profile shall be:
  - 1:2000 horizontally, and
  - 1:200 vertically
- The profile shall be plotted on the profile sheet with a direction of the line route left to right depending on correspondence with route map and consecutive tower numbering.
- In general, individual profile sheets shall start and end at tension supports but where this is not practicable and continuation sheets are necessary the ground line is to be drawn so that there is an overlap of at least 50 m between successive profile sheets. Each tension section shall normally begin on a new sheet.
- The date of survey of each section shall be stated.

3.9 Tower Spotting

Tower spotting shall be based on the ground profile drawings (terrain model based on geodetic survey) prepared by the Contractor and on the design data and principles, as specified.

The following principles shall be taken into consideration:

- Tower spotting shall be performed with a computer-modelling program (for example PLS-CADD) where the conductor characteristics, sagging parameters (temperatures and related tensions) are defined as input data.
- Tower spotting shall be conducted using design spans defined in Sub-Section VII-4. The lengths of successive spans in one section shall be distributed evenly as much as practicable.
- Steep slopes shall be avoided as far as practicable, i.e., long valley crossings are preferable to towers located on steep slopes. Locations where the slope in any direction across tower legs is greater than 20° shall be jointly inspected by the Contractor and Employer/Engineer to confirm their suitability.
- Tower spotting shall take into consideration the specified external clearances, as stated in the Sub-Section VII-4.
- The usage of suspension towers shall be limited to locations where the minimum ratio of weight to wind span does not exceed the limit specified in Sub-Section VII-4. Where that criterion is not met, a light-angle tension tower, using tension insulator sets shall be used. Where this criterion is marginally missed the Contractor shall perform site specific internal clearance

check to check the possibility of using suspension tower. Application of counterweights to limit insulator swing may be considered, subject to approval of the Employer/Engineer.

- Maximum number of suspension towers in a straight section (included between two successive tension towers) shall be limited by the section length which shall not exceed 10 nominal spans.
- Minimum distance between two successive OPGW joint boxes shall be not less than 3,000 m unless otherwise agreed with the Employer/Engineer.

4. Geotechnical investigation

The objectives of the ground investigation are to obtain sufficient reliable information to produce an economic and reliable foundation design and to assess any hazards (physical or chemical) associated with the ground, thereby verifying, and expanding information previously collected.

For the majority of overhead line projects confirmation of the geological conditions can usually be achieved by trial pits, CPTs and/or boreholes. Similarly, the soil and/or rock profiles can be established by visual inspection and systematic description of the ground from disturbed samples and undisturbed samples recovered during the exploration, by in-situ tests and by limited laboratory testing.

4.1 Standards

EN 1997-1	Eurocode 7 - Geotechnical design - Part 1: General rules
EN 1997-2	Eurocode 7 - Geotechnical design - Part 2: Ground investigation and testing
EN ISO 14688-1	Geotechnical investigation and testing — Identification and classification of soil — Part 1: Identification and description
EN ISO 14688-2	Geotechnical investigation and testing — Identification and classification of soil — Part 2: Classification principles
EN ISO 14689-1	Geotechnical investigation and testing — Identification and classification of rock - Part 1: Identification and description
EN ISO 22475-1	Geotechnical investigation and testing — Sampling by drilling and excavation and groundwater measurements — Part 1: Technical principles of execution
EN ISO 22476-1	Geotechnical investigation and testing — Field testing — Part 1: Electrical CPT and CPTU
EN ISO 22476-2	Geotechnical investigation and testing — Field testing — Part 2: Dynamic probing
EN ISO 22476-3	Geotechnical investigation and testing — Field testing — Part 3: Standard penetration test
EN ISO 22476-4	Geotechnical investigation and testing — Field testing — Part 4: Ménard pressuremeter test
EN ISO 22476-9	Geotechnical investigation and testing — Field testing — Part 9: Field vane test
EN ISO 22476-12	Geotechnical investigation and testing — Field testing — Part 12: Mechanical CPT
EN 50522	Earthing of power installations exceeding 1 kV a.c.

4.2 Geotechnical investigation programme

The Contractor shall be responsible for ascertaining that the foundations to be employed are suitable for the sub-soils encountered at each tower location.

Detailed soil investigations shall be carried out by the Contractor along the line route as a pre-requisite for planning of the foundations. The extent of the investigations shall be such as to permit the satisfactory determination of all necessary sub-soil characteristics, to exclude any un-acceptable settlement and to reliably determine the type, size, and appropriate execution method of foundations.

The Contractor shall prepare and submit for Employer’s/Engineer’s approval Geotechnical Investigation Programme, based on requirements of EN 1997-2, detailing planned extent, type, methods, locations and timing of field investigations and laboratory tests. Geotechnical Investigation Programme shall, as a minimum, contain information specified in Clause 2.4.1.2 of EN 1997-2 and specification for soil type dependent laboratory tests based on Table 2.3 of EN 1997-2.

Use of alternative standards is subject to Employer’s/Engineer’s approval prior to submission of Geotechnical Investigation Programme.

Anticipated work activities breakdown is summarized in, but not limited to, the following list:

- desktop study of available information as part of investigation programme preparation
- site reconnaissance with the principal aim of identifying areas with potential for high variability of the ground types, potentially unstable areas, and areas with potentially high underground water levels
- preparation of Geotechnical Investigation Programme as described above, based on conclusions/findings from desktop study and site reconnaissance
- review of topographical survey results for interchange of information to be superposed on topographic survey maps or to obtain topographic survey information useful in setting out site Investigation works
- in-situ geophysical and geotechnical exploration including open trial pits, boring, in-situ borehole and open pit testing, piezometer installation as per Geotechnical Investigation Programme
- collection of disturbed and undisturbed soil samples and extraction of water samples from boreholes and open trial pits
- selection of collected samples and performance of geotechnical laboratory tests to classify soils and assess their geotechnical behaviour
- concurrent review of test results as they become available to identify potential limitations in obtained data and, if necessary, recommend extension of the test programme subject to approval of the Employer/Engineer

- compilation of in-situ data collection, in-situ test results, laboratory test results and desk studies accounts
- preparation of a comprehensive factual report of resources, procedures, acquired data, field investigations and laboratory tests, desk studies, data processing and conclusions. Report shall also contain details about the soil resistivity. Further requirements are specified in Section 4.5.

4.3 Field tests

For soil classification purposes the Contractor shall carry out investigations by test pits or auger borings and penetration tests at all line angle point locations and additionally, at sufficient locations between the angle points depending on the terrain and geology.

For all soil investigation locations, the Contractor shall provide clear information of the following local conditions:

- surface condition and inclination of the ground
- judgment about the global stability and suitability of proposed location
- inclination of cracks and fissures in the rock and their stratification and
- relevant inclination of the ground surface in the vicinity of the future tower foundations if sliding or rock fall hazard is expected
- assessment of possibility for flooding or scour (wash out) action around foundations during periods of heavy water flow
- data about the maximum groundwater level for all tower sites. Consequently, the investigations shall preferably be undertaken in the most unfavourable season of the year (springtime, end of rainy season). Otherwise, inquiries and assumptions on the maximum subsoil water level shall be made or the investigations repeated at the appropriate point of time.

This information shall be provided to the Employer/Engineer through intermediate reports, to enable him to request more intensive or additional investigations, if necessary.

In-situ testing shall comply with the following requirements:

a) granular soil:

- standard penetration tests (SPT) shall be performed in accordance with EN ISO 22476-3
- dynamic probe tests (DPL) shall be performed in accordance with EN ISO 22476-2
- cone penetration tests (CPT) shall be performed in accordance with EN ISO 22476-1
- pressure meter tests (PMT) shall be performed in accordance with EN ISO 22476-4 (in presence of large gravel content).

b) cohesive soil

- as for granular soils except that use of SPTs is subject to the Employer's approval. Vane shear tests (VSTs) in accordance with EN ISO 22476-9 may also be used in uniform fully saturated soils.

c) rock:

- weak rock SPTs (EN ISO 22476-3), medium to hard rock PMTs (EN ISO 22476-4)

Penetration sounding equipment shall fully comply with provisions of the relevant standard.

Any other equipment is subject to approval and provision of the penetrometer’s characteristic data correlation charts to one of the above specified equipment and relation/interpretation to the various soil engineering properties.

At all soil investigation locations, the in-situ testing shall be advanced at least to the following limits:

- test pits up to -3 m or reaching rock prior to 3m depth
- Auger borings and rock drillings up to 6m depth
- SPT up to 8m depth or reaching 30 blows per 0.3 m prior to 8m depth
- DPL up to 8m depth or reaching 60 blows per 0.1 m prior to 8m depth
- CPT up to 8m depth or reaching 8 MN/m² per 0.2 m prior to 8m depth
- in soft, very loose soil up to 8m to 12m depth to advance penetration
- every test pit or auger boring or SPT sampling - one disturbed soil sample shall be collected at 1m, 3m, 5m (for test pits 3m) depth.

In-situ measurements of soil resistivity shall be undertaken in accordance with the four probe (Wenner) method (EN 50522).

A portable earth tester or a similar four terminal type instruments shall be applied for measuring the in-situ resistance evaluating the corresponding soil resistivity.

Site investigations shall be carried out by internationally certified, experienced, and reputable organization proposed by the Contractor and approved by the Employer/Engineer. In case the services of internationally certified organisation cannot be secured, nationally licensed organisations may be proposed for Employer's approval.

The Contractor shall name a professional soil mechanics expert and foundation engineering expert. The experts shall supervise the site investigation works.

4.3.1.1 Soil sampling

Sample quality classes shall conform to Table 3.1 of EN 1997-2 and corresponding requirements of EN ISO 22475-1. Required quality class, dependent on the laboratory test types, and appropriate sampling method and equipment shall be defined in Geotechnical Investigation Programme.

4.3.1.2 Rock sampling

Rock sampling shall be planned and executed in accordance with requirements for Category A sampling methods specified in EN ISO 22475-1.

4.3.1.3 Boreholes

Where weak soils are encountered, boreholes shall be continued down to a loadbearing stratum with a minimum thickness of 3 m proved. Casing shall be used where necessary to prevent the collapse of the borehole wall.

Drilling method and equipment as well as the required number and quality class of samples shall be defined in Geotechnical Investigation Programme.

4.3.1.4 Borehole Logs

Detailed bore logs/field books shall be kept for all borings. The soil stratifications encountered in the boreholes shall be logged during drilling and the borehole logs shall include at least the following information:

- the drilling method and used equipment
- coring and casing details
- the soil stratification
- the number, depth, and type of obtained soil samples
- the groundwater levels
- field test results, as applicable.

Following laboratory tests information on the conducted tests and their results as well as index and engineering properties of representative samples collected from different strata shall be added to the logs.

4.3.1.5 Standard penetration tests (SPT)

Down to the depth of drilling, SPT shall be performed in the boreholes at intervals specified in Geotechnical Investigation Programme but not exceeding 1.5m, in both cohesive and non-cohesive soils.

Standard penetration tests equipment, procedure, and reporting shall fully conform to requirements of EN ISO 22476-3.

Recovered samples shall be recorded and handled in accordance with EN ISO 22475-1 for the required quality class.

4.3.1.6 Groundwater level measurement

Groundwater measurements in soils and rocks shall be planned and executed in accordance with Clause 3.6 of EN 1997-2. Equipment and methods for measuring groundwater pressure shall be defined in Geotechnical Investigation Programme.

4.3.1.7 Cone penetration and piezocone penetration tests (CPT, CPTU)

The tests shall be carried out and reported in accordance with a method that conforms to the requirements of EN ISO 22476-1 for the electrical CPT and CPTU, or EN ISO 22476-12 for the mechanical CPT.

4.3.1.8 Test (trial) pits (TP)

Where samples are obtained from trial pits requirements of EN ISO 22475-1 shall be followed. Samples shall be taken at any change of stratum and distance between sample locations shall not exceed 3m.

The description of the encountered strata and of the strata sequence, accompanied by colour photographs, shall be submitted in the soil investigation report.

4.3.1.9 Minimum number of boreholes/soundings /trial pits

Actual number, locations and types of activities shall be defined in Geotechnical Investigation Programme. Minimum requirements specified in Sub-Section VII-4 shall be observed.

In locations where recent reliable soil reports from previous works are available new investigations may be omitted at Contractor’s request subject to approval of Employer/Engineer.

4.4 Laboratory tests

The Contractor shall arrange laboratory tests to determine the necessary soil mechanic parameters for foundation design such as:

- dry and effective (buoyant) density
- angle of shearing resistance
- effective cohesion
- undrained shear strength
- unconfined compressive strength.

In addition, typical index properties and observations listed in Table 4-1 shall be provided.

Table 4-1: Typical index properties

Cohesive soil	Granular soil	Rock
State of consistency	Degree of compactness	Degree of hardness
Atterberg limits	Grain size	Metamorphic grade
Unit weight	Unit weight	Weathering state

Cohesive soil	Granular soil	Rock
Water content CPT/DPL resistance	Saturation degree SPT/DPL resistance	Rock defects RQD core recovery
Subsoil description, texture, and stratigraphic sequence Ground water and flood water level Aggressiveness of ground water and subsoil (SO^2_4, Mg^2, pH) Position and depth of pit, borehole, sounding, and samples taken Electrical ground resistance (conductivity of in-situ soil)		

Requirements for common laboratory tests are summarized below. Details of any additional proposed tests, including governing standards, shall be provided in Geotechnical Investigation Programme.

Laboratory tests shall be conducted by internationally certified laboratory proposed by the Contractor and approved by the Employer/Engineer. In case the services of internationally certified organisation cannot be secured, nationally licensed organisations may be proposed for Employer's approval.

4.4.1.1 Natural moisture content

Tests to determine natural moisture content (natural water content) and the in-situ wet and dry densities shall be performed in accordance with procedures specified in EN ISO 17892, parts 1 and 2.

4.4.1.2 Atterberg limit tests

Tests to determine the liquid limit and the plastic limit shall be performed on representative cohesive soil samples collected from different strata. The Liquidity Index/Consistency Index shall be determined in accordance with procedure specified in EN ISO 17892-12.

4.4.1.3 Particle size distribution tests

The specific density and the particle size distribution of representative soil samples collected from different strata shall be determined in accordance with procedures specified in EN ISO 17892 parts 3 and 4.

Particle size distribution curves with classification of representative samples in accordance with classification principles laid out in EN ISO 14688 and EN ISO 14689 shall be submitted in the soil investigation report.

4.4.1.4 Unconfined compression tests

Unconfined compression tests shall be performed in accordance with procedure specified in ISO 17892 part 7. Stress-strain diagrams shall be attached to the soil investigation report.

4.4.1.5 Consolidation tests

Consolidation tests shall be performed in accordance with procedure specified in EN ISO 17892 part 5.

4.4.1.6 Chemical analyses

The groundwater and the soil shall be analysed and classified regarding their aggressive action on concrete. The classification shall be based on Table 2 of EN 206.

The results and recommendations shall be part of the soil test report.

4.4.1.7 Electrical resistivity tests

Shall be conducted by four probe method in accordance with provisions of EN 50522. Alternative appropriate method conforming to IEEE 81 may be used subject to agreement with the Employer/Engineer.

4.5 Reporting

Copies of the field reports shall regularly be provided to the Employer/Engineer during site investigations. These shall include borehole and test pit logs and protocols with all pertinent data, SPT, DPL, CPT sounding diagrams, ground water locations, core drilling diagrams.

Within six weeks of completion of the field work, the Contractor shall submit to the Employer/Engineer a draft of Geotechnical Investigation Report with the following information:

a) Layout location plan of soil investigations, showing:
- project area
- general layout plan
- locations of boreholes, soundings, trial pits and plate tests (if any) carried out
- comprehensive map surroundings

b) Description of the activities carried out containing:
- work programme

- technical data and calibration certificates of used equipment
- details of sampling, drilling and test methods applied during the investigation
- photo record of site investigations.

c) Logs, tables

The subsurface conditions (e.g., the sequence of the strata, the nature and properties of the individual strata as well as the groundwater conditions) shall be determined and described in the borehole logs. The results of the laboratory tests and the diagrams of the test results shall be included in the report.

Borehole logs, trial pit logs and surroundings logs shall include:

- actual ground level and reference to the local datum
- description and limits of various soil layers
- number, type, and category of samples taken
- SPT results
- water levels
- depth of borehole/pit/sounding.

d) Laboratory tests results and conclusions

- details of laboratory tests, observations, and test results both in tabular and graphical form
- practical and theoretical considerations for the interpretation of the test results, supporting calculations, conclusions
- practical and theoretical considerations for the design and construction of the foundations for different types of structures.

e) Soil profiles (cross-sections)

The results of the subsoil investigations shall (in addition to the borehole logs) also be shown in the form of cross-sectional drawings with a vertical scale of 1:100 showing:

- actual ground level and plant datum at the points of investigations
- results of boreholes including standard penetration test (SPT) graphs
- trial pit profiles
- CPT diagrams
- proposed foundation levels
- limit lines of soil layers (soil strata)
- groundwater level
- legend (key).

f) Soil classification

The soils shall be classified according to classification principles specified in EN ISO 14688 and EN ISO 14689. In addition, main characteristics (e.g., dry and buoyant density, compression, and shear stress limits) relevant for design purposes shall also be provided for each tower location.

g) Groundwater classification

After the chemical analysis, the groundwater shall be classified according to its aggressive action on concrete. The classification shall be based on Table 2 of EN 206.

h) Foundation Proposal

Relevant design parameters, consistent with definitions and symbols in EN 1997-1 for different foundation types shall be specified. Type and engineering values of proposed pile foundations, where applicable, shall be provided. Explanation of recommended soil improvement methods shall be made. Geotechnical restrictions of earth work (cut and fill slopes, etc.) shall also be specified.

i) Additional information

The Report shall also contain:

- any proposals which the Contractor may consider necessary regarding the parameters and dimensions for the design of standard foundations
- conclusions and recommendations regarding the need for any special foundations
- information regarding the conductivity of soils necessary for the design of earthing system.
- any other relevant information.

The report shall be signed by the named geotechnical expert.

A final revision of the report shall be issued after incorporation of comments and amendments as required.

5. Design Basis

Basic design requirements and considerations are defined as follows:

- reliability
- security from progressive collapse (cascading)
- safety to construct and maintain
- safety of the public
- durability
- maintainability
- environment preservation.

5.1 Electrical Requirements

Electrical requirements are specified in Sub-Section VII-4.

5.2 Actions on Lines

Detailed requirements are specified in Sub-Section VII-4.

6. Towers

Tower design and detailing shall conform to the requirements of EN 50341-1, and applicable standards referenced therein.

In case that existing towers designs is proposed, it must be demonstrated that the structures conform to the minimum electrical and mechanical requirements specified herewith, or that suitable design adjustments shall be applied.

Suitable preliminary design tower outline shall be included in the Bid submission to facilitate the technical evaluation of the Bid. The Contractor shall submit schematic line drawings of towers containing all basic dimensions. The table of weights of all towers shall be submitted, containing all body extensions combined with standard legs.

Tower design shall, unless otherwise agreed with Employer/Engineer, cover the full extent of possible body and leg extensions and their combinations for each tower type.

6.1 Standards

EN 50341-1	Overhead electrical lines exceeding AC 1 kV. General requirements. Common specifications
EN 10025-1	Hot rolled products of structural steels. General technical delivery conditions
EN 10025-2	Hot rolled products of structural steels. Technical delivery conditions for non-alloy structural steels
ISO 7010	Graphical symbols. Safety colours and safety signs. Registered safety signs
ISO 3864	Graphical symbols. Safety colours and safety signs. Design principles for product safety labels
EN 1011-1	Welding. Recommendations for welding of metallic materials. General guidance for arc welding
EN 1011-2	Welding. Recommendations for welding of metallic materials. Arc welding of ferritic steels
EN 1011-3	Welding. Recommendations for welding of metallic materials. Arc welding of stainless steels
EN 1011-4	Welding. Recommendations for welding of metallic materials. Arc welding of aluminium and aluminium alloys
EN 1011-5	Welding. Recommendations for welding of metallic materials. Welding of clad steel
EN 1011-6	Welding. Recommendation for welding of metallic materials. Laser beam welding
EN 1011-7	Welding. Recommendations for welding of metallic materials. Electron beam welding
EN 1011-8	Welding. Recommendations for welding of metallic materials. Welding of cast irons

ISO 9606-1	Qualification testing of welders — Fusion welding — Part 1: Steels
EN 1179	Zinc and zinc alloys. Primary zinc
EN 60652	Loading tests on overhead line structures
ISO 6892-1	Metallic materials — Tensile testing — Part 1: Method of test at room temperature
ISO 6892-2	Metallic materials — Tensile testing — Part 2: Method of test at elevated temperature
ISO 6892-3	Metallic materials — Tensile testing — Part 3: Method of test at low temperature
ISO 2178	Non-magnetic coatings on magnetic substrates — Measurement of coating thickness — Magnetic method
ISO 898-1	Mechanical properties of fasteners made of carbon steel and alloy steel — Part 1: Bolts, screws and studs with specified property classes — Coarse thread and fine pitch thread
ISO 898-2	Mechanical properties of fasteners made of carbon steel and alloy steel — Part 2: Nuts with specified property classes — Coarse thread and fine pitch thread
ISO 898-3	Mechanical properties of fasteners made of carbon steel and alloy steel — Part 3: Flat washers with specified property classes
EN ISO 1461	Hot dip galvanized coatings on fabricated iron and steel articles — Specifications and test methods
EN 10204	Metallic products. Types of inspection documents
EN 1090-1	Execution of steel structures and aluminium structures. Requirements for conformity assessment of structural components
EN 1090-2	Execution of steel structures and aluminium structures. Technical requirements for steel structures

6.2 Design

The design shall be based on the limit state concept applied in conjunction with the partial factor method.

The European Standard EN 50341- 1 “Overhead electrical lines exceeding AC 45 kV” with the approach of Part 1 - “General requirements – Common specifications” shall be applied for the design of towers unless otherwise specified in Sub-Section VII-4 or agreed with the Employer/Engineer. Tower types and detailed tower design requirements are specified in Sub-Section VII-4.

6.2.1 Structural analysis

For the structural tower design, the Contractor shall use the three-dimensional indeterminate stiffness design method. The Contractor may propose for approval another recognized design method proven to be accurate.

Design software be used shall be developed and tested by a recognized institute, acceptable to the Employer/Engineer. The correctness of the design method and the accuracy of the computer software shall be confirmed by full scale tower loading tests if required by Sub-Section VII-4.

The Contractor shall submit the following data:

- name and version of the computer software and standards applied for the structural analysis
- detail calculation of loads
- loading tree schemes
- outline drawing of tower model for the structural analysis, showing the individual modelling elements (e.g., beams, trusses, stabilizers) including joints (nodes)
- label and joint degree of freedom
- tower outline drawings of all 4 faces showing the joint labels
- three-dimensional coordinates of all tower joints in electronic format.

The results of the structural analysis shall show in a table:

- total stresses in each member for each load case and the critical case
- the effective slenderness ratio, calculated capacity, and ratio of maximum total stress to calculated capacity for each member and connection
- size and type of steel for each member and number and type of bolts required for its connection
- the calculated weight of the complete galvanized tower
- the compression and uplift reactions and corresponding horizontal shears at each leg of all towers for all loading cases as well as summarized extreme values, for foundation calculation
- maximum load values decisive for foundation design inclusive of applicable partial load factors.

In addition, separate drawing shall present the scaled outline of the tower showing size of all bracing and redundant members as well as the size and number of connection bolts.

The resistance of members shall be determined in accordance with EN 50341-1, Annex J. Partial material factors for various characteristic values of resistance are specified in Sub-Section VII-4.

For calculation of the net section for tension members, the diameter of the bolt hole shall be taken as 2 mm greater than the nominal diameter of the bolt. The determination of the net section area shall be as specified in the EN 50341-1, Annex J.

6.2.1.1 Member Slenderness Limits

Slenderness ratio limits for different members are specified in Sub-Section VII-4. Built-up members composed of two or more rolled shapes shall be connected with stitch bolts such that the slenderness ratio of either shape, between bolts, does not exceed 75% of the governing slenderness ratio of the built-up member as a whole.

6.2.1.2 Minimum Size and Thickness of Steel Members

The minimum thickness and size of steel members are specified in Sub-Section VII-4. The minimum connected leg of the angle section shall be such that the bolt head or nut does not bear on the fillet.

6.2.1.3 Connections

The tower structures shall be of the bolted type. Welding can only be used with explicit permission from the Employer/Engineer.

Bolted connections shall consist of metric threaded bolts together with a flat washer, a spring washer, and the nut. Bolts shall bear on the shank. Rivets shall not be used.

The Contractor shall supply the net quantities plus 5% of all permanent tower bolts, nuts and other similar items and materials required for installation of the works at the site. Quantities of such bolts, nuts, etc., which are surplus after the installation of the equipment has been completed shall become spare parts and shall be wrapped, marked, and handed over to the Employer/Engineer.

The minimum diameter of bolts at each connection for load-bearing members shall be 16 mm.

All nuts, washers and bolts shall be hot dip galvanized. Threads before galvanizing shall be coarse threads. There shall be no excess of galvanizing at the root of the thread and nuts shall turn easily on the complete bolts.

Bolts shall be rejected if they have an excessively loose or tight fit.

6.2.1.4 Miscellaneous

The tower model shall be a fully triangulated system and the tower body slope shall not exceed the value specified in Sub-Section VII-4. Stubs suitable for the foundation types and for legs of the tower types are part of the scope and templates for the alignment of the stubs shall be provided.

To facilitate easier transportation and handling, the length of any structural member shall not exceed the maximum length specified in Data Sheets.

Redundant members shall be capable of supporting an axial tensile or compressive load of at least 2.5% of the maximum computed compressive load in the supported main member applied perpendicular to the axis of the main member.

The crossarms of suspension towers shall be designed to allow the attachment of single and/or double suspension insulator sets. Additionally, for maintenance purposes, each suspension crossarm tip shall incorporate two attachment points of equal strength at approved positions: one for the suspension insulator set and the other for maintenance equipment.

The crossarms of tension towers shall be designed to allow the two-point attachment of double insulator strings and an additional attachment with two holes for maintenance purpose. It shall be possible to apply full conductor tension safely to either additional hole.

The tension insulator sets attachment points of angle towers shall be designed to have the two sub-strings of the double insulator set in parallel position for the average line angle.

6.3 Detailing

Tower dimensions, framing, member sizes and length, number, size and length of bolts, thickness of each filler, detailed dimensions of gusset plates and other necessary details to fabricate each piece shall be shown on the approved detailed drawings. No change shall be made without the written approval of the Employer/Engineer.

All bracing members shall be in one piece where practicable. All double diagonal bracing members (X – bracing) shall be connected at their point of intersection by at least one bolt.

Plan bracing of towers at the levels of crossarms shall be such a type to prevent the cross section of the towers from deforming from the original form under torsion loads.

The angle included between any two connecting stressed members shall not be less than 15°.

The angle included between diagonal members and main members for the medium angle and heavy angle tension towers shall not be less than 25°.

Stubs shall be provided with suitable holes for connection to the basic and additional earthing system.

The lowest bolt hole in the stub for connection of the main bracing member shall be at least 50 mm above the foundation concrete level.

6.3.1 Joints

All joints shall be such that eccentricities are kept as small as practicable. Connection design shall conform to EN 50341-1 Annex J.5.

Spaces between members at the connection points, created by the arrangement of members in the tower structure, shall be filled using fillers with proper thickness. For all bolts in tapered flanges beveled washers shall be furnished.

Bolt spacing and edge distance shall be as follows (all dimensions in mm):

Nominal Bolt Diameter	Bolt Spacing		Minimum Edge Distance	
	Min.	Max.	Rolled Edge	Sheared Edge
12	30	120	16	20
16	40	160	20	25
20	50	200	27	30
24	60	240	32	40

6.3.2 Drawings

All members and plates shall be designed on drawings. Contractor shall endeavour to use as few designations as possible and each member of identical size and detail shall have the same designation, regardless of its position in the structure.

The member and plate designation shall be successively grouped on individual drawing. The groups of designations shall be indicated on the drawings. A proper cross-index shall be furnished, correlating the tower part numbers with the tower types and drawing number.

A bill of materials shall be submitted containing the size, length and galvanized weight of each member and the total weights of body, body extension and foundation stub conforming to the detailed drawings approved. It shall also include the number of bolts, nuts, washers, and attachment devices per structure.

6.4 Materials

The steel members shall be free of damages, repairs, or corrosion. Special attention shall be paid to elimination of burrs and inconsistent galvanization. Material handling and erection shall not result in any damage to steel members, including surficial damages.

Unless stated to the contrary in Sub-Section VII-4, the following materials shall be applicable:

a) Rolled shapes and plates

All materials shall be hot-rolled and shall conform to the steel qualities specified in Sub-Section VII-4.

The chemical composition and mechanical properties of the grades of steel shall correspond to the EN 10025.

b) Connection bolts, nuts, and washers

All tower steel connection bolts, nuts and washers shall conform to ISO 898-1 and –2 or equivalent. Only bolts classes 5.6 and/or 8.8 shall be used.

c) Locking devices

All tower bolt connections shall be provided with one flat washer and one spring washer.

d) Tower signs

e) Bird Protection Guards

6.5 Signs, furniture, and accessories

6.5.1 Step bolts

Each tower shall be provided with step bolts of an approved type on two diagonally opposite legs. Step bolts shall be spaced alternately on the angle flanges at not more than 380 mm between centres, starting immediately above the anti-climbing device and continuing to each earth wire. The minimum diameter of the step bolts shall be 16 mm. Step bolts shall not be used as connection bolts.

Holes for removable step bolts below the anti-climbing guards shall be provided at no more than 380 mm between centres on the legs to which the permanent step bolts are fitted.

6.5.2 Attachment devices

Attachment devices shall be suitably furnished on all crossarms to suspend and to terminate insulator strings or earth wire assemblies. The attachment points shall be designed in accordance with the requirements of this technical requirements and the calculation shall be submitted together with the structural analysis of the tower.

6.5.3 Tower signs

The Contractor shall furnish all materials for tower signs including all bolts, nuts, washers, brass eyelets fitted with the holes and supporting structures, if required, for attaching signs to the structure as per the structure list.

Signs shall be of corrosion resistant aluminium with embossed letters and painted, or of enamelled mild steel.

Safety colours, safety symbols and safety signs must comply in construction, geometrical form, colour and meaning with the ISO 7010 and ISO 3864 and shall be in line with Employer/Engineer requirements.

The Contractor is required to make provision in the tower members for attaching signs at the locations to be indicated by Employer/Engineer. Further requirements for tower signs are provided in Sub-Section VII-4.

6.5.4 Anti-theft devices

To prevent theft of tower members, special measures shall be taken, or special bolts connections shall be installed for the connection of all diagonal members and secondary bracing members below the anti-climbing device. The Contractor shall describe his offered system and verify the effectiveness of the anti-theft device as well as mechanical strength capacity, bolt geometry and corrosion resistance in comparison with an ordinary bolt connection.

6.5.5 Anti-climbing devices

Each tower shall be fitted with an approved anti-climbing device which shall provide climbing facilities for use by authorized personnel. The height of the anti-climbing device shall be maximum 3m above ground level. The anti-climbing devices may be of the "spikes" type or “barbed wire” type.

Spikes shall be of a solid design, have a sharp end, a minimum length of 250 mm and shall be pointed downwards. The maximum distance between the strings of barbed wire shall not be more than 100 mm. The horizontal separation of the strings of barbed wire shall be maintained by the provision of spacers at a maximum distance of not more than 2m. Strings of barbed wire shall protrude minimum 250mm outward from the nearest tower member.

6.5.6 Bird guards

Tower members positioned above insulator strings shall be fitted with galvanized steel spikes or strips, effectively preventing birds from sitting in these locations. The spikes/strips shall extend horizontally enough beyond the protected location and shall be applied to all surfaces a bird can land on.

Where spikes are projecting from cross arm contour towards live parts, the tower clearance diagram shall consider their length.

6.6 Fabrication

6.6.1 Workmanship

Fabrication of materials shall not commence until approval of assembly drawings and completion of successful tower type tests.

All pieces shall be straight, true to detailed drawings and free from lamination flaws and other defects. All clipping, back-cuts, grindings, bends etc. must be true to the detailed drawings and free of burrs.

All identical pieces bearing the same erection number must be interchangeable with each other and interchangeable in their relative position in all structures of which they form a part.

The Contractor shall be responsible for the correct fitting of all parts. He shall replace any defective material discovered during erection and bear all costs of supplying such elements and field works for such replacement.

All parts of the structure shall be neatly finished and free from kinks, twists, or bends. The fabrication shall be in strict accordance with the shop drawings prepared by the Contractor and approved by the Employer/Engineer.

6.6.2 Shearing and cutting

Materials may be sheared to length, but the ends, unless otherwise noted, must be square with length and free of burrs so that difficulty of assembly caused by interference of end section with other members at the time of assembling the steel tower may not occur.

The use of a burning torch is permitted for cutting members provided that all irregular edges are trimmed smoothly before galvanizing. Stresses shall not be transmitted into the metal through a burned surface. The material adjacent to a burned surface for a distance equal to the thickness of the material shall not be considered a part of the net section for tension members. The use of a burning torch for cutting bolt holes shall not be allowed.

6.6.3 Punching and drilling

All bolt holes in steel members shall be punched, sub punched, reamed, or drilled before galvanizing. Holes for conductor attachment shall not be punched but only drilled.

All members shall be cut to jig, and all holes shall be punched or drilled to jig.

Holes are to be punched with racks and jigs employed to ensure accuracy throughout. The punches and dies for this work must be maintained sufficiently sharp to produce clean round holes normal to the plane of material. Holes shall be free of burrs, folds and depressed, upset, or ragged edges.

Bolt holes shall be drilled full size and at right angles to the surface of the steel, accurately spaced and true to line, pitch gauge and edge distance. Any member having holes or cut more than 0.8 mm from correct position will be subject to rejection. No welding, filling, or plugging shall be permitted unless explicitly approved by the Employer/Engineer.

Holes may be punched subject to the following limitations. In the cases listed below, holes shall be drilled full size or sub-punched to a diameter of not less than 4mm smaller than the required diameter and reamed to the required diameter:

- structural steel more or equal to 14 mm thick
- high strength structural steel more or equal to 10 mm thick
- holes in the vicinity of bends in members or gusset plates
- holes in crossarm members normally loaded in tension.

Holes which are elongated or otherwise distorted by bending will not be accepted.

The diameter of bolt holes shall be 1.5mm larger than corresponding bolt diameter.

All parts shall be carefully cut, and holes accurately located so that when the members are in position the holes will be truly opposite each other before being bolted up. Drifting of holes shall not be allowed.

All matching holes for bolts shall pass freely through the assembled members in a direction at right angles to such members.

Threaded or tapered holes shall not be used unless explicitly approved by the Employer/Engineer.

6.6.4 Bending

All bending of high-strength structural steel must be done hot. Members bent hot shall be heated in a non-oxidizing flame over a sufficient area to prevent excessive deformation. Hot bends shall be left for slow cooling in air.

All bends shall be finished, free from waves, folds, or localized reduction in sectional area or flange length exceeding 5%.

Members bent in error with respect to the location of a bend line shall be rejected.

6.6.5 Welding

Welding, where approved by the Employer/Engineer, shall be done in accordance with approved welding procedure specification based on requirements of EN 1011 set of standards.

The structural steel, the welding process, electrodes, and treatment shall be fully in accordance with EN 1011.

All welds shall be made in such a manner that residual shrinkage stresses will be reduced to a minimum. All welders employed on items of plant for this Contract shall be qualified and certified in accordance with ISO 9606 by internationally certified independent examining institution. In case the services of internationally certified organisation cannot be secured, certification by nationally licensed organisations may be proposed for Employer's approval.

6.6.6 Tolerances

Tolerances of finished members shall be as specified in Sub-Section VII-4.

6.6.7 Marking

All individual pieces shall be marked with the correct designations shown on the detailed drawings approved and shall indicate the type of towers too. Markings shall be done by stamping the marks into the metal before galvanizing and details shall be clearly legible after galvanizing. The figures and letters shall be minimum of 12 mm in height.

Marking of bolts shall be made in accordance with Chapter 10 of ISO 898-1.

6.6.8 Corrosion protection

Steelwork shall be hot dip galvanized in accordance with ISO 1461, providing a smooth, clean, and uniform zinc coating. Minimum galvanization thickness is specified in Sub-Section VII-4.

The ingot zinc used for galvanizing shall comply with the requirements of EN 1179.

6.6.8.1 Galvanizing

All defects of the steel surface including cracks, surface laminations, laps and folds shall be removed. All drilling, cutting, welding, forming and final fabrication of unit members and assemblies shall be completed before the structures are galvanized.

The preparation for galvanizing and the galvanizing itself shall not adversely affect the mechanical properties of the coated materials.

It is essential that the shape of steel members and assemblies which are to be hot dip galvanized shall conform to the requirements of the process and contain drainage (vent) holes as required.

On removal from the galvanizing bath, the resultant coating shall be smooth, continuous, free from gross surface imperfections such as bare spots, lumps, blisters and inclusions of flux, ash or dross. Excessively thick or brittle coatings due to high levels of silicon or phosphorus in the steel, which may result in an increased risk of coating damage and/or other features that make the final product non-fit-for-purpose shall be considered as basis for rejection.

Bolts, nuts, and washers including the threaded portions shall be hot dip galvanized and subsequently centrifuged. The threads shall be cleaned of all surpluses on packing, clear of the ground and away from all materials that might stain or corrode the galvanizing.

Dies shall not be used for cleaning threads other than on nuts. Nuts shall be galvanized and tapped 0.4 mm oversize and threads shall be oiled after galvanization to permit the nuts to be finger turned on the bolt for the full depth of the nut.

Finished materials shall be dipped into a solution of dichromate or be otherwise treated after galvanizing for white rust protection during sea transportation and storage.

Protected slings shall be used for offloading and erection. Galvanized material which is to be stored at the works or on site shall be stacked to provide adequate ventilation to all surfaces to avoid wet storage staining (white rust).

6.6.8.2 Minor repairs

Materials on which galvanizing has been damaged shall be re-dipped unless in the opinion of the Employer/Engineer, the damage is local and can be adequately repaired by applying a coating of galvanizing repair paint.

Where such repair is authorized, the damaged area shall be cleaned by wiping with clean rags saturated with mineral spirits of xylene, followed by wire brushing. After wire brushing, the area shall be re-cleaned with solvent to remove residue and shall be given one heavy brush coat of galvanizing repair paint. The percentage of pure zinc by weight in dry film of galvanizing repair paint shall not be less than 85%.

Zinc repair paint or spray of approved quality shall be provided with the tower steel supply in sufficient quantity, to enable touch-up repairs of damaged areas.

6.7 Quality Control

The Contractor shall supply a detailed Quality Assurance Procedure including an Inspection and Test Plan (ITP) which shall be submitted to the Employer for approval. The Contractor shall be responsible for performing all tests and inspections required during the production of the towers.

The Contractor shall identify all materials, including bolts and nuts used in the project on the appropriate mill test reports and/or material certificates, and shall furnish the mill test reports and/or certificates to the Employer/Engineer for approval.

The Contractor shall make dimensional checks of all materials for conformity to the relevant material standard. The Contractor shall make a visual inspection of all materials before and after galvanizing. Size of test "lot" and number of tests shall be in accordance with relevant standards.

6.7.1 Shop assembly

One tower of each type and height, including every combination of body extension shall be assembled in the shop to such an extent as to ensure proper field erection. The test shall be performed with the Employer/Engineer in attendance. Any member distorted, twisted or bent due to incorrectness of detailed drawing shall be corrected. Reaming of mismatched holes will not be permitted. A reasonable amount of drifting will be allowed in assembling.

Assembly may be vertical or horizontal. If the assembly is horizontal, blocking, and adequate support shall be provided to prevent distortion and overstressing of members to ensure proper fit. In assembling, enough bolts need be used to hold members in their true position one to another.

If any errors on the drawings or fabrication are discovered, all incorrect drawings shall be revised, and the corrected part shall be re-fabricated and re-assembled at the Contractor's expense. All revised drawings shall be re-submitted for approval.

6.7.2 Tower type test

Type test reports of the existing tower designs, if proposed by the Contractor, shall be submitted with the Bid. For newly designed tower families the number and type of towers to be tested as well as the test type are specified in Sub-Section VII-4.

The test loads shall be the design loads multiplied by the corresponding partial safety factors and by the material factor for steel member sections.

The Contractor shall give the Employer/Engineer notification in writing, not less than 30 days in advance, of the date when towers will be ready for test. Test program shall be subject to approval by the Employer/Engineer prior to testing start.

The test shall be performed with the Employer/Engineer in attendance and in accordance with EN 60652 and complying with the following requirements:

a) Tower

The tower shall be fabricated according to the detailed drawings approved in a manner as close to final production procedures as practicable. The tower shall be complete in every detail. Markings for test tower members shall be prefixed with the letter "T".

b) Erection

The tower shall be erected on a rigid foundation using the specified tower bolts and nuts tightened to the specified torque.

c) Rigging

The Contractor shall submit for approval diagrams showing the proposed methods of applying loads and deflection measuring.

d) Loading

All test loads corresponding to conductor and earth wire loading shall be applied directly to the regular attachment details provided for those loads.

Test wind loads equivalent to wind loads on the tower shall be applied where convenient and in such a manner that the locations and the summations of applied load and overturning moment are as close as possible to the actual conditions, as designed.

An extra compressible member is not allowed for use in applying wind loads on tower. To ensure application of full-test loads to the tower, friction losses in rigging shall be computed and added to the rigging loads.

The first load case in a Heavy Angle tower testing program shall be the one that produces the largest leg force. If subsequent load cases also give sufficiently high leg force, tower bolts at major joints must be loosened and re-tightened prior to the test to minimize residual loads.

e) Loading program

The Contractor shall program the tests for the decisive load cases to demonstrate that the towers will carry all design loads and conditions specified in the loading diagrams.

f) Deflection measurements

Deflections shall be recorded at the beginning and end of each loading period to provide longitudinal and transverse deflections at the tower top, at the elevation of the crossarms and at least at one intermediate point of tower body.

g) Load tests

Load increments shall be in accordance with EN 60652. Each load increment shall be maintained for not less than two minutes except that under full design load, the period of five minutes shall be maintained and during this time there shall be no slacking off or adjustment of the loads. Should it become necessary to adjust the loading, the two- or five-minutes period shall start after the loading is stabilized and constant. All test loads shall be removed completely before the loads for testing under different loading conditions are applied. The ultimate normal conditions or the most critical load case shall be the last test (except heavy angle towers) to be carried out in the presence of the Employer/Engineer.

Load Cell Calibration shall be carried out before and after each test or series of tests in the presence of the Employer/Engineer.

h) Destruction test

After the successful completion of the load tests, the tower shall be further tested to destruction by increasing only the horizontal loads for a given loading case, as specified/approved by the Employer/Engineer. The load increment shall not exceed 5% of the full design loads. Each load increment shall be held at least five minutes while deflections are being recorded.

i) Modification of tower components

Any conspicuous yielding or permanent deformation or any failure of any part of the tower under any of the tests specified shall be considered as defect.

If a defect develops, the Contractor shall modify the design of the tower and submit it to the Employer/Engineer for approval. The modified tower shall then be re-tested.

The expenses associated with re-design and re-test due to a defect in the Contractor's work shall be borne by the Contractor.

j) Material tests

Steel materials used for tested towers shall be subject to tension or bend test in accordance with the relevant material standards. Tests shall be performed by the Contractor at no additional cost to the Employer. The test specimens shall be selected as follows:

- four sets selected from the destruction members of each test tower
- four sets selected from the undisturbed members of each test tower
- two sets of bolts and nuts selected from the adjoining destruction members of each test tower
- two sets of bolts and nuts selected at random from each test tower.

k) Reports

The Contractor shall furnish certified copies of full reports of all tower and material tests, the calibration of the dynamometers or gauges, including clear photographs of the test set-ups and nature of all failures, diagrams showing deflection of towers at each interval of loading, detailed diagrams showing the way all the loads were applied and deflection records.

6.7.3 Sample testing

In addition to the above inspection and tests, the Contractor is required to perform the following tests at own expense on samples selected at random by and in the presence of the Employer/Engineer.

a) Physical tests on samples of structural steel sections

The tests to be carried out shall include yield strength, ultimate tensile strength, and percentage elongation.

One set of tests shall be carried out for each 50 tons of steel passing through the fabrication plant. Selection, preparation of samples and testing methods shall conform to requirements of ISO 6892.

b) Galvanizing tests on samples of structural steel sections

The tests to be carried out shall include determination of thickness of zinc coating, adherence of zinc coating and surface appearance. One set of tests shall be carried out for each 50 tons of steel passing through the fabrication plant. Galvanization thickness shall be determined non-destructively in accordance with ISO 2178 or coulometrically in accordance with ISO 2177 or an equivalent standard.

c) Mechanical and galvanizing tests on bolts and nuts

Mechanical property and galvanizing tests on samples of bolts and nuts shall be carried out in accordance with ISO 898-1 and ISO 1461.

6.7.4 Routine tests

The Employer/Engineer shall inspect as soon as available at the Contractor's works the first consignment of complete foundation steelwork and stub setting templates. Thereafter inspection of galvanized steelwork will be limited to complete structures, with or without foundation steelwork. Type and frequency of inspections shall conform to EN 10025 parts 1 and 2. Inspection documents shall be prepared in accordance with EN 10204.

6.7.4.1 Galvanization Site Test

The galvanizing thickness shall be tested on site after receiving the galvanized steel members as well as during their erection. The zinc coatings must comply with the thickness requirements as defined in Sub-Section VII-4.

The Contractor shall provide calibrated electronic zinc thickness measuring instrument on site for the Employer’s/Engineer's use, suitable for the accurate checking of galvanizing thickness. The measuring instrument shall be available from the time of arrival of the first consignment of steelwork until the issue of the taking over certificate. The Contractor shall also be responsible for periodic re-calibration of the instrument in accordance with the manufacturer’s recommendations. The cost of the gauge and other operating expenses are deemed to be included in the Contract Price.

6.8 Packing and Transport

The whole of the goods shall be packed in non-returnable cases or otherwise prepared for overseas shipment in a manner suitable to withstand rough handling without sustaining damage. All packing materials shall remain the property of the Employer.

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

Galvanized steelwork, which is to be stored during sea transport or at the works on site, shall be stacked to provide adequate ventilation to all surfaces to avoid wet storage staining (white rust). Protecting slings shall be used for off-loading and erection.

All labels shall be of stamped metal. Steel straps shall be covered in such a way that no rust can pollute the galvanized surface of the members. Bundles of angles may also be arranged in rectangular formation with notched outer stout wooden battens to locate the angles, the battens being compressed on the bundles by outside tie bolts - the above binders being located at sufficiently close intervals to form a strong and homogeneous element.

The Contractor's attention is drawn to the requirement to protect all steelwork before shipment to prevent damage by white rust to galvanized surfaces. Provision shall be made for the circulation of air between angles within bundles to minimize white rust formation.

Bundles shall be as large as practicable to provide stiffness and resistance to careless handling.

Packing cases, where used, shall be strongly constructed and in no case is timber less than 25 mm in thickness to be used. The contents of packing cases shall be securely bolted or fastened in position with struts or cross battens. Cross battens supporting weight in any direction shall not rely for their support on nails or screws driven lengthwise into the grain of the wood but shall be supported by cleats secured from the inside.

Bolts and nuts shall be placed in crates for shipment. Crating together of components of different metals is unacceptable.

Particular attention shall be given to strutting before packing cases are fastened down. Cases shall be up ended after packing to prove that there is no movement of the contents.

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

If light parts are fastened to the sides of a case, hoop iron straps secured by screws shall be used for the purpose. Nails driven in and bent over shall not be permitted.

Where bolts are used, large washers shall be fitted under the head and nut to distribute the pressure and the timber shall be strengthened by means of a pad.

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

Waterproof paper and felt linings shall overlap at seams at least 13 mm and the seams secured together in an approved manner, but the enclosure shall be provided with screened openings to obtain ventilation.

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

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

The Employer/Engineer may require inspecting and approving the packing before the items are dispatched but the Contractor is to be entirely responsible for ensuring that the packing is suitable for transit and such inspection shall not exonerate the Contractor from any loss or damage due to faulty packing.

6.9 Installation

See Clause 16.11 for details.

7. Foundations

Following approval of Geotechnical survey report, the Contractor shall select and propose up-to-date methods and equipment to ensure that foundation design and construction are fit for intended purpose. Foundation design shall conform to EN 1997-1 with due consideration for supplementary details provided in Chapter 8 of EN 50341-1.

The Contractor shall prepare a schedule which clearly indicates the type of foundations proposed to be installed at each tower location and records of the soil investigation data on which the choice has been made. A field test procedure (field test method) shall be established and included in the report about assessment and classification of actual soil conditions once the foundation excavation is open to verify compliance with the defined foundation design parameters.

The Schedule shall be subject to the approval of the Employer/Engineer prior to commencement of foundation construction.

The Contractor retains full responsibility for:

- the use of the most suitable materials
- appropriate design
- competent workmanship
- full serviceability in unrestricted continuous operation
- observation of the Technical Requirements and compliance with relevant standards.

7.1 Standards

EN 1997-1	Eurocode 7. Geotechnical design. General rules
EN 50341-1	Overhead electrical lines exceeding AC 1 kV. General requirements. Common specifications
EN 197-1	Cement. Composition, specifications, and conformity criteria for common cements
EN 206	Concrete. Specification, performance, production, and conformity
EN 196-1	Methods of testing cement. Determination of strength
EN 196-2	Method of testing cement. Chemical analysis of cement
EN 1008	Mixing water for concrete. Specification for sampling, testing, and assessing the suitability of water, including water recovered from processes in the concrete industry, as mixing water for concrete
EN 12620	Aggregates for concrete
EN 16236	Assessment and Verification of the Constancy of Performance (AVCP) of aggregates. Type testing and Factory Production Control
EN 934-1	Admixtures for concrete, mortar, and grout. Common requirements
EN 934-2	Admixtures for concrete, mortar, and grout. Concrete admixtures. Definitions, requirements, conformity, marking and labelling
EN 12350-1	Testing fresh concrete. Sampling and common apparatus

EN 12350-2	Testing fresh concrete. Slump test
EN 12350-6	Testing fresh concrete. Density
EN 12390-1	Testing hardened concrete. Shape, dimensions and other requirements for specimens and molds
EN 12390-2	Testing hardened concrete. Making and curing specimens for strength tests
EN 12390-3	Testing hardened concrete. Compressive strength of test specimens
EN 12390-7	Testing hardened concrete. Density of hardened concrete
EN 10080	Steel for the reinforcement of concrete. Weldable reinforcing steel. General.
EN 12812	Falsework. Performance requirements and general design.
EN 13670	Execution of concrete structures.
EN 61773	Overhead lines. Testing of foundations for structures.

7.2 Design

Foundation design shall conform to the requirements of EN 1997-1, considering complementary details specified in Chapter 8 and Annex M of EN 50341-1. Alternative design methods, ensuring equal or higher reliability, can be adopted with prior approval of the Employer/Engineer.

All foundations shall be designed to withstand uplift, settlement, and overturning (as appropriate) when subjected to the applied system loading. Allowances shall be made in the foundation design for hydrostatic pressure where this may occur and the effects of seasonal rains, drying out or other cyclic loading.

The investigation of the ground conditions shall be carried out in accordance with requirements specified in Chapter 4 and on an adequate scale to enable the selection of the appropriate foundation type to be made for each support position. Any subsidence or failure, due to insufficient care having been taken in the site investigation or in the interpretation of the results of the site investigation or in the installation of the foundations shall be the Contractor's sole responsibility.

In areas where ground subsidence is likely to occur the Contractor shall, if necessary, carry out modifications to the support foundations as agreed by the Employer/Engineer. Collar or tie beams between individual footings shall not be used unless specifically authorized by the Engineer.

Foundation design shall cover the full extent of expected ground conditions determined based on Geotechnical Investigation Report for all tower types. Foundation types shall generally conform to those described in Clause 7.2.1 unless otherwise agreed with the Employer/Engineer.

Values of the partial material factors are provided in Particular Technical Specification.

To facilitate construction of foundations for angle towers located in difficult access locations, site-specific foundations reactions for the compressed legs and the uplift legs may be considered for the design of the corresponding differentiated (by legs) foundations, subject to Employer`s approval.

7.2.1 Foundation Types

Requirements for typical foundation types are specified below. Additional foundation types may be included in Sub-Section VII-4.

a) Concrete Slab with Rock anchors

Consisting of rock anchors and a reinforced concrete slab directly cast against rock. The length of the anchor bolts or anchor profiles shall be calculated with the consideration of the following mechanical characteristics:

- the bearing capacity of the anchoring bolts or profiles
- the friction capacity between the steel anchor and the grouting material
- the adhesion capacity along contact between the grout and rock sub-base
- the failure-rupture of the rock due to shear forces.

b) Concrete Block/Shaft foundations

Reinforced concrete shaft with an undercut. Square or circular shape and cast directly against firm sub-base.

c) Pad and pyramid (or chimney) foundations

Reinforced concrete base with pyramid shaft or chimney. Reinforced concrete chimneys shall be designed to withstand the maximum horizontal resultant residual shear component, with due allowance given where appropriate, of the lateral (passive) earth pressure of the backfill or surrounding soil.

d) Piled Foundations

Piled foundations may comprise multiple raked or vertical piles interconnected at or below ground level by a reinforced concrete cap or by single large diameter raked or vertical pile. Vertical piles shall be used when ground settlement is likely to impose unacceptable bending stresses on raked piles, or where the type of pile cannot be installed raked.

Ground beams shall be provided where the applied horizontal shear forces cannot be resisted wholly or partial by the lateral resistance of the piles and/or pile cap.

In assessing the compression loading on the piles, the weight of the pile cap, soil overburden and ground beams shall be multiplied by the appropriate factor for permanent actions. In determining the uplift loading on the piles, the actual weight of the pile cap, soil overburden and ground beams shall be multiplied by the appropriate factor for permanent actions (unfavourable). Due allowance shall be made for buoyance effects where applicable.

For piled foundations in very weak soil (e.g., where the average design value of the standard penetration test ‘N’ value is less than 5, or the undrained shear strength is less than 20 kN/m^2), the minimum dead weight of the piles, pile cap and ground beams (if any) shall not be less than 28 % of the applied loading.

e) Micro Piles

Micro piles used as the main foundation element shall be designed and constructed in accordance with the requirements of the specification and the recommendations of the ICE ‘Specification for Piling and Embedded Retaining Walls’, unless otherwise agreed by the Engineer.

Design compression and uplift loads on the piles shall be in accordance with the requirements of d) above.

For bored cast-in-situ micro piles a factory applied double protection system shall be provided to the central pile reinforcement comprising an impermeable sheath in conjunction with an inner cement grout annulus. A minimum external cement grout cover of 20 mm shall be provided. For self-drilling hollow core grouted piles, a minimum grout cover of 50 mm shall be provided.

All foundations on slopes greater than 1:4 shall be checked for stability against rotation where appropriate. Due consideration shall be given to the increased up-slope lateral loading of the soil and the decrease in downhill resistance provided by the soil, when compared to foundations installed on level ground.

A selection of the foundation type shall be made for each tower to suit its site conditions. The final foundation schedule shall be prepared accordingly. and submitted for approval to the Employer/Engineer.

Pre-cast elements may be used only with prior Employer’s/Engineer’s approval.

7.2.2 Design principles

Contractor shall provide specialized foundations design and propose the most appropriate engineering solutions. Geotechnical engineering specialists shall provide the complete foundations analysis, including verification of slope stability where required.

Foundations, regardless of the type, shall penetrate through potential slide plane and be firmly embedded in the underlying stable ground.

In all calculations and drawings, Contractor shall clearly show whether foundation contact with undisturbed soil is necessary.

In case particularly poor ground conditions impose the need for special types of foundation, the Contractor shall propose the design solution to the Employer/Engineer.

Stubs for all tower extensions shall be of the same design as that for a standard height tower. Only one design of stub shall be permitted for each type of tower and shall not be bent or cranked.

The thickness of the stub flanges shall not be less than the corresponding flanges of the tower leg member.

Cleats shall be capable of transferring 100 % of the design uplift and compression load.

All concrete foundations shall terminate at least 300 mm above ground level, sloped off and smoothly finished to ensure drainage away from the steelwork.

The minimum concrete cover shall be as follows:

- concrete parts above ground (external surface) 50 mm
- concrete exposed to underground and groundwater 75 mm

7.2.3 Design Submissions

The Contractor shall submit the following design submissions to the Employer/Engineer for approval:

- design methodology based on EN 1997-1 and soil properties to be used for design of all foundation types determined based on Geotechnical Investigation (Chapter 4). Alternatively, with Employer’s/Engineer’s prior agreement, design may be based on semi-empirical approach in accordance with Clause M.3 of EN 50341-1 with parameters for generic soil types as defined in Sub-Section VII-4. In this case the results of geotechnical investigations and field tests during construction shall be used to identify appropriate generic soil type for each tower location.
- foundation design calculations, which shall also include a cross-reference to the geotechnical report, applied foundation loadings, and foundation general arrangement drawings.
- foundation general arrangement drawings, which shall include as a minimum: the geotechnical design parameters, concrete class and steel reinforcement grade, cross-reference to the design calculations, stub details, reinforcing schedule etc. Details of the stub setting and excavation plus any chimney extension shall also be included or provided on a separate cross-referenced drawing. Drawings for the reinforcement shall be fully dimensioned and include both quantity and mass per item
- bar bending drawings/schedules
- foundation setting templates
- foundation formwork drawings where appropriate

- temporary works design where appropriate.

7.3 Materials

7.3.1 Materials for concrete

All materials used for concrete and reinforced concrete structures shall be free from defects likely to undermine the strength and duration of service of the works. The materials furnished shall comply with prescribed standards, and with all requirements described in these technical requirements.

All materials shall be stored and handled in a manner that shall prevent contamination and/or deterioration. Deteriorated and/or contaminated material shall not be used for the concrete and shall be removed from the site at the expense of the Contractor.

7.3.1.1 Cement

The cement used for concrete, reinforced concrete, mortar, grout, and plaster works shall be in accordance with EN197 1. The Contractor shall determine concrete exposure classes in accordance with EN 206 and propose adequate cement type for Employer's/Engineer's approval.

All deliveries of cement to the concrete supplier shall be accompanied by a certified mill test report and shall include all physical and chemical properties.

The manufacturer's test certificate shall normally be accepted as proof of compliance with the Technical Requirements. If required, confirmatory tests are to be conducted by an independent, internationally certified, quality control organization approved by Employer/Engineer. In case the services of internationally certified organisation cannot be secured, nationally licensed organisations may be proposed for Employer's approval.

The following information shall be provided for all cement shipments (either whole or part) which are intended for delivery to site: date of manufacture, date of original loading, destinations en-route, date of unloading, intended date of delivery to site.

Cement which has been manufactured more than 6 months before the proposed date of delivery to the site shall be inspected, sampled, and tested in accordance with provisions of EN 196 parts 1 and 2 for conformance with requirements of EN 197-1. Testing shall be done by independent, internationally certified, quality control organization approved by Employer/Engineer. In case the services of internationally certified organisation cannot be secured, nationally licensed organisations may be proposed for Employer's approval.

The Contractor shall obtain and provide to the Employer/Engineer the manufacturer's Bulk Average Test Certificate for each consignment of cement to the works.

Control samples shall be taken from each consignment of cement and tested as directed by the Employer/Engineer by approved independent, internationally certified, quality control organization. In case the services of internationally certified organisation cannot be secured, nationally licensed organisations may be proposed for Employer's approval.

All bagged cement shall be stored in a weatherproof building which shall always be kept swept clean.

Cement shall be adequately protected against rain, humidity and dewfall, and all charging and discharging points shall be properly sealed.

7.3.1.2 Water

Sampling, testing and assessment of suitability of water for preparing concrete and mortar shall conform to requirements of EN 1008. Water shall be obtained from suitable local sources protected from contamination and stored in clean containers. Each source shall be subject to separate assessment. Use of water from non-assessed sources is prohibited.

Potable water supplied by public utility does not require testing and is considered suitable for concrete production.

7.3.1.3 Aggregates

Materials used as aggregate shall be obtained from reputable supplier and shall be chemically inert, strong, hard, durable, of limited porosity and free from adhering coats, clay lumps, organic impurities that may impair the strength or durability of the concrete.

Aggregate shall conform to requirements of EN 12620 and be certified as type tested in accordance with EN 16236 by internationally certified quality control organization. Supplier shall also provide current factory production control certificate of compliance with procedures defined in EN 16236. In case the services of internationally certified organisation cannot be secured, nationally licensed organisations may be proposed for Employer's approval.

Aggregate stored on site shall be protected from contamination and different fractions shall be kept separate to prevent accidental mixing of two fractions.

7.3.1.4 Concrete additives

Concrete additives may be used to improve consistency, workability, quality, and strength of the concrete, subject to approval by the Employer/Engineer. Any proposed additives must conform to requirements of EN 934 parts 1 and 2.

7.3.2 Reinforcing steel

Reinforcing steel shall comply with EN 10080.

Reinforcement supports shall include all spacers, chairs, ties, slab bolster, clips, chair bars, and other devices for properly assembling, placing, spacing, supporting, and fastening the reinforcement.

Spacers shall be cast from concrete of the same quality as that in which they will be embedded.

Concrete block spacers shall be cast in metal molds with an approved means of separating blocks and of ensuring that the blocks are of the correct size.

7.3.2.1 Test certificates

Each consignment of steel reinforcement shall be accompanied by a test certificate from the manufacturer showing that reinforcement has been evaluated for conformity in accordance with EN 10080. Additionally, from each consignment, three random samples of every bar size shall be selected for testing of dimensional tolerances, ductility, yield, and tensile strength. Testing shall be done by independent, internationally certified, laboratory approved by the Employer/Engineer.

7.3.2.2 Rejection

Should any of the test results of any random sample fall outside of minimum requirements defined in EN 10080, further tests shall be done following verification procedure specified in Chapter 11 of EN 10080. In case this verification procedure demonstrates non-conformance, consignment in question shall be rejected.

7.3.3 Falsework and formwork materials

Falsework and formwork shall be constructed from steel or from sound timber well-seasoned and free from shakes. Plywood lining shall be of timber which is resin-bonded and water repellent.

Formwork surfaces in contact with concrete shall be free from adhering grout, projecting nails, splits, or other defects.

Joints shall be sufficiently tight to prevent the leakage of cement grout. Connections shall be constructed to permit easy removal of the shuttering and shall be either nailed, screwed, bolted, or otherwise secured to be strong enough to retain the correct shape during consolidation of the concrete.

7.4 Installation

See Clause 16.11 for details.

7.5 Quality Control

7.5.1 Concrete Compressive Strength

All test samples shall be prepared and cured in accordance with provisions of EN 12390-2. Molds used for preparation of test samples shall fully conform to requirements of EN 12390-1. Tests shall be performed by internationally accredited organization proposed by the Contractor and approved by the Employer/Engineer.

Required compressive strength class of concrete for use on this project is specified in Sub-Section VII-4. The minimum characteristic strength for different classes of concrete is specified in Table 12 of EN 206 and criteria for assessing conformity of compressive strength class is defined in Clause 8.2.1.3 of the same standard.

A minimum of nine test samples shall be made on each concreting day (from the same mix) and for at least each 40 m^3 of concrete mixed. Samples shall be tested for density and compressive strength in accordance with EN 12390-7 and EN 12390-3 respectively.

Any concrete not conforming with these Technical Requirements shall be removed and replaced to the satisfaction of the Employer/Engineer.

The Contractor shall bear all costs incurred in making, curing, transporting, and testing of concrete samples.

7.5.2 Design and Proof Tests

Foundation tests shall be executed in accordance with test program prepared by the Contractor and approved by the Employer/Engineer. Test program shall include enough design and proof tests to adequately demonstrate suitability of proposed foundation types to soil conditions encountered on site and shall be based on requirements of EN 61773.

Design tests must be successfully completed for each foundation type before installation of production foundations commences on site. Frequency of proof tests shall be defined in the test program but shall not be lower than minimum value recommended in EN 61773. Acceptance criteria and evaluation methods shall be defined in accordance with Chapter 10 of EN 61773 as part of foundation design.

All tests shall be done to full scale unless otherwise agreed with the Employer/Engineer. Foundation installation and test records shall be in accordance with Annex D of EN 61773 unless otherwise agreed with the Employer/Engineer.

7.5.2.1 Routine Tests

If, because of an examination, inspection, measurement or testing, the Engineer requires foundations to be retested, the test shall be repeated under the same terms and conditions without additional costs. The results of the tests shall be notified immediately to the Employer/Engineer in writing.

The Contractor shall give the Employer/Engineer at least 48 hours' notice of tests, to allow arrangement for inspection. No work may be backfilled or otherwise covered without an instruction from the Employer/Engineer, respectively without being tested or checked.

The Contractor shall obtain from material suppliers Certificates of Test, proof sheets, mill sheets, etc., required by the relevant applicable standard, showing that the materials have been manufactured in accordance with the requirements of these technical requirements.

Neither the omission of the Employer/Engineer to send an inspector nor the production of the manufacturer's certificates of test as aforesaid shall affect the liberty of the Employer/Engineer to reject after delivery, materials found not to be suitable, or not in accordance with these requirements.

Where materials or workmanship are rejected by the Employer/Engineer the objected part must be immediately removed from the site at the Contractor's cost.

7.5.2.2 Additional Tests

The Contractor shall carry out further successful foundation design tests, at request of the Employer/Engineer, to prove the suitability of the foundation selected with particular type of soil in case of:

- doubts regarding the suitability of the design approach for particular location
- doubts regarding the suitability of the applied soil parameters for particular location.

The Contractor may be required to carry out uplift tests on concrete block foundations within the line easement and at positions decided by the Employer/Engineer for the foundation types specified.

The contractor will cast a separate single leg foundation to the appropriate design and subject the leg to an uplift test. The Contractor shall provide all labour, materials, equipment, and apparatus for performing the load tests.

The tests shall be carried out or caused to be carried out by the Contractor without extra cost. Excavation, pouring concrete and backfill for the foundation, the test operation, the supply and removal of the testing equipment and any ancillary works which are necessary for the test is included. The tests also include the breaking out the concrete and cutting off the stub to a depth of not less than 0.7 m below ground level after the test has been concluded.

8. Earthing

Earthing continuity from the OPGW/earthwire support fittings to the earthing system shall be provided by surface contact of bolted members. The use of the basic earthing consisting of the structural foundation steel is essential, therefore each tower shall be connected to the ground by means of an earthing system.

Welded connections shall be provided to include the vertical reinforcement bars of the chimney as well as the horizontal ones of the foundation base (pad) into the earthing system.

Before commencement of stringing, footing resistance measurements shall be made at each tower site and results provided to the Employer/Engineer.

8.1 Standards

EN 50341-1	Overhead electrical lines exceeding AC 1 kV - Part 1: General requirements - Common specifications
EN 5052	Earthing of power installations exceeding 1 kV a.c.
IEC 60479-1	Effects of current on human beings and livestock – Part 1: General aspect
IEC 60479-2	Effects of current on human beings and livestock – Part 2: Special aspects
IEC 60287-3-1	Electric cables – Calculation of the current rating – Part 3-1: Operating conditions – Site reference conditions

8.2 Design

The tower earthing system shall be composed of:

- the basic earthing system of foundation reinforcement steel interconnecting two diagonal legs
- an additional earthing system
- extension of the additional earthing system, if required.

The design and tests shall conform to EN 50341 and IEEE 80.

The individual tower earthing resistance measured without the earthwire connected, in dry season is specified depending on the soil resistivity as per the following table unless otherwise specified in Sub-Section VII-4:

Soil resistivity (Ωm)	<100	100-500	500-	1,000-2,000	>2,000
Earthing resistance (Ω)	10	15	20	25	30

8.3 Materials

a) Earthing conductor

The tower earthing wire or earthing tape (earthing strap) shall be at least

- 11.5 mm diameter galvanized steel wire
- 40 mm x 6 mm galvanized steel tape.

The earthing conductor shall be connected to the tower steel structure (stub) by using connectors and/ or bolts.

b) Connectors

The connection of the ground conductor/tape/electrodes to the stub-angle shall be made with compression lugs, fixed to the stub-angles by two M16 bolts. To accommodate additional grounding, every stub-angle shall have a pair of holes for establishing the required earthing/grounding connection.

Bolts shall be of sufficient length to suit the steel connecting angle/ plate thickness and provide for the nut and washer.

A compression type connector may be used for the earthing connection of steel wire to steel wire/ to reinforcement bars. The connector shall be made of steel. The current carrying capacity of the connector shall not be less than that of ground wire. The effective length of the clamp shall be sufficient to grip the connecting wires firmly under normal service conditions.

Alternatively, bolted clamp connectors can be proposed.

c) Earthing Rod

The ground rods shall be of galvanized steel type, delivered in modules and provided with connectors. The minimum length shall not be less than 2 m and the diameter not smaller than 20 mm.

The earth electrode shall be connected to the tower steel by earthing conductor.

8.4 Installation

8.4.1 Basic earthing

The vertical foundations reinforcing bars shall be connected electrically to the stub angle inside the concrete by a steel wire/ tape (bolt or weld connection).

Further earthing connections shall be provided between vertical and horizontal bars to also include the horizontal reinforcing mesh.

Inside the foundation concrete, the grounding electrodes of the basic system shall be embedded in suitable plastic hoses

Two diagonal legs will be connected to earthing rods and interconnected by a half loop installed at a depth of 0.6 m from ground level.

8.4.2 Additional earthing

If required tower earthing resistance cannot be met, the tower basic earthing system shall be extended by additional measures.

a) Additional Earthing – Step 1

The type of additional earthing devices will be specified as earthing wire/ tape system. Another half loop shall be installed in same way but in opposite direction and shall be interconnected in such a way as to surround the tower location. The loop will be further connected to four earthing rods.

After installation of the additional earthing system, the Contractor shall measure the earth resistance at each tower structure and submit the results to the Employer/Engineer for approval.

b) Additional Earthing – Step 2

If required tower earthing resistance is not met following the Step 1 further measures shall be applied.

The loop shall be extended by additional earthing wires/ tapes of 10m length or more, running in radial direction from the tower centre. Earthing rods shall be used at each end of the tapes.

After application of Step 2, the Contractor shall repeat the resistance measurement in all concerned locations and submit the results to the Employer/Engineer for approval.

c) Grading Rings

At tower locations subject to special requirements regarding public safety a closed earthing ring shall be buried around the tower leg, to a depth of 0.6 m and at a distance of 1m to the tower steelwork. The ring shall be connected to the tower legs.

If necessary, a second grading ring shall be installed at a depth of 0.8 m 1 m from the first grading ring. Where installation of additional earthing rings is required for public safety, the Contractor shall perform calculations proving the safety limits of step and touch voltages. These calculations shall be subject to approval by the Employer/Engineer.

8.4.2.1 Earthing of structures under the transmission line

Where the line crosses metal roofs, pipelines, metallic fences, or other objects which may have induced voltages by the energized line, all such objects shall be earthed in accordance with relevant standards and national legislation.

The metallic fence gates within the right-of-way shall be electrically bounded to the fences.

After installation of the earthing system, the earthing resistance test shall be carried out.

8.5 Tower earthing resistance measurement

The tower earthing resistance shall be measured during initial installation and immediately before commissioning, but at least once during the dry season under reasonably dry soil conditions in presence of the Employer's/Engineer's representatives.

The measurements shall be carried out by means of a high frequency earth resistance measuring instrument, according to EN 50341 or equivalent standard, to allow readings of the impulse resistance value of the earthing system connected or not connected to tower and by towers having earth wires installed or not.

The measurements shall be clearly recorded in accordance with approved Quality Control Plan. The schedules used for the recordings shall contain in addition to the measured ohmic values, details of the surface soil and underground data at the time of tests as well as the soil resistivity values.

The Employer reserves the right to request further reduction of the tower earthing resistance by approved means such as the installation of earth rods or counterpoise.

9. Conductors

The conductor types and additional requirements are specified in Sub-Section VII-4.

The characteristics of the wires and complete conductor, manufacturing process and testing procedures shall be in accordance with the latest versions of the referenced standards.

9.1 Standards

EN 10244-1	Steel wire and wire products. Non-ferrous metallic coatings on steel wire
EN 50182	Conductors for overhead lines - round wire concentric lay stranded conductors.
EN 50183	Conductors for overhead lines - Aluminium-magnesium-silicon alloy wires.
EN 50189	Conductors for overhead lines - Zinc coated steel wires.
EN 50326	Conductors for overhead lines. Characteristics of greases
EN 50341-1	Overhead electric lines exceeding AC 1 kV - Part 1: General Requirements
EN 60889	Hard drawn aluminium wire for overhead line conductor
EN 61232	Aluminium-clad steel wires for electrical purposes.
EN 61395	Overhead electric conductors. Creep test procedures for stranded conductors
IEC 60468	Method of measurement of resistivity of metallic materials
IEC 61089	Round Wire Concentric Lay Overhead Electrical Stranded Conductors
IEC 61328	Live working - Installation of transmission line conductors and earthwires - Stringing equipment and accessory items.
ISO 7802	Metallic Materials-Wire-Wrapping test

Alternative standards are subject to approval by the Employer/Engineer.

9.2 Design

The minimum conductivity, dimensional and mechanical characteristics of all component wires shall be adequate to ensure strict compliance with Employer's Requirements and relevant provisions of referenced standards.

Where applicable, the galvanization class of the steel wires shall be suitable to cope with the most onerous environmental conditions of the geographic area crossed by the overhead line.

To reduce the risk of corrosion, the conductors shall be greased as specified in Sub-Section VII-4.

The Contractor shall provide the following design submissions to the Employer/Engineer for approval:

- sag and tension calculations and schedules for the phase conductors and earthwire/OPGW for every span at the proposed range of sagging operations, the ultimate limit state loading conditions and at the maximum rated temperature of the phase conductors
- the evaluation of the inelastic extension which is likely to occur in the conductor over the defined reference period. Compensation for the inelastic extensions so determined shall be made by the selection and use of an optimum pretension and time period, and over tensioning the conductor at the time of erection. Over tensioning of the conductor shall be made by an allowance in the erection temperature, i.e., Sagging temperature = conductor temperature - equivalent temperature correction.
- The Contractor shall prepare insulator offset schedules if specified in Sub-Section VII-4.

Maximum conductor tension under the defined limit state loading must not be exceeded. The Contractor shall ensure that the erection tensions do not exceed the appropriate ultimate limit state loading on the towers.

Conductor erection cannot commence before approval of the design submissions by the Engineer has been obtained.

9.3 Materials

Aluminium wire used for AL1, AL1/AL3, AL1/ST1A conductors or incorporated in OPGWs shall comply with the requirements of EN 60889.

Aluminium alloy wire used for AL3, AL5, AL1/AL3, AL3/ST1A conductors or incorporated in OPGWs shall comply with the requirements of EN 50183.

Zinc coated steel core wires used for AL1/ST1A and AL3/ST1A conductors shall comply with the requirements of EN 50189.

Aluminium-clad steel wires used for SA conductors or incorporated in OPGWs shall comply with the requirements of EN 61232.

9.3.1 Conductor Grease

All grease applied to the specified inner aluminium, aluminium alloy or steel strands of the conductor shall be of a neutral type and shall have the following properties:

- The grease shall protect the conductors from corrosion in service which may include operation in atmospheres containing salt spray or industrial pollution.
- The grease shall not corrode steel, aluminium or aluminium alloy wires or any combination of wires.
- The grease shall be compatible with any wire drawing lubricant present on the conductor wires.

- The grease or any component of the grease shall not flow within, nor exude from the conductor during storage, transport, erection or during service.
- The grease shall not be damaged by storage or by the conductor manufacturing process (a hot applied grease shall be unimpaired after heating to 20°C above its dropping point for 150 hours, or 10°C above the temperature reached during the application of the grease to the conductor whichever is greater).
- The grease shall have adequate resistance to oxidation.
- The grease shall not present a health hazard and shall conform to relevant health and safety requirements.

9.3.2 Corrosion Protection

All steel core wires shall be zinc coated to comply with the requirements of EN 50189.

Aluminium clad steel shall comply with the requirements of EN 61232.

Unless otherwise specified in Sub-Section VII-4, all layers of the conductor excluding the outer layer shall be uniformly covered with a neutral grease (i.e., as case b Annex B of EN 50182). The minimum fill factor of the grease shall not be less than 70 % unless otherwise specified in Sub-Section VII-4.

9.4 Manufacturing

Any eventual jointing of steel and aluminium wires shall be carried out in accordance with the procedures prescribed by the standard EN 50182.

The stranding of the wires shall be carried out in a way to ensure that wires of each layer stay in place or can be easily put back in place once the conductor is cut.

The stranding process shall ensure the correct lay ratios as per EN 50182 and uniform and smooth distribution of the wires. The wires in each layer shall be in close contact with the wires of the adjacent layers.

The stranding process shall be carried out in a way to ensure that no cage formation shall occur during and after stringing.

The stranding direction of the outer layer shall be to the right unless otherwise specified in Sub-Section VII-4.

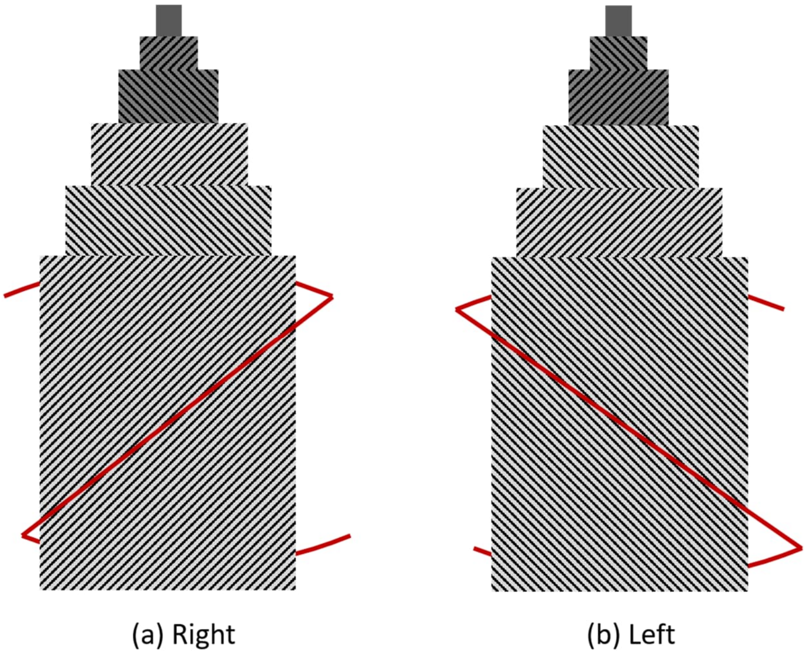


Figure 9-1: Stranding direction of the outer layer

Any component of the stranding machine (including reels) which have been in contact with other types of metals other than aluminium or galvanized steel wires, shall be adequately cleaned and any traces of other metals shall be completely removed.

Each layer of wire except the outer layer (unless stated to the contrary in the Sub-Section VII-4), shall have, both lengthwise and peripherally an even and continuous coating of grease.

Wax thickened greases shall be applied at a temperature above the dropping point. The applied grease shall be substantially free from contaminants. No grease shall be visible on the exterior of the conductor and every effort shall be made to minimize the presence of drawing oil on the surface of the finished conductor.

9.5 Quality Control

9.5.1 Type Tests

Type test requirements are specified in Sub-Section VII-4.

9.5.2 Routine Tests

The in-factory routine tests are intended to guarantee the quality of the conductor and compliance with all the relevant standards and requirements during the manufacturing process.

The Contractor shall provide the Quality Assurance Plan (QAP) of the proposed suppliers. The QAP shall provide detailed information on the complete manufacturing procedure and the prescribed quality control throughout the manufacturing stages. The quality control procedures shall be in accordance with the applicable standards.

As a minimum the following tests shall be carried out to confirm the adequacy of the materials to be incorporated in the conductor:

Table 9-1: Testing on the incoming or produced unit to be incorporated in the conductor

Item	Test	Sample size of the testing on the incoming or produced units
Galvanized steel wires	Visual inspection	100%
	Measurement of the diameter	100% of the drums and/or at least 20% of the coils
	Tensile strength	
	Elongation at break	
	Stress at 1% elongation	
	Zinc coating mass measurement and uniformity of the zinc layer	
	Wrapping test	
	Torsion test	
Aluminium clad steel wires	Visual inspection	100%
	Measurement of the diameter	100% of the drums and/or at least 20% of the coils
	Tensile strength	
	Elongation at break	
	Stress at 1% elongation	
	Cladding thickness/uniformity	
	Torsion test	
	Resistivity	100%
Aluminium wires	Measurement of the diameter	100%
	Resistivity	100%
	Tensile strength	100%
	Chemical composition	At least 20% of each batch
Grease	Visual inspection	100%
	Dropping point	At least 1
	Control of the grease supply certificate	100%

During the manufacturing process, the following tests shall be carried out:

Table 9-2: Testing during conductor manufacturing

Item	Test	Sample size
Drawn Aluminium wire	Measurement of the diameter	100%
	Visual inspection	100%
Complete conductor	Visual inspection	100%
	Stranding lay length of each layer	Start of the stranding
	Stranding lay ratio of each layer	Start of the stranding

Table 9-2 depicts the required post-manufacturing tests. The acceptance criteria shall be in accordance with EN 50182.

The acceptance or rejection of the manufacturing batch shall be in accordance with EN 50182.

Prior to shipment, the manufactured batch(es) shall be subjected to inspection by the Employer/Engineer. The manufactured batch shall not be released for shipment without the approval of the Employer/Engineer.

Irrespectively of the approval by the Employer/Engineer, the Contractor shall not be exempt of the responsibility of supplying the conductors in strict compliance with the quality parameters prescribed by the Technical Requirements and associated standards.

As a minimum the tests depicted in in Table 9-3 shall be carried out during the final inspection/factory acceptance tests (FAT).

Table 9-3: Tests after the completion of the manufacturing

Item	Test	Sample size on the manufactured batch
Post-stranding galvanized steel wires	Measurement of the diameter	10%
	Tensile strength	
	Elongation at break	
	Stress at 1% elongation	
	Adherence of the zinc layer	
	Mass of the zinc layer	
	Wrapping test	
	Torsion test	
Post-stranding aluminium clad steel wires	Measurement of the diameter	10%
	Tensile strength	
	Elongation at break	
	Stress at 1% elongation	
	Cladding thickness/uniformity	

Item	Test	Sample size on the manufactured batch
	Torsion test	
	Resistivity	
Post-stranded aluminium wires	Measurement of the diameter	10%
	Resistivity	10%
	Tensile strength	10%
	Elongation at break	10%
	Wrapping test	10%
	Torsion test	10%
Complete conductor	Visual inspection - surface condition, number, and type of wires	10%
	Total unit weight	10%
	Grease unit length	10%
	Inertness	10%
	Diameter over each layer	10%
	Stranding lay length of each layer	10%
	Stranding lay ratio of each layer	10%
	Conductor tensile breaking strength	10%

9.6 Packing, shipping, transport

The conductors shall be supplied on sound new wooden or steel drums. The drums shall be suitable for long term storage. Drums shall be securely fastened around the perimeter and shall be suitable for rolling on the flanges without causing damage to the conductor.

The drums shall be lagged with sound wood lagging. The clearance to the top layer of the conductor shall be enough to avoid damages on the outer surface of the conductors.

A waterproof paper shall cover the inner surfaces of the drum. After the winding, the top layer shall also be covered with the same type of waterproof paper. The winding of the conductor shall be uniform and free of empty spaces between adjacent turns. Moreover, the conductor layers shall not include sections of conductors from adjacent layers.

The disposal of all empty drums shall be the responsibility of the Contractor.

A weather resistant and waterproof label shall be attached to both flanges. As a minimum the following information shall be included:

- contract title and reference number
- manufacturer's name

- conductor type
- Gross and net weight
- length
- dimensions of the drum
- handling instructions.

The rolling direction shall be painted on both flanges.

Preliminary drawing of the proposed drums and details of the materials incorporated in the drum manufacturing shall be submitted with the Bid.

The minimum length of the conductor on drums is subject to the Employer's/Engineer's approval. Timing of the submission shall be defined in the Document Schedule (see Sub-Section VII-2), considering sufficient time allowance for approval process, including potential modifications, is allocated to prevent material delivery delays.

9.6.1 Spare parts

Spare conductors shall be delivered together with the last scheduled delivery and are to be provided in continuous lengths on non-returnable drums.

The spare conductors must be adequately protected against humidity, corrosion, etc. and packed and treated in such a manner as to be suitable for long term storage. They shall be delivered on steel drums provided with identification labels. The spare conductor shall be delivered to the Employer's storage area and checked by the Employer/Engineer. The Taking-Over will take place after delivery to the Employer's store.

10. OPGW

OPGW types and additional requirements are specified in Sub-Section VII-4.

The Contractor shall ensure close and continuous liaison between the manufacturers of OPGW and fittings so that the equipment will be perfectly adapted.

10.1 Standards

EN 50182	Conductors for overhead lines - Round wire concentric lay stranded conductors.
EN 50183	Conductors for overhead lines - Aluminium-magnesium-silicon alloy wires.
EN 61232	Aluminium-clad steel wires for electrical purposes.
EN 50326	Conductors for overhead lines. Characteristics of greases
EN 187200	Harmonized systems of quality assessment for electronic components. Sectional specification. Optical cables to be used along electrical power lines (OCEPL)
IEC 61089	Round Wire Concentric Lay Overhead Electrical Stranded Conductors
IEEE Std 1138	IEEE Standard for Testing and Performance for Optical Ground Wire (OPGW) for Use on Electric Utility Power Lines
ITA/EIA-598-C	Optical Fibre Cable Colour Coding.
IEC 60793-1-1	Optical fibres. Measurement methods and test procedures
IEC 60794-1-2	Optical fibre cables - Part 1-2: Generic specification - Cross reference table for optical cable test procedures
IEC 60794-4-10	Optical fibre cables - Part 4-10: Aerial optical cables along electric power lines
IEC 61395	Overhead electrical conductors - Creep test procedures for stranded conductors
ITU-T-G. 652 D	Characteristics of single mode optical fibre and cable (low water peak)
ITU-T-G. 655	Characteristics of a non-zero dispersion shifted single mode optical fibre cable

Alternative standards are subject to approval by the Employer/Engineer.

10.2 Manufacturing

There shall be no joints or splices in any optical fibre in a reel length of the complete optical cable. Successive stranding layers shall have reversed direction of lay. The outer layer shall be right hand (Z). The wires shall be adequately stranded to avoid its irreversible detachment in case the wires are cut.

The stranding process shall distribute the wires regularly in close contact with the adjacent wires. The adjacent layers shall be kept tight to avoid slippage or relative movement of strands or cage formation during stringing.

The OPGW manufacturer shall have ISO 9001 quality assurance system certified and shall prove a minimum experience in successful supply of similar OPGW of 10 years.

No joints are permitted in individual ACS or AA wires in the OPGW outer layer.

Eventual joints - executed prior to the stranding process - shall be compliant with EN 50183 and EN 61232. No wire joints will be permitted during or after the stranding process.

10.3 Quality Control

The Contractor shall supply a detailed Quality Assurance Procedure including an Inspection and Test Plan (ITP) which shall be submitted to the Employer/Engineer for approval. The Contractor shall be responsible for performing all tests and inspections required during the production of the OPGW.

The date of tests shall be announced in time to allow participation of the Employer/Engineer if requested. A test report shall be submitted to the Employer/Engineer for approval within two weeks after test performance.

All materials used in the manufacture of conductors shall be covered by test certificates stating their mechanical and chemical properties to prove compliance with these technical requirements.

The costs for these tests are deemed to be included in the Contract Price.

10.3.1 Type tests

Type test requirements are specified in Sub-Section VII-4.

10.3.2 Sample tests

Tests for aluminium clad steel wires shall be carried out in accordance with the requirements of EN 61232 / IEC 60889.

Samples taken on random sampling basis from the OPGW drums ready for shipment against each batch shall be tested for overall diameter, the lay length and lay ratio of layers, lay directions and DC resistance in accordance with EN 50182 or IEC 61089 at the factory by the manufacturer which may be witnessed by the Employer/Engineer.

For each of the supplied OPGW drums the Contractor shall provide full traceability of the optical fibres and optical units. A test report of the optical units shall be provided and shall include the following minimal data:

- optical attenuation of all the fibres measured at relevant wavelengths
- excess length (fibre surplus) for all the optical fibres

- welding depth of the longitudinal welding seam (if applicable)
- wall thickness
- outer diameter/inner diameter
- length.

In addition, attenuation shall also be measured on each fibre of above-mentioned sample drums of OPGW with OTDR.

10.3.3 Routine tests

The OPGW manufacturer shall develop and implement a routine test plan to fully confirm the quality of the complete manufacturing batch and the respective compliance with the required specification. All the single lengths/drums shall be fully tested at the manufacturer premises. The routine tests shall be carried out in accordance with the following standards (as applicable):

- IEC 61232
- IEC 61089
- EN 50182
- Relevant parts of IEC 60793.

As a minimum the following inspections and tests shall be performed:

a) Armor wires: As a minimum the following tests shall be carried out:

- visual examination and confirm the number of wires per layer
- diameter of the wires
- breaking strength
- elongation
- torsion
- wrapping
- lay length and direction of lay
- measurements of thickness of ACS wires.

b) Optical unit: As a minimum the following tests shall be carried out:

- visual inspection
- diameter and thickness of the optical unit
- fibre count and colouring scheme
- complete cable
- visual inspection, check the quality of the outer surface of the OPGW
- dimensional control - outer diameter and linear weight of the OPGW
- DC resistance measurement in accordance with IEC 61232/ IEC 60889/ IEC 61089 or EN 50182

- attenuation and discontinuities of all optical fibres included in the OPGW. The OTDR trace obtained at the relevant wavelengths shall identify the fibre attenuation and discontinuities. Each trace shall be unequivocally associated to the respective fibre number/colour identification.

10.3.4 Post-installation tests

Following the completion of the stringing process of each OPGW single length/drum, the Contractor shall obtain the backscatter pattern of all the fibres in the OPGW with a suitable Optical Time Domain Reflectometer (OTDR) and confirm the optical attenuation and fibre discontinuities.

Following the completion of the optical fibre joint enclosures (including assembly in the tower), the Contractor shall confirm the attenuation of concatenated link and the attenuation of the fibre splices. At this point the Contractor shall carry out the traceability of the concatenated link confirming that the fibre numbering/colour code sequence is maintained along the concatenated OPGW link (each optical fibre shall be spliced to the fibre with the same number/colour code of the adjacent OPGW single length/drum).

After the completion of the full OPGW link, the Contractor shall obtain the backscatter pattern of the optical fibre link and confirm compliance with the specified maximum attenuation, splice losses and discontinuities. The test shall be performed at both ends of the line with an OTDR with sufficient dynamic range and resolution.

The dynamic range reflects the total measurable optical attenuation from the initial backscatter level to the noise level after sufficient measurement time. Without a sufficient dynamic range, some events could be masked by the noise level - in Figure 9-1 the splice located at a distance L3 from the OTDR is not measurable.

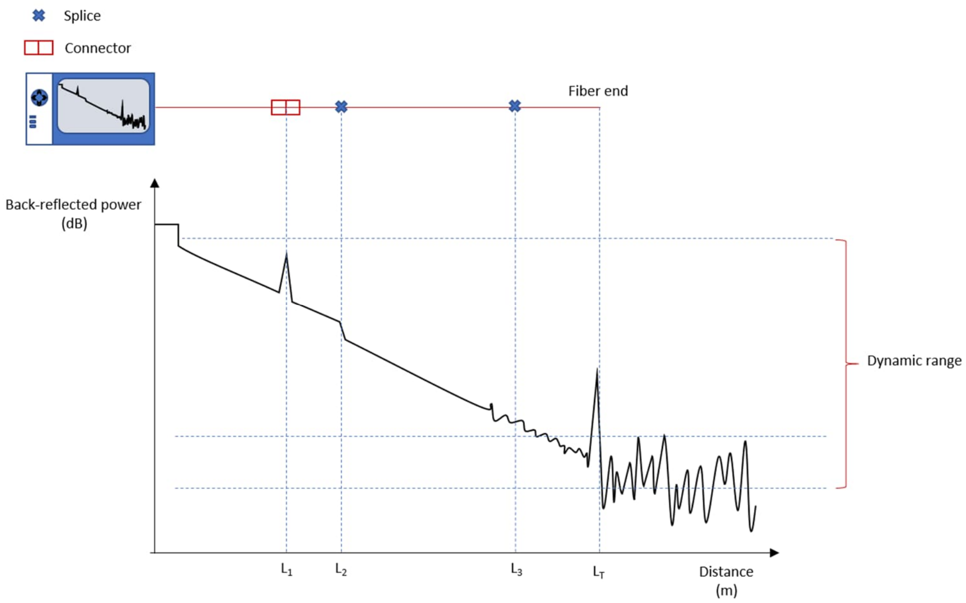


Figure 10-1: Example of an OTDR with insufficient dynamic range

The Contractor shall use an OTDR with a dynamic range exceeding by at least 5 dB the total loss to be encountered.

The maximum total loss to be encountered shall be calculated using the following formula:

$$P_{max}(dB) = \alpha_{wavelength} \cdot L + 0.10 \cdot N_{splices} + 0.8 \cdot N_{connectors}$$

where:

- $\alpha_{wavelength}$: maximum allowed attenuation coefficient (dB/km) at the applicable wavelength
- L: length of the OPGW link (km)
- $N_{splices}$: number of fusion splices between the end connectors
- $N_{connectors}$: number of connectors.

10.4 OPGW installation

The OPGW shall be installed in strict accordance with the recommendations of the OPGW manufacturer. Prior to the OPGW installation, the Contractor personnel shall receive a suitable training addressing the specific installation instructions of OPGW manufacturer and the safety aspects of the installation process.

To mitigate torsion and overbending efforts, the minimum diameter of the pulleys - measured at the bottom of the groove (Din in Figure 10-2)- shall be in accordance with the OPGW manufacturer installation instructions.

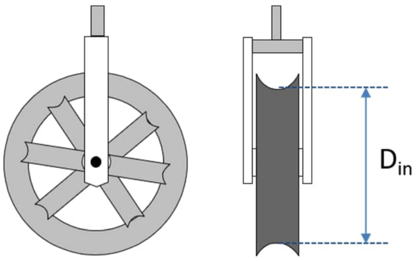


Figure 10-2: Pulley diameter

The pulley grove should have a neoprene (or other equivalent material) cover with a smooth surface.

Figure 10-3 shows a typical set-up for the OPGW installation. Ideally, the drum (A), the tensioner (B) and the winch (C) shall be positioned in line with the conductors. The maximum deviation shall not infringe the value recommended by the OPGW manufacturer.

Moreover, the tensioner (B) and the winch (C) shall be positioned at an adequate distance L from the tower so that the ratio between the distance L and the pulley height H exceeds the minimum value prescribed by the OPGW manufacturer (Kmin).

The angle Θ_{max} shall not infringe the limit prescribed be the OPGW manufacturer.

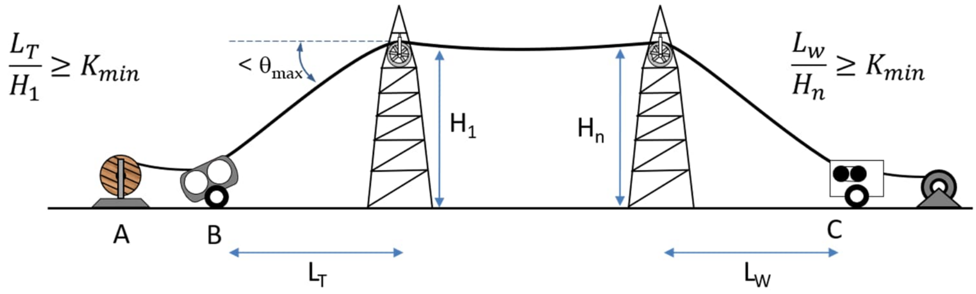


Figure 10-3: Typical set-up for the OPGW pulling

The pulling rope shall have anti-twisting characteristics and the respective minimum breaking load shall exceed at least 3.0 times the maximum stringing tension.

If the existing earthwire is used to pull the new OPGW, the Contractor shall confirm the mechanical conditions of the former to guarantee a safe pulling operation.

The pulling speed and tension shall be suitable for the specificities of the line and for the environmental and weather conditions at the time of the pulling operations. In any case, pulling speed and tension shall not exceed the values prescribed by the OPGW manufacturer.

10.5 Packing, shipment, transport

The required OPGW single lengths shall be supplied in new and robust wooden drums or alternatively steel drums. The drums shall be able to cope with the transport and storage constraints and the efforts during the cable pulling.

The inner surface of the drums shall be covered with oiled paper.

Both ends of the OPGW shall be accessible (to allow OTDR testing) and protected against water ingress with suitable heat shrinking caps.

The drums shall be protected with wooden battens or other equally performant protection mechanisms. The Contractor shall submit to the approval of the Employer/Engineer the alternative protection mechanism.

The individual length distribution shall be defined considering the following aspects:

- minimization of fibre optic joints
- distribution of tension towers and other aspects relevant to the project
- pulling tension shall not exceed the value recommended by the OPGW manufacturer (confirmed in the relevant type tests)
- transport and storage constraints.

Before starting the delivery of the goods, the Contractor shall submit the detailed OPGW length calculation for the line, according to the actual sections and spans.

A weatherproof label solidly attached to the drum flange shall provide the information below:

- Employer name
- project name/line on which the individual length will be installed
- order number/batch number
- length and gross weight
- date of manufacturing.

An arrow confirming the correct direction of rolling shall be painted in both flanges of the OPGW drum.

The Contractor shall submit a sketch or drawing showing the full details of drum design and the details of the proposed method of impregnation and lagging the inner drum surfaces with approved tarred paper or equivalent material prior to ordering. The minimum length of the OPGW on drums is subject to the Employer's/Engineer's approval.

The disposal of all empty drums shall be the responsibility of the Contractor.

11. Clamps and fittings for OPGW

All clamps and fittings shall comply with the requirements in the Data Sheets and must be approved by the Employer/Engineer.

They shall be suitable for the OPGW/earthwire type proposed by the Contractor.

The design and characteristics of the proposed fittings shall be equivalent or exceed the performance of the fittings used for the type tests of the proposed OPGW. Moreover, the proposed fittings and respective installations installation procedures shall be approved by the OPGW manufacturer.

All clamps and fittings shall be supplied by the same manufacturer. Splitting up of the supply of clamps and fittings will not be permitted.

Besides, the Contractor shall assure perfect fitting of the OPGW/earthwire set attachment assemblies (connecting hardware) to the tower steel construction. The design of adjacent metal parts and mating surfaces shall be such as to prevent corrosion of the contact surfaces and to maintain good electrical contact under service conditions.

At all suspension, tension towers and substation gantries, the OPGW/earthwire shall be electrically connected to the steelwork by means of jumpers and suitable fittings with a suitable cross-section and conductivity to evacuate the short-circuit currents without any mechanical degradation.

The OPGW/earthwire connections to the towers (connecting hardware, earthing connections) shall withstand the single-phase fault current shown in the Data Sheets without suffering damage, and this performance must be checked in accordance with the requirements.

All ferrous parts of the assemblies' component elements and of the accessories for OPGW/earthwire shall be hot dip galvanized according to EN ISO 1461.

The split pins of all clamps and fittings shall be of stainless steel.

All sets shall be designed for the selected OPGW/earthwire type and for the mechanical loads and loading conditions shown below as well as the partial safety factors given below and in the Data Sheets:

- OPGW/earthwire dead weight
- design spans as specified
- maximum wind speed
- maximum ice load
- ice load with reduced wind
- maximum working stress in the OPGW/earthwire.

The partial safety factors to be considered for the OPGW fittings design calculation are given in Data Sheets.

Care shall be taken during manufacture of clamps and fittings and during subsequent handling to ensure smooth surfaces free from burrs and sharp edges.

11.1.1 Suspension assemblies

Armor grip suspension clamps shall be used for OPGW/earthwire. The clamp body shall be of high-tensile strength corrosion-resistant aluminium alloy. The helical armor rods shall also be of aluminium alloy and shall not have diameters less than 4 mm.

The material of the clamps shall satisfy the norms EN 1559-4:2015 for aluminium alloy castings and EN 1562:2019 for malleable cast iron.

The neoprene or other non-metallic material shall have good resistance to aging and be capable of withstanding temperatures between –35°C and +45°C without changing of essential properties. The material shall have adequate resistance to the effects of ultra-violet radiation, ozone or pollution factors.

The rotational axis of the clamp shall be in the longitudinal axis of the OPGW/earthwire to avoid unacceptable distortion of the OPGW/earthwire due to unbalanced longitudinal loads. The Contractor shall ensure by appropriate design a suitable performance of the clamp-OPGW/earthwire assembly by wind induced vibration.

In addition to the suspension clamp, connecting hardware is required for a suitable mechanical and electrical connection to the tower and the Contractor is responsible to supply the complete set of the suspension assembly.

11.1.2 Tension assemblies

The OPGW/earthwire attachments to tower shall be of helical grip type consisting of two helical parts (fittings), one for OPGW/earthwire protection and the other one as actual dead-end fitting. Preformed helical dead ends shall have "cabled loop" eyes. The material of the spiral rods shall be high-tensile strength aluminium clad steel.

The material of the clamps shall satisfy the norms EN 1559-4:2015 for aluminium alloy castings and EN 1562:2019 for malleable cast iron.

The protection part is defined to protect the OPGW/earthwire against radial forces produced by the high longitudinal tensions during operation. The protection part must be laid in the opposite direction of the outer layer of the OPGW/earthwire and the dead-end part must be laid in opposite direction to the protection part. The grip strength shall be at least 95% of the ultimate tensile strength of the OPGW/earthwire or 2.5 times the maximum working tension.

The tension attachment devices must correspond to the OPGW/earthwire type and dimensions. The protection part must be longer than the tension (dead-end) part and the length must be sufficient to install vibration dampers. The number and diameter of the spiral rods of the two parts are generally different but must be coordinated to meet the operational requirements.

11.1.3 Vibration dampers

The Contractor shall provide the vibration study defining the number of relevant vibration dampers to be installed along all the OPGW spans. Moreover, the vibration study shall specify the number and location of the vibration dampers, along all the spans.

The vibration frequencies considered for the vibration study shall be calculated given the most onerous wind conditions and specific topography and geographical location of the line. The local most onerous ambient conditions shall be considered.

The manufacturer of the vibration dampers shall carry out a detailed investigation to confirm the most suitable type of vibration dampers for the proposed OPGW given the topography of the line and the most onerous local ambient conditions.

11.2 Fibre splice enclosures

Following the completion of the OPGW sagging and clipping, the Contractor shall assemble the splice enclosures between adjacent OPGW single lengths.

The length of OPGW running down the tower shall be sufficient to permit the assembly of the splice enclosure under safe conditions in the ground.

The fibre optic splicing shall be carried out by experienced jointers using equipment and tools with adequate performance to meet the splice loss requirements of this specification. The fibre splicing shall be carried out in a controlled clean environment.

The splice enclosure shall be attached to the tower above the anti-climbing devices. The surplus of OPGW shall be adequately coiled and attached to the tower also above the anti-climbing devices. The bending radius of the OPGW storage coil shall not infringe the minimum bending radius specified by the OPGW manufacturer.

The length of OPGW running down the tower as well as the storage coil, shall be attached to the tower with suitable guide/earthing clamps providing a sound fixation and an adequate earthing connection. The guide/earthing clamps shall be designed in accordance with the characteristics of the OPGW and shall not cause any mechanical constraints to the OPGW.

The OPGW shall enter the splice enclosure via entry ports in the base, properly sealed to prevent moisture ingress. The splice enclosure shall be suitable for jointing OPGW with OPGW and OPGW with OPUG by substitution of appropriate glands in inlets.

The inlets of the joint boxes shall be sealed with thermofit plastic. These inlets shall be possible to match necessary branches. The outer material of the box shall be oil resistant and metallic, preferably stainless-steel or aluminium. The enclosure is to be re-enterable and re-sealable without detriment to the integrity of the enclosure and optical fibres. Enclosure re-entering and re-sealing shall not require power tools and use a minimum number of special tools.

The Contractor shall provide detailed drawings showing the location of all splice enclosures which shall be consecutively numbered.

The fusion splice tray shall comply with the minimum bending radius of the fibres and shall not have any sharp edges or protrusions which may damage the optical fibre.

Number tags for fibre and tube identification are to be included.

The Contractor is responsible for the operational continuity of the optical fibre system considering that the interface point between line and underground cable is the splice enclosure at the gantry. The Contractor shall submit with his Bid a calculation of the total attenuation (overall losses) for the complete telecommunication link considering all splices, connectors, and fibre aging, etc. The total attenuation shall be a guaranteed value. All design documents shall be submitted to the Employer/Engineer for approval before starting of the manufacture in the workshop.

11.2.1 Tests for splice enclosures

The required performance of the fibre splice enclosures shall be duly confirmed via adequate tests. The Contractor shall submit for the Employer/Engineer approval valid test reports confirming the required performance of the fibre splice enclosures. As a minimum the Contractor shall submit the test reports for the following tests:

a) Dust ingress test

The test shall be in accordance with EN 60529.

The splice enclosure shall be assembled with at least two samples of the proposed OPGW. The test sample shall be sub-pressurized (20 mbar) and placed inside a chamber with dust powder in suspension (particles with a maximum diameter of 75 µm).

Acceptance criteria: the fibre splice enclosure shall have a minimum IP class: IP 6x.

b) Water ingress test

The test shall be in accordance with EN 60529.

The splice enclosure shall be assembled with at least two samples of the proposed OPGW. The test sample shall be immersed under 1.0 m of water for a minimum period of 30 minutes.

Acceptance criteria: the fibre splice enclosure shall have a minimum IP class: IP x7.

c) Impact test

The test shall be in accordance with EN 62262. The splice enclosure shall be subjected to a minimum of 3 impacts on each face. The impact test characteristics: IK10.

Acceptance criteria: no damages that could undermine the functionality and reliability of the splice enclosure.

d) Vibration and temperature test (splice tray)

The test shall be in accordance with IEC 61300-2-1 with a minimum sample length of 3 meters and all the fibres spliced. The fibre attenuation measurement wavelength shall be 1550 nm. The splice tray shall be submitted to two temperature cycles intermediate by an ageing period of at least 7 days at 85°C. For each temperature cycle the temperature shall be lowered to -40°C and kept at this temperature for 4 hours. Then the temperature is raised up to +80°C and kept at this temperature for 4 hours.

Acceptance criteria: no permanent attenuation change and no damages in the splice tray.

e) Cable retention test

The test shall be in accordance with IEC 61300-2-4. The minimum retention force shall be 5 ± 0.5 N for 1 minute.

Acceptance criteria: no permanent attenuation change and no damages.

The costs for these tests are deemed to be included in the Bid Price.

12. Insulators and insulator Sets

12.1 Standards

EN 60305	Characteristics of string insulator units of the cap and pin type.
EN 61466-1	Composite string insulator units for overhead lines with a nominal voltage greater than 1000 V — Part 1: Standard strength classes and end fittings.
EN IEC 60120	Ball and socket couplings of string insulator units. Dimensions.
EN IEC 60372	Looking devices for ball and socket couplings of string insulator units: dimensions and tests.
EN 60672-1	Ceramic and glass insulating materials - Part 1: Definitions and classification
EN 60672-2	Ceramic and glass insulating materials. Methods of test
EN 60672-3	Ceramic and glass-insulating materials - Part 3: Specifications for individual materials
EN 1179	Specification for ingot zinc.
EN ISO 1461	Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods.
IEC 61109	Composite insulators for a.c. overhead lines with a nominal voltage greater than 1000 V - Definitions, tests methods and acceptance criteria.
EN 60383-1	Insulators for overhead lines with a nominal voltage above 1 kV - Part 1: Ceramic or glass insulator units for a.c. systems - Definitions, test methods and acceptance criteria.
EN 60383-2	Insulators for overhead lines with a nominal voltage above 1000 V - Part 2: Insulator strings and insulator sets for a.c. systems - Definitions, test methods and acceptance criteria.
EN 60437	Radio interference test on high-voltage insulators.
EN 60507	Artificial pollution tests on high voltage insulators to be used on a.c. systems.
EN 61325	Insulators for overhead lines with a nominal voltage above 1000 V - Ceramic or glass insulator units for d.c. systems - Definitions, test methods and acceptance criteria.
IEC 383-2	Insulators for overhead lines with a nominal voltage above 1000 V - Part 2: Insulator strings and insulator sets for a.c. systems - Definitions, test methods and acceptance criteria
IEC 60797	Residual strength of string insulator units of glass or ceramic material for overhead lines after mechanical damage of the dielectric.
EN 61211	Insulators of ceramic material or glass for overhead lines with a nominal voltage greater than 1000 V. Impulse puncture testing in air
IEC 60587	Electrical insulating materials used under severe ambient conditions – Test methods for evaluating resistance to tracking and erosion
IEC 61467	Insulators for overhead lines with a nominal voltage above 1000 V - AC power arc tests on insulator sets.
Cigré TB 255	Material properties for non-ceramic outdoor insulation. State of the art.

12.2 Design

Insulator units shall comply with the general requirements of the following applicable standards, except where specified otherwise in the Technical Requirements:

- cap and pin string insulator units EN 60305
- composite string insulator units EN 61466.

Unless stated to the contrary in the Sub-Section VII-4, all ceramic insulators shall be glazed light grey in colour.

Reference should be made to the Sub-Section VII-4 for any specific requirements for the colour of glass or composite insulators.

All insulator units shall be designed to withstand the design service voltages including lightning, switching and power frequency, the mechanical loads relevant to the installation, service, and maintenance conditions, the service temperature, and the environmental effects. Internal stresses due to expansion and contraction of any part of the insulator unit shall not lead to deterioration.

The design of insulator units shall be such as to avoid local corona formation and no significant radio interference shall be exhibited.

When required by the Sub-Section VII-4 the pins of cap and pin insulator units shall be fitted with zinc sleeves for additional corrosion protection.

Zinc sleeves shall be 25 mm long and metallurgically bonded to the insulator pin. The radial thickness of the sleeve shall taper from 4 mm at the cone end to 5 mm at the ball end. The outer edges of the collar shall be rounded with a radius of 4 mm.

Details of the individual insulator units and complete insulator sets in accordance with the requirements of the Technical Requirements shall be submitted to the Employer/Engineer for approval.

12.2.1 Electrical Requirements

The electrical withstand voltages defined in Sub-Section VII-4 shall be achieved by the complete insulator set and/or individual insulator units as appropriate.

12.2.2 RIV Requirements and Corona Extinction Voltage

All insulator units and insulator sets shall satisfy the radio interference and corona requirements specified in Sub-Section VII-4.

12.2.3 Pollution Performance Requirements

Details of the minimum creepage distance required are specified in Sub-Section VII-4. No tolerance is permitted on the minimum creepage length specified.

12.2.4 Audible Noise Requirements

No discernible audible tones shall be generated by aeolian mechanisms under any conditions.

12.2.5 Mechanical Requirements

Details of the mechanical requirements are specified in Sub-Section VII-4.

12.2.6 Couplings

Ball and socket couplings for cap and pin string insulator units shall be in accordance with the requirements of EN IEC 60120. Sockets shall either have ‘W’ type security clips, or split pin (R) clips in accordance with the requirements of EN IEC 60372 as appropriate.

Ball, socket, tongue, clevis, and eye couplings for composite string insulator units shall be in accordance with the requirements of EN 61466.

12.2.7 Insulator Protective Devices

The design of insulator protective devices shall comply with the following requirements:

- shall effectively protect the insulator units and the fittings from damage caused by power arcs
- shall effectively improve the voltage distribution along the insulator string
- shall effectively improve the corona performance of the insulator set
- shall effectively inhibit the formation of dry band arcing on composite insulators adjacent to the end fittings
- shall be designed in such a way as not to be subject to wind induced fatigue failure
- shall withstand a specified mechanical load
- shall be suitable where specified for use under live-line maintenance techniques.

For details of the materials, workmanship and quality assurance requirements for insulator protective fittings reference should be made to Chapter 13.

12.2.8 Arcing rings

As arcing devices, the arcing rings/horns shall be designed to protect insulators and conductors when flashover occurs. The arcing fittings shall be made of hot dip galvanized steel and must have the capability to withstand a short circuit current specified in Sub-Section VII-4. The arcing fittings must be designed so that in case of flashover the arc will be led to the end burning spot.

They may reach a final temperature not exceeding 600°C during the short circuit. The function of arcing protection must not be greatly altered by the power arc.

As corona shield devices, the arcing ring/horn as part of the string shall be designed to ensure under fair weather and under the specific site conditions a corona-free insulator set as well as the specified insulator set radio noise performance.

The ring/horn attachment shall be via bolted connections to the hardware assembly.

For corona purposes the insulator strings shall be equipped with additional guarding rings. If the Contractor desires to supply insulator string sets without these additional guard rings he shall provide evidence by calculation and tests that all parts of the string set are protected against corona sufficiently. Related documents shall be submitted for approval to the Employer/Engineer.

12.3 Materials

Ceramic or glass used in the manufacture of insulator units shall comply with the requirements of EN 60672. Metallic materials shall meet service life requirements and shall not be liable to intergranular or stress corrosion. They shall not induce corrosion in materials in contact with them.

Security 'W' clips shall be manufactured from a suitable grade of phosphor-bronze and supplied in the half-hard condition with a minimum hardness of 155 VPN. Security 'R' clips shall be manufactured from a suitable grade of austenitic stainless steel and shall not be subject to inter-crystalline corrosion.

Non-metallic materials shall have good resistance to ageing and be capable of withstanding service conditions without a detrimental change in their properties. The materials used shall have adequate resistance to the effects of nitrogen oxides, ozone, ultra-violet radiation, and air pollution over the whole range of service temperatures defined in Sub-Section VII-4. They shall not induce corrosion in materials in contact with them.

Zinc sleeves shall be manufactured from ingot zinc in accordance with EN 1179 and shall have a total impurity less than 0.05 %.

Drawings for insulator units shall in addition to the dimensions, show material types and grades, protective treatment, and any other pertinent information. Particular attention shall be paid to those dimensions which involve interchangeability, correct assembly and those for which gauges are specified.

The nominal overall dimension of an actual insulator string shall be within ±2 % of the specified value. For string insulator units, the measurement shall be taken from the bottom of the ball on the first unit to the bottom of an imaginary ball fitted into the socket of the last unit.

Ball end fittings shall be free from cracks, surface flaws laminations and other defects. Drawings of ball-end fittings shall be submitted to the Employer/Engineer for approval. The manufacturing process for zinc sleeves shall ensure that the effects of intergranular stress corrosion are minimized. The zinc sleeve shall have a smooth finish, shall not be porous and all mold lines shall be removed. When assembled a minimum of 52 % of zinc sleeve shall be embedded within the cement.

12.3.1 Corrosion Protection

All materials used in the manufacture of insulators shall be inherently resistant to atmospheric corrosion which affect their performance.

All ferrous materials shall either be inherently resistant to atmospheric corrosion or be suitably protected against corrosion that can occur during transportation, storage, or service. All ferrous parts which will be exposed to the atmosphere in service, except those made of the appropriate grade of stainless steel, shall be protected by hot dip galvanizing in accordance with the requirements of ISO 1461.

12.4 Manufacture

All parts of the insulator shall be free from any defects which may impair the mechanical or electrical properties of the insulator.

The permitted tolerances shall meet the requirements specified in chapter 8 of IEC 61109.

Each insulator shall be marked with the following information:

- manufacturer's name or logo
- year of manufacturer
- specified mechanical load
- identification code providing traceability.

The manufacturer shall have an adequate experience in the production of composite insulators. As proof, the manufacturer shall submit a supply-list for the last 10 years indicating type of insulator, quantity supplied, name and address of client, system voltage and year of delivery.

12.5 Installation

The Contractor shall submit the method statement containing sequential details of the proposed erection method to the Employer/Engineer for approval. The manufacturer shall, where necessary, provide comprehensive instructions in a suitable format regarding the handling and installation of composite insulator units.

The Contractor bears full responsibility for protection of insulator units against the strains or damages during erection.

Care shall be exercised during handling and erection of insulator units to prevent scratches, chipping or cracking of the insulation medium. For composite insulators care shall be exercised to ensure there is no damage to either the weatherproof sheath or sheds. Composite insulators shall not be climbed upon during any erection or conductor stringing operation.

Any insulator units which are scratched, chipped, or abraded shall be removed and replaced. Insulator units and fittings shall be laid on plastic sheets or other suitable protective surface prior to erection and any foreign matter shall be removed prior to installation.

The internal surfaces of all socket couplings shall be lightly coated with an approved grease prior to assembly.

12.6 Quality Control

The Contractor shall supply a detailed Quality Assurance Procedure including an Inspection and Test Plan (ITP) which shall be submitted to the Employer for approval.

The Contractor shall be responsible for performing all tests and inspections required during the production of the insulators and fittings. The date of tests shall be notified at least one month in advance to allow participation of the Employer/Engineer.

Design test reports and associated test certificates on composite string insulator units previously undertaken in accordance with the requirements of EN 61109 and certified by an independent quality assurance organization shall be submitted to the Employer/Engineer.

Type, sample, and routine tests shall be undertaken as appropriate on insulator units and insulator sets in accordance with the requirements of these Technical Requirements, EN 60383, EN 60437, EN 60507, EN 61325, IEC 60797 and EN 61109 as applicable. Approved drawings previously submitted to the Employer/Engineer shall be available at the time of testing.

12.6.1 Identification and Marking

All insulator units shall be marked to ensure a system of traceability. Marking shall be legible and indelible in accordance with the requirements of IEC 60383-1 and Section 12.4. This shall also apply to composite string units.

Details of the proposed marking system shall be submitted to the Employer/Engineer for approval.

12.6.2 Type Tests - String Insulator Units

a) Ceramic or glass

Standard type tests on string insulator units and pin type insulators of ceramic material or glass shall be undertaken fully in accordance with the requirements of EN 60383-1.

b) Composite

Standard type tests on composite insulator string units shall be undertaken fully in accordance with the requirements of IEC 61109. Additionally, the following tests shall also be performed:

- 96 h acid resistance test (Cigre TB 255) of the loaded rod
- Tracking and erosion test as per IEC 60587 applied for specimen of housing material

Additional insulator type tests, if required, shall be defined in Sub-Section VII-4.

12.6.3 Type Tests - Insulator Sets

Type tests on insulator sets shall be undertaken fully in accordance with the requirements of EN 60383-2 (IEC 60383-1), to determine the dry lightning impulse withstand voltage, wet switching impulse withstand voltage and the power frequency withstand voltage as appropriate. Insulator protective fittings with the maximum arc gap shall be used unless otherwise requested by the Employer/Engineer.

Prior to the commencement of the tests the Contractor shall, where appropriate, submit details of the proposed simulation of the support structure and mounting arrangement of the insulator sets to the Employer/Engineer for approval.

Additional insulator set type tests, if required, shall be defined in Sub-Section VII-4.

12.6.4 Sample Tests

Sample tests on ceramic and glass string units shall be undertaken in accordance with the requirements of EN 60383-1.

Sample tests on composite string insulator shall be undertaken in accordance with the requirements of IEC 61109.

Additional sample tests, if required, shall be defined in Sub-Section VII-4.

12.6.5 Routine Tests

Routine tests on ceramic and glass string units shall be undertaken in accordance with the requirements of EN 60383-1.

Routine tests on composite string insulator units shall be undertaken in accordance with the requirements of IEC 61109.

12.6.6 Test Reports and Certificates

All test reports and test certificates shall be submitted to the Employer/Engineer no later than two weeks after completion of the relevant tests. For already completed type tests valid certificates shall be provided with the Bid.

12.7 Tests during erection

a) Galvanizing Thickness

The galvanizing thickness shall be randomly tested on site after receiving the galvanized components as well as during erection. The zinc coatings must comply with the thickness requirements for each component.

The Contractor shall have available on site for the Employer's/Engineer's use an instrument suitable for the accurate checking of galvanizing thickness. The measuring instrument shall be available from the time of arrival of the first consignment of material until the issue of the taking over certificate. The cost of the gauge and other operating expenses are deemed to be included in the Contract price.

12.8 Packing and Transport

Insulators and fittings shall be packaged in non-returnable timber crates in a manner that prevents damage during transport and handling. Small items may be packed in jute bags up to a gross weight of 25 kg within larger containers. Containers over 25 kg shall be delivered on pallets suitable for handling by forklifts. Components of dead ends, mid-span joints, armor rods etc., shall be packaged as complete sets. Cardboard containers and metal drums are not acceptable.

13. Insulator and Conductor Fittings

All clamps and fittings, except vibration dampers, shall be supplied by the same manufacturer. Splitting up of the supply of clamps and fittings shall not be permitted.

All insulator strings shall be assembled to insulator sets with appropriate fittings.

The design of adjacent metal parts and mating surfaces shall be such as to prevent corrosion of the contact surfaces and to maintain good electrical contact under service conditions.

All parts shall be designed to withstand the mechanical loads during the lifetime as calculated for the insulator string sets and to avoid loosening in service due to vibrations or any other reasons.

13.1 Standards

EN 61284	Overhead lines - Requirements and tests for fittings.
EN 61466-1	Composite string insulator units for overhead lines with a nominal voltage greater than 1000 V — Part 1: Standard strength classes and end fittings.
IEC 60372	Locking devices for ball and socket couplings of string insulator units: dimensions and tests.
ISO 2859-1	Sampling procedures for inspection by attributes — Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection
EN ISO 1461	Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods.

13.2 Design

All insulator and conductor fittings shall be designed to:

- ensure that the conductor is unaffected by installation of the fitting, either immediately, e.g., opening or damaging of the strands, or during service, e.g., fretting, fatigue or corrosion of the strands
- for fittings designed for use with OPGW avoiding damaging the fibre optic cable and impairing the optical characteristics
- withstand the design operating current including both maximum continuous and short circuit currents, without exhibiting a corresponding rise in temperature greater than that of the associated conductor
- withstand the specified short circuit current or power arc requirements without adversely affecting the mechanical strength of the fitting
- ensure that the voltage drop across current carrying fittings is less than that for the equivalent length of conductor

- withstand the mechanical loads relevant to the installation-service-maintenance conditions, the service temperatures, and environmental effects
- minimize the number of parts and the possibility of incorrect assembly and installation
- ensure that individual components are secured against becoming loose in service and that all threaded fasteners are locked
- for compression fittings ensure that there is no relative movement between individual layers of the conductor after compression
- fittings subjected to articulation or wear shall be designed, including material selection and manufacture to ensure the maximum wear resistance
- manufactured from materials, which have sufficient strength, ductility, and environmental resistance to withstand both static and dynamic loading. Where appropriate, designed such that the magnetic losses are acceptably low.

To maintain low corona and low radio interference, the design of all clamps and fittings shall avoid sharp corners or projections which would produce high electrical stress. The design of adjacent metal parts and mating surfaces shall be such as to prevent corrosion of the contact surfaces and to maintain good electrical contact under service conditions. Care shall be taken during manufacture of clamps and fittings and during subsequent handling to ensure smooth surfaces free from burrs and sharp edges.

All line fittings shall be designed to withstand the three or single-phase short-circuit currents (whichever higher) specified in the Sub-Section VII-4 without damage.

Adequate bearing area shall be provided between different fittings. Point contacts shall be avoided.

All ferrous parts of the assemblies' component elements and of the accessories for conductors shall be hot dip galvanized according to EN ISO 1461. The split pins of all clamps and fittings shall be of stainless steel.

13.2.1 Mechanical Requirements

Mechanical capacity verification for Ultimate Limit State shall be demonstrated considering maximum applicable design loads. Partial material factors are specified in Sub-Section VII-4.

13.2.2 Insulator Set and Earthwire Fittings

Details of the complete insulator set and/or earthwire set shall be submitted to the Employer/Engineer for approval.

13.2.3 Live line Fittings

In case live line working (hot stick working) is specified in the Sub-Section VII-4, the design of the fittings shall consider the following:

- Both tension and suspension insulator sets shall include clevis fittings, or yoke plates incorporating cut-outs correctly dimensioned for use with live-line tools.
- The minimum distance between the attachment point, and the shoulder for clevis fittings shall not be less than 125 mm, where no yoke plate is adjacent.
- Clevis and tongue and clevis-clevis connections shall be provided with ‘R’ type security clips.
- Insulator protective devices attached to yoke plates shall utilize captive studs.

13.2.4 Low-duty Insulator Sets

Low duty tension insulator sets shall be used for terminating downleads between terminal supports and line landing structures or at other locations where the conductor tensions are at a reduced value. At the lower end of the span the low duty tension insulator sets shall be capable of having their insulator units reversed.

13.2.5 Tension Insulator Sets - Earth-end Linkages

Additional earth end links shall be provided where necessary to ensure that either the specified electrical clearance is maintained between the tension insulator set and the support steelwork, or satisfactory paring is achieved between the phase sub-conductors.

13.2.6 Suspension Clamps

Suspension clamps shall be designed to meet the following requirements:

- the effects of aeolian vibration both on the conductor and on the clamp are minimized
- to avoid localized pressure or damage to the conductor, and shall have sufficient contact surface to avoid damage by fault currents
- shall be free to pivot in the vertical plane of the conductor with a minimum range of movement of ±30° about the vertical centre line and with the trunnion axis of the clamp passing through the conductor centre line to within ±5 % of the conductor diameter
- shall have a slipping capacity between the minimum and maximum slipping loads specified in Sub-Section VII-4
- the suspension clamp assemblies shall have sufficient strength and durability to prevent deterioration in service
- the mouth of the suspension clamp shall be rounded and slightly flared. The grooves in the clamping piece shall be bell-mouthed at each end and all conductor grooves and bell-mouths shall be smooth and free from waves, ridges, or other irregularities.

Special attention shall be paid to the mass moment of inertia of the clamp to avoid resonance of the joint clamp/ conductor system by wind induced vibrations. The Contractor shall verify the suitability of proposed clamps by appropriate design calculations.

The phase conductors shall be protected within the suspension clamps by means of armor rods and the clamp dimensions shall be selected accordingly. The armor rods shall be designed in such a way as to strengthen the conductor in the suspension points and to reduce the static and dynamic bending strains in the strand wires of the outer conductor layer.

The suspension clamp components shall be dimensioned and shaped in such a way that no undue crushing or bending stresses are imposed upon the conductors and armor rods. The conductor supporting groove shall be curved at its ends in the vertical plan to an appropriate radius to permit the conductor to leave the clamp at the maximum angle of inclination defined by the manufacturer.

The mouth of the supporting groove shall be slightly flared in plan.

The bolts used in the suspension clamps shall be hexagonal hot dip galvanized or stainless-steel

Attention shall be paid to the elimination of fair-weather corona emission from all parts of conductor suspension clamps under the specific site conditions.

Details of the suspension clamps shall be submitted to the Employer/Engineer for approval.

13.2.7 Earthwire Suspension Clamps

In addition to the general requirements specified above, the earthwire suspension clamps and all suspension clamps for use with OPGW shall be capable of being used in conjunction with factory formed helical armor rods. Earthwire suspension clamps shall be provided with an earth bond attachment lug.

13.2.8 Counterweights

Exceptionally, counterweights could be fixed, subject to approval of the Employer/Engineer, under the suspension clamps of the suspension towers with insufficient span weight. The maximum weight that can be fitted shall be determined by the Employer/Engineer.

The counterweights attachment system shall be designed to avoid impeding or limiting the rotation of the suspension clamp around its axis.

13.2.9 Tension Joints and Clamps

Tension joints and clamps shall be designed to meet the following requirements:

- that after installation the initial contact area between the fitting and the conductor does not raise stresses which may lead to failure under aeolian vibration or other conductor oscillation conditions
- to avoid localized pressures which may cause excessive cold flow of the conductor or earthwire material

- to minimize internal voids and to prevent the ingress or entrapment of moisture during service
- tension joints and clamps shall not permit slipping of, or cause damage to, or failure of the complete conductor, or any part thereof at a load less than 95 % of the rated strength of the conductor
- tension clamps with auxiliary eyes intended for use during construction or maintenance shall be marked with the specified minimum load, which shall not be less than 75 % of the rated strength of the strongest conductor for which the clamp is designed

Conductor tension clamps and joints shall be of the compression type, suitable to withstand maximum working temperature defined in Sub-Section VII-4. The conductor tension clamps shall be supplied with a jumper terminal which may be bolted at 0° or 30°. The coupling element of the tension clamps to the string shall be clevis-type, hot dip galvanized.

The electrical conductivity and current carrying capacity of the tension clamps, joints and jumper terminals shall not be less than those of the equivalent length of conductor.

Attention must be paid to avoid fair weather corona emission from the conductor tension clamps and joints.

Details of the tension clamps and joints shall be submitted to the Employer/Engineer for approval.

13.2.10 Mid-span Joints

Mid-span joints shall not be installed within 30 m from the nearest conductor clamp. Without explicit Employer's/Engineer's approval, mid-span joints shall not be used under the following circumstances:

- in spans crossing power lines, railways, and main roads
- in single span sections

13.2.11 Repair Sleeves

Repair sleeves for the conductors shall be of compression type.

After compression, the electrical resistance of the joint/ sleeve must be less than that of the conductor with the same length as the joint/sleeve, and the ultimate tensile strength of the joint/sleeve must not less than 95% of the ultimate tensile strength of the conductor.

Details of the repair sleeves shall be submitted to the Employer/Engineer for approval.

Repair sleeves shall not be used without explicit permission of the Employer/Engineer.

13.2.12 Armor rods

Preformed armor rods shall be used to protect the conductors in suspension assemblies. The direction of the armor rod lay shall be equal to the direction of the outermost wire lay of the conductor. The suspension clamps shall accommodate the increased diameter resulting from armor rods.

The ends of the armor rod wires shall be well rounded, without sharp edges, to avoid an increase in corona level.

13.3 Materials

Materials used in the manufacturer of insulator and conductor fittings shall have the following properties as appropriate:

- adequate strength for the intended application and service life requirements (including mechanical loads, vibrations, electrical currents, and environmental effects) and free from defects that would affect the performance of the fitting
- not be liable to intergranular or stress corrosion
- capable of withstanding the cold working of the material due to compression
- steel compression components shall have sufficient impact strength after compression
- compatible with the conductor material or capable of being used with an intermediate material such that there can be no deleterious effects on the conductor or fittings from their use
- shall not be adversely affected in the long term by a coating applied for the corrosion protection.

All phase conductor fittings shall only have aluminium or aluminium alloy in contact with the conductor.

Security 'W' clips shall be manufactured from a suitable grade of phosphor-bronze and supplied in the half-hard condition with a minimum hardness of 155 VPN. Security 'R' clips shall be manufactured from a suitable grade of austenitic stainless steel and shall not be subject to intercrystalline corrosion.

Suspension clamp bodies and keeper shall be manufactured using a forged material, or an equivalent process acceptable to the Employer/Engineer.

The clamp bolts, screw and nuts used in pilot suspension weights and jumper weights shall be of high tensile steel.

Drawings for insulator and conductor fittings shall in addition to the dimensions, show material types and grades, protective treatment, and any other pertinent information. Particular attention shall be paid to those dimensions which involve interchangeability, correct assembly and those for which gauges are specified.

Fittings shall be free from sharp edges, burrs and swarf and particular attention shall be paid to insulator protective devices to prevent corona in service. The faces of flat faced fittings shall be sufficiently parallel and flat to provide a suitable contact service and remain so after fabrication.

The mouth of all suspension and wedge clamps and suspension set and bolted jumper weights shall be free of sharp radii of curvature, ridges or other irregularities which could lead to localized pressure or damage to the conductors or separation of the individual strands.

The contact surface of all bolted palm joints shall be scratch brushed or rough machined. In addition, care shall be taken to remove any surface contaminates prior to packing, other than material specifically introduced as a protective measure.

Ball end fittings shall be free from cracks, surface flaws laminations and other defects.

For factory formed helical fittings the individual rods or sub-sets of rods making up each fitting shall be tied or taped together.

13.3.1 Corrosion Protection

All materials used in the manufacture of insulator and conductor fittings shall be inherently resistant to atmospheric corrosion which could affect their performance.

All ferrous materials shall either be inherently resistant to atmospheric corrosion or be suitably protected against corrosion that can occur during transportation, storage or service. All ferrous parts which will be exposed to the atmosphere in service, except those made of the appropriate grade of stainless steel, shall be protected by hot dip galvanizing in accordance with the requirements of EN ISO 1461.

All external threads shall be cut or rolled before hot-dipped galvanizing. Nuts to be galvanized shall be subsequently tapped 0.4 mm oversize and the threads oiled.

The rough machined contact surfaces of bolted tension and partial tension clamps and line termination fittings shall be protected with a removable dry weatherproof coating after manufacture.

Compression fittings shall be filled with an oxide inhibiting compound prior to dispatch from the manufacturer with the ends temporarily protected. The quantity of oxide inhibiting compound shall be sufficient to ensure the integrity of the fitting.

Where grease is used as an oxide inhibiting compound, it shall be of a neutral soft type with a high melting point and shall be in accordance with the requirements of Clause 9.3.1.

13.4 Quality Control

Type, sample, and routine tests shall be undertaken as appropriate on the conductor and insulator fittings in accordance with Employer's Requirements and EN 61284. Reference should also be made to Clause 12.6 for details of the test requirements for complete insulator sets.

Approved drawings previously submitted to the Employer/Engineer shall be available at the time of testing.

Unless otherwise agreed with the Employer/Engineer, following procedure for all sample tests conducted by inspection by attributes shall be applied (designations in accordance with ISO 2859-1):

Inspection level III shall be used initially until conditions specified in clause 9.3.2 of ISO 2859-1 have been met. From this point inspection level II shall be used. Further reduction of inspection level may be made only with explicit permission of the Employer/Engineer.

Single sampling plan shall be used unless otherwise requested by the Employer/Engineer. Sample size code letter shall be determined based on delivery lot size as per Table 1 of ISO 2859-1.

Acceptance Quality Level (AQL) shall be as follows:

- 0.1 for all items and characteristics thereof which are vital for safe and reliable service of the transmission line
- 1.0 for all other items and their pertinent characteristics.

13.4.1 Identification and Marking

All insulator and conductor fittings shall be marked to ensure a system of traceability. Corona free markings shall be in accordance with the requirements of EN 61284.

Installation torque values shall be stated in Newton-meters (Nm), and for compression die sizes the metric 'across flats' dimension of the die shall be used unless otherwise agreed with the Employer/Engineer.

Details of the proposed marking system shall be submitted to the Employer/Engineer for approval.

13.4.2 Insulator Set and Earthwire Fittings Type Tests

Three samples of each fitting shall be subjected to the type tests. One sample of each fitting, subjected to the visual examination, dimensional, materials and finish and corona (if appropriate) type tests, shall be retained by the manufacturer for comparison with the production fittings.

13.4.2.1 Visual Examination, Dimensional Checks, Materials and Finish

Visual examination, dimensional checks, materials and finish including that of any coating, e.g., galvanizing type tests, shall be undertaken in accordance with the requirements of Sections 7, 8 and 9 of EN 61284.

13.4.2.2 Damage and Failure Load Tests

Damage and failure load type tests shall be undertaken in accordance with the requirements of Sections 11.1 and 11.3 of EN 61284.

13.4.2.3 Non-destructive rests

Requirements for Non-destructive tests, where required, shall be specified in Sub-Section VII-4.

13.4.2.4 Corona and RIV tests

Requirements for Corona and RIV tests, where required, shall be specified in Sub-Section VII-4.

13.4.3 Suspension Clamps Type Tests

Three samples of each fitting shall be subjected to the type tests, except for magnetic losses test where five samples shall be tested. One sample of each fitting, subjected to the visual examination, dimensional, materials and finish and corona (if appropriate) type tests, shall be retained by the manufacturer for comparison with the production fittings.

13.4.3.1 Visual Examination, Dimensional Checks, Materials and Finish

Visual examination, dimensional checks, materials and finish including that of any coating, e.g., galvanizing type tests, shall be undertaken in accordance with the requirements of Sections 7, 8 and 9 of EN 61284.

13.4.3.2 Non-destructive rests

Requirements for Non-destructive tests, where required, shall be specified in Sub-Section VII-4.

13.4.3.3 Vertical Damage and Failure Load Test

Vertical damage and failure load type tests shall be undertaken in accordance with the requirements of Section 11.4.1 Method B of EN 61284.

Acceptance criteria: After the completion of the damage load test, the clamp shall be stripped down and visually inspected for cracks and deformations. The clamp shall be free from cracks and any deformation that would affect its functional operation. For tests on clamps for use with OPGW no pinching of the cores of the optical cable shall occur. After the completion of the test, all the layers of strands shall be removed, and the optical cable checked for damage or distortion.

13.4.3.4 Slip Test

Slip type tests shall be undertaken in accordance with clause 11.4.2 or 11.4.3 of EN 61284, as appropriate.

Conductor, earthwire and OPGW clamps shall be fitted with armor rods as appropriate.

Acceptance criteria: As per relevant Clause of EN 61284.

13.4.3.5 Clamp Bolt Tightening Test

Clamp bolt tightening type tests shall be undertaken in accordance with the requirements of clause 11.4.5 of EN 61284. For factory formed armor rods all the rods shall be checked to ensure that they contact the conductor over their entire length.

Acceptance criteria: As per relevant Clause of EN 61284. For tests on clamps for use with OPGW no pinching of the cores of the optical cable shall occur. After the completion of the test, all the layers of strands shall be removed, and the optical cable checked for damage or distortion.

13.4.3.6 Magnetic Losses

Requirements for Magnetic losses tests, where required, shall be specified in Sub-Section VII-4.

13.4.3.7 Corona and RIV tests

Requirements for Corona and RIV tests, where required, shall be specified in Sub-Section VII-4.

13.4.4 Tension Joints and Clamps Type Tests

Three samples of each tension joint and clamp shall be subjected to the type tests, except for the heat cycle test where six samples shall be tested. One sample of each tension joint and clamp, subjected to the visual examination, dimensional, materials and finish and corona (if appropriate) type tests, shall be retained by the manufacturer for comparison with the production fittings.

13.4.4.1 Visual Examination, Dimensional Checks, Materials and Finish

Visual examination, dimensional checks, materials and finish including that of any coating, e.g., galvanizing type tests, shall be undertaken in accordance with the requirements of Sections 7, 8 and 9 of EN 61284.

13.4.4.2 Clamp Bolt Tightening Test

Clamp bolt tightening type tests shall be undertaken in accordance with the requirements of clause 11.4.5 of EN 61284. For factory formed helical dead ends all the rods shall be checked to ensure that they contact the conductor over their entire length.

13.4.4.3 Tensile Test

Tensile type tests shall be undertaken in accordance with the requirements of clause 11.5.1 of EN 61284. The specified minimum failing load shall be taken as equivalent to 95 % of the conductor's minimum rated strength.

Acceptance criteria: There shall be no movement of the conductor relative to the fitting due to slip during the holding period of 60 s. No failure or visible distortion of the fitting shall take place when the load is increased to 95 % of the conductor's minimum rated strength.

Prior to the commencement of the test for compression dead-ends and mid-spans the performance of the compression dies shall be checked. The tension fitting shall be installed on the conductor strictly in accordance with manufacturer's instructions using the full range of compressors and appropriate die sizes.

Acceptance criteria: The dies shall fully close on each bite and the fitting shall remain straight after compression, with no damage to the jumper terminal flag or weld.

13.4.5 Tests during erection

Galvanizing thickness

The galvanizing thickness shall be randomly tested on site after receiving the galvanized components as well as during erection. The zinc coatings must comply with the thickness requirements for each component.

The Contractor shall have available on site for the Employer's/Engineer's use an instrument suitable for the accurate checking of galvanizing thickness.

The measuring instrument shall be available from the time of arrival of the first consignment of material until the issue of the taking over certificate. The cost of the gauge and other operating expenses are deemed to be included in the Contract price.

13.4.6 Test Reports and Certificates

All test reports and test certificates shall be submitted to the Employer/Engineer no later than two weeks after completion of the relevant tests. For already completed type tests valid certificates shall be provided with the Bid.

14. Vibration dampers

14.1 Standards

EN 61897	Overhead lines — Requirements and tests for Stockbridge type aeolian vibration dampers.
EN 61284	Overhead lines — Requirements and tests for fittings.
EN ISO 1461	Hot dip galvanized coatings on fabricated iron and steel articles — Specifications and test methods.

14.2 Design

The exact number and location of vibration dampers shall be determined by a damping study.

All aeolian vibration dampers shall be so designed to:

- damp aeolian vibration and avoid damage or corrosion to the conductor or individual strands during installation or service
- for vibration dampers designed for use with OPGW avoiding damaging the optical fibre cable and impairing its optical characteristics
- withstand the mechanical loads during installation, maintenance and specified service conditions including conductor temperature variations, ultraviolet radiation, ozone, and atmospheric pollutants applicable to the site
- be free from unacceptable levels of corona and radio interference under all service conditions
- avoid audible noise under all weather conditions
- maintain its function over the entire service temperature range defined in Sub-Section VII-4
- easy to remove and reinstall without damaging the conductor
- be suitable for safe and easy installation. The clamp design shall retain all parts when opened for attachment to the conductor and shall be designed to ensure the damper can be suspended from the conductor during installation before tightening the clamp.
- ensure individual components will not come loose in service.

When installed in accordance with the supplier's recommendations the vibration damper(s) shall limit the aeolian vibration levels so that the dynamic bending strain on the surface of the outer wires of the conductor shall not exceed 150 micro-strains (peak to peak) at the vibration damper clamp and at the adjacent suspension clamp or dead-end tension joint / tension clamp. This requirement shall be met for all frequencies up to and including

$$f = \frac{1480}{d}\ Hz \text{ (where d is the conductor diameter in mm)}$$

The supplier shall provide suitable laboratory test results, field test results or calculations to demonstrate that this requirement is met for each aeolian vibration damper – conductor combination.

Drawings for aeolian vibration dampers shall in addition to the dimensions, show material types and grades, protective treatment, and any other pertinent information. Drawings, calculations and supporting test results shall be submitted to the Employer/Engineer for approval.

Vibration dampers shall be mounted over protection armor rods, clamp size shall be selected accordingly. Minimum two dampers per span shall be provided.

Stockbridge type aeolian vibration damper clamps shall be designed to ensure that after the bolt has been correctly tightened, no slackening of the clamp can occur in service. The design of the clamp shall take account that all Stockbridge type aeolian vibration dampers will be installed with grease filling the interfaces between the clamp and the conductor to prevent the ingress of moisture.

The messenger cable for Stockbridge type aeolian vibration dampers shall comprise stranded fatigue resistant high tensile steel wires. The cable shall be protected against corrosion either by sleeving over the complete length of the cable, or by alternative means that have shown to have proven fatigue and corrosion resistance in similar environmental areas for a minimum of 20 years' service life. Details of the alternative corrosion protection shall be submitted to the Employer/Engineer for approval.

The design of the Stockbridge type aeolian vibration damper shall ensure that no contact occurs between damper weights and the messenger cable under service conditions.

14.3 Materials

Materials used in the manufacture of aeolian vibration dampers shall have the following properties as appropriate:

- adequate strength for the intended application and service life requirements (including mechanical loads, vibrations, electrical currents and environmental effects) and free from defects that would affect the performance of the aeolian vibration damper
- not be liable to intergranular or stress corrosion
- compatible with the conductors' material such that there can be no deleterious effects on the conductor or aeolian vibration dampers from their use
- shall not be adversely affected in the long term by a coating applied for the corrosion protection
- Non-metallic materials shall have good resistance to ageing and be capable of withstanding service conditions without a detrimental change in their properties. The materials used shall

have adequate resistance to the effects of nitrogen oxides, ozone, ultraviolet radiation, and air pollution over the service temperature range defined in Sub-Section VII-4. They shall not induce corrosion in materials in contact with them.

The aeolian vibration dampers shall be free from defects and irregularities. Aeolian vibration damper weights and conductor clamps shall have all outside surfaces smooth and all edges and corners well rounded.

14.3.1 Corrosion Protection

All materials used in the manufacture of aeolian vibration dampers shall be inherently resistant to atmospheric corrosion which could affect their performance. All ferrous materials shall either be inherently resistant to atmospheric corrosion or be suitably protected against corrosion that can occur during transportation, storage, or service. All ferrous parts which will be exposed to the atmosphere in service, except those made of the appropriate grade of stainless steel, shall be protected by hot dip galvanizing in accordance with the requirements of EN ISO 1461.

Where zinc coated steel messenger wires are used, they shall be hot dip galvanized in accordance with the requirements of EN 50189.

All external threads shall be cut or rolled before hot-dipped galvanizing. Nuts to be galvanized shall be subsequently tapped 0.4 mm oversize and the threads oiled.

Drain holes (minimum 6 mm diameter) shall be provided where applicable to ensure that no water is trapped inside of damper weights.

14.4 Installation

The manufacturer shall provide comprehensive instructions in a suitable format covering the selection and installation of the aeolian vibration dampers, including the number of aeolian vibration dampers per span, distance from the suspension clamp or mouth of dead-end tension joint / tension clamp considering the possibility of armor rods being fitted and the clamp bolt installation torque.

14.5 Quality Control

Type, sample, and routine tests shall be undertaken in accordance with the requirements of Technical Requirements and EN 61897. Approved drawings previously submitted to the Employer/Engineer shall be available at the time of testing.

Type and sample tests shall be in accordance with Table 1 of EN 61897. Additional sample tests for clamp slip test and damper effectiveness evaluation shall also be performed. The Contractor shall prepare and submit the test programme and procedures for Employer's/Engineer's approval.

14.5.1 Identification and Marking

All Stockbridge type aeolian vibration dampers shall be marked to ensure a system of traceability. Corona free markings shall be in accordance with the requirements of EN 61284. In addition, the range of conductor sizes for which the aeolian vibration damper is intended to be used, together with type of conductor shall be clearly shown.

Installation torque values shall be stated in Newton-meters (Nm) and shall be marked adjacent to the appropriate fasteners tightened during installation.

Details of the proposed marking system shall be submitted to the Employer/Engineer for approval.

14.5.2 Test Reports and Certificates

All test reports and test certificates shall be submitted to the Employer/Engineer no later than two weeks after completion of the relevant tests. For already completed type tests valid certificates shall be provided with the Bid.

15. Spacers

15.1 Standards

EN 61854	Overhead lines — Requirements and tests for spacers.
EN 61284	Overhead lines — Requirements and tests for fittings.
EN ISO 1461	Hot dip galvanized coatings on fabricated iron and steel articles — Specifications and test methods.

15.2 Design

A|| spacers shall be so designed to:

- maintain within specified limits the sub-conductor spacing (at spacer locations), under all service conditions excluding short-circuit currents
- prevent in sub-spans between spacers, physical contact between sub-conductors, except during the passage of short-circuit currents when the possibility of contact is accepted provided that the specified spacing is immediately restored following fault clearance
- withstand mechanical loads during installation, maintenance and specified service conditions including conductor temperature variations, short-circuit conditions, ultraviolet radiation, ozone, and atmospheric pollutants applicable to the Site
- be free from unacceptable levels of corona and radio interference under all service conditions
- avoid audible noise under all weather conditions
- maintain its function over the entire service temperature range defined in Sub-Section VII-4
- be easy to remove and reinstall without damaging the conductor
- be suitable for safe and easy installation. The clamp design shall retain all parts when opened for attachment to the conductor and shall be designed to ensure the spacer can be suspended from the conductor during installation before tightening the clamp
- ensure individual components will not come loose in service.

15.2.1 Overall Flexibility

All spacers excluding rigid spacers, shall permit the following minimum relative movements between sub-conductors without damage to the spacer or the conductor:

- longitudinal movement of ±25 mm
- vertical movement of ±50 mm
- conical movement of 20°(conical angle)
- for spacer dampers only a horizontal movement perpendicular to the conductors of ±D, where D is the conductors’ diameter.

15.2.2 Spacer Dampers

When installed in accordance with the manufacturer's instructions the spacer dampers shall achieve the following performance criteria such as to adequately damp both aeolian vibration and sub-span modes of oscillation, to prevent sub-conductor clashing, fretting or fatigue under all applicable frequencies:

a) Aeolian vibration limits

The spacer damper(s) shall limit the aeolian vibration levels so that the dynamic bending strain on the surface of the outer wires of the conductor shall not exceed 150 micro-strains (peak to peak) at the spacer damper clamp and at the adjacent suspension clamp or dead-end tension joint / tension clamp. Unless otherwise agreed with the Employer/Engineer, this requirement shall be met for all frequencies up to and including

$$f = \frac{1480}{d}\ Hz\ \text{(where d is the conductor diameter in mm)}$$

b) System damping performance

The system damping performance as measured by the logarithmic decrement of the fundamental wind induced anti-phase modes of the conductor shall not be less than 0.5. Where the log decrement, (d):

$$d = \frac{1}{n} \cdot \ln\left[\frac{A_0}{A_n}\right]$$

where:

A_0=peak to peak amplitude
A_n=peak to peak amplitude at the n^{th} cycle

The manufacturer shall provide suitable laboratory test results, field test results or calculations to demonstrate that this requirement is met for each spacer damper - conductor combination.

15.2.3 Conductor Clamp

Spacer clamps shall be designed to ensure that after the fastener has been correctly tightened, no slackening of the clamp can occur in service. The design of the clamp shall take account that all spacers, except those with elastomeric clamp liners, shall be installed with grease filling the interfaces between the clamp and the conductor to prevent the ingress of moisture.

15.2.4 Electrical Resistance

For all spacers with elastomeric components the electrical resistance between the spacer arm and the central frame shall be greater than 1 MΩ to avoid galvanic corrosion of the conductor unless satisfactory endurance from a corrosion test or appropriate service experience is provided.

The maximum resistance shall not exceed 20 MΩ to avoid problems caused by capacitive charging of the spacer components in service. Details of alternative electrical resistance shall be submitted to the Employer/Engineer.

For spacers with elastomeric clamp liners the electrical resistance between the conductor and spacer arm shall be between 1 MΩ and 20 MΩ.

15.3 Materials

Materials used in the manufacture of spacers shall have the following properties as appropriate:

- adequate strength for the intended application and service life requirements (including mechanical loads, vibrations, electrical currents, and environmental effects) and be free from defects that would affect the performance of the spacer
- not be liable to intergranular nor stress corrosion
- be compatible with the conductors' material such that there can be no deleterious effects on the conductor or the spacers
- shall not be adversely affected in the long term by a coating applied for the corrosion protection
- non-metallic materials shall have good resistance to ageing and be capable of withstanding service conditions without a detrimental change in their properties. The materials used shall have adequate resistance to the effects of nitrogen oxides, ozone, ultraviolet radiation, and air pollution over the whole range of service temperatures from -20°C to 90°C. They shall not induce corrosion in materials in contact with them
- the conductivity of the non-metallic material shall be selected to ensure that any potential differences between metallic components does not cause damage due to electrical discharges and any current flowing between sub-conductors does not degrade any spacer materials.

Unlined conductor clamps shall be manufactured from aluminium or aluminium alloy. All clamp fasteners and nuts, where used, shall be manufactured from high tensile steel.

Spacer drawings shall in addition to the dimensions, show material types and grades, protective treatment, and any other pertinent information, including the spacer mass and the characteristics of the elastic and damping properties of the spacer.

The spacers shall be free from defects and irregularities. All outside surfaces shall be smooth and all edges and corners well rounded.

Spacer drawings shall be submitted to the Employer/Engineer for approval.

15.3.1 Corrosion Protection

All materials used in the manufacture of spacers shall be inherently resistant to atmospheric corrosion which could affect their performance. All ferrous materials shall either be inherently resistant to atmospheric corrosion or be suitably protected against corrosion that can occur during transportation, storage, or service. All ferrous parts which will be exposed to the atmosphere in service, except those made of the appropriate grade of stainless steel, shall be protected by hot dip galvanizing in accordance with the requirements of EN ISO 1461.

Where zinc coated steel wires are used, they shall be hot dip galvanized in accordance with the requirements of EN 50189.

All external threads shall be cut or rolled before hot-dipped galvanizing. Nuts to be galvanized shall be subsequently tapped 0.4 mm oversize and the threads oiled.

15.4 Installation

The manufacturer shall provide comprehensive instructions in a suitable format covering the selection and installation of the spacers, including the sub-span spacing considering the possibility of an additional spacer being fitted adjacent to the tension dead-end joint / tension clamp and the clamp bolt installation torque.

The manufacturer shall make available any special installation tool if required.

15.5 Quality Control

Type, sample, and routine tests shall be undertaken as appropriate on the spacers in accordance with the requirements of EN 61854. Approved drawings previously submitted to the Employer/Engineer shall be available at the time of testing.

Type and sample tests shall be in accordance with Table 1 of EN 61854. Additional sample tests for clamp slip, elastomer characteristics and electrical resistance shall also be performed. The Contractor shall prepare and submit the test programme and procedures for Employer's/Engineer's approval.

15.5.1 Identification and Marking

All spacers shall be marked to ensure a system of traceability. Corona free markings shall be in accordance with the requirements of EN 61284. In addition, the following information shall be provided:

- the range of conductor sizes for which the spacer is intended to be used, together with the type of conductor
- installation torque values shall be stated in newton-meters (Nm) and shall be marked adjacent to the appropriate fasteners tightened during installation
- correct installation orientation of the spacer using ‘Top’ or vertical up arrows etc.
- for compression spacers the metric ‘across flats’ dimensions of the die to be used, the longitudinal limits of compression and direction of compression.

Details of the proposed marking system shall be submitted to the Employer/Engineer for approval.

15.5.2 Test Reports and Certificates

All test reports and test certificates shall be submitted to the Employer/Engineer no later than two weeks after completion of the relevant tests. For already completed type tests valid certificates shall be provided with the Bid.

16. Construction

This Chapter covers general construction practices and typical OHL construction operations. Additional requirements, specific for the Contract, are provided in Sub-Section VII-4.

16.1 Health and Safety

The Contractor shall prepare a Health and Safety Plan and submit it to the Employer for approval. Health and Safety plan shall consider best practices in line with internationally recognized guidelines (e.g., UK HSE HSG150 Health and Safety in Construction or equivalent). Health and Safety Plan shall define appropriate safety measures for:

- safety of the public
- working at height
- lifting operations
- working in proximity of heavy machinery
- working in confined spaces
- excavation safety
- handling hazardous substances
- working in proximity of energized power lines
- other operations specific to the project.

When carrying-out the works maximum safety, consistent with good construction practice must be afforded to all personnel engaged on this Contract. The Contractor shall deploy sufficient resources to ensure safe work practices can be fully implemented, monitored, and reported as per approved Health and Safety Plan.

16.2 Mobilization and Demobilization

The Contractor shall commence the design and execution of the works as soon as reasonably practicable after the Commencement Date and shall then proceed with the works with due expedition and without delay.

16.3 Works Supervision

All site works included in this Contract shall be supervised by enough qualified and experienced representatives of the Contractor.

In case of residual minor defects, the Contractor shall during maintenance after the completion of the works provided for by the conditions of the Contract, keep on Site such necessary staff and for such periods as required for remedying identified defects.

The Contractor shall keep the construction site(s) and storage areas clean and tidy. All waste material shall be collected, transported, and treated in accordance with approved Site Waste Management Plan.

On completion of the works, site is to be left clean and tidy to the satisfaction of the Employer.

16.4 Site Office Facilities

The Contractor shall submit for approval to the Employer/Engineer all drawings and details for the buildings, services, equipment intended to be used for site office facilities before starting with the execution works on the site.

All Contractor's facilities as well as the offices of the Employer/Engineer shall be provided with the services necessary for their operation, such as electrical energy, potable water supply, sewers, drainage system, fire extinguishing system, cleaning service, etc. The Contractor shall install an independent communication system to his site offices and to the Employer's/Engineer's offices.

16.5 Accommodation and Storage

The Contractor shall make own arrangements regarding accommodation for his expatriate and locally recruited staff during the construction period.

All dwellings and buildings, existing or erected for the purpose by the Contractor, shall comply with local regulations regarding construction, electricity, gas and water supply, sanitation, and any other relevant requirements.

Temporary construction camps shall be provided with proper sanitation and other necessary facilities. All accommodation facilities shall be removed by the Contractor when no longer required. After the removal of the accommodation facilities the ground shall be left in a clean and tidy condition.

16.5.1 Office Accommodation

The Contractor shall provide such facilities as may be necessary for office accommodation for his site staff during the construction period. The Contractor shall also provide office accommodation for the Employer's and Engineer's staff as per Contract requirements.

16.5.2 Storage Facilities

The Contractor shall submit Materials Management Plan defining locations and details of planned storages for Employer's/Engineer's approval.

Care shall be taken to ensure any hazardous materials and pollutants are stored in appropriate manner. Drip trays shall be used under all stationary vehicles to prevent soil contamination from oil and/or fuel leaks. All vehicles with identified oil and/or fuel leaks must be immediately repaired. Vehicle repairs and cleaning shall be done only in designated areas with facilities for liquid waste catchment. Liquid waste shall be disposed of in appropriate manner as defined in Site Waste Management Plan prepared by the Contractor and approved by the Employer/Engineer.

The Contractor shall provide any necessary protection and safeguarding of the materials in the allocated areas. The Contractor shall ensure the protection of all materials against vermin attack, corrosion, and mechanical damage in accordance with measures defined in approved Materials Management Plan.

The site storage area shall be adequately prepared for the orderly storage of conductor drums, tower steelwork, insulators, and fittings so that material will not be damaged by effects of adverse weather during storage. Materials and equipment packed in flammable crates or drums shall be marked as flammable with appropriate safety notices and kept at a distance to other easily flammable substances (fuel, oil, etc.). Use of open flames, welding and power tools shall be prohibited throughout the storage compound except in specifically designated areas. Smoking shall be prohibited outside of designated areas.

16.5.3 Compressed Air

The Contractor shall make own arrangements for a supply of compressed air if required for the execution of the Contract works. Measures for safe transport, storage and use of compressed air shall be defined in approved Materials Management Plan.

16.5.4 Lifting Facilities

The Contractor shall make own arrangements to provide lifting facilities required for materials and equipment handling and transport on the site.

16.6 Tower pegging

It shall be the Contractor's responsibility that the final tower positions within the overhead line sections are correctly aligned, that the spans and relative levels of all proposed tower centre pegs correspond with the approved profile drawings and that all required safety clearances are achieved.

As part of the detailed design the Contractor shall prepare diagonal cross sections of all tower locations, to determine foundation platform/protection requirements, foundation setting levels and, where required, leg extensions/reductions.

Angle and terminal towers shall be placed within required survey accuracy limits defined in Sub-Section VII-4. Suspension towers shall be located within 0.10 m of the centre line transversely and within a 0.5% deviation of their back-span length longitudinally, relative to their specified position on the profile plan.

Overhead line route pegs shall be provided on the centre line of the transmission line. The Contractor shall verify and provide adequate protection for these pegs to prevent disturbance during easement clearing, site preparation and construction.

16.7 Route modifications during construction

The Contractor shall verify the suitability of all tower locations during detailed design stage, including but not limited to:

- geological and topographical conditions
- presence of any obstacles and underground installations
- availability of access
- availability of space for all required work operations, including space for positioning of the stringing equipment.

If, during the construction, the site of any tower as shown in the plan and profile drawings is found out to be not suitable the Contractor shall recommend alternative location of the tower to the Employer/Engineer for consideration. Selection of potential alternative locations shall consider all relevant environmental and/or social restrictions that may be specified in Environmental and Social Impact Assessment.

The Contractor shall carry out the work in accordance with the Employer's decision.

For route modifications agreed with the Employer/Engineer, the Contractor shall carry out a complete line survey, elaboration of the longitudinal profile drawings including the necessary uphill side slope information, plotting of the towers, pegging the tower positions, and surveying diagonal profiles for determination of leg extensions and updating access route maps as necessary - complete as required for the project.

16.8 Earthworks

All works shall be performed in accordance with effective site conditions and the approved execution drawings.

This clause describes all foundation earthworks which are to be performed to ensure the bearing of all loads without detriment and damage to the structures. The Contractor shall apply suitable design and construction methods and equipment to ensure conformance with requirements of EN 1997-1 and these Technical Requirements.

The Contractor is responsible for the suitability of the foundation design and construction technique for the existing underground conditions.

Immediately following excavation, the Contractor shall verify that soil conditions at foundation level are consistent with the findings of geotechnical investigations by appropriate field test method.

At least three months before planned start of the works the Contractor shall submit for approval to the Employer/Engineer a comprehensive method statement(s) giving sequential details of his proposed installation methods. The method statement(s) shall include, but not be limited to, the following details:

- site safety procedures
- method of excavation (for all types of foundations)
- method of protection from excavation sides collapse based on soil type
- excavation dewatering methods
- methods for heating, welding and site bending of reinforcement
- method of stubs setting
- method of formwork installation
- method of placing of concrete
- method of curing and protecting the concrete
- method of pile installation
- method of backfill and compacting
- reinstatement of working areas
- quality control procedures.

16.8.1 Protection of existing utilities and services

The Contractor is responsible for identification and protection of all existing underground utilities. The Contractor shall provide all necessary measures for protection for existing utilities and services and retains full responsibility for prevention of any damage and/or accidents.

16.8.2 Excavations

Excavation shall be done to the required dimensions and depth and shall be finished according to the specified lines and slopes as defined by approved design drawings.

The Contractor shall be responsible for all necessary safety measures which shall be defined in approved Health and Safety Plan and related Method Statements. Contractor's nominated soils expert and safety expert shall inspect all excavations and confirm that appropriate safety measures had been implemented. Any necessary corrections and/or modifications shall be immediately implemented. Inspection records shall be kept and provided to Employer/Engineer upon request.

In case excavation depths are executed beyond the required dimensions the Contractor shall backfill over-excavation with lean concrete. In case of over-excavation of the layout for foundations designed to transfer the load by direct contact with undisturbed soil the Contractor shall propose specific remediation measures for Employer's/Engineer's approval.

The Contractor shall not be entitled to any additional payment for unplanned costs due to over-excavations.

16.8.2.1 Blasting

The Contractor shall not make use of any explosives without the express permission in writing by the relevant authorities.

The Contractor shall strictly comply with approved Hazardous Substance Handling and Storage Management Plans and local regulations as required by the authorities regarding purchase, storage, issuance and use of explosives and transport of same to and from site and shall be deemed to have included all costs arising from the use, storage, and transport of explosives as well as from supervision of blasting by security forces.

Blasting shall furthermore be strictly and in every case subject to Employer's/ Engineer's permission.

All blasting shall be carried out by approved experts only and the Contractor shall be fully liable for any claims arising from damage or alleged damage, injury to the public etc. due to blasting.

The Contractor shall be insured with an approved insurance company against all claims with respect to damage and injury arising from blasting.

Fuses, detonators or blasting caps shall not be transported or stored together with dynamite or other explosives. The location and design of the storage places, the transportation methods and the precautions that shall be taken to prevent accidents shall be subject to the Employer's/Engineer's approval, but it is understood that this approval does not exempt the Contractor of his responsibility regarding handling of explosives.

Drilling and blasting plans shall be submitted at least three months in advance of the planned works for the Employer's/Engineer's approval.

When blasting is carried out, trees, structures etc. in exposed position shall be adequately protected from damage.

Drilling and blasting shall be arranged and, where necessary, the rock being blasted shall be protected to prevent any scattering of the rock liable to cause injury to the public or damage to dwellings, buildings and other property and the works.

Blasting shall be carried out carefully to avoid the loosening of rock surfaces that are to remain intact, particularly in those cases where concrete is to be placed directly against these rock surfaces.

16.8.2.2 Verification of Soil Conditions

The soil conditions encountered at the foundation level, shall be checked by the Contractor, recorded, and compared with previous known and investigated results.

If significant differences in soil properties relevant to soil classification performed as part of geotechnical investigations are identified, the Contractor shall inform the Employer/Engineer and propose further actions required for reliable soil classification and selection of appropriate foundation type.

16.8.2.3 Dewatering

During the foundation works the excavated areas, foundation levels and pits shall be kept free of water down to at least 0.5m below the foundation level.

16.8.2.4 Stockpiles and Disposal of Excavated Material

Excavated material from the works, suitable for backfilling purposes, shall be stockpiled near excavation. Material not suitable for backfilling shall be removed from the site in accordance with approved Waste Management Plan.

The Contractor shall not have the right either to additional payment or to claim because of work involved in stockpiling materials, re-use of for carting to the waste disposal areas.

16.8.3 Backfill

Refilling around the foundation shall be carried out only after all works within the excavations have been inspected and accepted by the Employer/Engineer. It shall be noted that Employer’s/Engineer’s acceptance, or lack of objection, does not relieve the Contractor from any of his responsibilities under the Contract.

Foundations and structures shall be backfilled with suitable material and compacted in layers as per approved Method Statement. Backfilling shall be compacted to achieve bulk density as per the value used for foundation design but no less than 1600kg/m^3. Bulk density shall be confirmed by tests in accordance with EN ISO 11272. If requested by the Employer/Engineer additional tests shall be performed by the Contractor to demonstrate the compliance of backfill properties to foundation design requirements and assumptions.

During backfilling, the side sheeting to the excavation shall be progressively withdrawn such that the toe of the sheeting is never more than 600 mm below the surface of the compacted material. Extreme care shall be taken by the Contractor during compaction to ensure that the foundation is not damaged nor moved out of position.

The Contractor shall propose the compaction equipment and methods most suitable for achieving the required bulk density based on the soil type.

Backfill shall be deposited and compacted using approved material in layers of thickness less than 150mm for hand compaction and 250mm for mechanical compaction. First two layers shall always be placed and compacted manually to prevent damage to the foundation slab. The fill moisture content shall be controlled and adjusted to achieve required compaction. Fresh water shall be used for watering of soils. All decomposable materials shall be removed from the excavations prior to backfill.

Fill material shall be of such nature that it can be compacted to the specified densities. It shall be free of soluble or swelling components such as plastic clays, and of all materials subject to decay, decomposition or dissolution or other materials that could corrode metal. In case excavated material is not suitable for backfilling the Contractor is responsible to provide substitute material for backfilling and disposal of unsuitable material in accordance with approved Waste Management Plan.

The sites of all towers shall be levelled so that on completion of the work the finished ground level shall normally at least be the same as prior to commencement of the work.

Following finalization of the backfilling works, site shall be reinstated and cleaned to satisfaction of the Employer/Engineer. Any permanent erosion control measures in accordance with Sub-Section VII-3 shall also be installed as required.

The Contractor shall be responsible for making good all settlements of filling which may occur up to the end of the Defects Notification Period.

16.8.3.1 Backfill tests

Backfilled material shall be placed in layers not exceeding 200mm in thickness and compacted to 93% of maximum dry density unless otherwise agreed with the Employer/Engineer.

Quality control shall record all of the following values:

- bulk density and maximum dry density (ISO 17892 parts 1 and 2)
- results of dynamic probing test according to EN 22476-2:2005

- plate load test in accordance with ASTM D 1196/D1196M:2012
- sand cone test in accordance with ASTM D 1556/D1556M.

Acceptance criteria shall be clearly defined before the tests based on relevant design values dependent on soil class, foundation type, etc.

16.9 Foundations

The execution of tower foundations shall be done in accordance with approved CESMP and relevant method statements which shall define procedures for safe execution, supervision, and quality control of the following works:

- site preparation and setting out
- excavation works
- verification of suitability of proposed foundation type to actual soil conditions
- other necessary preliminary works before pouring concrete of the foundations (anchor settings, grouting, soil exchange, compaction, etc.)
- concrete works in accordance with Execution Specification as defined in Clause 16.9.1
- piling works in accordance with Section 16.10
- backfill works
- cleaning the site and removal of all superfluous materials in accordance with approved Site Waste Management Plan
- protection of the interface between steel tower leg and top section of concrete foundation.

16.9.1 Concrete - Execution Specification

Contractor shall prepare and submit for approval Execution Specification for execution of concrete structures at least three months before concrete works are scheduled to commence on site. Execution specification shall, as a minimum, conform to requirements for Execution Class 2 as defined in EN 13670 and any additional Employer requirements as specified in the Contract. Detailed Quality Control Plan and associated documents (e.g., inspection forms and report templates) required for its application shall be included in the specification.

16.9.2 Stub Setting

The stubs shall be set using prefabricated templates or by applying approved single stub setting procedure.

The maximum permitted tolerances measured at the top of the stubs shall be as detailed below and shall be verified in advance of the tower erection. Should these tolerances not be achieved the Contractor shall submit details of his proposed remedial measures to the Employer/Engineer for approval.

Records of the foundation setting out measurements shall be submitted to Employer/Engineer.

The stub setting tolerances shall be as per the following table:

Table 16-1: Stub setting tolerances

Principal Dimension	Tolerance
Nominal face dimension	10 mm or ± 0.1% of face dimension (whichever is greater)
Nominal diagonal dimension	± 15 mm or ± 0.1% of diagonal dimension (whichever is greater)
Rake of stub from required face or hip slope	1:100
Stub level	
(a) Maximum difference in level between all dimension (whichever is greater)	10 mm or 0.05% of diagonal four stubs of a foundation
(b) Maximum difference between the mean levels of pairs of diagonally opposite stubs	±6 mm
Twist of stub in plan	1˚ about longitudinal axis

16.9.3 Falsework and Formwork

For stability and type of falsework and formwork used, provisions of EN 12812 shall apply. Alternatively, empirical design methods based on allowable stress limits may be used, subject to prior agreement with the Employer/Engineer. Falsework design shall be submitted to the Employer/Engineer for approval at least two months before its intended use on site.

The falsework and formwork shall be so dimensioned as to be able to withstand all vertical and horizontal forces safely. In addition to supported dead loads (including own weight), design shall, where applicable, consider live loads from workers and equipment as well as lateral pressures from fresh concrete, loads from inclined supports and wind loads.

Falsework shall be sufficiently rigid to maintain the formwork in its correct position and to be true to shape and dimensions so that the final concrete is within the limits of the dimensional tolerances.

16.9.3.1 Preparation of Contact Surfaces

All surfaces on which or against which concrete is to be poured shall be carefully cleaned and/or roughened to the Employer's/Engineer's satisfaction.

The rock surface shall be free of oil, stagnant or running water, mud, loose rock, residue and impurities or any other improper material. Immediately before concrete placing, all rock surfaces shall be thoroughly cleaned.

All earth surfaces against which concrete is to be poured, shall be clean and free of any detrimental impurities, organic matter, or unsuitable material.

The effective bearing capacity of the soil shall be confirmed before pouring of concrete by a qualified soil specialist.

16.9.3.2 Preparation and inspection

Before concrete is placed, all falsework and formwork shall be inspected according to the approved quality assurance plan and inspection findings recorded. Formwork shall be cleaned and free from sawdust, shavings, dust, mud, earth, or other contamination and properly oiled. Contact surfaces of panels shall be treated with a suitable release agent (e.g., non-staining mineral oil) where applicable. Surfaces which are not oiled shall be wetted thoroughly to prevent warping.

16.9.3.3 Erection and placing

All falsework and formwork shall be erected to approved construction drawings. Shuttering shall be true to line, braced and strutted to prevent deformation underweight and pressure of the fresh concrete, live loads, wind, and other forces. The deflections shall not exceed 3 mm.

Formwork for walls and elsewhere shall be arranged for a maximum concreting height of 2.5 m in a single pour.

Where necessary, panel openings are to be provided in the forms for cleaning, inspection, access of vibrators, etc.

16.9.3.4 Concrete mixes

The mix proportions are to be determined by proper mix design based on the requirements for compressive strength, workability and, where applicable, the specific circumstances of particular site in which the concrete is to be placed (e.g., aggressive environment). The mix design shall be carried out by the Contractor's responsible specialist and approved by Employer/Engineer.

Required compressive strength concrete classes for various elements (e.g., standard, piled or pre-cast foundations) are specified in Sub-Section VII-4. Depending on proposed placement method and equipment, the Contractor shall suggest adequate slump and compaction class as part of a mix design.

Concrete aggregates and cement shall be proportioned and batched by weight. Water shall be proportioned considering required water-cement ratio as per mix design, accounting for aggregate moisture content measured by moisture probes or otherwise adjusted for by automatic mixing water adjustment systems.

16.9.3.5 Trial mixes

Before concreting commences, the Contractor shall, at his own expense, make trial mixes to determine the mix proportions required to produce the strengths specified for each class of concrete and for each degree of workability required to allow placing, transporting, and compacting of the concrete with the equipment he proposes to use in any situation.

Only materials which the Contractor intends to use for concreting (including all admixtures) shall be used in the trial mixes. Trial mix shall be prepared in the same facility and using the same equipment that Contractor proposes to use for concrete production.

Sufficient test samples from trial mixes shall be obtained in accordance with EN 12350-1 and EN 12390-2. Samples shall be used for verification of:

- slump class in accordance with EN 12350-2
- compaction class in accordance with EN 12350-4
- density of fresh concrete in accordance with EN 12350-6
- density of hardened concrete in accordance with EN 12390-7
- compressive strength class in accordance with EN 12390-3.

Shape and dimensions of molds for test specimens used for determination of density of hardened concrete and compressive strength class shall fully conform to EN 12390-1. Curing and transportation of test specimens shall conform to requirements of EN 12390-2.

16.9.4 Concrete Mixing

The cement and aggregate shall be thoroughly mixed in a batch-type pull mill mixer. The capacity of the mixer shall not be less than 1 (one) cubic meter and the total capacity of the batching mixing plant shall be such to accommodate the various concrete quantities to be cast in a continuous way.

The water shall not be added until all the aggregate and cement are in the drum. Mixing shall continue until the concrete is uniform in colour and for not less than 1 (one) minute after all the materials and water are in the drum.

16.9.4.1 Concrete Consistency

The amount of water used in the concrete shall be adjusted for aggregate moisture content as described above to ensure appropriate consistency required for transport, placement, and compaction without segregation of components or bleeding of fresh concrete. Addition of water, or liquid admixtures to compensate for stiffening of the concrete before placing shall not be permitted. Consistency of concrete shall be verified by slump test in accordance with EN 12350-2 immediately before placement. Test results shall be recorded in accordance with Execution Specification and related Method Statements.

16.9.5 Concrete Transport

Immediately after mixing, the concrete shall be conveyed to the place of use as rapidly as possible using methods which prevent the segregation, loss, or contamination of materials.

The concrete shall be placed and compacted within 90 minutes of the addition of water to the mix. Any concrete left unplaced after this time shall be rejected and removed from the site.

16.9.6 Concrete Placement

Concrete placing shall not commence before the Employer/Engineer has confirmed that all preparatory works had been inspected and documented as per approved Quality Control Plan.

Only concrete placement methods specified in approved Execution Specification shall be used on site. Concrete shall be placed in the forms as close as possible to its final position in a continuous operation with intermediate compaction of layers not exceeding 30cm in height to the full thickness of slabs. The rate of placing and compaction shall be high enough to avoid cold joints forming between compaction layers or at connection of the horizontal and vertical elements.

The Contractor shall organize the placement of concrete in such a manner that once concreting of a section has started the operation shall be continuous and each operation shall be completed without stoppage.

The temperature of concrete at the time of placement shall not be below 5°C nor exceed 30°C. Concrete shall not be placed when the ambient temperature is 40°C or above, or when it is above 37°C and is rising. Placement of concrete in ambient temperatures below 5°C and above 30°C shall conform to requirements of Clause 16.9.10 of this document and any additional requirements defined in Execution Specification.

Where specified on the drawings, construction, expansion, or contraction joints shall be provided and the concrete shall be poured continuously between two adjacent joints. No joints other than those shown on the drawings shall be permitted. Stoppage (cold) joints formed between two concreting operations separated by more than 6 hours' time shall be subject to the same treatment as the construction joints.

Concrete shall not be deposited into place from a height exceeding 0.8 m without use of trunking and/or chutes approved by Employer's/Engineer.

Concrete which has partially hardened shall not be exposed to injurious vibration or shock, except for controlled re-vibration where specified.

If concreting of a certain large structural element is specified strictly as to be poured continuously, then the concreting operations shall be organized for day and night working, in long shifts, as necessary. Such operations shall be planned in accordance with appropriate safety measures as defined in approved method statement.

16.9.7 Concrete Compaction

As concrete is being placed it shall be compacted by mechanical vibrators, to obtain a dense material free from honeycombing, free from water and air holes. For compacting the concrete, internal vibrators with minimum operating frequency of at least 120Hz shall be used. Alternative compacting methods may be proposed in Execution Specification.

The Contractor shall ensure that the vibrators are used in such a manner that the reinforcement is not displaced, the formwork not damaged and no segregation caused, but complete compaction of the concrete is achieved.

Vibration shall not be used as a means of concrete placement. Excessive vibration which might promote weak surface layers or segregation shall be avoided.

Care shall be taken to ensure proper compaction at changes in cross-sections, in narrow locations, at congested reinforcement arrangements and at construction joints. Specific measures for such cases shall be defined in Execution Specification.

16.9.8 Construction Joints

The number of construction joints shall be kept as low as possible consistent with reasonable precautions against shrinkage. Concreting shall be carried out continuously up to construction joints.

Where it is necessary to introduce construction joints, careful consideration shall be given to their exact location, which shall be indicated on the design drawings. Alternatively, the location of joints shall be subject to agreement between the Employer/Engineer and the Contractor before any work commences.

Construction joints shall be at right angles to the general direction of the member and shall take due account of shear and other stresses.

Immediately prior to recommencement of concreting on a joint, the surface of the concrete against which new concrete will be cast shall be free from laitance and shall be roughened to the extent that the largest aggregate is exposed but not disturbed.

Care shall be taken that the joint surface is cleaned immediately before the fresh concrete is placed against it and that surface temperature at the joint is above 0°C.

A record shall be kept on site of the time and date of placing the concrete in each section of the work.

16.9.9 Concreting at Night

Concreting at night is subject to approval by the Employer/Engineer. Specific safety measures shall be defined in task specific method statement based on requirements of approved Health and Safety Plan.

16.9.10 Concreting in Low and High Ambient Temperature

The temperature of the mixed concrete shall not drop below 5°C nor exceed 30°C before and during placement. The Contractor shall take appropriate measures during mixing, placing, and curing of concrete, such as shading of aggregates, spraying of aggregates with water, cooling of the mix constituents (introduction of ice to the mixing water), reduction of transportation time to the minimum and any other measures prescribed in approved Execution Specification. During placing suitable measures shall be provided to prevent premature setting of concrete placed in contact with hot surfaces.

All concreting areas, formwork and reinforcement shall be shielded from the direct rays of the sun and further protective measures (e.g., placing of wet coverings on the surface) as defined in Execution Specification shall be applied and documented as per Quality Control Plan.

Daily maximum and minimum atmospheric shade temperatures shall be recorded using calibrated thermometers on each work site.

16.9.11 Protective Measures

Minimum concrete curing periods for individual elements shall be defined in Execution Specification, considering requirements and recommendations of Clause F.8.5 of EN 13670.

Immediately after the pouring of the concrete has finished, the Contractor shall ensure adequate protection measures as defined in approved Execution Specification are applied and documented in accordance with Quality Assurance Plan.

Curing compounds or other methods of preventing evaporation may only be used if approved by the Employer/Engineer. Where formwork cannot be removed within 24 hours after placing the concrete, the formwork shall be kept shaded from the direct rays of the sun and shall be sprayed with water.

Where large sections of concrete are poured, special measures shall be defined in Execution Specification to reduce and dissipate the heat generated by the setting and hardening of the concrete.

The minimum amount of reinforcement shall be present to prevent shrinking cracks.

No load of any kind shall be allowed on concrete which has not properly set, and the Contractor shall prevent any load to be imposed on the concrete structures until minimum period defined in approved Execution Specification for individual elements expires.

16.9.12 Repairs

Concrete which has completed its final setting shall be inspected by the Employer/Engineer and any cracks, honeycombed areas, segregations, etc. shall be marked.

No repairs shall be carried out without explicit approval by the Employer/Engineer. Repair of defective concrete shall be performed only in the presence of the Employer/Engineer.

Concrete that is damaged (e.g., fractured and/or honey-combed) but deemed reparable by the Employer/Engineer shall be cut out to a depth at which sound concrete is exposed and filled within dry pack, mortar or concrete matching the structure. All concrete used for patching shall be bonded tightly to the surface of the sound concrete and shall be sound and free from shrinkage cracks and rough areas after curing and drying.

All areas to be patched shall be coated with an approved concrete bonding agent in accordance with the manufacturer's printed instructions.

16.9.13 Finishing

The finished surface of the concrete shall be sound, solid, and free from honeycombing, protuberances, air holes or exposed aggregate. No plastering, cement wash, mortar or paint shall be applied to cover defective concrete surfaces. Required finish types for individual elements in accordance with Table F.4 of EN 13670 shall be defined in Execution Specification.

The concrete face shall have the finish as specified in approved Execution Specification.

The top or final surface of all concrete works shall be finished by screeding, floating, troweling, grinding, or tooling as specified in approved Execution Specification.

Dry cement or cement and sand shall not be used to dry excess water on the concrete surface.

All surfaces which may be polluted by oil or oily water shall be adequately protected (paint, etc.). The finished surface of all concrete work shall be sound and free from defects. No plastering, cement wash or mortar shall be applied to cover defective concrete faces. Any repairs can only be executed with prior approval and in presence of the Employer/Engineer.

All concrete surfaces of cable basements and the like which are endangered by ground water shall receive a water proofing membrane of approved type with protection board against the soil.

All concrete in contact with soil shall receive a bituminous coating of at least two layers.

The striking period for cast in situ concrete shall be specified in approved Execution Specification.

Extreme care shall be taken to avoid chipping of corners during removal of formwork.

16.10 Piling works

The piling work includes (as applicable, depending on pile type):

- identification and protection of any underground utilities or service installations
- identification and implementation of any protective measures necessary for prevention of damage to any nearby objects, including their foundations, from piling activities
- preparatory works, the installation of the piling equipment and all the temporary works required for the execution of the piling works
- drilling of the piles using a temporary casing (bentonite or slurry drilling shall not be used)
- preparation and placement of the steel reinforcement
- concreting works
- grouting of the pile base
- concrete cut-off
- any geotechnical investigations required for execution of piling works in addition to those already defined in Chapter 4 of this document
- tests on the materials (concrete, reinforcement, grout) in accordance with clauses 16.10.5, 16.10.6 and 16.10.7 of this document
- testing of piles in accordance with approved procedure described in Clause 16.10.9
- cleaning of the working site, including the disposal of any debris produced by the piling.

16.10.1 Documents to be submitted

The following documents shall be submitted by the Contractor to the Employer/Engineer in due time and are to be approved before starting the piling works:

- references concerning pile foundations carried out by the Contractor for similar structures and soil conditions, list of qualified staff

- detailed descriptions of the plant, equipment, materials, and procedures proposed for every type of piling operation to be undertaken. These descriptions shall include plant and equipment specifications, pile construction sequence, protective systems, detailed construction or installation procedures, tests procedures
- a proposal of pile record book and pile record sheets (see 16.10.8.6)
- drawings and calculations with the following information:
  - number, geometry and location of the piles and pile caps
  - working and ultimate loads acting on the piles
  - verification of ultimate stress limits in piles, pile caps and steel reinforcement
  - bearing pressures, settlements, horizontal displacements of the piles (isolated pile and groups of piles)
  - the “useful” length of the piles with cut-off level and base level
  - steel reinforcement details
  - general planning of the piling works
  - testing procedure and programme
  - any other information relevant to execution of piling works.

16.10.2 Design and Execution

The piling design shall be in accordance with EN 1997-1 and associated EN standards as referenced therein. Piling work execution shall conform to requirements of EN 1536 in case of bored piles, EN 12699 for driven cast-in-situ piles or EN 14199 for micro piles. Where relevant, special design considerations listed in execution standards shall be considered.

Other internationally recognized standards which ensure equal or higher quality than referenced EN standards can be submitted to the approval of the Employer/Engineer. If any standard contains a provision which is inconsistent with a provision in another standard, the more stringent requirement shall apply.

16.10.3 Soils characteristics

The detailed soil and rock characteristics and accurate levels shall be provided by the confirmatory soil investigation made by the Contractor at the beginning of the works.

16.10.4 Pile types

Three types of piles can be proposed by the Contractor: cast-in place driven piles, cast-in-place bored piles or micro piles.

Grouting of the rock below the piles shall be considered if appropriate.

The piles bases shall be embedded in the rock level, determined by the soil investigations.

The net vertical pile capacity computed from the soil investigation report shall be used to determine the maximum test load for piles testing.

16.10.5 Materials for concrete

Provisions of Section 7.3.1 shall be applied.

16.10.6 Steel reinforcement

The piles shall be longitudinally reinforced over full length. The pile reinforcement drawings shall be approved by the Employer/Engineer. Provisions of Section 7.3.2 shall be applied.

16.10.7 Grout

Grout composition shall be planned and carried out in a manner appropriate to the application and the ground conditions and shall fully conform to requirements of EN 1536 or EN 14199 depending on the pile type.

Laboratory and field tests for verification of mixture, mixture efficiency, setting time and performance of the grout shall be done in accordance with EN 445.

16.10.8 Execution

The program of piling work is to be submitted for the approval of the Employer/Engineer. Three working days before the end of each week, the Contractor shall submit to the Employer/Engineer the detailed piling program for the next week, including adequate notice of any intention to work outside normal hours and at weekends if applicable.

16.10.8.1 Staking-out tolerances

The landmarks to be used for the implementation of the piles shall be effective, solid, and well protected.

The selection of reliable method for setting out the piles and its implementation is responsibility of the Contractor. The setting out shall be carried out from the main grid lines of the proposed structures.

Construction tolerances shall conform to requirements of appropriate standard for the pile type as listed in Clause 16.10.4 of this document.

16.10.8.2 Cut-off

The piles are to be concreted up to a minimum of 60 cm above the cut-off level.

The cut-off shall eliminate all polluted or poor characteristics concrete at the top of the pile and shall be carried minimum 10 cm into sound concrete.

16.10.8.3 Rejection

If a pile is rejected by the Employer/Engineer, the Contractor shall replace it by others in the vicinity of the rejected pile.

The Contractor shall bear the cost of:

- re-design of pile caps
- all additional construction costs due to unsatisfactory or incorrectly positioned piles.

16.10.8.4 Concreting

Before starting concreting, the Contractor shall check the implantation of the driven tube and verify that no water or soil is present within the tube. A special procedure must permit to execute this control at any moment.

In case of continuous pouring over the full length of the tube, the concreting curve is drawn up by measuring the concrete top level every time the tube is raised over 2 m.

Before starting the concreting, the bottom of the hole shall be cleaned. All loose or disturbed soil shall be removed from the base of the hole. This operation is to be executed after the introduction of the steel reinforcement cage immediately before starting the concreting.

If the checking at the base of the pile shows a penetration of sediments between the rock and the end of the steel casing, the Contractor shall submit to the approval the method to ensure the sealing of the casing within the rock.

All concrete is to be placed by tremie pipe.

If the concrete consumption is not normal (under-volumes or more than 30% of over-volumes), special procedures shall be taken by the Contractor in agreement with the Employer/Engineer.

Water level within the hole must be permanently higher than the groundwater level during concreting.

16.10.8.5 Concrete control

Required compressive strength class of concrete for piles is specified in Sub-Section VII-4.

Quality control shall be in accordance with provisions of Section 7.5.

16.10.8.6 Piling record

For each pile, a piling record book giving the main checked values during execution shall be drawn up and updated by the Contractor with all the work hazards and incidents. That record book shall be submitted daily to the approval of the Employer/Engineer as the execution proceeds.

This record book shall include for each pile details on:

- location, reference number (corresponding to the number fixed on the drawing), type and diameter of the pile
- length of the temporary casing where applicable
- start and completion times of each operation (e.g., drilling, reinforcement setting, concreting)
- level from which the pile is bored or driven (platform level)
- level at the pile base
- top level of the concreted pile before the cut-off operation
- equipment details (driving or drilling tools, concreting equipment)
- cleaning results of the bottom of the hole before putting down the reinforcement cage and before concreting
- nature and description of the encountered soils
- poured concrete volume and theoretical volume (measured concrete curves)
- behaviour, workability, fluidity of concrete, results of the compression tests (to be added once available)
- water level within the hole before concreting.

16.10.9 Testing

The Contractor shall prepare detailed testing procedure and submit to Employer/Engineer for approval. The procedure shall define all the necessary details of test methods, equipment, loading cycles, proof load levels and acceptance criteria. Testing procedure shall be based on provisions of EN 61773 and associated standards referenced therein. The Contractor may propose the use of alternative governing standard subject to approval of Employer/Engineer.

As a minimum, three design tests shall be done for both compression and uplift loads. Test shall be done to full scale, unless otherwise agreed with Employer/Engineer in advance.

Testing procedure shall define the minimum frequency of proof tests to be conducted on working piles. No less than 5% of all piles of the same type shall be proof tested.

The loading arrangement shall be designed to safely transfer maximum test loads to the test pile. Design shall be submitted to Employer/Engineer for approval at least one month before any work related to the testing process is scheduled to commence. All equipment shall be verified for safe use under maximum test loads.

Details and calibration certificates of proposed load and displacement measuring devices shall be provided in testing procedure.

16.11 Tower Erection

The Contractor shall erect the towers and tower accessories in accordance with the approved detailed drawings.

No steel tower shall be installed until at least seven days after the last placing of concrete in the foundation, and backfilling has been completed.

Assessment of component conformance, execution of material delivery, assembly and erection of tower structures shall be done in accordance with EN 1090 parts 1 and 2.

Foundation stubs shall be clean and free of any mud or dirt prior to tower erection works commencement.

If evidence of white rust is apparent upon receipt at site of bundled steel sections, the Contractor shall propose the measures to determine the extent of damage and the remedial measures to the Employer/Engineer for approval.

16.11.1.1 Bolt Tightening

In general, the towers shall be assembled and erected with bolts finger tight only. Final tightening of bolts shall only take place when all members are in place.

The bolts shall be tightened to torque values as per Table 19 of EN 1090-2 unless otherwise required by approved design.

16.11.1.2 Damaged Members

Members that are bent, twisted, or otherwise deformed in storage, transportation, handling, or erecting operations shall be straightened or replaced by the Contractor. Straightened members shall only be accepted - at Employer's/Engineer's discretion - if they can still satisfy erection tolerances specified in EN 1090-2.

Members that are damaged in a manner causing reduction in their strength shall be replaced at the Contractor's expense.

16.11.1.3 Damaged Galvanization

Any tower members arriving on site with damaged galvanizing due to mishandling or formation of white rust shall be notified to the Employer/Engineer immediately. With Employer's/Engineer's agreement the Contractor may attempt to repair the damage and submit the repaired members to the Employer/Engineer for approval before erection commences. Members rejected by the Employer/Engineer shall be reworked until the Employer/Engineer is satisfied that the repaired coating will provide adequate protection to the member.

16.11.1.4 Painting of Towers

For sites which may potentially be flooded, the tower body (all types) shall be painted with two coats of coal tar epoxy to a height of 1m above the maximum expected flood level based on 1% annual probability of exceedance.

The first coat of coal tar epoxy shall be spray applied to the clean, dry steel to give a dry film thickness of not less than 150 µm. The coating shall be checked for thickness using a magnetic coating thickness gauge and for pinholes using a spark tester. Any deficiencies shall be repaired immediately.

A second coat of coal tar epoxy shall be applied after a minimum of four hours after the application of the first coat but not later than five days after the application of the first coat to give a total dry film thickness of not less than 300 µm. Coal tar epoxy shall not be applied when relative humidity exceeds 85%.

16.12 Conductor and OPGW/earthwire stringing

At least three months before intended stringing commencement date, the Contractor shall submit a fully detailed stringing schedule to the Employer/Engineer for approval. This schedule shall indicate locations of conductor and earthwire drums and pullers, the proposed position of mid-span joints, together with temporary staying of towers and all other relevant information required for the stringing operations including the maximum tensions to be used during pulling of conductors and OPGW/earthwire.

Stringing schedule shall detail all crossings of existing infrastructure such as main roads, railways, gas pipelines, power lines, etc. It shall also include all anticipated Contractor's requirements such as temporary road closures, power lines outage schedule, obstacle locations, etc. In addition, 48h notice shall be provided to the Employer/Engineer before commencement of the stringing process for each section. Stringing can commence only after Employer's/Engineer's representatives confirm compliance with approved method statement(s) described below.

Any manufacturer's instructions for OPGW stringing shall be strictly followed. The Contractor shall engage the manufacturer erection supervisor for entire duration of the stringing works.

The tension stringing method as well as the selection of equipment and tools shall be done in accordance with approved Method Statement which shall include as a minimum:

- number and competence levels of required personnel, including supervising staff
- details of mandatory personal protective equipment (PPE) and safety measures including grounding methods and equipment. Safety related notes shall be highlighted in bold red font
- details of required tools and equipment including verification of safe working load (SWL) for specific tasks

- detailed step-by-step procedure for task execution
- relevant limits for positioning of equipment (e.g., minimum distance of pulling machines from the towers) and conductor/OPGW/earthwire tension for each stage of the stringing operation (pulling, sagging, fixing)
- detailed description of the jointing method, equipment, and tools
- requirements and equipment for any temporary support measures (e.g., backstays or temporary crossarm supports)
- detailed risk assessment with clearly defined risk mitigation measures
- confirmation of compliance verification with evaluated erection and maintenance loading on towers from the Contractor’s Chief Designer
- abstract from, or clear reference to, relevant sections of approved Quality Control Plan including records templates.

16.12.1 Fittings and Insulator Strings Installation

Insulators and fittings shall remain in their crates and shall be removed only just prior to erection and shall be handled carefully to avoid damage.

Insulators shall be cleaned immediately prior to lifting onto structures with a soft cloth to remove all dust and deposits. Abrasives or wire brushes shall not be used.

The execution of line hardware and insulator string set installation shall be done in accordance with approved Method Statement.

16.12.1.1 Sagging

The conductors and OPGW/earthwire shall be sagged in accordance with tension/sag tables calculated by the Contractor and approved by the Employer/Engineer. The Contractor shall as part of design submit for the Employer’s/Engineer's approval his proposals for a system of initial tensioning which shall ensure that the conductors and OPGW/earthwire are so erected as to reach the required final tensions after 10 years in service.

16.12.1.2 Jointing of conductors/earthwire and OPGW

Conductor joints shall be of the compression type. Conductors shall be terminated at tension towers by means of compression type dead-end assemblies.

Jointing of all conductors shall be performed as much as practicable at the same position. All compression joints shall be free of flash and sharp points, which might be a source of corona or radio interference. The Contractor shall furnish all necessary tools, including compression tools and dies required.

At joints and terminations, the contact surface of conductors, dead-ends, mid-span joints and jumper terminals, including the faces of contact palms, shall be bright and clean and shall be liberally coated with an approved jointing compound before compression and bolting operations are carried out.

The Contractor shall ensure that no bird-caging, over-tensioning of individual wires or layers or other deformation or damage to the conductor or OPGW/earthwire occurs. Cutting of layers of conductors, earthwire and OPGW shall be carried out with tools designed to prevent damage to underlying strands or optical fibre tubes.

The Contractor shall keep a record of each compression fitting showing its location, date of assembly, and the name of the linesman responsible for the assembly.

All conductor joints shall be at least 30m away from a suspension or tension clamp or compression dead-end. There shall be not more than one such joint per conductor in any one span.

16.12.1.3 Conductor and earth wire clamps and joint test

The electrical resistance of at least 10 (ten) completed clamps, joints and terminal fittings of each type shall be accurately measured by the Contractor in the presence of the Employer/Engineer. Should one clamp fail the test, another lot of 5 (five) clamps shall be tested.

Where the joint consists of several parts bolted together (e.g., dead-end clamp with bolted on jumper terminal) the resistance to be measured is that of the complete assembly. The resistance of any such fittings shall not exceed 75% of the resistance of an equivalent length of conductor, measured adjacent to the fittings, and the current carrying capacity shall be at least equal to that of the conductor.

The Contractor shall provide suitable equipment (such as the Chance Digital Micro Ohmmeter) to perform the above tests and shall submit details of the proposed instruments to the Employer/Engineer for approval. Suitable clamps shall also be supplied for connecting the current leads of the measuring instrument to the test sample to provide adequate surface contact at the interfaces. Test probes as used for potential contacts are unsuitable for current connections. Stringing of conductor and earth wire shall not commence until the instruments are on site and ready for use.

The contact behaviour of the conductor and earth wire joints and terminals shall be tested according to the requirements of EN 61284.

16.12.2 Crossing of Major Obstacles

The Contractor shall, at own expense, make any necessary arrangements and take the necessary precautions where the route crosses buildings, telecommunication and power lines, orchards, gardens, railways, or other obstructions and where erection cannot be carried out by standard methods.

Crossing specific Method Statement supported by calculations and drawings for each special crossing shall be provided as a deliverable to be approved by the Employer/Engineer and statutory authority where required. Crossing specific method statement shall account for the hazards not normally covered under generic stringing method statement. Crossing specific method statement shall be submitted at least three months before intended start of stringing activities to avoid delays in obtaining permits from relevant authorities.

Site specific method statements shall also be prepared in cases where general procedures might not be adequately implemented (e.g., constrained space for positioning of the stringing equipment).

The Contractor shall provide all necessary scaffolding and other necessary accessories for the crossing of telecommunications or power lines, roads, railways, buildings, or other obstacles. Drawings of the proposed scaffolding, where applicable, shall be submitted to the Employer/Engineer for approval.

The scaffolding used to cross over powerlines shall be of such dimensions to allow the power lines being crossed to remain operational during construction of the new transmission line. Shutdowns on the lines to be crossed shall be provided for scaffold erection but shall not be deemed obtainable continuously for long periods.

Such restrictions in building and use of the scaffolds shall not be grounds for claiming additional costs.

The scaffold shall be designed to withstand the maximum design wind speed for reduced return period as per Table 3.2 of EN 50341. Consideration shall also be given due to impact loading by dropping of the phase conductor. The scaffold shall consist of square mesh nylon nets attached to steel wire ropes running perpendicular to the lower line route, carried by metal scaffolding at maximum 3 m intervals. The nets shall be attached to the catenary wires by means that do not require the presence of any persons on the net or the catenary wires whilst the lower line is alive. The scaffold shall extend at least 5m either side of the outermost conductors of the upper line. A maximum of 2m of this distance may be provided by means of catchers. Catchers shall be provided at each end of each scaffold support. The catchers may be vertical or inclined to a maximum angle of 45° from the vertical.

Where possible the resistance to earth of the scaffold shall be less than 10 ohms. Special consideration by the Employer and the lower line operator shall be given in cases where this is not attainable with a reasonable number of driven earth rods. Bonding the scaffold to the earthing systems of either the live-line or the line under construction is not acceptable.

Drawings of the scaffold complete with details of the clearance plates and earthing arrangement, together with supporting calculations shall be submitted to the Employer/Engineer for approval.

16.12.2.1 Repair of damaged conductors and OPGW/earthwire

Any damage caused to a conductor or OPGW/earthwire shall immediately be reported to the Employer/Engineer whose decision to replace or repair shall be final.

Damage is any deformity on the surface of the conductor which can be detected visually or by contact. Damage includes, but is not limited to, nicks, scratches, abrasions, kinks, bird-caging, popped-out strands, and broken strands.

Repair of the damage shall be carried out in the manner approved by the Employer/Engineer at the expense of the Contractor.

When there is repeated damage on the same span or in consecutive spans, all the conductor, earthwire and OPGW affected in these spans shall be replaced.

Kinked, bird-caged or severely damaged sections shall be cut out.

All damage caused by come-along clamps and other gripping devices shall be repaired or cut out before final sagging.

Conductor and earthwire repair sleeves shall not be used without the permission of the Employer/Engineer.

Re-drumming because of damage by the Contractor shall be at the expense of the Contractor.

17. Inspection and Testing

17.1 Introduction

This section contains general requirements for inspections and tests of material, parts, equipment, and workmanship of the plant during manufacture, assembling and erection and upon completion to demonstrate compliance with Technical Requirements.

The Employer/Engineer and/or authorized agents shall, at all reasonable times, be allowed free and ready access to the Contractor's premises and those of his suppliers for the purpose of inspecting the specified equipment components and obtaining information as to the progress of the work.

Failure on the part of the Employer/Engineer, at this or any other time, to discover or reject materials or work which do not meet specified requirements shall not be deemed an acceptance thereof nor a waiver of defects therein.

The approval of the Employer/Engineer shall not prejudice the right of the Employer/Engineer to reject equipment if the plant or works are wholly or partially deficient.

17.2 Extent, program, documentation

All main components and equipment offered for and supplied under this Contract shall be type tested. Type Test Certificates for each main component and equipment offered shall be submitted with the Bid.

Type test certificates of all major equipment and major material shall be submitted together with the Bid Documents as stated in the relevant specifications. If necessary, type test certificates shall be translated in all aspects to the English language by the issuing test institute. Type test certificates shall be properly issued to the manufacturer and to the manufacturer’s factory location.

Type test certificates/ type test reports are subject to the approval of Employer/ Engineer. Type-test certificates/ type test reports shall not be older than five (5) years at the time of their submittal. Compilation of type test certificates/ type test reports shall be covered by a table of contents, clearly structured by equipment designation, the relevant standards, their sub clauses and designation of the relevant test.

Type tests shall have been performed by an internationally accredited independent testing laboratory not associated with the manufacturers. Also type tests performed at manufacturer’s laboratory and witnessed by accordingly accredited independent third party are acceptable. Accreditation to the testing laboratory/ third party shall be provided by an according signatory member of International Laboratory Accreditation Cooperation (ILAC).

Upon submission of relevant type test certificates and proof that the equipment and material to be tested is identical to that covered by the test certificates, the Employer/ Engineer will waive the requirements for corresponding type tests called for in this Specification and/ or specified in the Standards.

On request of Employer/ Engineer full type test report/ protocol shall be provided.

During manufacture, erection and after completion all materials, components and equipment supplied as well as works performed under this Contract may be subjected to inspection by the Employer/Engineer.

The works may also be subjected to inspection and tests by any approved agencies of insurance or inspection companies, approved by the Employer/Engineer, in accordance with the requirements of these technical requirements.

17.3 Facilities for inspections and tests

The Contractor shall provide all the test equipment and test sets required for carrying out the inspection and tests agreed upon on the inspection and test plan.

The Contractor shall submit test programs for factory and site testing that is subject to approval by the Employer/Engineer. Test methods shall be based on IEC, EN and ISO set of recommendations and standards. Other international standards may be used subject to prior agreement with the Employer/Engineer.

A tentative test program and a test procedure shall be supplied before each individual test. The test procedure shall specify in detail the tests to be performed, based on the specified requirements. Detailed documentation of the tested equipment/materials shall also be available to the Employer/Engineer at the same time. Formats of the test reports intended to be used shall be submitted for approval together with test program.

The Contractor shall duly consider provisions specified in the bidding documents as minimum requirements when preparing the inspection and test plan with respect to type and extent of inspection and tests, to location, orientation, and number of test samples, to frequency and amount of taking samples for statistical quality control and with respect to acceptance criteria for all QA measures.

The Employer/Engineer will return a copy of the Contractor's proposed inspection program indicating those inspection stages for which notification is required. Notification shall be communicated in writing and shall be provided at least 20 days prior to the intended test date. If the Employer and/or the Engineer intend to be present at the test, he will provide at least 24 hours' notice and if his representative does not attend on the notified date the test may proceed unless an alternative date has been requested by the Employer/Engineer.

Within thirty (30) calendar days of completion of each test, copies of all test records, test certificates, graphs, and any other relevant data shall be supplied for all tests carried out in accordance with the provision of the contract. Information provided on such test records shall be sufficient to identify the equipment or materials to which the certificates refer and shall also bear the Contractors' reference and heading.

The test reports shall indicate the tests performed, contract and standard references, the results obtained, instruments used and their valid calibration certificates, names of test personnel, and provide for witnesses' signatures. They shall also be numbered and dated.

17.4 Rejection of elements

Any item of plant or component which fails to comply with the requirements of these technical requirements in any respect at whatever stage of manufacture, test, erection or on completion at site may be rejected by the Employer/Engineer either in whole or part as considered necessary and appropriate.

After modification or adjustment, the Contractor shall submit the item for further inspection and/or tests.

Plant or components with defects of such a nature, that Employer's Requirements cannot be met by adjustment or modification, shall be replaced by the Contractor at his own expense and to the satisfaction of the Employer/Engineer.

17.5 Rules and standards

All equipment shall be inspected and tested in accordance with the requirements of the relevant standards and rules and these Technical Requirements.

The type and extent of inspection shall generally be in accordance with that specified in the standards used for design and construction of the item of equipment.

Additional design tests shall also be carried out as described within Technical Requirements.

Reference to special rules and standards, where designated either directly or as "relevant", is intended to provide a measure of performance, safety, in-shop and on-site testing, and methods of construction and/or installation that shall be considered as complying with minimum requirements of concerned rules and standards.

Where no appropriate standard is available, tests shall be carried out in accordance with the manufacturer's standard practice, which needs the approval of the Employer/Engineer. In such cases the Contractor shall submit to the Employer/Engineer complete data and a suggested procedure for the testing to be performed before manufacture commences.

If the proposed procedure is accepted, the Contractor shall provide the Employer / Engineer with four additional copies before any test is performed.

17.6 Services prior to and during inspections and tests

In accordance with and in addition to agreed standards, the Contractor shall submit procedures for material testing, manufacture, quality control and performance testing as they apply from the procurement phase of raw materials to the finished product.

No inspection shall be made or deemed valid unless the Employer's / Engineer's head offices, the Contractor and Supplier are in possession of all relevant approved drawings and procedures for the item to be tested.

The Contractor shall supply the Employer/Engineer with a copy of drawings and procedures at least one week prior to testing.

All instruments and apparatus required for the inspection or used for the performance of tests shall be calibrated to an agreed standard at reputable, internationally certified laboratory approved by the Employer/Engineer. The cost of making such calibrations shall be borne by the Contractor in all cases.

17.7 Quality Control of Materials

Materials shall be manufactured and tested in accordance with these Technical Requirements, specified standards and testing programs approved by the Employer/Engineer. Where appropriate standards are specified, the equipment shall be tested in accordance with the relevant EN/IEC regulations.

All materials shall be suitably identifiable and traceable to supporting test certification.

Material supplier's certificates of compliance will be acceptable for minor items only at the discretion of the Employer/Engineer.

17.8 Workshop Assembly

In addition to the quality and production control tests, the following shop assembly work and tests shall be made to check measurements, fitting, and functioning.

Equipment to be furnished shall be shop assembled to a status sufficient to prove that the design and workmanship have been executed in accordance with the technical requirements, that the delivery is complete, and that no work remains to be done at site which reasonably may be done at the workshop.

Where applicable, each item of the equipment shall be assembled completely prior to delivery.

Field joints shall be temporarily connected.

All parts shall be properly match marked, identified, and doweled to ensure and, where practicable, facilitate correct and quick field assembly.

If the assembly shows defects in the design or manufacture or unforeseen difficulties in assembling and dismantling, these shall be eliminated. If required, design alterations or corrective machining may be executed provided that no sacrifice with respect to reliability of operation or interchangeability is made and provided that the agreement of the Employer/Engineer has been obtained.

If the corrections cannot be carried out in accordance with the terms mentioned above, the components concerned shall be rejected. The decision on possible subsequent corrections is reserved exclusively to the Employer/Engineer. Faulted equipment parts shall not be delivered.

17.9 Welding

For all structural welded items, the Contractor shall submit the following documented proposals for approval of the Employer/Engineer prior to commencement of welding:

- welding procedure specifications compliant with requirements of EN 1011 set of standards as appropriate
- proposal for the execution of welding procedure tests in accordance with ISO 15614 set of standards as appropriate
- details of qualified personnel and their qualification records based on relevant procedure defined in ISO 9606 set of standards as appropriate and issued by internationally certified independent examining body. If not available, certification procedure specified in 6.6.5 shall be applied.
- post weld heat treatment procedures where applicable
- inspection schedule and quality control documentation templates in accordance with EN 1011 set of standards as appropriate
- non-destructive testing procedures, containing clear references to test methods and associated governing standards, details of qualified personnel and their qualification records based on ISO 9712 or alternative, internationally recognized, certification standard
- standard weld repair procedures.

All welders employed on items of plant for this Contract shall be qualified and certified as specified above.

All welds shall be visually examined and shall be of smooth contour, free from cracks, undercuts, and other defects. Welds shall be non-destructively tested in accordance with approved testing procedure, results recorded on approved quality control document templates and submitted to Employer/Engineer.

17.10 Galvanized zinc coatings

Surfaces shall be visually inspected. Bare patches, lumps, blisters, or inclusions of foreign matter shall be cause for rejection.

Zinc coating thickness shall be determined non-destructively in accordance with ISO 2178 or coulometrically in accordance with ISO 2177 or an equivalent standard.

17.11 Inspections and Tests during Manufacture

As far as practicable, quality of materials, workmanship, and performance of all items of the equipment furnished under the present contract shall be inspected at the places of manufacture by the Contractor's QA inspectors.

Equipment shall wherever practical be subject to tests on completion to prove that the reliability, operation, and performance conform to the requirements of these technical requirements and the provisions of the relevant standards.

All facilities shall be provided by the Contractor to enable the Employer and the Engineer to carry out the necessary inspection of the equipment components and the costs of all tests during manufacture and preparation of test records are to be borne by the Contractor.

The Contractor shall submit for approval procedures describing the proposed test methods to be used. Type and layout of test facility, location of instrumentation, formula for calculation of results and correction to site conditions, etc. shall be included where appropriate.

All measuring instruments used in tests shall be regularly calibrated and records shall be available for examinations by the Employer/Engineer.

The passing of the inspection or test shall not, however, prejudice the right of the Employer/Engineer to reject the equipment components if they do not comply with the technical requirements when erected, or give complete satisfaction in service. Where the Contractor desires to use stock material, not manufactured specially for the work, satisfactory evidence that such material conforms to the Technical Requirements shall be submitted to Employer/Engineer.

Arrangements shall be made for expediting the shop inspection by having all shop assemblies or pieces covering a single shipment ready at one time. Any packing work as well as transport to the site of the equipment concerned shall not be started before the approval of the Employer/Engineer has been obtained and all QA certificates due at this time for the equipment concerned have been received and reviewed by the Employer/Engineer.

VII-4

Particular Technical Requirements

Table of Contents

1 Preface

The purpose of this document is to define the plant details and the implementation criteria for the design and works to be carried out under this Contract. This document provides supplementary details to the requirements specified in Sub-Section VII-3; therefore, it is necessary to consider the requirements of both documents in conjunction. In case conflicting requirements are specified, those included in this document shall prevail.

The Contractor is expected to diligently familiarize himself with the proposed route and the physical conditions affecting the implementation of the Contract.

The equipment and all materials shall conform to the guaranteed values provided in the Data Sheets.

Furthermore, during Contract implementation, the Contractor shall verify that all plant required for the fully functioning overhead line is provided, enabling plant commissioning in conformance with the Contract.

Prior to delivery, equipment and material data shall be submitted for review and approval.

The project shall be implemented in one phase.

The works performed under this Contract shall enable full functionality of the specified overhead lines.

The anticipated time for completion, including initial phase (surveys, design, procurement, and testing), construction phase and commissioning phase shall be in line with the tentative Project Time Schedule.

2 Project background and objectives

The overall development objective of the project "Efficient Transmission of Energy from Renewable Energy Sources in Nepal" is contributing to sustainable economic and social development of Nepal, while improving living conditions, contributing to poverty reduction, and fighting against climate change.

The expansion of the network infrastructure contributes by enhancing the efficient transmission of electricity from renewable sources, strengthening the reliability of the electricity supply.

3 Project components

The Project includes design and construction of a 220 kV transmission system comprising approximately 45 km of double-circuit transmission line between Lekhnath and Damauli, as well as substations at the termination locations. The Project provides facilities for evacuation of energy generated by hydro-power plants (HPP) in the Seti-Madi river basin.

The Project consists of two components:

Package A:

- Double circuit 220kV overhead transmission line Lekhnath - New Damauli
- Loop-in/Loop-out (LI-LO) connection of 220kV Tanahu Hydro OHL into New Damauli substation
- LI-LO connection of existing 132kV Damauli - Bharatpur OHL into New Damauli substation.

Package B:

- Extension of existing 220/132kV Lekhnath substation
- New 220/132/33/11kV Damauli substation.

For procurement purposes the Project is divided in two Lots as follows:

Lot 1: Overhead line works (Package A)

Lot 2: Substation works (Package B)

This document sets out Contract-specific Technical Requirements for Lot 1: Overhead line works. It is a part of a set of documents forming the Employer’s Requirements, as defined by the General Conditions of the Contract, and should therefore be read in conjunction with other documents from this set. For further details about the content of Employer’s Requirements and Lot 1 Scope of Works reference shall be made to Sub-Section VII-1.

4 Standards

For design, manufacturing, packing, transporting, storing, installation and testing of the transmission line components, equipment, and material the following standards, regulations, and rules shall apply:

- EN standards
- IEC standards and recommendations
- ISO Standards
- Nepalese standards, regulations, and rules as applicable.

The transmission line design shall generally follow the requirements of EN 50341-1.

Within this document references to industry standards / norms do not include the year of issue of the current version (at the time of writing) of each document. It shall be understood that intention of the Employer’s Requirements is the usage of latest version of the industry standards / norms. Compliance with this intention is responsibility of the Contractor.

5 Overhead line routing

5.1 Preliminary line route

Layout drawings of the preliminary proposed overhead line route and the list of angle points are provided in Annex A

WGS 84 coordinates (World Geodetic System 1984) are used for the horizontal datum (X and Y). The projection is Universal Transversal Mercator (UTM) Zone 45N.

The detailed topographic survey of the proposed route corridor shall be provided by the Contractor to enable finalization of the line design. The minimum width of the survey swathe shall be 60m (30m on each side of the centreline).

Route modifications shall only be possible with Employer's approval. As a general principle, no deviations from preliminary line route shall be accepted except where such deviations are demonstrated by the Contractor as unavoidable.

5.2 Line Survey and Route Finalization

The Contractor shall carry out detailed line survey, following the preliminary proposed line routes, to finalize the line design.

The line survey shall be performed by qualified and experienced surveyors in accordance with requirements of Sub-Section VII-3. At least one month before planned commencement of the work, Contractor shall submit qualification records of the proposed personnel, the work program, and a list of survey equipment for approval by the Employer/Engineer.

During the survey, the Contractor shall also verify the location of existing services like water mains, gas pipelines, telecommunication equipment or electricity distribution lines in the proximity of the line route.

The Contractor shall ensure that no induced voltages or any other interferences or hazards affect the proposed line.

Based on topographical survey outcome and site observations, the Contractor shall confirm the viability of preliminary route or propose adjustments, if any, for Employer's approval. Adjustments shall be limited to the areas already assessed for environmental and social impact under ESMP wherever possible. Detailed procedure for route change management is provided in the ESMP.

The costs of these works are part of lump sum cost for the line survey and approval in price schedules.

Following guiding principles shall be observed for determination of potential route adjustments:

- avoiding inhabited areas, villages, and individual houses wherever possible. Minimization of the eventual impact of construction activities to private properties
- avoiding protected or otherwise restricted areas, diligent and considerate approach to environmental issues
- avoiding or minimizing crossings over other high voltage lines and main roads. The crossing angles need to be as close to 90 degrees as possible
- remaining in proximity of the existing roads to facilitate access for construction, inspection, and maintenance
- avoiding areas prone to flooding and erosion, intermittent water courses, run-off areas and areas of alluvial sediment
- For angle tower locations the need to enable transport and positioning of conductor drums and stringing equipment shall be considered.

Final detailed drawings of the line route shall be submitted to the Employer/Engineer for approval. The drawings form the basis for obtaining the building permit by the Employer.

5.3 Line Route Approval

The Contractor shall submit to Employer/Engineer, for review and approval the following:

- route maps and profile drawings
- tower lists and the proposed tower locations accurately presented to facilitate identification of Project Affected Persons (PAP)
- clearance reports demonstrating that all safety clearance requirements are met
- a map showing all access roads, work areas (including positions for drums and stringing equipment), and storage yards necessary for the construction works overlayed with cadastral data for identification of PAPs, including identification of all individual owners affected by the works or whose properties are situated within the Right of Way.

During the approval procedure by the authorities and negotiations with Project Affected Persons the Employer may request route modifications. The Contractor shall consider such changes after surveying the modified line route to accommodate them into revised line design.

6 Overhead line design

European Standard EN 50341- 1:2012 “Overhead electrical lines exceeding AC 45kV”, with the approach of Part 1 - “General requirements – Common specifications” shall be applied for the integral design of the overhead line and its components.

The following are the basic defining parameters of the design approach:

- Design Working Life: 50 years
- Theoretical return period T of climatic actions: 50 years

Based on the preliminary line route and the Employer’s Requirements, the Contractor shall perform own investigations, calculations, and studies to optimize the line design.

The Contractor retains full responsibility for the complete and comprehensive design adapted to the actual project conditions.

Reference altitudes for design parameters are:

- wind pressure 1,500 m
- insulation design 1,500 m

6.1 Design method

The design method defined in EN 50341-1:2012 is based on limit state concept used in conjunction with the partial factor method. Limit states are defined as states beyond which the overhead line no longer satisfies the design performance requirements. Distinction is made between:

a) ultimate limit states associated with collapse, excessive deformation, loss of stability or other forms of structural failure and
b) serviceability limit states defined as conditions (i.e., flashovers, violations of clearance limits) beyond which specified service requirements for an overhead line are no longer met.

Partial factor method enables consideration of varying probability levels for verification of compliance with specified requirements:

a) the effects of design actions shall not exceed the design resistance of the OHL at the ultimate limit state
b) the effects of design actions shall comply with the performance requirements of the OHL for the serviceability limit state.

6.2 Electrical system requirements

Main electrical system requirements are summarized in Table 6-1.

Table 6-1: Electrical system requirements

<table>
<tr><td>Description</td><td colspan="2">Value</td><td></td></tr>
<tr><td>Nominal voltage</td><td colspan="2">132kV</td><td>220kV</td></tr>
<tr><td>Highest voltage for equipment</td><td colspan="2">145kV(RMS value)</td><td>245kV(RMS value)</td></tr>
<tr><td>Rated frequency</td><td colspan="2">50Hz</td><td>50Hz</td></tr>
<tr><td>Conductor configuration</td><td>158-AL1/37-ST1A (Wolf)</td><td>2 x 528-AL1/69-ST1A (Moose)</td><td>2 x 382-AL1/49-ST1A (Bison)</td></tr>
<tr><td>Maximum power transfer capacity</td><td>1 x 70MVA</td><td>540 MVA per circuit, 1080 MVA in total (IEEE Standard 738-2012 method of calculation for 30°C T_{cond} rise, 1120 W/m^2 Solar radiation, 0.6 m/s wind speed)</td><td>450 MVA per circuit, 1080 MVA in total (IEEE Standard 738-2012 method of calculation for 30°C T_{cond} rise, 1120 W/m^2 Solar radiation, 0.6 m/s wind speed)</td></tr>
<tr><td>Standard lightning impulse withstand voltage</td><td>650kV (peak value)</td><td>1050kV (peak value)</td><td>1050kV (peak value)</td></tr>
<tr><td>Short duration power frequency withstand voltage</td><td>275kV(RMS value)</td><td>460kV(RMS value)</td><td>460kV(RMS value)</td></tr>
</table>

6.2.1 Electrical clearances

6.2.1.1 Internal clearances

Internal clearances include phase-to-phase and phase-to-earth clearances at the top of support and in the span.

Following values shall be used (symbols as defined in EN 50341-1):

Still air condition:

D_{pp} = 2.80 m

D_{el} = 2.50 m

Nominal wind condition (3-year return period, ref. EN 50341-1, Clause 5.6.3.3):

D_{el} = 1.70 m

Extreme wind condition (50-year return period, ref. EN 50341-1, Clause 5.6.3.2):

$D_{50Hz\_p\_e}$ = 0.85 m

6.2.1.2 External clearances

Clearances to obstacles shall be as per Table 6-2.

Table 6-2: External clearances

Description	Vertical clearance[1] (m)
Residential areas	8.5
Natural land	7.0
Cultivated land	7.5
Trees	5.0
Road	8.0
Highway	9.0
Rivers and water areas	6.5
Telecommunication lines	4.0
Railway tracks (non-electrified)	18.0
Railway tracks (electrified)	4.5[2]
Overhead lines up to and including 220kV	5.0
Overhead lines above 220kV up to and including 400kV	5.5

In addition, horizontal clearances for conductor in swung condition (see Clause 6.2.2) shall satisfy requirements specified in Section 5.9 of EN 50341-1.

6.2.2 Load cases for calculation of clearances

For determination of electrical clearances following load conditions shall be used:

1. Still air
2. Nominal wind load, with a 3-year return period, for 10 minutes mean wind velocity
3. Extreme wind load, with a 50-year return period, for 10 minutes average wind velocity.

Basic wind speed (50-year return period) is specified in Section 6.4.2.1. Wind speed for 3-year return period shall be calculated using conversion factor C_T=0.76. Wind loads for clearance verification shall be based on mean wind pressure as defined in Clause 4.3.3 of EN 50341-1.

Maximum conductor temperature specified in Clause 6.3.1 shall be considered for all load cases.

6.2.3 Pollution and specific creepage distance

Medium pollution level with creepage distance of 25 mm/kV shall be considered.

[1] Additional 0.20m shall be considered to account for potential survey and sag errors
[2] Clearance to railway electrical system

6.2.4 Electric and magnetic field limits

Unless otherwise specified by stricter local regulations, , the electric field and the magnetic field at the edge of Right-of-Way shall not exceed the allowable limits specified below.

The maximum electric field:

- 5 kV/m in populated areas and
- 10 kV/m in the rest of line if general public is not exposed to emissions exceeding 5 kV/m.

The maximum magnetic field shall be 100µT

6.2.5 Audible noise

Unless otherwise specified in stricter local regulations, the maximum audible noise level at the edge of Right-of-Way in case the most onerous weather conditions shall be limited to ensure that at the following areas the respective limit values are not exceeded :

- general urban areas: 63 dB(A) during the day and 45 dB(A) at night
- urban centre: 60 dB(A) during the day and 45 dB(A) at night
- small and scarce residential areas: 55 dB(A) during the day and 40 dB(A) at night
- dense residential areas: 50 dB(A) during the day and 35 dB(A) at night
- hospitals and nursing homes: 45 dB(A) during the day and 35 dB(A) at night.

6.3 Design criteria

6.3.1 Temperature

Temperatures to be considered shall be as per Table 6-3.

Table 6-3: Temperature limits

Description	Value
Maximum air temperature	50°C
Minimum air temperature	0°C
Annual average temperature (Every-Day-State)	32°C
Maximum phase conductor temperature	80°C
Minimum phase conductor temperature	0°C
Maximum phase conductor temperature under short-circuits current based on initial temperature of 60°C and 1 second duration	170°C
Maximum OPGW temperature	50°C
Minimum OPGW temperature	0°C

6.3.2 Sag-tension criteria

Following conditions shall be considered for determination of conductor / earthwire / OPGW sag and tension:

Ultimate Limit State (ULS)

- Maximum wind pressure (peak value) derived from basic wind velocity specified in 6.4.2.1 at minimum temperature

ULS tension limits shall be based on the rated strength of conductor / earthwire / OPGW and appropriate material factor defined in 6.5.2.

Serviceability Limit State (SLS)

- Every-Day-State (EDS)
- maximum temperature
- minimum temperature.

Tension limit for EDS condition (initial) shall be set at 22% of the rated strength values (aeolian vibration control criteria).

If the manufacturer prescribes lower limits for the maximum OPGW stress than those allowed by these Requirements, those lower limits shall prevail.

The OPGW shall be suitable for stringing on spans up to 800 m in length, with sags coordinated to those of the conductor. For the nominal span under everyday condition, the final OPGW sag shall not exceed 90% of the phase conductor sag.

At all angle points the prescribed minimum bending radius shall be observed. If necessary, special tandem or multiple stringing blocks shall be used for stringing the OPGW at angle points.

The Contractor shall supply stringing data (initial and final, accounting for conductor creep) calculated for different line spans in a chart or tabular form, sag and tensions for the temperatures between 0° and +50°C.

The Supplier shall state the maximum tension to which the OPGW may be strung without affecting the optical properties of the fibres. The Contractor shall ensure this tension is not exceeded during stringing.

6.4 Actions on lines

6.4.1 Permanent loads

Self-weights of supports, insulators, conductors, fittings, and equipment act as permanent loads and shall therefore be included in all design load combinations.

6.4.2 Climatic Loads

Climatic loads due to wind and/or ice (if applicable) on the overhead line components shall be determined in accordance with the following requirements.

6.4.2.1 Wind loads

Value $V_{b,0}$=28m/s shall be considered as basic wind velocity in accordance with EN 50341-1, Clause 4.3.1. Conductor temperature corresponding to EDS shall be used for calculation of the conductor tension under extreme wind loads.

Calculation of wind forces on individual OHL components shall be done fully in accordance with Section 4.4 of EN 50341-1. Appropriate terrain category as per Table 4.1 of EN 50341-1 shall be determined based on the observations of detailed line survey.

Reference heights, structural and drag factors shall be as specified below.

Table 6-4: Reference height, structural and drag factors

Element	Reference height	Structural factor	Drag factor
Conductors	determined as mean arithmetical height of centre of gravity of all conductors (method 3 as per Table 4.3)	calculated in accordance with Clause 4.4.1.2. Where appropriate, reduction of the effect of the wind pressure due to the section length shall be considered.	calculated in accordance with Clause 4.4.1.3
Insulator sets	calculated as mean arithmetical height of centre of gravity of all insulators	taken as 1.0	taken as 1.2
Towers	lattice towers shall be divided into sections in accordance with method 1 specified in Clause 4.4.3.2. Reference height of each section shall be taken as the height at the mid-point of the section. Individual section height shall not exceed 8m	calculated in accordance with Clause 4.4.3.2	calculated in accordance with Clause 4.4.3.2 for each section considering its solidity ratio

6.4.3 Security loads

Security loads based on the failure containment concept shall be used to secure adequate torsional and longitudinal resistance of supports. Detailed description of load combinations which include security loads is provided in Clause 6.5.

6.4.4 Safety loads

Two loading conditions described below shall be considered:

6.4.4.1 Construction and maintenance loads

These loads largely depend on applied construction methodology. Appropriate loading values shall be determined based on actual working procedures as defined by the Contractor's Method Statements for various activities (e.g., tower erection, stringing). The sequence of installation of conductors shall be duly considered. Load calculations shall be based on the requirements of IEC 60826. Pre-stressing tension of temporary support guys shall be considered. Methods for controlling pre-stressing tension of temporary support guys shall be included in stringing method statement and strictly implemented during stringing works. Proposed methodology and calculated loads shall be the submitted for approval by the Employer/Engineer.

6.4.4.2 Loads related to the weight of linesman

Characteristic concentrated load of 1.0kN shall be applied to the most unfavourable position on all members which can be climbed and are inclined at an angle less than 30° to the horizontal plane.

Additionally, on the most unfavourable position of all members of crossarm compression chord plan view, a characteristic concentrated load of 3.0kN shall be applied under construction and maintenance condition.

6.5 Load combinations

The load combinations to be considered for the structural verification (design) of the line supports, foundations and components shall be based on Table 4.6 of EN 50341-1 modified as specified below.

All load combinations shall include permanent loads described in Clause 6.4.1.

Wind perpendicular to the line is designated 'transverse wind'. The wind direction at 45° and 60° at the line is designated 'oblique wind.' The wind in longitudinal direction (in direction of the line) is designated 'longitudinal wind'.

Traditionally, load combinations that include only permanent and climatic loads are referred to as "*normal working conditions*".

The loads on towers shall always include conductor tensions caused by load cases included in corresponding combination. Transverse and longitudinal components of these loads shall be applied in such a way as to ensure:

a) structural resistance of towers for the full range of applicable deviation angles for all loading combinations
b) determination of maximum foundation loads, both uplift and compression for all loading combinations
c) structural resistance of towers for potential longitudinal imbalance under normal working conditions arising from large variation in length of adjacent spans and/or large variation in the length of the 'ruling' spans of two adjacent sections.
d) structural resistance of towers to maximum torsional effects under security loading conditions
e) structural resistance of bracing members of 'box' crossarms under normal working conditions (namely vertical unbalance).

Conductor tensions in this context means tensions caused by the loading both in conductors and earthwire/OPGW.

Load combinations for different structure types shall be as specified in tables below - labelling as per Table 4.6 of EN 50341-1 with additional sub-designations for clarity.

All double circuit towers shall also be verified for condition with single circuit (3 phases) strung on one side of the tower.

Six circuit towers shall also be verified for condition with three (3) circuits (9 phases) strung on one tower side only.

Table 6-5: Load combinations for suspension towers

Label as per Table 4.6 (EN 50341-1)	Conditions as per Table 4.6 (EN 50341-1)	Sub-designation	Load cases to be considered
1a	Wind loads	C1	Permanent loads Transverse wind loads on conductors, insulators, and towers
		C2	Permanent loads 45° Oblique wind loads on conductors, insulators, and towers
		C3	Permanent loads 60° Oblique wind loads on conductors, insulators, and towers
		C4	Permanent loads Longitudinal wind loads on conductors, insulators, and towers

Label as per Table 4.6 (EN 50341-1)	Conditions as per Table 4.6 (EN 50341-1)	Sub-designation	Load cases to be considered
5a	Security loads: torsional loads	SC1	Permanent loads Transverse wind loads on conductors, insulators, and towers Force due to unbalanced conductor tension applied to any one phase or earthwire/OPGW attachment point. Force intensity as follows (depending on attachment point): -70% of phase conductor tension (complete bundle) calculated for above listed loads, or -100% of the earthwire/OPGW tension calculated for above listed loads
5b	Security loads: longitudinal loads	SC2	Permanent loads Still air condition Force due to unbalanced conductor tension applied to all phase and earthwire/OPGW attachment points simultaneously. Force intensity as follows (depending on attachment point): -20% of phase conductor tension (complete bundle) calculated for above listed loads -40% of the earthwire/OPGW tension calculated for above listed loads
6a	Safety loads: construction and maintenance loads	S1	Permanent loads Construction and maintenance loads as described in Clause 6.4.4.1
6b	Safety loads: loads due to the weight of linesman	S2	Permanent loads Construction and maintenance loads as described in Clause 6.4.4.2

Table 6-6: Load combinations for angle towers

Label as per Table 4.6 (EN 50341-1)	Conditions as per Table 4.6 (EN 50341-1)	Sub-designation	Loads to be considered
1a	Wind loads	C1	Permanent loads Longitudinal conductor unbalance due to maximum/minimum back vs ahead spans Transverse wind loads on conductors, insulators, and towers
		C2	Permanent loads Longitudinal conductor unbalance due to maximum/minimum back vs ahead spans 45° Oblique wind loads on conductors, insulators, and towers
		C3	Permanent loads Longitudinal conductor unbalance due to maximum/minimum back vs ahead spans 60° Oblique wind loads on conductors, insulators, and towers
		C4	Permanent loads Longitudinal conductor unbalance due to maximum/minimum back vs ahead spans Longitudinal wind loads on conductors, insulators, and towers
5a	Security loads: torsional loads	SC1	Permanent loads Transverse wind loads on conductors, insulators, and towers Force due to unbalanced conductor tension applied to any two phase, or any one phase and one earthwire/OPGW, attachment points. Force intensity as follows (depending on attachment point): -100% of phase conductor tension (complete bundle) calculated for above listed loads, or -100% of the earthwire/OPGW tension calculated for above listed loads
5b	Security loads, longitudinal loads	SC2	Permanent loads Still air condition Force due to unbalanced conductor tension applied to all phase and earthwire/OPGW attachment points simultaneously. Force

Label as per Table 4.6 (EN 50341-1)	Conditions as per Table 4.6 (EN 50341-1)	Sub-designation	Loads to be considered
			intensity as follows (depending on attachment point): -75% of phase conductor tension (complete bundle) and earthwire/OPGW tension calculated for above listed loads in one span
6a	Safety loads: construction and maintenance loads	S1	Permanent loads Construction and maintenance loads as described in Clause 6.4.4.1
6b	Safety loads: loads due to the weight of linesman	S2	Permanent loads Construction and maintenance loads as described in Clause 6.4.4.2

Table 6-7: Load combinations for terminal towers

Label as per Table 4.6 (EN 50341-1)	Conditions as per Table 4.6 (EN 50341-1)	Sub-designation	Loads to be considered
1a	Wind loads	C1	Permanent loads Transverse wind loads on conductors, insulators, and towers.
		C2	Permanent loads 45° Oblique wind loads on conductors, insulators, and towers
		C3	Permanent loads 60° Oblique wind loads on conductors, insulators, and towers
		C4	Permanent loads Longitudinal wind loads on conductors, insulators, and towers

Label as per Table 4.6 (EN 50341-1)	Conditions as per Table 4.6 (EN 50341-1)	Sub-designation	Loads to be considered
5a	Security loads: torsional loads	SC1	Permanent loads Transverse wind loads on conductors, insulators, and towers No force applied to any two phase, or any one phase and one earthwire/OPGW, attachment points. Force intensity on other attachment points as follows (depending on attachment point): -100% of phase conductor tension (complete bundle) calculated for above listed loads, or -100% of the earthwire/OPGW tension calculated for above listed loads
6a	Safety loads: construction and maintenance loads	S1	Permanent loads Construction and maintenance loads as described in Clause 6.4.4.1
6b	Safety loads: loads due to the weight of linesman	S2	Permanent loads Construction and maintenance loads as described in Clause 6.4.4.2

6.5.1 Load factors

The partial factors for actions defined in Table 6-8 below shall be used in conjunction with the partial factors on material properties defined in Table 6-9 for verification of design resistance of overhead line components in ultimate limit state.

Table 6-8: Partial load factors

Action	Symbol	Value	Applicable for load combinations
Permanent actions: self-weight	γ_G	1.10 (0.9 where effect is favourable)	All except Construction and Maintenance
Variable actions - Climatic loads: Maximum wind	γ_W	1.35	C1, C2, C3, C4
Security Loads (Transverse & Longitudinal)	γ_S	1.00	SC1, SC2 suspension Tower
Security Loads (Transverse & Longitudinal)	γ_S	1.35	SC2 Tension Towers

Action	Symbol	Value	Applicable for load combinations
Construction and maintenance loads (Vertical γ_G, Transverse γ_c Longitudinal γ_c)	γ_c γ_G)	1.50 (2.0)	S1, S2

Calculation of conductor tensions shall include above factors as per corresponding load combination for verification of ultimate limit state. Load factors shall not be applied for serviceability limit state (clearance) verifications.

6.5.2 Material factors

Partial material factors shall be as per Table 6-1.

Table 6-9: Partial material factors

Component	Symbol	Value
Conductors, earthwire, OPGW*	γ_M	1.65
Insulators and hardware	γ_M	1.8
Towers		
- Resistance of cross-section areas to yield strength	γ_0	1.1
- Resistance of members to buckling	γ_1	1.1
- Resistance of cross-section areas in tension to fracture	γ_2	1.25
- Resistance of bolted connections to fracture	γ_2	1.25
Foundations:		
Soil properties:		
- Angle of shearing resistance	$\gamma_{\Phi'}$	1.35
- Effective cohesion	$\gamma_{c'}$	1.35
- Undrained shear strength	γ_{cu}	1.4
- Unconfined strength	γ_{qu}	1.4
- Weight density	γ_v	1.0
Materials for foundations:		
- Concrete	γ_c	1.5
- Reinforcing steel	γ_s	1.15

* Unless stricter requirement is prescribed by manufacturer.

7 Overhead line components

7.1 Towers

The towers shall be self-supporting lattice steel and provided with two earthwire peaks designed for carrying one conventional ACS earthwire and one OPGW.

Due to the generally hilly to mountainous terrain, the Contractor shall adopt slim tower design. For double circuit towers maximum ‘true’ slope of the tower legs shall be limited to 200mm/m unless otherwise agreed with the Employer/Engineer. The width of six-circuit towers at base shall be minimized as far as technically practicable.

The design of towers comprises of principal structural design, site-specific verifications, and detailing. The design will be verified by testing of selected tower types.

The choice of the number of tower types is made on a conventional basis. Angle towers are specified for 15°, 30°, 60° and Dead End / Terminal, but following detailed line survey two types of angle towers may be combined in a single design type subject to approval by the Employer/Engineer.

7.1.1 Tower types

The following types of towers shall be used:

- DA: normal suspension tower applicable for line deviation angles α = 0° - 2°
- DB: light angle and section tension tower applicable for line deviation angles α = 0° - 10°
- DC: medium angle tension tower applicable for line deviation angles α = 10° - 30°
- DD: heavy angle tension tower applicable for line deviation angles α = 30° - 60°
- DE: dead-end application suitable for 0 to 45° angle in line direction and 0° to 45° angle of the slack span to the gantry.
- 6T: Multi-circuit tower arranged with 6 crossarms on each side of the tower supporting:
  - on the three bottom crossarms 2 phases each crossarm (total 2 circuits)
  - on the top three crossarms 1 phase each crossarm (total one circuit)
- UCG: undercrossing double circuit gantry to pass under other transmission lines

Tower dimensions shall comply with specified clearance requirements between conductors, earth-wire and optical ground wire, live parts, earthed parts and the ground and obstacles.

Following the detailed line survey, if found economically efficient the Contractor may propose to combine two of the above listed tower types.

Normal suspension tower DA shall have all phase conductors attached by "I"-type vertical suspension insulator set.

The earthwire peak of suspension towers shall be designed to withstand full loads of OPGW as if on tension towers, to enable the option of OPGW jointing on suspension towers.

The bottom width of the towers shall be chosen in such a way that four separate different types of foundations can be installed, if required by nature of soil variation between the four legs.

The stub angles shall be embedded into the foundation and used for connection between the tower and the foundations. The stub angles shall be quoted as foundation part.

Sufficient torsional rigidity and transverse stability of the long horizontal members shall be provided by compliance with conclusions and recommendations listed in Chapter 5 of CIGRE Technical Brochure No. 196. Maximum recommended spacing of 10 m between diaphragms may be exceeded with approval of the Employer/Engineer but shall in no case exceed 12m.

The preliminary tower outlines, along with basic preliminary towers data are presented in Annexes B and C. The tabulated dimensional values are preliminary and approximate, to be used for bidding purpose only. The Contractor shall propose the optimal tower geometry.

In the bidding phase the Contractor shall submit schematic outline of towers showing all tower types, body extensions and leg extensions. The drawings shall contain all relevant dimensions including a table of weights.

7.1.2 Tower top geometry

The tower`s top geometry shall be designed to comply with the internal (at tower) and in-span clearances requirements as defined in this document. The Contractor shall verify the required minimum at-tower and in-span (internal and external) clearances under specified loading conditions and propose the optimal tower geometry.

Additionally, the following aspects shall be observed:

- The dimensions of the cross-arms of the tension towers shall ensure that horizontal spacing between conductors in a plane perpendicular to the conductors are not less than that at normal suspension towers.
- The earth wire support positions shall ensure the corresponding spacing between earth wires as well as the assumed shielding angle (≤20° for double circuit towers and a shielding angle of 0° for the top circuit of the six circuit towers).
- The phase-to-phase and phase-to-earth wire in-span clearances determine the maximum span of the respective tower.
- The earth wire support positions shall ensure the corresponding spacing between earth wires. The phase conductors shall be within the area of the assumed shielding angle.

- Medium angle type DC and heavy angle type DD tension towers shall be equipped with auxiliary jumper suspension insulator sets to restrict the sway of jumper loops. The jumper suspension insulator sets are required only on in-angle crossarms.

7.1.3 Standard tower height

Standard tower height (common tower body with body extension ±0 and four ±0 leg extensions) shall be determined considering the maximum conductor sag at maximum temperature corresponding to the nominal span, the suspension insulator string length, and minimum required ground clearance.

All basic height towers shall be arranged so that, after considering the length of insulator strings and fittings, the point of suspension or attachment of conductors above ground level shall be the same for the towers of any designation.

7.1.4 Body and leg extensions

The towers shall have a wide range of positive and negative leg extensions, facilitating application in steep transverse slopes of up to 30° (approximately 60%).

The typical arrangement of towers standard height, body and leg extensions is shown in Annex D.

To adapt the tower height to the terrain, allow crossing of obstacles and to use the towers as economical as possible the towers shall be provided with a wide range of body and legs extensions.

Each type of tower shall be designed to allow variations in height and therefore shall consist of a common part to which typical trunks (body extensions, four tower legs and four stubs) shall be added for obtaining a complete tower structure.

The common portion shall not require modification to accommodate the different body extensions or leg extensions. The legs shall be suitable for fitting to the common part or to any of the body extensions, without modification to the legs.

Proposed range of tower body and leg extensions is shown in Table 7-1. The Contractor may propose alternative range for Employer’s / Engineer’s approval.

Table 7-1: Range of body and leg extensions

Tower type	DA	DB	DC	DD	DE	6T
Body extensions min / max	-6/+12	-6/+9	-6/+12	-6/+9	-3/+6	-6/+9
Step height	3m	3m	3m	3m	3m	3m
Leg extensions min/max	-3/+6.0	-3/+6.0	-3/+6.0	-3/+6.0	-3/+6.0	-3/+6.0
Step height	1.5m	1.5m	1.5m	1.5m	1.5m	1.5m

7.1.5 Design spans

Recommended design spans are based on the preliminary line routes, terrain configuration and experience with previous projects in similar areas.

They are intended for bidding purposes and as a general guidance, however, may be subject to further adjustments during project implementation design stage, according to findings of detailed line survey and tower spotting analysis. Limited deviation (up to 50m) from nominal design spans may be proposed by the Contractor for Employer's/Engineer's approval.

Table 7-2: Design span limits

Tower type	Line Angle (°)	Nominal Span (m)	Wind Span (m)	Weight Span (max/min) (m)	Max. Phase Span (m)
Normal suspension (DA)	0 - 2	350	450	700/0.7 x wind span	600
Light Angle / Section Tower (DB)	0 - 15	350	450	1500/-700	600
Medium Angle Tower (DC)	15 - 30	350	450	1000/-700	600
Heavy Angle Tower (DD)	30 - 60	350	450	2000/-700	600
Dead End Tower (DE)	0-45	250	250	700/-300	400
Multi-circuit Tower (6T)	0-50	350	350	1500/-700	375
Under Crossing Gantry (UCG)	0 - 10	200	200	500/-500	200

Notes:

1) *The wind spans for angle-tension towers are defined for the maximum design angles. For lower angles, the towers may be used at higher wind spans, based on application charts.*

2) *For the DE the indicated angles refer to one side of the tower while for angle towers the angles given are actual line angles (i.e., line deviation angle at both sides).*

3) *In case of 2°-line angle for the suspension tower DA, the horizontal conductor tension component due to line angle deviation shall be compensated by corresponding reduced wind span*

4) *The phase-to-phase and phase-to-earthwire mid span clearances determine the maximum span of the respective tower.*

5) *The maximum span limited by two different tower types is the average of the maximum spans of the two towers.*

6) *Multi-circuit Tower 6T (six circuit tower) shall be used be also in the section with 4 circuits.*

7) *Multi-circuit Tower 6T to be designed as angle tension tower and junction tower based on actual circuit arrangement and anticipated construction sequence*

7.1.6 Materials and furniture

Steel material shall conform to below requirements:

All load bearing elements (including connection plates) shall be of grade S355J0 as specified by EN 10025-2. Secondary bracing members may be of grade S235J0. Chemical composition, mechanical, technological, and surface properties shall fully conform to requirements of EN 10025-2 for respective steel grades.

For angle members tolerances on shape, dimensions, mass, and length shall be as defined by EN 10056-2. Tower design (detailing) shall include two versions for each tower type:

- standard version to be used in all locations accessible by heavy transport vehicles
- alternative version with reduced length of heavy members (e.g., legs, long bracing members) and additional connections suitable for animal transport.

The minimum thickness (t) and size of steel members of towers shall be as follows:

▪ leg, stub, and main compression members in cross arm	6 mm
▪ all other members having computed stresses	5 mm
▪ redundant members without computed stresses	4 mm
▪ gusset plates	6 mm
▪ equal angle sections	L 45 mm x 45 mm x t
▪ unequal angle sections	L 45 mm x 30 mm x t

Individual member slenderness shall be limited as follows:

▪ for leg members and crossarm chords:	≤120
▪ for main bracing members:	≤180
▪ for secondary bracing:	≤250.

The tower structures shall be of the bolted type. Mechanical and physical properties of bolts shall fully conform to the requirements of EN ISO 898-1. Only property classes 5.6 and 6.8 may be used.

For connections of main load bearing members minimum bolt diameter of 16 mm shall be used. Minimum diameter of 12 mm may be used for secondary bracing connections. Nominal stress area shall be used for calculation of bolt shear capacities.

All bolts shall be installed with one flat washer and one spring washer.

Each tower shall be provided with step bolts of an approved type on one leg spaced alternately on the angle flanges at not more than 380 mm between centres, starting immediately above the anti-climbing device and continuing to each earth wire. The minimum diameter of the step bolts shall be 16 mm. Step bolts shall not be used as connection bolts.

Signs, consisting of aerial patrol signs, phasing signs, circuit name signs, danger signs and number signs shall be made of mild steel covered with enamel on both sides, or of aluminium. The thickness shall not be less than 2 mm.

Writings on signs shall be in Nepali and English language or as otherwise specified by the Employer/Engineer. The graphic standard for all the signage will be supplied by the Employer.

Tower members positioned above insulator strings shall be fitted with galvanized steel needle strips, effectively preventing birds from landing and nesting in these locations. The strips shall extend horizontally enough beyond the protected location and shall be applied to all surfaces a bird can land on.

7.1.7 Corrosion protection

All steel materials shall be hot dip galvanized and tested in accordance with EN ISO 1461. Minimum coating thickness shall be as follows:

- for steel sections and fittings:
  - local coating thickness: 70µm
  - mean coating thickness: 85µm
- for bolts, nuts, and washers:
  - local coating thickness: 45µm
  - mean coating thickness: 55µm

7.1.8 Tower type tests

Following tower type tests shall be performed under the Contract:

- one (1) full scale destruction test of tower type DA
- one (1) full scale ultimate loading test of tower type DB
- one (1) full scale ultimate loading test of tower type DC
- one (1) full scale ultimate loading test of tower type DD
- one (1) full scale ultimate loading test of tower type 6T

Tests shall be performed in accordance with EN 60652 and relevant provisions of the Employer's Requirements. Standard tower heights shall be used for testing unless otherwise agreed with the Employer/Engineer.

7.2 Foundations

The soil geotechnical parameters for bidding purposes provided in Table 7-3 are intended for Tender purpose only. These are based on semi-empirical geotechnical design model as described in Clause M.3 of EN 50341-1.

Table 7-3: Generic soil types

Soil type	Description	Ultimate bearing capacity [kN/m^2)	Frustum angle [°]	Density [kN/m^3]
Type 1	Hard rock	≥1230	N/A	25
Type 2	Fissured rock			
	Dry	≥500	20	15
	Wet (in presence of sub-soil water)	≥500	10	10
Type 3	Normal soil			
	Dry	≥270	25	15
	Wet (in presence of subsoil/surface water)	≥135	15	10/15
	Wet black cotton	≥135	0	-
Type 4	Sandy soil	≥250	20	15

For detailed foundation design, the Contractor shall perform extensive soil investigations as described in Employer's Requirements and provide design calculations based on the obtained information. Geotechnical investigations and laboratory tests shall enable reliable determination of the following design parameters:

For soils:

- weight density
- effective (buoyant) weight density in case of high groundwater levels
- internal friction angle
- effective cohesion, where applicable
- undrained shear strength
- unconfined compressive strength.

In case of multi-layered soils, the parameters shall be determined for each layer.

For rocks:

- crushing strength
- tensile strength
- Young's Modulus
- Poisson's coefficient
- internal friction angle.

In addition to above, Geotechnical report shall also indicate corresponding generic soil type (as per Table 7-3) for each tower location and suitable foundation type. For tower locations where investigations were not performed during geotechnical survey, foundation type and generic soil type shall be specified based on assumed geotechnical profile of the route. Suitability of proposed soil type shall be confirmed, as described below, before installation of foundations.

The types of foundations and quantities in price schedule shall be revised in accordance with the actual geotechnical report. The Contractor shall submit the foundation design and the revised price schedule to the Employer/Engineer for approval.

The minimum extent of geotechnical survey works shall be as follows:

- boreholes or trial pits: minimum 2 per kilometre of the route
- penetration tests (CPT or SPT): minimum 2 per kilometre of the route
- minimum percentage of boreholes based on total number of investigations: 40%
- maximum distance (along the route) between two boreholes: 1.5km

Investigation sites shall, wherever possible, correspond to foreseen tower locations. In case access to tower location is not available for large equipment during geotechnical survey works, manual trial pit excavation shall be performed. Dynamic Penetrometer Light (DPL) test may be performed at such locations in lieu of CPT or SPT. Correlation of DPL test results shall be performed by comparison of SPT and DPL results at accessible site with similar soil characteristics.

For tower locations where site investigations were not performed during geotechnical survey, foundation type shall be proposed based on assumed geotechnical profile of the route. Suitability of the proposed foundation type shall be confirmed by visual examination and field tests (CPT, SPT or DPL in case reliable SPT correlation is already established for the assumed soil type) following the excavation.

Annex Q includes a preliminary geotechnical investigation which is provided to the Bidders/Contractor only for Bidding purposes.

7.2.1 Foundation types

Following foundation types are anticipated:

a) Block (rock) anchor foundation - concrete is cast directly against the face of the excavation with grouted anchors embedded in the rock. Number of anchors and depth of embedment depends on load levels and rock type. Envisaged for soil type 1.
b) Concrete shaft - concrete is cast directly against the face of the excavation with an undercut at the base. Envisaged for soil types 1 and 2.
c) Pad and chimney or pyramid and chimney - common types of OHL tower foundations consisting of a single / stepped pad or pyramid and a chimney which encompasses the stub. Suitable for soil classes 2 to 4. Two main purposes of the pad or pyramid are:
   - spreading of load to larger area, thus reducing the bearing pressure
   - increase of the area with activated soil shearing resistance to increase uplift capacity.
d) Piled foundations - typically consisting of several piles (raked or vertical) and a pile cap. Shall be considered in locations with deep deposits (>3.5m) of wet black cotton soil and locations with frustum angle under 10°.

Contractor may propose alternative foundation solutions, where deemed more economical and adequate for the actual conditions on site.

As a result of the soil investigation undertaken by the Contractor at the tower locations, other types of foundations may be required. The appropriate foundations design is within Contractor's responsibility.

Any alternative foundation type proposed by the Contractor shall meet the following requirements:

- identical or higher safety in all aspects
- the record of previous application of the similar type of foundations, for the similar type of projects
- practical feasibility of implementation of proposed construction works.

Schematic drawings of typical foundations are presented in Annex E.

7.2.2 Materials

Concrete used for foundations shall conform to requirements of EN 206. Minimum compressive strength classes for concrete shall be as follows:

- for foundation types a) to c): C20/25
- for foundation type d) C30/37

Steel reinforcement shall conform to EN 10080 or equivalent international standard approved by the Employer/Engineer. Minimum yield strength for reinforcing bars shall be as follows:

- for diameter <12mm: 300N/mm^2
- for diameter ≥12mm: 420N/mm^2

7.3 Earthing system

Design of earthing system at power frequency shall satisfy the following requirements:

- ensure personal safety with regards to step and touch voltages appearing during an earth fault
- avoid damage to property and equipment
- withstand, from a thermal point of view, the highest fault current as determined by calculation
- ensure mechanical strength and corrosion resistance by observing minimum dimensions.

The calculation of the cross-section of the earth electrodes and earthing conductors depends on the value and duration of the fault current which shall be determined as per requirements of Clause G.3 of EN 50341-1.

Minimum dimensions of earth electrodes shall be as specified in Table G.1 of EN 50341-1. Touch voltage limits shall be as per Figure 4 of EN 50522 unless otherwise agreed with the Employer.

The design and tests shall generally follow requirements of EN 50341-1 and EN 50522. The Contractor shall submit proposal of the testing programme for Employer's/Engineer's approval at least three months before planned commencement of construction works.

The footing resistance shall be measured by the Contractor and approved by the Employer or the Employer's Representative for every tower prior to the stringing of the earth wire. The maximum footing resistance to the general mass of earth shall be 10 ohms, measured during dry season or extrapolated with reference to the driest period of the year.

Typical arrangement of Earthing System is included in Annex J.

7.4 Phase conductors

7.4.1 Technical Requirements

The Aluminium Conductor Steel Reinforced (ACSR) conductors shall have of concentric lay stranded form. One or multiple layers of round hard drawn aluminium wires are stranded over central a steel core. The steel core shall be made of round galvanized steel wires.

The minimum conductivity of the hard drawn aluminium wires shall be sufficient to ensure the required maximum allowed electric resistance of the ACSR conductor (as per the relevant Technical Schedules/Data Sheets included in the Employer's Requirements).

Moreover, the dimensional and mechanical characteristics of the hard drawn aluminium wires shall be adequate to ensure strict compliance with the dimensional and mechanical characteristics required for the ACSR conductor (as per the relevant Technical Schedules/Data Sheets included in the Employer's Requirements).

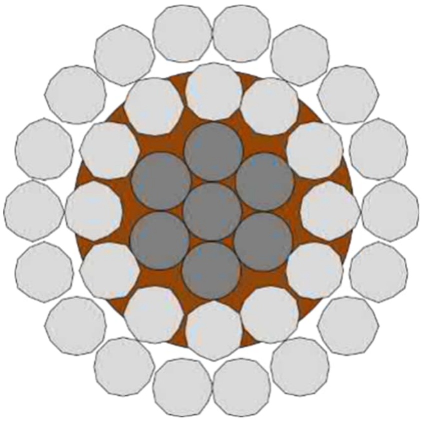
The dimensional and mechanical characteristics of the galvanized steel wires incorporated into the core of the ACSR conductor, shall be adequate to ensure strict compliance with the dimensional and mechanical characteristics required for the ACSR conductor (as per the relevant Technical Schedules/Data Sheets included in the Employer's Requirements).

Moreover, the galvanization class of the steel wires shall be suitable to cope with the most onerous environmental conditions of the geographic area crossed by the overhead line and ensure the required longevity of the ACSR conductors.

To reduce the risk of corrosion, the ACSR conductors shall be greased. The grease shall be in accordance with the standard EN 50326: "Conductors for overhead lines - Characteristics of greases". Moreover, the grease shall be applied in strict compliance with the specification/instructions from the grease supplier.

All interstices between the wires shall be filled except for the outer layer - Case 2 of EN 50182 as per Figure 7-1. The amount of grease shall not vary more than ±10% from the calculated nominal value.

Figure 7-1: Grease application (EN 50182, case 2)



7.4.2 Quality Assurance

Type Tests

The Bidders shall provide type test reports which confirm compliance with the required standards. As a minimum the following test reports shall be provided:

- tensile strength as per EN 50182, Chapter 6.4.8
- stress strain curves as per EN 50182, Chapter 6.4.7
- stringing test as per EN 50182, Chapter 6.4.9.

Type tests carried out on similar ACSR conductors may be accepted as preliminary evidence of the capabilities and quality of the proposed ACSR supplier. Prior to the supply of the ACSR conductor, the Contractor shall provide as a minimum the test reports confirming the successful completion of the above listed type tests.

7.4.3 Conductor Fittings

The Contractor shall ensure close and continuous liaison between the manufacturers of the phase conductors and manufacturer of clamps and fittings so that the equipment will be perfectly adapted.

All the data and performance characteristics shall be duly substantiated with suitable calculations and tests as specified. Non-compliance with the required guaranteed values will result in rejection of the respective goods during the Contract implementation. The Contractor shall then replace the non-compliant goods at his own expense and shall bear the subsequent contractual accountabilities.

7.4.4 Phase Conductor Types

Following phase conductors shall be used:

Table 7-4: Conductor configuration

Line Name	Conductor configuration
Lekhnath - Damauli 220 kV double circuit OHL	2 x 528-AL1/69 - ST1A
Tanahu - Bharatpur 220 kV four circuit LILO	2 x 382-AL1/49-ST1A
Old Damauli - Bharatpur 132 kV double circuit LILO	1 x 158-AL1/37-ST1A

Main conductor properties are provided in Table 7-5.

Table 7-5: Conductor properties

Description	Unit	Value		
Reference Standard: EN 50182-12 Table F.42	-	528-AL 1/69 - ST1A	382-AL1/49-ST1A	158-AL1/37-ST1A
Conductor type	-	ACSR	ACSR	ACSR
Designation	-	MOOSE	BISON	WOLF
No. in a bundle	-	2	2	1
Bundle horizontal spacing	mm	450	450	-
Cross-sectional area: - Aluminium - Steel - ACSR	mm^2	 528.5 68.5 597.0	 381.7 49.48 431.2	 158.1 36.9 194.9
Number of wires: - Aluminium - Steel	-	 54 7	 54 7	 30 7
Wire diameter: - Aluminium - Steel	mm	 3.53 3.53	 3.0 3.0	 2.59 2.59
Diameter	mm	31.8	27.0	18.1
Mass per unit length	kg/km	1997.3	1443.4	725.3
Breaking load	kN	159.92	120.9	68.91
Electrical resistance at 20°C	Ohm/km	0.0547	0.0757	0.1829

7.4.5 Packing, Shipping, Transport

Empty conductor drums shall be transported to the location specified by the Employer and handed over to the Employer. Storage of empty drums until the handover shall be responsibility of the Contractor.

7.5 OPGW and earthwire

7.5.1 Technical Requirements

The Optical Ground Wire (OPGW) is fundamentally an earth wire incorporating optical fibres. Therefore, its design shall serve the purpose of ensuring the specific electric and mechanical features required for the earth wire while ensuring adequate protection for the optical fibres.

The basic functionality of the OPGW is therefore to provide protection against lightning, to carry the short circuit currents without physical degradation of both the metallic components and the optical fibres and to serve as a reliable telecommunication cable.

The OPGW shall be suitable for service in the local climate with the main characteristics confirmed in the Data Sheets. The main design data and performances of the conductors are to be entered by the bidders in the Data Sheets and shall become part of the Contract. All these data shall be proven by means of calculations and tests as specified. If the guaranteed values are not achieved, the Employer/Engineer may reject the said part of the goods at the Contractor's expense.

The supplier shall demonstrate suitable operation experience and provide type test records for the proposed OPGW type.

All existing type test certificates submitted shall be not older than 10 years.

7.5.1.1 Optical Fibres

All fibres shall be proof tested ≥ 1GPa maintained during 1 second for a minimum elongation of 1.5%.

No joints shall be allowed in any fibre in any drum length.

Point discontinuities shall be acceptable if OTDR measures taken from both ends of the cable at the applicable wavelength show a difference of less than 0.05dB or every fibre in every drum.

The refractive index of the optical fibres at 1550 nm and all basic parameters of the proposed fibre shall be provided in the Data Sheets.

The coating shall be mechanically easily removable over a length of up to 50 mm for the purpose of cleaning, cleaving and fusion splicing.

The optical fibre coating material shall not generate H2 gas around the optical fibres that will increase the optical loss as specified above over the designed life span of the optical fibre. Details of the methods employed to minimize the generation of H2 gas shall be provided with the Bid.

The individual optical fibres shall be uniquely identifiable through a colour coding scheme in accordance with ITA/EIA-598-C.

In case duplicate colours are to be used, the fibres shall be uniquely identifiable through black tracers.

The required characteristics of the optical fibres are included in the Technical Data Sheets.

7.5.1.2 Optical Unit

The optical fibres shall be housed in a central metallic tube protected by a layer of helically applied metallic wires, or alternatively inside jelly-filled stainless-steel tubes stranded over the central wire. The optical unit shall not be included in the calculation of the Nominal Breaking Load rating of the OPGW.

The optical fibre housing shall be made of extruded aluminum or longitudinally welded stainless steel (or a combination of both). The fibres shall be loose inside the metallic tube. The fibre overlength shall ensure the required strain margin without introducing excessive overbending of the fibres. Excessive overbending causes additional attenuation and might reduce the life expectancy of the fibres.

The optic unit shall be adequately designed, manufactured and tested to ensure a suitable incorporation of the required number of optical fibres.

To avoid any physical degradation of the optical fibres under the most onerous loading conditions, the OPGW shall be adequately designed to ensure suitable strain margin. In this regard, the optical fibres shall remain without any mechanical stress when the OPGW is submitted to the following loading conditions:

- design span at the minimum temperature and no wind
- design span at maximum temperature and no wind
- design span with Everyday Stress
- design span carrying the specified short-circuit current.

In the event of a short-circuit, the maximum admissible temperature in the optical unit shall not exceed 180°C.

A water block mechanism shall prevent longitudinal water penetration in the optical core and in the individual tubes with optical fibres.

The water-blocking compound shall retain its characteristics up to the rated fault current temperature. The requirements of the water-blocking compound are as follows:

- shall not inhibit movement of the fibre within the tubes
- be compatible with other materials incorporated in the OPGW
- avoid water ingress under the most onerous operating conditions
- shall not generate H2 gas emissions over the operating temperature range and service lifetime
- shall be dermatological safe.

The inside surface of the tube shall be smooth. In case of steel tubes with a welded seam, no welding debris shall be left inside the tube. Lengths of tube shall not be welded together, i.e., there must be no transverse welds. The tube shall be free of pinholes.

The welding depth of the longitudinal seam in stainless steel tube shall be in the range 120% to 140%. The non-circularity of the stainless-steel tubes shall not exceed 5%.

The design of the OPGW shall prevent longitudinal fibre sliding in the loose tubes.

If the OPGW incorporates more than one optical unit a permanent identification scheme shall identify unambiguously each of the optical units - typically the tubes are marked with a scheme of black rings made with indelible black ink.

The identification scheme for the optical fibres incorporated in the optical unit shall permit an easy and unambiguous identification of the fibres.

The individual optical fibres shall be uniquely identifiable through a colour coding scheme in accordance with ITA/EIA-598-C.

7.5.1.3 Armor

The armor protecting of the optical unit is made of stranded aluminum clad steel wires (ACS) or a combination of stranded aluminum alloy wires (AA) and ACS wires.

The ACS wires of the OPGW shall be type A20SA with a conductivity of 20.3% IACS. The aluminum coating shall be smooth, clean, of uniform thickness and free from defects.

The aluminum alloy wires shall be type AL 3 or AL4 in accordance with EN 50183. The outer surface shall be smooth and without visible defects.

The outer strands shall be dimensioned to cope with the isokeraunic level of the area where the OPGW will be strung. This feature shall be demonstrated via suitable lightning type tests.

Alternatively, the Contractor may submit reports of lightning type tests carried out with identical or more onerous condition on OPGWs with similar design having an outer layer made with wires of the same type and with diameter not exceeding the diameter of the outer wires of the proposed OPGW.

The armor of the OPGW shall be designed to withstand the most onerous dynamic and permanent loads expected during continuous operation at nominal parameters, as well as for faults and transient events. The OPGW shall be designed to evacuate the required phase–to-ground short circuit current without any performance degradation. The short-circuit capacity of the OPGW cable shall be calculated using the maximum allowed temperature in the optical unit as the final temperature, and the maximum ambient temperature as the initial temperature.

The inner interstices of the armor shall be protected with cold-applied grease (Type A) in accordance with Case 2 of EN 50182. The drop point of the grease shall exceed 110°C.

Regarding cable installation and storage, the OPGW shall be designed and manufactured to cope with the hereunder conditions:

- storage temperature range: - 40°C up to + 50°C
- installation temperature range: - 10°C up to + 50°C
- operating temperature range: - 40°C up to + 80°C.

7.5.2 Quality Control

7.5.2.1 Type Tests

Tests shall be performed in accordance with IEC 60794-4. IEC 60794-1-2 and EN 50182. Type tests certificates may be accepted provided that tested OPGW structure corresponds to the offered one.

The suspension and anchoring sets used in the type tests shall be of the same type as those to be used in the project.

Prior to manufacturing, the Contractor shall submit for the approval of the Employer/Engineer the following minimal set of test reports:

7.5.2.1.1 Stress-strain test

The stress-strain test shall be performed in accordance with Annex C of the EN 50182. The objective is to obtain the stress-strain curves and the OPGW elastic modulus. Acceptance criteria:

- No sliding of the OPGW in the tension sets shall be observed.
- No wire breaking shall be observed.

7.5.2.1.2 Tensile performance

The tensile performance test shall be performed in accordance with Method E1 of the IEC 60794-1-2. The tensile performance test is intended to assess the adequacy of the OPGW strain margin. The objective is to confirm the OPGW load for which the fibres become under strain - value T_0 in Fig. 3 "Example of fibre and cable elongation as a function of load" page 35 IEC 60794-1-2.

The minimum length of the cable under test is 100 m and the minimum length for the concatenated fibres is 1000 m.

The test shall be carried out following the steps:

- initial load: 2% of NBL
- Step1: 20% of the NBL during 30 minutes
- Step 2: 40% of the NBL during 30 minutes
- Step 3: 60% of the NBL during 30 minutes
- Step 4: 80% of the NBL during 30 minutes
- return to 2% of the NBL and maintain during 30 minutes.

Acceptance criteria:

- No fibre elongation nor attenuation increase is permitted up to 60% of the OPGW nominal breaking load.

7.5.2.1.3 Temperature cycle test

The temperature cycle test shall be performed in accordance with Method F1 of the IEC 60794-1-2.

The OPGW under test shall have a minimum length of 500 m.

The OPGW under test shall be subjected to two temperature cycles with a duration of 18 hours:

- minimum temperature: -40°C
- maximum temperature: +60°C.

Acceptance criteria:

- The maximal average optical attenuation increase shall not exceed 0.05 dB/km.

7.5.2.1.4 Short-circuit test

The test shall be performed on a length of OPGW (with at least 10 m) equipped with the tensioning fittings proposed for this project. The short-circuit test shall be performed in accordance with Method H1 of the IEC 60794-1-2.

The initial test temperature shall correspond to the maximum ambient temperature at the project location.

During the test the temperature in the optical core and adjacent layers shall be monitored with thermocouples.

Acceptance criteria:

- The final temperature shall not exceed 180°C.
- Permanent attenuation rise kept below 0.05 dB/km.
- Visual inspection after the completion of the test shall not confirm damages in the strands nor in the tensioning fittings.

7.5.2.1.5 Lightning test

The lightning test shall be performed in accordance with Method H2 of the IEC 60794-1-2.

The sample under test shall be tensioned with a load corresponding to 15% of the OPGW NBL.

The optical attenuation of the concatenated fibres shall be measured during the test.

The OPGW sample under test shall be subjected to lightning discharge wave with 4 components:

- Component A: front duration of 15 μs (±5 μs), half current after 100 μs and a peak current of 200 kA
- Component B: charge transfer of 10 Coulombs during 5 ms
- Component C: charge transfer of 200 Coulomb during 500 ms
- Component D: peak current of 100 kA during 0.5 ms.

Acceptance criteria:

- After the completion of the test the residual load of the sample shall exceed 60% of the OPGW NBL.
- The attenuation rise shall not exceed 0.05 dB/km

7.5.2.1.6 Aeolian vibration test

The aeolian vibration test shall be performed in accordance with Method E19 of the IEC 60794-1-2.

The minimum length of the active span should be 20 m and the total length should not be less than 30 m. The OPGW length under test shall be loaded with a mechanical tension corresponding to 20% of the NBL.

The test vibration frequency shall be within 30 and 60 Hz.

Acceptance criteria:

- The attenuation rise shall not exceed 1.0 dB/km.
- Visual inspection after the completion of the test shall not confirm damages in the strands nor in the tensioning and suspension sets.

Type tests carried out on similar OPGW may be accepted as preliminary evidence of the capabilities and quality of the proposed OPGW supplier. Prior to the supply of the OPGW conductor, the Contractor shall provide as a minimum the test reports confirming the successful completion of the above listed type tests.

- The lightning protection level shall be sufficient for the OPGW to cope with a charge transfer of 200 C during 0.5 s.
- The OPGW shall be designed to evacuate the phase–to-ground short circuit current without any performance degradation.
- The optical unit of the OPGW shall include 48 optical fibres (24 fibres, single mode type, according to ITU-T G.652D Standard.

7.5.3 OPGW and Earthwire Types

OPGW and earthwire selection is based on the following criteria:

- standardized equipment used in similar or recently constructed 220 kV Transmission Lines in NEA Network
- required mechanical and electrical properties
- existing OPGW installed on Tanahu - Bharatpur 220 kV

Earthwire and OPGW configuration and technical details are shown below.

Description	Unit	Value
OPGW type	-	Electrically and mechanically equivalent to the earthwire
No. of fibres	-	48
Earthwire type	-	93-A20SA
Cross-section area	mm^2	93.3
No. of wires	-	19
Wire diameter	mm	2.5
Overall diameter	mm	12.5

Description	Unit	Value
Mass per unit length	kg/km	624.9
DC resistance - Aluminium only - Aluminium and steel	Ohm/km	1.2286 0.9245

7.5.4 Packing, Shipping, Transport

Empty OPGW and earthwire drums shall be transported to the location specified by the Employer and handed over to the Employer. Storage of empty drums until the handover shall be responsibility of the Contractor.

7.5.5 Spare parts and tools

Spare OPGW, as per the price schedules shall be delivered together with the last scheduled dispatch and shall be provided in continuous lengths on non-returnable steel drums as specified.

The spare OPGW shall be adequately protected against humidity, corrosion, and all environmental conditions that might undermine its lifetime.

The steel drums shall be provided with waterproof labels identifying the project, the Contractor, gross weight, length, and date of manufacturing.

The spare OPGW shall be delivered to the Employer’s stores and delivery will not be deemed to be completed until the packing material has been checked by the Employer/Engineer. The Taking-Over shall take place after delivery to the Employer’s store.

The Bidder shall supply a list of recommended spares for maintaining the fibre optic link over its expected lifetime.

The test equipment and other special tools described in the Technical Data Sheets shall be of the same type or of better performance than those used by the Contractor for erection and commissioning.

All test equipment shall be supplied completely with Operator's Manuals and Repair & Maintenance Handbooks. All test equipment shall be provided with weatherproof, foam-lined transport cases. Moreover, the equipment shall be suitable for the local electric supply characteristics and all the field test equipment shall be equipped with batteries.

7.5.6 Air traffic warning system

The Contractor shall verify with Civil National Authority of Nepal (CAAN - Home (caanepal.gov.np)) the need for installation and any specific requirements of the air traffic warning system. All system components shall be compatible with CAAN requirements.

7.6 Insulators and insulator sets

The Contractor shall ensure close and continuous liaison between the manufacturers of insulators, clamps, and fittings so that the equipment will be perfectly adapted.

7.6.1 Insulator units

The insulator units shall be of composite long-rod type featuring a glass-fibre reinforcing epoxy rod core with high temperature vulcanized silicone rubber housing and clevis caps.

The insulators shall be of sufficient length to provide the required electrical performance in one single unit, if possible. In-line coupling of two or more units is not acceptable unless otherwise agreed with the Employer.

The core shall be an epoxy resin rod with axial glass fibre reinforcement of high strength (fibre reinforced plastic rod). The interface formed between rod and housing shall be of a quality to prevent brittle fracture phenomena, i.e., high electrical strength and equivalent acid resistance are required. Therefore, E-CR-glass fibres shall be used for the core.

The core of the composite insulator shall be protected against environmental influences by silicone rubber housing. The thickness of the silicone rubber covering the rod shall be at least 3 mm. The housing shall be perfectly (chemically) bonded to the core. The chemical bond between the core and the housing must be stronger than the tear strength of the housing material. The manufacturer shall prove that he masters non-destructive technique to check the quality of the core to housing interface.

The silicon rubber can be directly moulded onto the core. To achieve an excellent pollution performance and tracking performance (minimum class 1A 3.5 according to EN 60587), the application of high temperature vulcanizing (HTV) silicon rubber filled with an appropriate amount of aluminium tri hydrate (ATH) shall be applied. The material shall be of blue/grey colour and be resistant against the ultra-violet radiation being present in the solar spectrum at ground level. For the design of shed profiles, IEC 60815 shall be applied.

The metal end fittings shall be made of forged steel and hot dip galvanized according to EN 1461. The fittings shall be attached onto the rod by a compression method process which does not damage the individual fibres of the rod in any way. Fittings shall be defined by the actual need (e.g., ball and socket or clevis and tongue connection) and shall comply to the specific Standards requirements.

The gap between fitting and core housing shall be sealed permanently against the ingress of moisture. Sealing by compression only shall not be considered as permanently waterproof. Covering the cap, even partly, with housing material is unacceptable due to electrical reasons. Sealing of the interface by application of an elastomer with permanent elasticity is an acceptable solution. The material shall adhere to the surface of the metal cap, as well as to the housing.

7.6.2 Insulator sets

Complete insulator sets consisting of composite insulator units and assembling fittings are required as described below and in the Data Sheets.

Insulator sets shall generally follow the typical assembly as shown in Annexes: F, G, H and I.

The Contractor shall provide detailed assembly drawings for each type of assembly required.

All insulator sets including their clamps and fittings shall be in fair weather free from visible corona discharges. In particularly, the live part of all insulator sets shall be conceived and shielded in a way to avoid visible corona under fair weather condition. Visible corona extinction voltage shall not exceed 200kV unless otherwise agreed with the Employer / Engineer.

All insulator sets shall be provided with the necessary arcing devices to keep their radio and television noise as low as possible. A noise level less than 46 dB above 1 microvolt shall be ensured under standard laboratory conditions. This shall be demonstrated by tests in accordance with EN 60437.

All insulator sets shall be provided with arcing fittings for assuring the necessary corona radiation level and to protect the insulators from the effects of the electric arc. The upper and lower horns/rings shall be installed on the insulator assemblies as recommended by the fittings manufacturer and confirmed by electrical tests.

All insulator sets shall be dimensioned and designed to withstand the three or single-phase short-circuit currents (whichever higher) shown in the Data Sheets without the temperature exceeding 200°C in the fittings and without welding between the component parts.

The Employer/Engineer may require tests to be carried out to demonstrate the short circuit characteristics of each type of insulator set. The cost of such tests shall be borne by the Contractor.

Locking devices for the insulator units themselves and for associated ball and socket fittings shall be of stainless steel and shall comply with EN 60372. The design shall be such as to allow easy removal for replacing of insulator units or fittings without the necessity to remove the insulator set from the crossarms. Locking devices shall be incapable of rotating when in position.

For the dimensioning of the insulator sets from the mechanical point of view, the maximum resulting loads under loading conditions defined in 6.5 along with partial load and material specified in Sections 6.5.1 and 6.5.2 respectively shall be considered.

The insulator string shall be of sufficient length to provide the required electrical performance as regards the specific leakage path and minimum required withstand voltages. This shall be determined as per catalogue data but shall also be finally proven by tests on complete sets (insulators and fittings).

Suspension towers shall be equipped with “I” (single or double, as appropriate) suspension insulator sets. For river, main road, highways and powerline crossings double string sets shall always be used. Mechanically lower rated “I” arrangement suspension insulator set shall also be used as jumper suspension (pilot) set on the angle and terminal towers where required for maintaining internal clearances.

Suspension clamps shall have the following slip limits:

- minimum: 7kN or 5% of the conductor rated strength, whichever is the greater value
- maximum: 30% of the conductor rated strength.

Same requirement also applies for suspension clamps used for OPGW and earthwire.

Tension towers (angle-tension and dead-end towers) and gantries will be equipped with single/double tension insulator sets as appropriate. For river and powerline crossings double string sets shall always be used. Major road crossings and all railway crossings shall always utilize two tension towers with double insulator string sets. In case of crossing the national highway, the length of crossing span shall be limited to maximum 250m.

For all crossings it shall be Contractor’s responsibility to confirm and incorporate into their design any additional requirements imposed by the relevant road/railway/river/powerline (in case it is not operated by NEA) authorities.

Spacing between the strings shall be sufficient to assure good behaviour of insulators and good performance of arcing horns/rings.

Two independent fixing points to the tower shall be used for tension insulator sets. Each attachment point shall be capable of transferring full maximum insulator set load to the tower.

Suitable adjustment, in case of tension sets, shall be done for the different line angles to assure equal repartition of the loads on two insulator units of the set.

In general, attachments to the tower are to be secure connection such as with swivels. Hooks are not acceptable.

Between the terminal towers and gantries (in the slack span), upright and inverted low duty tension sets shall be installed.

8. Construction

The Contractor shall develop Contractor's Environmental and Social Management Plan (CESMP) and associated sub-plans and documents. The plan shall consider and fully conform to all requirements of the Project Environmental and Social Impact Assessment (ESIA) Report which is included in the Contract.

The Contractor shall submit CESMP for approval within the timelines specified in Sub-Section VII-2 for Employer's/Engineer's approval.

8.1 Environmental Protection

Approved Contractor's Environmental and Social Management Plan (CESMP) shall define necessary processes, procedures, damage limitation and mitigation measures aimed at minimizing the environmental damage caused by the project. CESMP shall strictly follow requirements specified in the Environmental and Social Impact Assessment (ESIA) Report which is included in the Contract. All plans shall include detailed procedures defining implementation methods as well as compliance monitoring and reporting process and tools.

The Contractor shall act diligently to avoid damage to public, land, property, crops, etc. The works shall be adequately supervised by qualified and experienced personnel.

The Contractor shall be responsible to the occupants of the land which are crossed by the transmission line or otherwise affected by construction works for any damage to personal property resulting from his fault or negligence, including damage caused to straying livestock.

The Contractor shall be responsible for notifying the Employer in writing of all instances of damage to crops plantation, livestock, etc.

The Contractor shall use all means necessary to control dust on roads, construction areas and borrow pits. Surfaces shall be regularly watered to prevent dust becoming a nuisance for the public and interfering with the proper execution of the works.

8.1.1 Protection of Livestock

Adequate provision shall be made by the Contractor to prevent the straying of or injury to livestock during the execution of the works and until the permanent reinstatement of fences, walls, hedges, and gates is completed.

The Contractor shall be liable for any injury to or loss of livestock due to failure to comply with the above requirements. Means shall be provided on all lattice steel towers and tower extensions to avoid the risk of livestock being caught between tower members and being injured.

8.1.2 Protection of Vegetation

The Contractor shall limit the movement of crews and equipment to the right-of-way and on approved access routes. No movement of machinery or vehicles is permitted outside approved access roads and construction platforms.

8.1.3 Vegetation Clearance

The Contractor shall be responsible for all vegetation clearing including removal from site and appropriate disposal of all tree cutting remains, branches, scrubs, bushes, etc. Route clearing shall be executed in conformance with approved Vegetation and Tree Clearance Plan. Timber shall be transported to location as indicated by Employer. Burning the wood debris on site is not allowed.

The Contractor shall give adequate notice of commencement of work to the respective land-owner(s).

Fruit trees and crops shall not be removed unless otherwise agreed with the Employer. The Contractor shall take the necessary precautions to avoid damage to these crops and trees when carrying out the easement clearing. The compensation or consequences caused by any damage, which in the opinion of the Employer could have been avoided, shall be borne by the Contractor. Tree and vegetation clearance shall be done in line with procedures specified in approved Vegetation and Tree Clearance Plan prepared in accordance with ESIA report.

No tree may be cut without the express permission of the Employer. Roots and other plants shall not be removed, unless specifically requested by the Employer/Engineer, to prevent excessive surface erosion.

The Contractor shall take all appropriate precautions when clearing vegetation in the vicinity of public buildings, watercourses, roads, and private houses. Fallen trees shall be removed from these specified areas immediately after clearing. Any damage caused by carelessness, ignorance and oversight shall be compensated by the Contractor.

The necessary permission for the removal of obstructions e.g., fences, buildings, telecommunication and power lines shall be in the responsibility of the Employer. No obstruction may be removed without the express permission of the Employer.

8.2 Site Preparation and Erosion Protection

Prevention and control of soil erosion at sites is of prime importance for the stability of the tower locations. Good selection of tower locations by avoiding potentially problematic areas (e.g., steep slopes, areas in proximity of watercourses, flood plains) is crucial for minimization of soil erosion risks. Access to location shall also be considered during tower location determination.

As a rule, towers shall not be placed on slopes exceeding 30° in any direction. Exceptions may be made, with approval of the Employer/Engineer, in areas of good soil quality (solid rock).

Where ground conditions (soil quality) allow, levelling of tower locations shall be minimized in sloped terrain; therefore, leg extensions adapted to the terrain profile shall have priority over extended soil movement and excavation works.

In case of cutting a slope, the upper surface material of the ground shall be protected from sliding. It shall be ensured by:

- stone pitching
- gabions
- stone walls (erected without or with mortar)
- concrete walls or
- other suitable means proposed by the Contractor and approved by the Employer/Engineer.

The bottom edge of the tower site in sloped terrain shall be reinforced by stone or concrete wall if required. Drainage ditches shall be provided as appropriate to prevent soil erosion by surface water run-off.

The tower sites shall be graded to protect against erosion due to water flow. If there is a natural flow of water across the site, the water flow shall be diverted around the site or the site shall be suitably protected against erosion by grading and/or placing of riprap or other erosion barriers, installation of drainage swales or other appropriate methods.

Prior to taking over of the OHL all tower locations susceptible to erosion shall be inspected in presence of the Employer/Engineer to check the effectiveness of the applied erosion protection. Any indications of erosion shall be rectified by the Contractor and improvements of erosion protection provided as approved by the Employer/Engineer.

8.3 Access Roads

The Contractor shall at an early stage of the Contract assess the line route and prepare access road maps detailing the proposed access routes to all towers of the line for Employer's/Engineer's review and approval.

The various access types shall be identified and mapped (showing length and terrain features):

- sections of existing public roads to be used (without enlargement or other modification)
- existing roads not maintained by local authorities (which may need upgrade and stabilization works)
- existing community tracks (which will need to be enlarged and stabilized, thus creating environmental and social impacts)

- proposed new access tracks which can be restored to natural condition after construction
- proposed new access tracks which will require cutting of slopes or terraces and cannot be restored to natural condition and thus need to be stabilized with roadside stabilization, erosion protection and drainage to prevent degradation and negative environmental impacts
- tower locations that cannot be accessed by road and need to be accessed by animal, cable, or aerial (e.g., helicopter) transport. This category also includes tower locations where the construction of access roads would require excessive environmental damage.

The types of new access tracks to be constructed shall be shown on maps. Type(s) of Contractor's heavy machinery which shall traverse the access routes shall also be indicated.

Access maps shall be submitted together with the final detailed routing design (at least 12 months before the physical construction commencement date). The maps will also show the following details:

- locations for storage of topsoil
- locations for storage of excavated material (undersoil)
- laydown areas for material and work equipment storage
- workers camps
- locations of the work areas required for positioning of the stringing equipment
- access to the work areas required for positioning of the stringing equipment.

Once the access maps have been approved, the Contractor shall not make use of any other access routes without the prior approval of the Employer and Engineer.

The Contractor is also required to assist the Employer in the implementation of the Resettlement Action Plan. The envisaged assistance mainly consists of accurate identification of all private properties that will be affected by the construction activities, including modification of existing and construction of new access roads. Further details and detailed procedures are provided in the Project ESMP.

After obtaining permission for the construction of access roads, the Contractor shall undertake all necessary measures to make the access suitable for use and shall take all precautions to avoid damage to existing properties.

The Contractor is required to minimize the need for new access roads by:

- using existing roads as much as possible
- create short 'finger' roads from existing roads to tower locations instead of long roads along the line route where possible
- consider alternate means of transportation described earlier instead of constructing long roads through forested hilly/mountainous areas.

Selection criteria for types of access roads in order of priority shall be as follows:

8.3.1 Existing roads (without the need for modifications)

Any damages to existing roads shall be fully rehabilitated so that condition of the roads is equal to that at the start of the Project. Environmental and social impacts shall be avoided.

8.3.2 Existing roads with modifications

Necessary modifications (e.g., widening, side stabilization) shall be shown on access maps and shall be the subject of the Employer's/Engineer's approval. The Contractor is responsible for maintenance of the roads during construction and reparation of any damages. Environmental and social impacts shall be avoided where possible or minimized.

8.3.3 New access roads on flat terrain

All new access roads required over reasonably firm and level terrain shall be located, where possible, within the OHL easement (RoW). The Contractor is responsible for restoration of affected ground to initial condition before handing over. If traversing agricultural lands all losses shall be compensated until the full restoration of the productive capacity of the land (if temporary impact). If permanent impact, the lands shall be acquired and PAPs compensated for permanent losses. Cutting of trees for new access roads shall be avoided where possible or minimized.

8.3.4 New Access roads in hilly terrain

Adjustment of access road geometry to existing terrain features is of crucial importance. Cutting into steep slopes (which might lead to slope destabilization and cannot be restored to natural condition) shall be avoided as much as possible. Where this cannot be avoided, alternative means of access shall be considered (e.g., aerial or animal transport). In case alternative transport is not a feasible option, adequate slope stabilization measures (retaining walls, roadside stabilization, drainage, or other measures as appropriate) shall be installed during construction of the access roads. These measures shall be designed as permanent structures with consideration of long-term impacts. Necessary maintenance measures shall be included in the Operations and Maintenance Manual. Identification and installation of appropriate erosion prevention measures is the sole responsibility of the Contractor and shall be monitored by the Employer /Engineer.

The Contractor shall endeavour to minimize the environmental and social impacts by implementing the following:

a) Measures to avoid environmental and social impacts
Appropriate measures such as avoidance of tree cutting, avoidance of agriculture areas shall be implemented in design phase.

b) Measures to mitigate environmental and social impacts

Measures to mitigate environmental and social impacts shall be implemented for the remaining/residual environmental and social impacts. Some examples of appropriate measures are listed below. For detailed requirements reference shall be made to Environmental and Social Management Plan (ESMP).

- Excavated material shall be stored in designated storage areas to be used for site reinstatement after completion of construction.
- Topsoil layer shall be removed and stored separately from undersoil.
- Procedures for transport and storage of excavated material and site reinstatement shall be defined in approved CESMP.
- Any residual material shall be disposed of in accordance with approved Waste Management Plan
- Disposal or storage of excavated soil on the slopes above or below access roads shall be strictly prohibited. Appropriate safety measures (e.g., anchored barriers) shall be installed below excavation sites to prevent accidental rockfall down the slopes.
- The access tracks shall be constructed in such a way as to minimize damage to property, land, crops, and vegetation and shall be adequately drained to prevent washouts or soil erosion.
- All watercourses shall be crossed by means of bridges or culverts covered with stone material and suitable grading. Drainage shall be provided by swales and appropriately placed culverts. Access route maps shall include location of all bridges, culverts, and swales.
- The Contractor shall continuously maintain the drainage systems and surface of new access tracks for the duration of the works (and leave the measures in place for the time after works e.g., erosion prevention measures, drainage etc.).
- Replantation of access roads that will not be used for maintenance shall be considered especially in forest areas or not-cultivated slopes. If located in RoW this can be done with low growing bushes and grass to stabilize slopes.

8.3.5 Use of existing roads without the need for modifications

Where Contractor uses existing roads maintained by the local authorities, he shall ensure that the drains (culverts) are properly maintained, protected and/or reinforced. Drains shall not be blocked for the duration of the Contract. Any damage to the road surface, drainage facilities, or any road accessories (e.g., signs, markings) caused by the Contractor shall be urgently repaired.

When the Contractor has approval to use existing community roads which are not maintained by local authorities, he shall get the consent from the concerned local community and shall maintain the road during the construction period to such a standard that its use by the customary traffic is not impeded in any way. This requirement also applies to roads described in 8.3.6.

All existing roads shall be restored at least to a condition equal to that before the construction activities commenced. Such restoration shall be completed before the issue of the Taking-Over Certificate. This requirement also applies to roads described in 8.3.6.

Specific procedures for use of existing roads, including measures for minimizing disruption to local communities shall be defined in approved Traffic Management Plan.

8.3.6 Use of existing roads/tracks with modifications

Widening or any other modification (e.g., side stabilization, installation of drainage systems) of existing access roads/tracks may only be done with Employer’s/Engineer’s approval.

Widening of existing access tracks will almost invariably impact the properties of local residents e.g., agriculture areas, forest areas etc. The Contractor will need to get consent for widening and upgrade of the tracks and all affected assets will need to be compensated. The terrain needed for widening of access roads shall have to be acquired and be part of the Resettlement Action Plan (RAP). Modifications (e.g., drainages, retaining walls) shall be suitable for long term use.

8.3.7 New Access Roads Construction

The land needed for new access roads will have to be acquired from private owners or allocated by the responsible government organizations / municipalities. The land acquisition will be part of the RAP. Houses shall be avoided, thus preventing any additional physical displacement by way of construction of access roads.

The first earthworks operation shall be the removal and separation of topsoil. Topsoil shall be kept separate from other material and stock-piled for site reinstatement.

Access roads shall be made in two layers (load bearing and cover layer) with a minimum width of 3.0 m or maximum vehicle width plus 0.5m. The load bearing layer and cover layer shall be made for heavy transports with a maximum axle load of 12 t and a maximum total weight of 60 t.

Load-bearing layer shall be based on a surface with in-situ value of California Bearing Ratio (CBR) of at least 7%. In poor soil areas where this CBR value cannot be achieved at shallow excavation depth, replacement of soil layer (ca 1m thickness) with crushed rock, or alternative method of soil reinforcement shall be considered.

Proper turning angles and light slopes shall be provided for safe turning and access for heavy vehicles. The safety of the access roads shall additionally be ensured by means of side protections (safety barriers) above dangerous slopes. Passing places shall be incorporated where necessary to ensure safe operation of the access road.

During heavy rains and adverse weather conditions the viability and practicability of access roads must be guaranteed. For loose and unsustainable clay, marl, loam or soggy soil layers, the use of a geotextile is recommended to avoid an entry of fine-grain components in the base and to stabilize the subsoil.

During the construction of the access roads, the Contractor shall grade and slope the roads to prevent any unnecessary water flow across the road and to minimize soil erosion. Appropriate measures shall be provided to ensure continuity of flows of existing watercourses (e.g., by installation of culverts) and surface run-off. Surface protection and erosion mitigation measures (drainage, stone pitching, gabions, etc.) shall be installed.

8.3.8 Access Roads Maintenance

Contractor shall be responsible for maintaining all new (maintenance requirements for existing roads are specified in 8.3.5) access roads in usable condition for the duration of the Contract. Usable condition is to be understood as safely passable for all 4WD vehicles and fully loaded construction machinery.

In particularly difficult terrain, and with agreement of the Employer/Engineer, limited usability roads- defined as safely passable for 4WD vehicles with use of gear reduction system and partially loaded construction vehicles - may be accepted. In such cases, limited usability sections of the access roads shall be clearly marked with appropriate safety warnings.

Care shall be taken to ensure the roads are free from ice and mud during wet seasons. Drainage systems must be regularly inspected and cleared from any blockages.

In case the roads are damaged or considered unsafe after heavy rainstorms, access to hazardous sections of the roads shall be prevented by means of temporary barriers until corrective works are completed and appropriate road condition restored.

Local population shall not be put to any inconvenience in gaining safe and timely access to their properties.

All necessary measures connected with the access, transport and maintenance are Contractor's responsibility. These measures shall include, but not be limited to:

- provision of all necessary means of transport, preparation of access roads and tracks associated with levelling, gravelling, safety measures, bridges, culverts etc.
- clearing and establishing of storage facilities, traffic control, making good of damages, as well as obtaining necessary approvals from authorities where applicable
- regular maintenance of access roads, including installed stabilisation and erosion protection facilities (e.g., drainage swales, retaining walls).

8.3.9 Culverts and Bridges

Culverts and bridges shall be installed for the purpose of crossing existing watercourses. Culverts shall also be installed where required for effective drainage systems.

The locations and types of culverts and bridges shall be proposed by the Contractor and approved by the Employer/Engineer.

8.3.10 Reinstatement of access roads

After completion of the works, access roads shall be reinstated, and the topsoil placed in its original position to ensure full reinstatement of the area to the original / natural condition. Same requirement also applies to the storage areas used for excavated materials and topsoil, as well as all platforms used for stringing equipment.

Reinstatement of access roads and other listed areas shall be the responsibility of the Contractor. A method statement and programme for reinstatement works shall be submitted to Employer/Engineer for approval at least three months before planned commencement of related works.

Reinstatement works, shall include all necessary actions such as soil restoration (backfilling and compaction), topsoil restoration and preparation for hydro-seeding and planting of shrubs and trees to a standard at least equal to the condition of the site prior to construction.

The sequence of work shall ensure establishment of all native plant species to achieve successful replanting at site.

Ruts and scars shall be removed, damage to ditches, terraces, roads, and other features of the land shall be corrected, and the land shall be restored to its original condition.

All such work shall be completed to the full satisfaction of the Employer/Engineer and the relevant regulatory authorities before the issue of the Taking-Over Certificate.

8.3.11 Adaptation for Long-Term Use

In case the Employer indicates that any access road(s) should be preserved for OHL maintenance or full area reinstatement is not possible for any other reason, the Contractor shall propose, for Employer's/Engineer's approval, any additional measures necessary for adaptation of the roads for long-term use and prevention of long-term erosion as appropriate. These roads and associated adaptation measures shall be considered a part of the Permanent Works as defined by the Clause 1.1.5.4 of the GCC.

Based on assessment of the needs for future maintenance access and assessment of the local geotechnical and hydrological conditions, additional works shall be executed to ensure safe use and durability of access roads which shall be preserved beyond Project completion. Such works shall typically include, but are not limited, to:

- widening of the road to 4.0m
- widening and further compaction of the load-bearing layer
- replacement and compaction of the cover layer (gravel or crushed rock)
- Increase of the thickness of the cover layer to min. 40 cm
- upgrade of the drainage system (e.g., underground pipe installation, geotextile and riprap lining, culverts)
- installation of permanent safety features (e.g., signs, fences, safety barriers) as required by the Employer
- installation of long-term erosion protection systems (e.g., erosion mats, retaining structures).

Other appropriate actions as may be required on site-specific basis.

The compaction procedure and plant shall be proved by trials at the commencement of the works. The weight, type, and number of passes of compaction plant shall be varied to determine the optimum compaction.

Long-term stability of earth retaining structures shall be confirmed by an appropriate geotechnical design method prepared by the Contractor and approved by the Employer/Engineer.

8.4 Overhead line construction

Chapter 16 of Sub-Section VII-3 applies with following modifications:

Clause 16.8.2.1 blasting is not allowed.

Clause 16.8.3.1 Backfill shall be compacted to 95% of maximum dry density

Clause 16.2 Stringing shall only be performed using approved equipment (puller and tensioner) set(s).

8.5 Inspections and Tests during Erection and Commissioning

The Contractor's scope of delivery includes all site tests and inspection expenses, e.g., all labour, materials, water, electricity, consumables, chemicals and stores.

Contractor is responsible for and shall include in his delivery all safety measures such as barriers, warning signs etc. required for inspection and testing while erection is in progress and all interruption of work in this connection shall be at his expense.

All instruments and apparatus used for site inspection and testing shall be calibrated to an agreed standard at internationally certified laboratory nominated by the Contractor and approved by the

Employer/Engineer. The cost of making such calibrations shall be borne by the Contractor in all cases.

During the erection of all mechanical, electrical, and telecommunication equipment the Contractor shall make the plant item available at any reasonable time for inspection by the Employer/Engineer, if requested.

To assist the Employer/Engineer in their review of the quality of the work being performed, the Contractor shall provide them with a schedule of the specific areas and items of work that will be performed during each work week. The list shall be presented to the Employer / Engineer at least 72 hours before starting the works.

In particular, the Contractor shall show on the implementation schedule all stages of erection or commissioning which are subject to the Employer's/ Engineer's acceptance and shall notify one week in advance when such acceptance becomes due. The stages subject to acceptance shall include but not be limited to the items indicated in these Technical Requirements.

Prior to placing plant into commercial operation, commissioning tests shall be performed. These tests shall be coordinated by the Employer/Engineer, but the Contractor shall assume full responsibility for the testing operation and safety of plant within his scope of work.

The Contractor shall cooperate with the Employer/Engineer and other Contractors, where applicable, to facilitate safe execution of all necessary tests.

The Contractor shall provide all necessary instruments to perform the tests on plant within his scope of work. The test instruments shall be new, of a current model and type, and with the precision required to conduct the specified tests. The Contractor shall follow operating procedures approved by the Employer/Engineer.

Copies of all log sheets and test readings shall be provided to the Employer/Engineer as soon as practicable.

After the conclusion of the tests, the Contractor shall compile a comprehensive test report to the approval of the Employer/Engineer. This report shall include copies of all log and calculation sheets and any necessary calculations, tables, graphs required for recording and interpretation of the test results.

9. Final Inspection and Commissioning

9.1.1 Final inspection

After the completion of the construction, the Contractor shall carry out final inspection of the transmission line.

Final Inspection Program shall be prepared and submitted to the Employer/Engineer for approval at least three months before planned commencement of the tests.

The date of tests shall be notified well in advance to allow participation of the Employer/Engineer. A test report shall be submitted to the Employer/Engineer for approval within two weeks after test performance.

The final inspection shall include but not be limited to:

- visual check on equipment damage
- visual check of correct and neat installation
- check of critical minimal clearance distances
- tightening of bolts and fixing of missing members to towers
- check of completeness of earthing connections
- measurement of tower earth resistance
- check of removal of all scaffolds and equipment and clearing of all debris and waste materials from the site
- check that restoration of surface damage, foundation subsidence and erosion control measures, where directed by the Employer/Engineer or as required by local authorities or regulations had been implemented to satisfaction of the Employer/Engineer
- check that all left-over materials are removed from winch yards, drum yards and store yards
- check that complete danger tree clearing and tree re-clearing on the easement had been completed in accordance with the Contract
- re-conditioning and handing over of access roads which shall be used for maintenance purposes
- check of tower signs and phase sequence plates on both sides of all points of the line
- measurement the OHTLs and communication (OPGW) parameters.

Minor deficiencies detected during the final inspection of the line shall be recorded and corrected by the Contractor as soon as practicable.

Contractor shall make any replacement or repair necessary or correct any errors in the installation to the satisfaction of the Employer/Engineer and at no extra cost.

9.1.2 Commissioning

The Contractor shall submit a schedule of energizing for Employer's/Engineer's approval at least three months in advance. Where applicable, the schedule shall contain a sequence of energizing different line sections.

Prior to the energizing of a complete line sections a visual inspection of this line section including the shield wire system shall be performed and any deficiencies which could affect the safety of the line and personnel shall be rectified immediately.

If any failure is detected, the Contractor shall locate and determine the cause of the failure and shall make any replacement or repair necessary or correct any errors in the installation to the satisfaction of the Employer/Engineer and at no extra cost.

Prior to the energizing, the Contractor shall provide the Employer/Engineer with a written statement, signed by the Contractor's authorized representative, that all temporary erection earthing points are withdrawn, and the line is safe for energizing.

The line shall be energized for at least 24 hours at full nominal system voltage before handing over and the arrangement for this, and other required tests shall be made by the Contractor who shall provide such labour, transport, and other assistance as required without extra charge.

Prior to the hand-over of the completed line, the following (as a minimum) tests shall be carried out in the presence of the Employer/Engineer:

- conductor electrical continuity proving tests for each phase, by telephone connection or an alternative method proposed by the Contractor and approved by the Employer/Engineer
- insulation resistance tests for each phase
- phases coincidence
- tower earthing system electrical resistance measurements by means of a high frequency instrument supplied by the Contractor and approved by the Employer/Engineer
- attenuation and continuity of the fibre optic link in the OPGW
- measurement of the OHL electrical parameters: direct current electric resistance of the conductors measured at ambient temperature (this value shall be then used to confirm the direct current electric resistance at 20°C to compare the measured value with the guaranteed values), zero sequence impedance, positive and negative impedance, charging current, capacitance.

The optical fibre attenuation shall be measured between the joint boxes installed on the terminal gantries unless otherwise requested by the Employer/Engineer. The test shall be carried out in accordance with the instructions prescribed in Sub-Section VII-3.

The maximum loss in the end-to-end fibre optic link shall not exceed the value calculated obtained using the formula provided in Sub-Section VII-3.

Coordination with the Contractor(s) responsible for the Substation works, if applicable, shall be arranged to allow the validation (under the same principle) of the end-to-end optical fibre link: between the substations.

9.1.2.1 Handing-over

On completion of the final inspection and commissioning testing on the nominal voltage, the Contractor shall provide to the Employer/Engineer a written statement (Certificate of Completion), signed by the Contractor’s authorized representative, certifying that the line is complete in every respect, that all temporary earths placed by the Contractor have been removed and that every member of the Contractor's staff has been informed that no further work on the line is allowed unless a working permit signed by the Employer/Engineer is issued.

Tools, appliances, and spare materials required for maintenance of the transmission line shall be handed over as detailed in the price schedules.

The documentation to be handed over prior to the issue of the Certificate of Completion shall include:

- Site Test Certificates (with the results of the site checks/ tests/ commissioning tests)
- as-built drawings
- list of spare parts
- punch (snag) list showing that all pending work, remedying of defects and damages have been executed.

VII-5

Environmental and Social Management and Monitoring Plan (ESMMP)

Environmental and Social Management and Monitoring Plan

Lekhnath-Damauli 220kV Transmission Line Project, Nepal – Package A Transmission Line

8 February 2022

Project No.: 0529927

The business of sustainability

Signature Page

8 February 2022

Environmental and Social Management and Monitoring Plan

Lekhnath-Damauli 220kV Transmission Line Project, Nepal – Package A Transmission Line

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Acronyms and Abbreviations

AP	Angle Point
APLIC	Avian Power Line Interaction Committee
BAP	Biodiversity Action Plan
CDC	Compensation Determination Committee
CF	Community Forest
CFUG	Community Forest Users' Groups
DFO	Division Forest Office
E&S	Environmental and Social
EBRD	European Bank for Reconstruction and Development
ECoW	Ecological Clerks of Work
EHS	Environmental, Health, and Safety
EMF	Electro-Magnetic Field
EPRP	Emergency Preparedness and Response Plan
ERM	Environmental Resource Management GmbH
ESHS	Environmental, Social, Health, and Safety
ESIA	Environmental and Social Impact Assessment
ESMMP	Environmental and Social Management and Monitoring Plan
ESSD	Environmental and Social Studies Department
FPIC	Free, Prior and Informed Consent
GBV	Gender-based Violence
HPP	Hydro Power Plant
IC	Implementation Consultant
IEE	Initial Environmental Examination
IFC	International Finance Corporation

ILO	International Labour Organization
IP	Indigenous Peoples
KfW	German Development Bank *Kreditanstalt für Wiederaufbau*
LDTLP	Lekhnath-Damauli 220 kV Transmission Line Project
LRP	Livelihood Restoration Plan
MCC	Millennium Challenge Corporation
MoFSC	Ministry of Forests and Soil Conservation
NEA	Nepal Electricity Authority
NR	Nepali Rupee (currency)
NTFPs	Non-timber forest products
OHL	Overhead Line
OHS	Occupational Health and Safety
OMCN	Office of the Millennium Challenge Nepal
PAP	Project Affected Person
PPE	Personal Protective Equipment
PS	Performance Standards
Ramsar	Convention on Wetlands
RAP	Resettlement Action Plan
RPF	Resettlement Policy Framework
RoW	Right of Way
SEP	Stakeholder Engagement Plan
TL	Transmission Line
ToF	Trees Outside of Forest
USD	United States Dollar (currency)
WMP	Waste Management Plan

EXECUTIVE SUMMARY

This Executive Summary presents the Environmental and Social Management and Monitoring Plan (ESMMP) for the proposed Lekhnath-Damauli 220kV Transmission Line (TL) Project. This ESMMP covers the TL (Package A), and the ESMMP Package B covers the Damauli Substation. The ESMMP provides the purpose, project information, key environmental and social (E&S) impacts and determines mitigation and monitoring approaches. The text of the ESMMP will be for the entire Project and therefore be the same for Package A and B, but the mitigation and monitoring measures will be tailored to the development and operation of each individual package.

The purpose of the ESMMP is to provide the framework of management plans and monitoring regimes by describing in detail the important environmental mitigation measures identified during the impact assessment studies, necessary management plans, responsibilities, and monitoring procedures. The ESMMP addresses the anticipated E&S project impacts, and provides measures to avoid, minimise or compensate adverse impacts on the environment and the quality of life of impacted communities.

The developer of the Project will construct a 42 km 220 kV double circuit line between Lekhnath and Damauli, a connection from the new Damauli Substation to the 220 kV TL from the Tanahu Hydropower plant to Bharatpur (Package A), a new substation near Damauli, as well as an expansion of the existing substation at Lekhnath (Package B). The Project developed by NEA is part of Nepal's strategy to overcome the continuing power shortages and satisfy the growing demand of electricity. The TL will serve as the power evacuation route for the Tanahu Hydropower Project. The proposed route was determined through the process of line route optimisation. An Alternative Analysis of three alternative routes was carried out. For the final routing of the TL, potential E&S impacts have been considered by the technical planner. The proposed towers are between 29 m and 44 m in height. The provisional right of way (RoW) under the TL will be 30 m - 40 m in total.

Key potential E&S impacts associated with the proposed Project are related to land acquisition, economic and physical displacement, disturbance of fauna especially avifauna, deforestation, soil erosion as well as potential risks during construction such as occupational health and safety (including Covid-19 risks), waste generation, fugitive dust and other emissions (eg. from vehicle traffic, land clearing activities), noise from heavy equipment and truck traffic, hazardous materials and oil spills associated with operation and fuelling activities, the amount of raw material needed (leading to mining for sand or gravel from riverbeds), landslides caused by access road construction and impact on community safety (including Covid-19 risks).

The ESMMP includes measures to protect the environment, especially regarding biodiversity, workers and communities' health and safety, as well as labour aspects and relations with local communities. Land acquisition and resettlement aspects will be addressed by a separate Resettlement Action Plan (RAP).

The overall responsibility for implementation of a given measure always rests with Nepal Electricity Authority (NEA); the specific implementation of ESMMP items is then (usually, though not always) undertaken by the contractors who construct the Project. All contractors must adopt and comply with the policies and plans required as part of this ESMMP.

A Biodiversity Action Plan has been developed, determining the Project's mitigation strategy and biodiversity commitments to mitigate and manage biodiversity impacts, including conservation action. A plantation program will be carried out as compensation of trees cleared by the Project. The plantation sites will be determined consulting with the Ministry of Forests and Soil Conservation, the Division Forest Office and Project Affected Community Forest Users' Groups. The separate RAP will address land compensation in accordance with the rates determined by the Compensation Determination Committee. The RAP does not cover construction-related losses and damages, which will be compensated by the contractor as part of this ESMMP.

A Stakeholder Engagement Plan and Grievance Mechanism including Free Prior Informed Consent (FPIC) requirements for the engagement with Indigenous People (IP) are established for the Project in case affected persons have concerns regarding the Project, including the implementation of the ESMMP. Complaints are expected to be addressed and resolved in a timely manner.

The ESMMP provides a monitoring procedure to ensure that construction and operation of the proposed Project remain compliant with performance standards, guidelines and safeguards established by the lender, as well as national legislation. A key objective of the monitoring is to identify any unanticipated changes by the Project and to identify environmental, health and safety issues before they become significant and to take remedial action.

A cost estimate is stated in this ESMMP for mitigation measures, this includes cost estimates that are stated in the Updated IEE, 2020.

1. INTRODUCTION

Environmental Resources Management Germany (ERM, the Consultant) was appointed by KfW Development Bank (KfW, the Client) to prepare an Environmental and Social (E&S) Gap Closing for the proposed Lekhnath-Damauli 220kV Transmission Line Project (LDTLP, the Project).

The Project is being developed by the Nepal Electricity Authority (NEA, the Project Developer). The Project is part of Nepal's strategy to overcome the continuing power shortages and satisfy the growing demand of electricity. The Transmission Line (TL) will serve as the power evacuation route for the Tanahu Hydropower Project. Fichtner Germany supports NEA as an Implementation Consultant (IC).

The Project is located in the Kaski and Tanahu Districts and consists of the following components:

Package A

- Lekhnath - Damauli 220 kV Double Circuit TL;
- Tie in of loop-in-loop-out (LILO) connection of Tanahu Hydro 220 kV TL into new Damauli Substation (Tanahu TL under-construction, separate financing); and
- Tie in of LILO connection of Old Damauli - Bharatpur 132 kV TL into new Damauli substation.

Package B

- 220 kV GIS extension at existing Lekhnath substation; and
- New 220/132kV GIS Damauli Substation.

This ESMMP is only applicable for Package A. For Package B a separate ESMMP has been developed. The text of the ESMMP will be for the entire Project and therefore be the same for Package A and B, but the mitigation and monitoring measures will be tailored to the development and operation of each individual package.

The existing Initial Environmental Examinations (IEEs) are the basis for the approval by the Nepali Ministry of Energy under Nepali laws. The Environmental and Social Studies Department (ESSD) at NEA is responsible for conducting the IEEs for this Project.

So far, the following documents have been submitted:

- IEE, prepared by NEA's ESSD, November 2017;
- Updated IEE, prepared by NEA's ESSD, November 2019; and
- Updated IEE, prepared by NEA's ESSD, January 2020.

The first IEE drafted in 2017 served as the basis for the Gap Analysis against International Standards. Based on changes in the technical planning, such as the new location of the Damauli Substation the IEE has been updated. According to the planning on which the IEE 2017 is based, the substation has been planned at Belbas of Byas Municipality. In the Updated IEE from November 2019, the new substation is proposed in Khairbote of Byas Municipality. Due to further changes in the technical planning, the IEE was updated again in January 2020. Land acquisition for the Damauli Substation is a time-taking process, and is still going on due to pending case at court.

The ERM assignment includes, besides this Environmental and Social Management and Monitoring Plan (ESMMP) the preparation of the following documents:

- Rapid Assessment for the New Damauli Substation;
- Biodiversity Assessment;
- Biodiversity Action Plan (BAP);
- Gap closing IEE Addendum Report;
- Project-specific Environmental and Social Management System (ESMS);

- Updated Stakeholder Engagement Plan (SEP), including Free Prior Informed Consent (FPIC) requirements and Grievance Mechanism.

A Resettlement Action Plan (RAP) will be developed by the IC based on the Resettlement Policy Framework (RPF), which was developed by ERM as part of a previous assignment and received NEA/KfW approval in 2018.

2. PURPOSE OF THE ESMMP

ESMMP is a fundamental component of an Environmental and Social Impact Assessment (ESIA), since its purpose is to provide the framework of management plans and monitoring regimes that will deliver the commitments, and to ensure these can be implemented practically speaking. This ESMMP describes in detail the important environmental mitigation measures identified during the impact assessment study, necessary management plans, responsibilities, and monitoring.

The broad purpose of the ESMMP is:

- To provide a structured list of actions to be undertaken during project implementation to ensure that E&S risks identified during the assessment process are addressed to international good practice and standards; and
- To provide assurance to third parties, that their requirements, with respect to E&S performance, will be met.

The specific objectives of this ESMMP are:

- To provide an institutional mechanism with well-defined roles and responsibilities for ensuring that measures identified are implemented;
- To minimise any adverse environmental, social and health and safety impacts resulting from the project activities by implementing all suggested mitigation measures identified through the process;
- To prevent or compensate for any loss of the affected persons;
- To conduct project activities in accordance with relevant Nepali Laws and the international guidelines;
- To prevent environmental degradation resulting from cumulative impacts;
- To ensure the ESMMP is feasible and cost-efficient; and
- To ensure all stakeholders concerns are addressed.

The overall responsibility for implementation of a given measure always rests with NEA; the specific implementation of ESMMP items is then (usually, though not always) undertaken by the contractors who construct the Project. All contractors must adopt and comply with the policies and plans required as part of this ESMMP.

3. DEVELOPMENT OF THE ESMMP

The existing Initial Environmental Examinations (IEEs) are the basis for the approval by the Nepali Ministry of Energy. However, the national IEE documents do not provide sufficient details to cover the E&S requirements of the World Bank Group and the German Development Bank *Kreditanstalt für Wiederaufbau* (KfW). Several reports were prepared by ERM to close this gap. Therefore, this ESMMP includes all mitigation measures stated in the IEEs combined with the measures from the gap closing documentation:

- IEE, prepared by NEA's ESSD, November 2017;
- Updated IEE, prepared by NEA's ESSD, November 2019;
- Updated IEE, prepared by NEA's ESSD, January 2020;
- Rapid Assessment for New Damauli Substation, prepared by ERM, 2021;
- Biodiversity Report and BAP, prepared by ERM, 2021; and
- Gap closing Addendum Report, prepared by ERM, 2021.

4. LEGISLATION AND REGULATIONS

4.1 Nepalese Legislation

For this Project, the relevant Nepalese legislation is applicable. A list of the relevant regulations and other relevant instruments and guidelines is presented below.

- Policies and Plans:
  - National Bio-Diversity Strategy and Action Plan (2014-2020);
  - National Climate Change Policy 2076 (2019);
  - National Policy on Land Acquisition, Compensation and Resettlement (2015);
  - Land Use Policy 2072 (2015);
  - National Forest Policy 2075 (2019).
- Acts:
  - Land Acquisition Act (1977);
  - Soil and Watershed Conservation Act, 2039 (1982);
  - Water Resource Act, 2049 (1992);
  - Electricity Act, 2049 (1992);
  - Forest Act, 2049 (1992);
  - Labour Act, 2074 (2017);
  - Environment Protection Act, 2076 (2019);
  - Local Government Operation Act (2017);
  - Child Labour (Prohibition and Regulation) Act, 2056 (2000);
  - Control of International Trade of Endangered Wild Fauna and Flora Act, 2073 (2017);
  - Solid Waste Management Act, 2068 (2011).
- Rules and Regulations:
  - Electricity Rules, 2050 (1993);
  - Environment Protection Rules, 2075 (2020);
  - Water Resources Rules, 2054 (1997);
  - Forest Rules, 2051 (1995);
  - Labour Rules, 2075 (2018);
  - Solid Waste Management Rules, 2070 (2013);
  - Contribution Based Social Security Regulation (2018);
  - Electricity Regulatory Commission Rules, 2075 (2018).
- Guidelines:
  - National EIA Guidelines, 2050, (1993);
  - EIA Guidelines for Forestry Sector, 2052 (1995);
  - Forest Production, Collection & Sales Distribution Guidelines, 2073 (2016);
  - Community Forest Guidelines, 2071 (2014);

- Community Forest Inventory Guidelines (2005);
- Working Procedure with Standards for the Use of National Forest Land for National Priority Project, 2076 (2019).

- Conventions:
  - Convention on Biological Diversity (1992);
  - Convention on International Trade of Endangered Species of Wild Fauna and Flora (CITES)(1973);
  - Convention on Wetlands of International Importance (Ramsar Convention);
  - International Labor Organization (ILO) Convention of Indigenous and Tribal Peoples, 1989 (No. 169).

4.2 International Standards

For this Project, the Bank's (KfW) Sustainability Guidelines[1] are applicable. This means that the application of the following sets of policies and guidelines are required:

- IFC Performance Standards (PS), 2012:
  - PS1 - Assessment and Management of E&S Risks and Impacts;
  - PS2 - Labour and Working Conditions;
  - PS3 - Resource Efficiency and Pollution Prevention;
  - PS4 - Community Health, Safety, and Security;
  - PS5 - Land Acquisition and Involuntary Resettlement;
  - PS6 - Biodiversity Conservation and Sustainable Management of Living Natural Resources;
  - PS7 - Indigenous Peoples;
  - PS8 - Cultural Heritage.
- IFC/World Bank General Environmental, Health, and Safety (EHS) Guidelines, 2007[2];
- IFC/World Bank Environmental, Health, and Safety Guidelines for Electric Power Transmission and Distribution, 2007[3];
- Human Rights Principles outlined in the BMZ Strategy "*Human Rights in German Development Policy*"[4] and specified in the BMZ Guidelines on Incorporating Human Rights Standards and Principles, Including Gender, in Programme Proposals for Bilateral German Technical and Financial Cooperation, 2013;
- Core Labour Standards of the International Labour Organisation (ILO)[5];

[1] KfW (2021) Sustainability Guidelines. Available at: https://www.kfw.de/About-KfW/Service/Download-Center/Konzernthemen/Nachhaltigkeit/Richtlinien/
[2] IFC/World Bank (2007) Environmental, Health, and Safety General Guidelines. Available at: https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/policies-standards/ehs-guidelines.
[3] IFC/World Bank (2007) Environmental, Health, and Safety Guidelines for Electric Power Transmission and Distribution. Available at: https://www.ifc.org/wps/wcm/connect/7b65ce6b-129d-4634-99dc-12f85c0674b3/Final%2B-%2BElectric%2BTransmission%2Band%2BDistribution.pdf?MOD=AJPERES&CVID=jqeI4Rs&id=1323162154847.
[4] BMZ (2013) Human Rights in German Development Policy. Available at: https://www.bmz.de/resource/blob/70448/14b3b6b3fe59eab4dcc05efe266e57b4/guidelines-human-rights-bilateral-cooperation.
[5] Core Labour Standards of the International Labour Organisation. Available at: https://www.ilo.org/global/standards/introduction-to-international-labour-standards/conventions-and-recommendations/lang--en/index.htm on July 2021.

- the UN Basic Principles and Guidelines on Development-based Evictions and Displacement, namely §§ 42, 49, 52, 54 and 60)[6] and guidance provided within the IFC (2002)[7] Handbook for Preparing a Resettlement Action Plan and World Bank (2004) Involuntary Resettlement Sourcebook[8]; and
- FAO Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests (VGGT), 2012[9].

[6] https://www.ohchr.org/Documents/Issues/Housing/Guidelines_en.pdf
[7] ttps://www.ifc.org/wps/wcm/connect/22ad720048855b25880cda6a6515bb18/ResettlementHandbook.PDF?MOD=AJPERES&CACHEID¬=22ad720048855b25880cda6a6515bb18
[8] http://documents.worldbank.org/curated/en/206671468782373680/pdf/301180v110PAPE1ettlement0sourcebook.pdf
[9]FAO (2012) Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests. Available at: http://www.fao.org/docrep/016/i2801e/i2801e.pdf

5. PROJECT DESCRIPTION

5.1 Project Overview

The Project developed by the NEA is part of Nepal's strategy to overcome the continuing power shortages and satisfy the growing demand of electricity. The TL will serve as the power evacuation route for the Tanahu Hydropower Project. It relates to the construction of a new substation (Damauli Substation) and the expansion of an existing substation (Lekhnath Substation), which will be linked by a double circuit TL. The main components of the Project are:

Package A

- Construction of 42 km 220 kV Double Circuit TL between Lekhnath - Damauli;
- Tie in of loop-in-loop-out (LILO) connection of Tanahu Hydro 220 kV TL into new Damauli Substation (Tanahu TL under-construction, separate financing); and
- Tie in of LILO connection of Old Damauli - Bharatpur 132 kV TL into new Damauli Substation.

Package B

- 220 kV GIS extension at existing Lekhnath Substation (on land which already belongs to NEA); and
- New 220/132kV GIS Damauli Substation.

The Project is located in the Kaski and Tanahu Districts of Province No. 4 in the Gandaki Zone of the central part of Nepal.

The currently proposed TL has a length of about 42 km. The proposed route starts at the existing substation of Lekhnath, near Pokhara, and terminates at the proposed Damauli Substation in the Byas Municipality of Tanahu District.

The majority of the proposed TL will be a double/four circuit with two separate aluminium conductor steel reinforced (ACSR) per phase. The proposed towers are between 29 m and 44 m in height. The provisional right of way (RoW) under the TL will be 15 m either side of the centre line (30 m in total). For the multi-circuit line from AP44 to the new Damauli Substation, the RoW will be 20 m either side of the centre line (40m in total).

Developing the Project will require expanding some foot trail and feeder roads in order facilitate the transport and placement of towers.

The approximate size of the Damauli Substation will be 7 ha.

The following map shows the final line routing of the LDTL. Since the E&S documentation has been developed during the design process and the AP numbers have changed in the detailed design, therefore the reference points contain old and new AP numbering. The Figure 5-1 contains the new AP numbering from the final line routing.

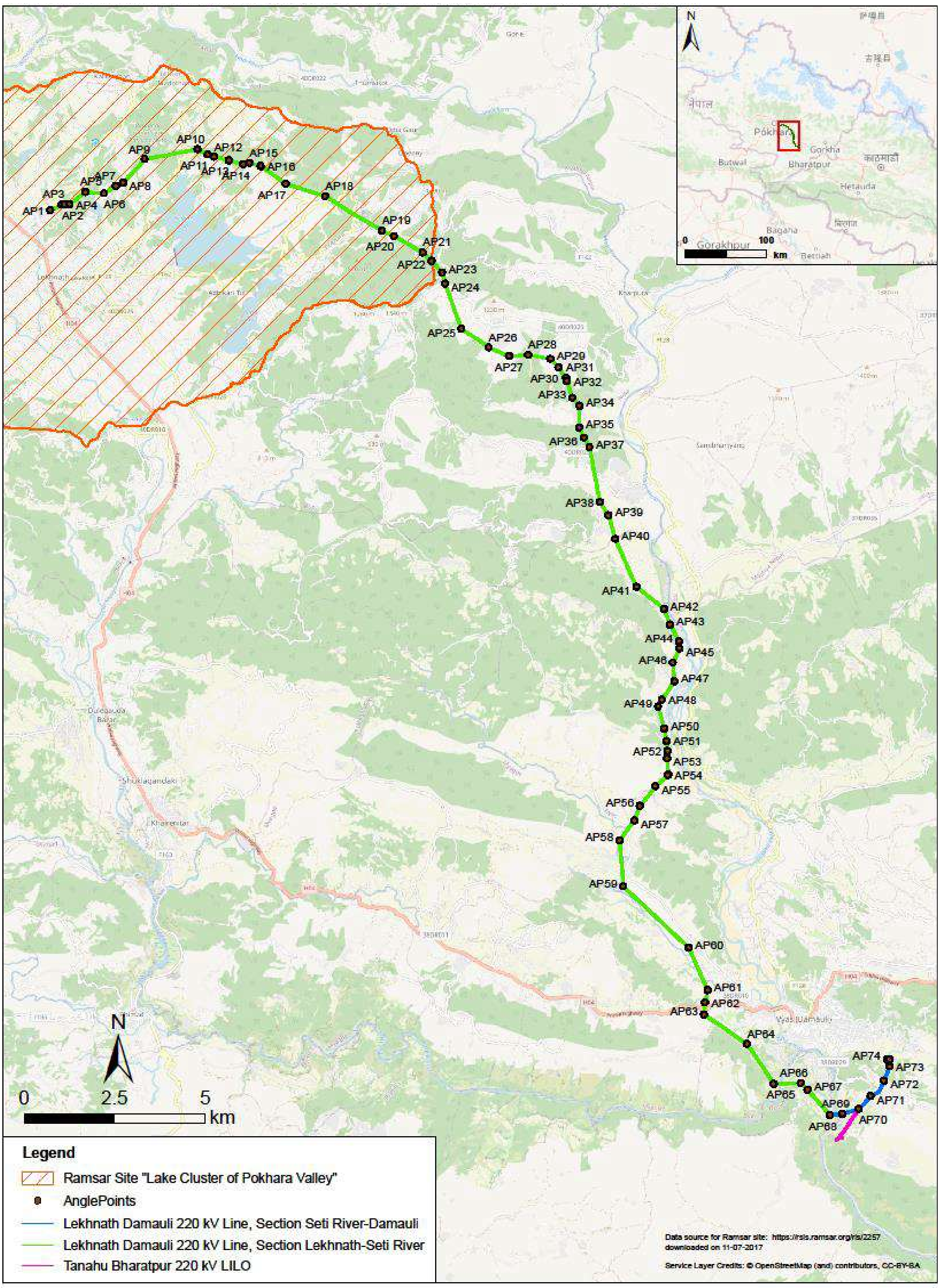


Figure 5-1 Project Overview

5.2 Construction Planning

The implementation of the proposed project comprises construction of the foundation for and erection of towers, wire stringing, testing and commissioning of the line. The estimated period of project completion is two years. According to the Updated IEE for the Project (NEA ESSD, January 2020), the following key phases are envisaged.

Preliminary Works

Preliminary works for the TL consist of contract award, the detail design study and mobilisation of the contractors. The detail design study will carry out the detailed route survey, spotting the tower locations, preparation of longitudinal profiles, geological field test and laboratory testing, tower design etc. To achieve effective tower footing resistance, earth resistance will also be measured at each tower site.

Land Acquisition and Resettlement

Once the Contractor is selected, the final line profile/design will be determined. This includes the necessary line routing, which needs to be approved by NEA, IC and KfW. After the design of the tower locations is finalised, the required land will be acquired by NEA as per the Land Acquisition Act (2034 B.S.), the requirements stipulated in the RPF (2018) and concretised in the RAP developed and supported by the IC in coordination with Compensation Determination Committee (CDC). Based on the final design to be developed by the Contractor, the Interim RAP will be prepared. For the Interim RAP a Social Survey and Census of PAPs will be made. The census will be accompanied by an inventory of lost assets and a detailed land measurement survey to determine all houses/structures in the RoW and land ownership of tower foundations and access roads that will have a permanent impact on land, which cannot be fully restored to prior condition. Overspanning of private lands in the RoW will be compensated as well.

The design of the substation site is already finalised. Out of the 84 plots of the Damauli Substation, all owners have already claimed and received the compensation, except for only two plots belonging to one person. These plots remain to be compensated because the case is currently pending at court.

The impacts that were not avoided and not compensated during the prior RAP implementation, will need to be compensated by the Contractor (according to RAP entitlements).

Forest and Land Clearance

The trees will be felled for the tower foundation and under the RoW in coordination with the Division Forest Office (DFO) and other stakeholders. Loss of crops will be compensated.

Extension at Lekhnath Substation

At Lekhnath substation, the new 220 kV switchgear will be connected to the existing 132 kV AIS outdoor switchyard by means of 220/132/11 kV single-phase auto-transformers, and the existing 132 kV yard will be extended accordingly.

Damauli Substation Construction

In Damauli, a new 132kV switchyard shall be constructed together with the 220kV substation. An indoor, double bus bar system SF6 Gas Insulated Switchgear (GIS) type has been selected for both substations. Construction of the new substation at Damauli will include civil works for ground elevation, boundary wall, control building, office/staff quarter buildings and line bay foundation. Following completion of the main civils works, the transformers and equipment will be transported to the sites and installed. The level of the substation will be raised by about 2 m for purpose of flood protection; for this a quantity of minimum 20,000 m³ of filling material will be needed. Additional permanent and stabilised access roads will be needed to enable the transport, storage and management of the soil at the substation site. Also, the transportation traffic through the villages will increase.

Tower Foundations

The construction of tower foundations will be undertaken by manual labour assisted by the mechanical equipment wherever possible. The mechanical plant will be limited to small demountable steel skid framed concrete mixers, air compressors, air drills/chisels and tamping/compaction tools. Excavation and the concreting of the tower foundations will be carried out as per the design requirements and after necessary curing, the foundations will be backfilled with suitable material. The average area required for each tower foundation is 15m x 15m (0.0225ha).

Erection of Towers

Galvanised steel lattice towers, manufactured offsite at a centralised factory, will be transported to the individual tower locations and are assembled and erected manually by employing pulleys, winches, etc. into the tower foundations.

Insulator Fittings, Conductor and Ground Wire Stringing

Conductors, optical ground wire (OPGW), ground wires, insulators and necessary accessories will be transported manually to the tower locations. Stringing of conductors, OPGW and extra high strength wire will be carried out with the help of a tension machine and other pulling devices as per the design requirements.

Access Roads

Primary site access for the substation construction will be gained from Byas through Belbas road. The TL and its foundation construction sites will be accessed from Prithvi Highway and its various feeder roads that pass near the settlements along the alignment. Existing feeder roads and tracks will be used for construction and maintenance where available. The construction material up to the nearest road head will be carried where possible by vehicle and later transported manually up to the individual tower locations. Various options for access road types have been identified by the IC[10]:

- Sections of existing public roads to be used (without enlargement or other modification);
- Existing roads not maintained by local authorities (which may need upgrade and stabilisation works);
- Existing community tracks (which will need to be enlarged and stabilised, thus creating E&S impacts);
- Proposed new access tracks which can be restored to natural condition after construction;
- Proposed new access tracks which will require cutting of slopes or terraces and cannot be restored to natural condition and thus need to be stabilised with roadside stabilisation, erosion protection and drainage to prevent degradation and negative environmental impacts; and
- Tower locations that cannot be accessed by road and need to be accessed by animal, cable, or aerial (e.g. helicopter) transport. This category also includes tower locations where the construction of access roads would cause excessive environmental damage.

Dumping Site

Since the construction of TL towers requires clearing and excavation of fairly small areas at tower locations, construction work will not require soil dumping sites. According to the IEE project description, the soil will be filled up and compacted in the tower base area. Similarly, soil generated

[10] Internal Document on Mitigation measures for access roads prepared by Fichtner, ERM received 17.11.2021.

from the substation during construction will be used for levelling of the access road and river protection work near the substation. However, attention must be paid to avoid erosions caused by access road development and soil disturbance. Adequate mitigation measures to address this issue are listed in Chapter 10.

Construction Materials

The materials required for civil construction works related to the TL, switching station and substation will be:

- Steel reinforcement;
- Cement;
- Coarse aggregate;
- Fine aggregates (sand);
- Batteries; and
- Admixtures, etc.

Steel reinforcing bars and cement may be acquired from local manufacturers or may also be imported. Coarse aggregates will be produced at site from excavated materials or purchased from the local market. Likewise, fine aggregates will be collected from existing major quarries and the excavated foundation material will be used as a backfill material required for the foundation construction. Amounts required of each material are presented in Table 5-1.

Table 5-1 Construction Materials Quantities of the Project

Description	Unit	Quantity
Coarse aggregates	m^3	4,588
Total Reinforced Steel Quantity	Tons	460
Total Cement Quantity	Bags	47,120
Total Fine Aggregates	m^3	2,356
Filling Material	m^3	20,000

Source: NEA, Updated IEE 2020

5.3 Requirement of Workforce

During the construction period of the Project, altogether approximately 350 people will be employed including 265 unskilled, 60 semi-skilled and 25 skilled personnel. The requirement of the workforce will be from start to end of the construction stage. Most of the unskilled manpower will be hired locally as per available skill and experiences.

5.4 Project Schedule

The estimated completion period of the project is 24 months, including 6 months pre-construction and 18 months construction and commissioning. According to the IEE project description, the construction work will primarily be carried out during the dry season when ground conditions are essentially dry and river flows low to allow easy movement of materials and placement of towers. However, it should be noted that a document from the IC[11] including mitigation measures states that culverts and bridges shall be installed for the purpose of crossing existing watercourses. The locations and types of culverts and bridges shall be proposed by the Contractor and approved by NEA and the IC. Construction activities during the monsoon season will primarily be restricted to stringing of

[11] Internal Document on Mitigation measures for access roads prepared by Fichtner, ERM received 17.11.2021.

conductors, although this activity may also be restricted by the adverse weather conditions. The construction work of the switching station and substation will be conducted throughout the year.

6. ROLES AND RESPONSIBILITIES

6.1 Nepal Electricity Authority

NEA has the overall responsibility for E&S management during the planning, construction and operation phase of the Project. This role includes the following responsibilities:

- Ensuring compliance with all relevant national legislation, as well as with the environmental controls and mitigation measures contained in this ESMMP;
- Ensuring that the design and planning is in compliance with national requirements and aligned with international Standard / Best practice;
- Ensuring that the relevant mitigation measures during construction are part of contractor’s contract;
- Monitoring the performance of contractors and sub-contractors used for providing workforce, supplies and services; and
- Acting as point of contact for consultation and feedback to stakeholders and the public (stakeholder engagement).

NEA ESSD

The Environment and Social Studies Department (ESSD) of NEA executes all activities related to the environmental aspects of project studies, design, construction and operation by NEA. Being the concerned department, ESSD had prepared the IEE reports of this Project.

NEA Environmental Management Unit

An **Environmental Management Unit** will be formed, responsible for managing and implementing mitigation measures and monitoring on behalf of the Project. The Environmental Management Unit will prepare and disseminate monthly reports containing information on the implementation status of the measures and monitoring results.

For the implementation of the E&S measures specially trained staff has to be employed (ESMS Manager, Occupational Health and Safety (OHS) Expert, Environmental Expert, Social Expert (e.g. Community Liaison Officer). Staff involved in the management and implementation of the E&S measures during construction and operation need to be especially trained for ESMMP implementation (capacity building).

Environmental Management and Grievances Redress Unit (NEA / NEA ESSD)

NEA will establish an **Environmental Management and Grievances Redress Unit** under the Project organisational setup. This Unit will be under direct supervision of the **Project Manager Office (PMO)** and will have three sections, namely

- Land Acquisition and Rehabilitation Section (LARS);
- Project Information Centre (PIC);
- Mitigation Implementation Section (MIS).

LARS will be responsible for the implementation of land acquisition and rehabilitation program, whereas public disclosure activities will be conducted through PIC supported by IC. The MIS will implement mitigation measures proposed in the ESMMP. The MIS will coordinate the work district level agencies such as District Forest Office, District Development Committee, and District Land Revenue and others.

6.2 Contractor

Construction Contractors are required to fulfil the Environment, Social, Health and Safety (ESHS) requirements as set out in this ESMMP and to ensure that their sub-contractors fulfil the ESMMP. This typically includes tasks before and during construction and rehabilitation of work areas after construction:

- Conduct internal monitoring and on-site audits to verify implementation of the ESMMP and report on findings to NEA.
- Communicate any environmental issues and incidents to NEA immediately.
- Training of the construction workers to raise awareness in the fields of E&S topics and in general implementation of this ESMMP.
- Ensure that workers comply with all OHS requirements e.g. safety working at height, wearing of PPE etc.
- Conduct Stakeholder Engagement, including FPIC requirements.
- Establish a Grievance Mechanism and implementation of corrective actions.

6.3 Implementation Consultant

The Implementation Consultant (IC, Engineer) is responsible for managing engineering activities in close cooperation with NEA. This includes technical, managerial and supervisory activities as well as provision of necessary guidance during all project phases. The project implementation has three (3) different phases. The IC supports NEA in all three of them:

- **Procurement Phase:** comprises all tasks until award of a contract, such as review services, the preparation of tender documents while considering the E&S aspects, conduct the tender process, including tender evaluation and assistance for the award of contract(s).
- **Implementation Phase:** comprises all tasks related to design audit, site supervision, testing, handing over, reviewing, updating, monitoring and reporting activities related to the E&S concerns of the Project. Main tasks related to E&S aspects will be the
    - Support NEA in implementing the ESMMP and any sub-plans, including the interim and final RAP, the SEP, to achieve FPIC, the BAP etc;
    - Attendance at any consultation meetings held by NEA or other responsible agencies with the PAP and attendance at any key milestone resettlement related activities (e.g. during the physical resettlement period (if any), etc.);
    - Monitoring and reporting on implementation of the ESMS / ESMMP (including any updates), including preparing and summarising reports on construction-related E&S aspects;
    - Continuous updating and preparing of final RAP inter alia to record the final compensation entitlements and payments made to each PAP household and provide actionable details of any livelihood initiatives and implementation arrangements which require follow-on action;
    - Monitoring, following-up and resolving any complaints or grievances in relation to construction health and safety, labour conditions or environmental pollution, land issues, disturbance of population, etc. while considering as well the available Grievance Redress Mechanism (GRM); and
    - Monitoring E&S success indicators.

- **Post-construction Phase:** comprises tasks related to services rendered during the Defects Liability Period (assumed to be 24 months) and related reporting activities to the Project completion and E&S concerns of the Project.

6.4 Other Stakeholders

A tree plantation program will be carried out as compensation of trees cleared by the Project. The plantation sites will be determined consulting with the Ministry of Forests and Soil Conservation (MoFSC), the Division Forest Office and Project Affected Community Forest Users' Groups (CFUGs).

Land compensation will be given in accordance with the rates determined by the Compensation Determination Committee (CDC). The district-level CDC was established under Section 13 (2) of the Land Acquisition Act, 2034 (1977) to determine replacement value and compensation rates for property acquired under the Act.

6.5 Agencies Responsible for Implementation and E&S Monitoring

The overall responsibility for implementation of a given measure rests with NEA as the Project Proponent; the specific implementation of ESMMP items is then (usually, though not always) undertaken by the contractors who construct the Project. The division of responsibilities for each individual mitigation measure is defined in the Tables below in Chapter 10. All contractors must adopt and comply with the policies and plans required as part of this ESMMP.

Ministry of Energy, Water Resources and Irrigation (MoEWRI) and the Department of Electricity Development (DoED) will be responsible for monitoring. However, NEA will have the prime responsibility for carrying out the monitoring activities. NEA ESSD will be responsible for pre-construction and construction phase monitoring of the Project. EMU comprising the staff from NEA ESSD will be established for the construction phase of monitoring of the project. The EMU will be responsible for compliance and impact monitoring works.

7. STAKEHOLDER ENGAGEMENT

NEA, supported by the IC, will ensure that the local communities are informed at an early stage about the planned Project, timelines, expected impacts and communication channels and will assign personnel in charge of the engagement with stakeholders. NEA will also seek for feedback from the communities about the Project. As part of its community liaison process, NEA will initiate and implement a Grievance Mechanism to ensure that all stakeholder comments, suggestions and objections are captured and considered. It will allow the affected community and the workers to express their concerns and any complaints directly to NEA. Contact details and information on the procedure, including grievance form, will be distributed to the local communities. It is envisaged that grievances will be responded to within 20 working days after receipt.

All comments and complaints will be investigated by NEA, and if necessary appropriate action will be conducted. Records of all complaints and actions will be maintained on site.

The SEP and, thus, the engagement process will aim to achieve FPIC from Indigenous Peoples (IP) affected by the Project through good faith negotiation between the Project proponent and the Affected Communities of IPs. ERM developed a SEP for this Project in 2017.[12] The SEP needs to be updated when necessary, since Stakeholder Engagement will be continued throughout the Project life cycle.

The Contractor is responsible for Worker's Grievance Mechanism and communication with PAP's during construction works.

[12] Stakeholder Engagement Plan for the Lekhnath Damauli Transmission Line Project, Nepal (2017)

8. SUMMARY OF MAIN E&S PROJECT IMPACTS

Key potential impacts associated with the proposed TL and proposed mitigation measures during construction and operation of the Project are provided in Chapter 10. The Contractor will be responsible for implementing mitigation measures as required in the ESMMP. For the construction and establishment of the TL connecting the two substations, the following key impacts are expected or can potentially occur:

- **Potential land use impacts**
  - Land will be temporarily and permanently acquired;
  - Land acquisition will generate economic and physical displacement (loss of structure, loss of crops, and loss of livelihood); and
  - Certain land use restrictions will persist for any land within the RoW (e.g. maximum height of trees underneath the TL).
- **Potential impacts during construction**
  - Construction site waste generation;
  - Soil erosion from material sourcing areas, site preparation activities and development of access roads and foundations for the TL towers;
  - Fugitive dust and other emissions (e.g. from vehicle traffic, land clearing activities and materials stockpiles);
  - Noise from heavy equipment and truck traffic;
  - Potential for hazardous materials and oil spills associated with heavy equipment operation and fuelling activities;
  - Potential landslides caused by access road construction;
  - Raw material demand increases risk for potential (illegal) mining for sand or gravel from riverbeds as well as impact on quarries (E&S management required);
  - Occupational Health and Safety (OHS) risk also in regard to workers' accommodation (including risks of Covid-19);
  - Community Safety (increased traffic, construction site, risks of Covid-19);
  - No impacts on groundwater are anticipated as construction works will only comprise of the foundations for the tower, which will have a limited footprint and not impact upon groundwater or aquifers;
  - Potential impacts of the Project on biodiversity receptors
    - Habitat loss and degradation within the Project Area (including for new access roads);
    - Species loss – flora removal from vegetation clearance;
    - Species loss - fauna mortality due to direct loss or injury from vehicle or machinery strike or as a result of poaching by the construction workforce;
    - Disturbance and displacement of fauna; and
    - Loss of ecosystem services.
- **Potential impacts during operation**[13]
  - Adverse health impacts from electromagnetic fields (EMF);

[13] Operational phase includes operation of the TL and respective maintenance.

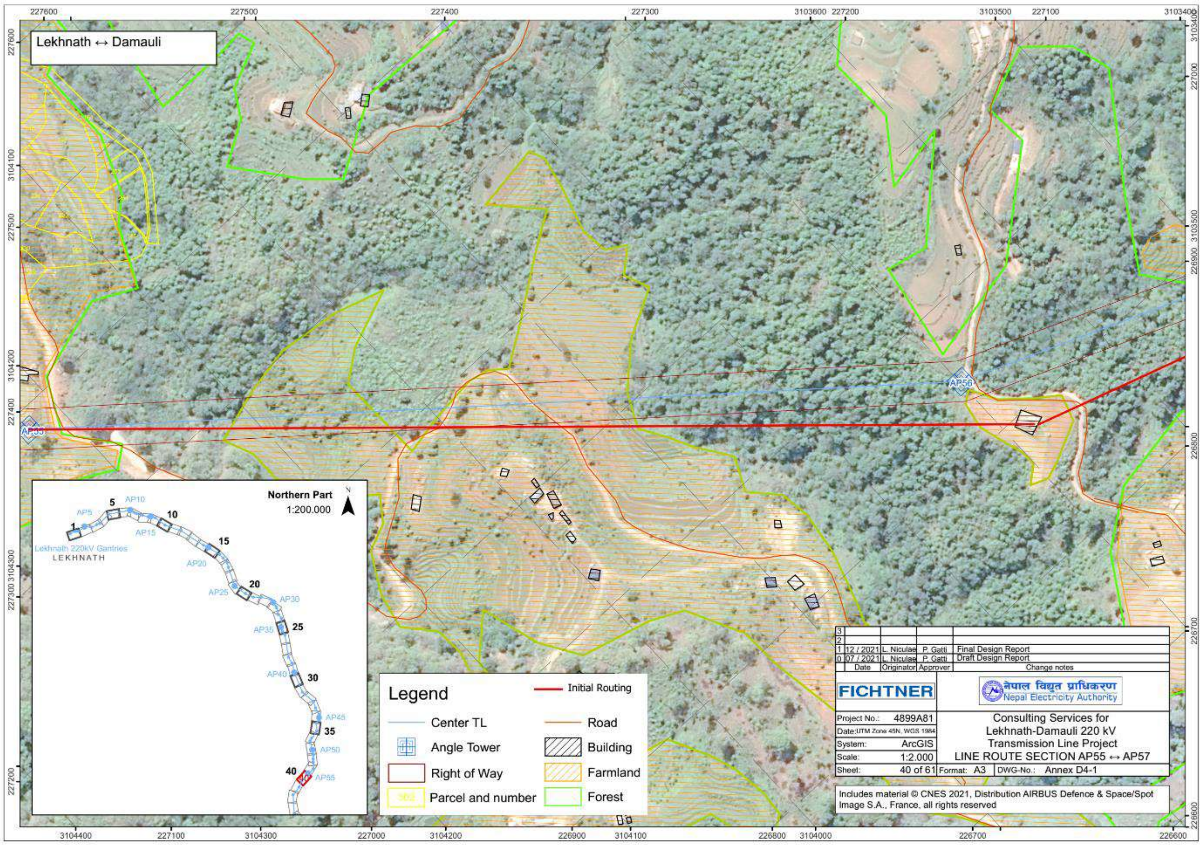
- Acoustic noise as produced under specific weather conditions by high voltage TL;
- Waste management risks;
- Impacts of the Project on biodiversity receptors
  - Induced habitat degradation and loss of flora;
  - Induced loss of and displacement of fauna species;
  - Collision of birds and bats; and
  - Impacts from invasive species.

9. E&S LINE ROUTE OPTIMISATION

The process of line route optimisation also included considerations of minimising potential E&S impacts. An Alternative Analysis of three alternative routes was carried out in the Addendum Report. After reviewing the various options, the decision was made for a route option. This line route was then further optimised in the design process.

For the final routing of the TL, potential E&S impacts have been considered by the technical planner. The line route was optimised based on ERM's recommendation to avoid and minimise E&S impacts where possible. Main concerns regarding E&S impacts are physical displacement, disturbance of fauna especially avifauna as well as deforestation. In September 2021, the following four modifications were integrated in the technical planning (detailed design).

Minor modifications of angle tower position (AP) reduce resettlement impacts at AP 31 (now AP 57) avoiding relocation of at least one household. Figure 9-1 shows the minor modification of the AP position, hereby the red line shows the initial line route, the blue line and the dark red lines show the final TL and its 30 m Right of Way (RoW).



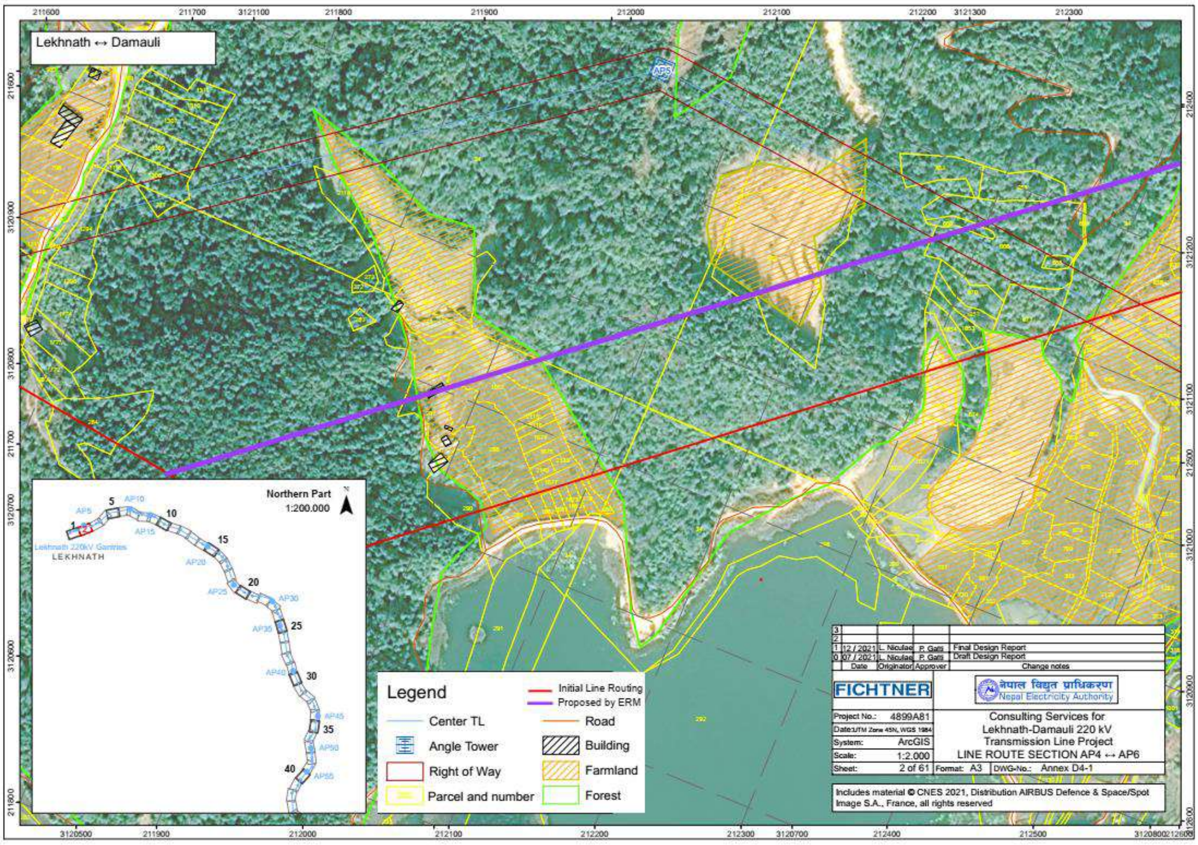
Source: Fichtner (2021)[14]

Figure 9-1 Minor Modifications of AP for Reduced Resettlement Impact

The Project passes through areas of native forest that qualify as natural habitat and is partly located within the Lake Cluster of Pokhara Valley Ramsar Site. ERM proposed routing diversions mainly to avoid forest and wetlands in order to minimise deforestation, loss of habitat and disturbance of flora and fauna.

The disturbance of fauna will be reduced with an alignment diversion, which has been implemented between AP 4 and AP 6 (now AP 4 – AP 9) to set the line back from the lake by 100 m to reduce the disturbance and displacement of waterfowl at Dipang Lake. Figure 9-2 shows the increased distance to Dipang Lake at AP 4 – AP 6 (now AP 4 – AP 9) towers of now 115 m to the proposed line route, which will reduce the impact on wetlands and respective fauna. Hereby the red line shows the initial line route, the purple line the recommendation ERM made based on the initial line, the blue line the proposed final line route, and the dark red lines show the 30 m Right of Way (RoW). The final proposed line took ERM's previous made recommendation into account.

[14] Fichtner (2021) Consulting Services for "Lekhnath – Damauli 220kV Transmission Line Project" Study of Lekhnath – Damauli 220 kV OHL crossings in Lekhnath S/S area: Line Routing Optimization regarding Environmental and Social Impacts for Discussion with ERM and KfW [Powerpoint slides].

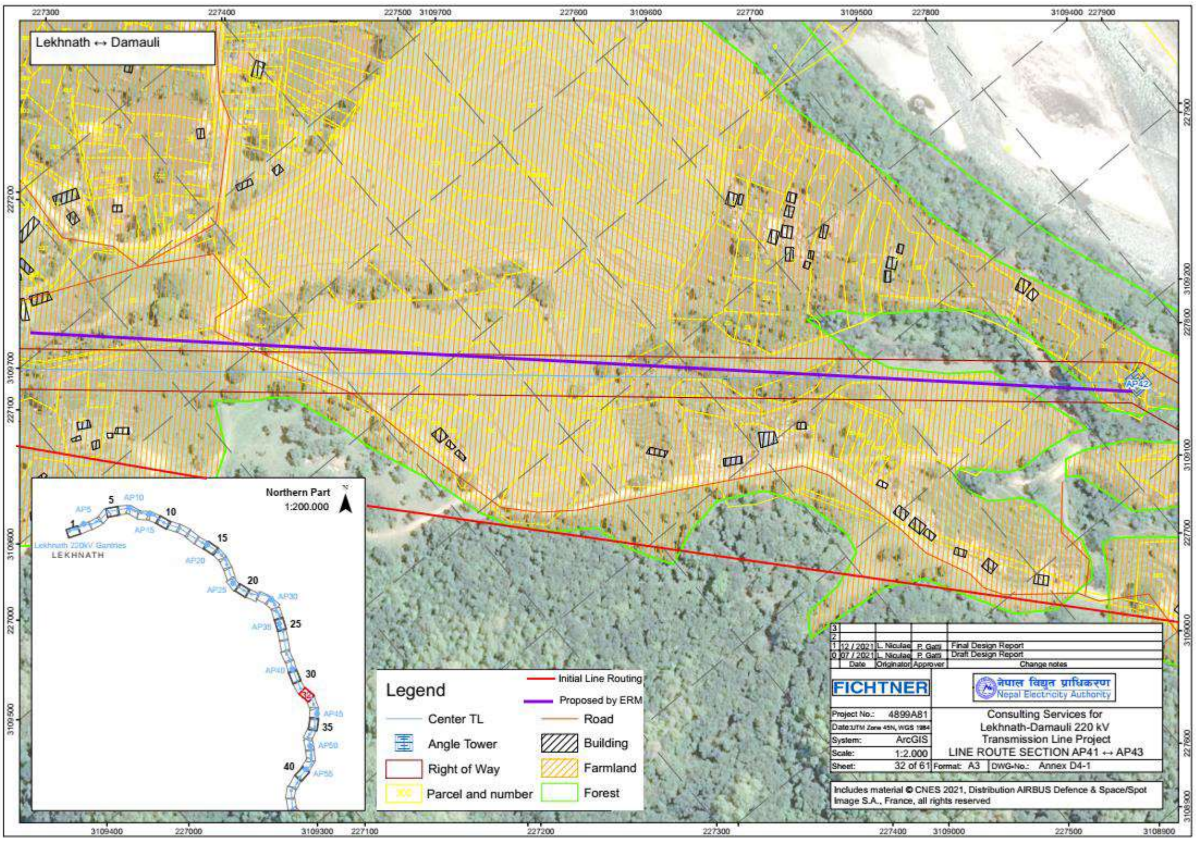


Source: Fichtner (2021)[15]

Figure 9-2 Routing Diversions for Reduced Impact on Wetlands

The route alignment at AP 23 (now AP 41 - AP 42) has been adjusted to avoid impacts on a white-rumped vulture colony. The line route optimisation achieved distance to the vulture colony of 150 m, which will reduce bird collision risk and reduce the disturbance of avifauna (see Figure 9-3). The red line shows the initial line route, the purple line the recommendation ERM made based on the initial line, the blue line the proposed final line route, and the dark red lines show the 30 m Right of Way (RoW). The final proposed line took ERM's previous made recommendation into account.

15 Fichtner (2021) Consulting Services for "Lekhnath – Damauli 220kV Transmission Line Project" Study of Lekhnath – Damauli 220kV OHL crossings in Lekhnath S/S area: Line Routing Optimization regarding Environmental and Social Impacts for Discussion with ERM and KfW [Powerpoint slides].



Source: Fichtner (2021)[16]

Figure 9-3 Increased Distance to Vulture Colony to Prevent Bird Collision

16 Fichtner (2021) Consulting Services for "Lekhnath – Damauli 220kV Transmission Line Project" Study of Lekhnath – Damauli 220kV OHL crossings in Lekhnath S/S area: Line Routing Optimization regarding Environmental and Social Impacts for Discussion with ERM and KfW [Powerpoint slides].

10. E&S MANAGEMENT AND MONITORING PLAN

10.1 Overview of ESMMP for the Project

This document determines the ESMMP. The ESMMP captures the typical E&S impacts and associated mitigation measures that need to be considered at the Project development and operation. The ESMP includes also respective monitoring procedures and means of verification. NEA - together with the contractors and other involved entities - shall use this document as guidance.

The ESMMP is divided into the ESMMP for the design/planning, construction and operational phase for the development of the TL. The ESMMP follows the structure of the KfW standard bidding documents:

- A – General Requirements for ESHS Management;
- B – Protection of Environment;
- C – Workers Health & Safety; and
- D – Labour and Relations with Local Communities.

However, Section A – General Requirements for ESHS Management are identical for all projects and are therefore unrevised included in the KfW standard bidding documents. Thus, this ESMMP only includes the Sections B – D.

An ESMS with the supporting management plans as listed in Table 10-1 should be prepared. However, further plans may be needed.

Table 10-1 Required Supporting Management Plans and Responsibilities

Plans	Phase	Responsibility
Biodiversity Action Plan (BAP) (existing)	Construction	NEA (prepared by ERM)
	Operation	
Chance Finds Procedure	Construction	Contractor
Community Health and Safety Management Plan	Construction	Contractor
	Operation	NEA
Contract Management Plan	Construction	NEA
Earthworks, Erosion and Reinstatement Management Plan	Construction	Contractor
Emergency Preparedness and Response Plan (EPRP)	Construction	Contractor
	Operation	NEA
Environmental, Health & Safety (EHS) Policy	Construction	Contractor
	Operation	NEA
Grievance Mechanism	Construction	NEA
	Operation	
Workers and Community Grievances	Construction	Contractor
Human Resources Management Plan	Construction	Contractor
	Operation	NEA
Resettlement Policy Framework (RPF) (existing)	Before Construction	NEA (prepared by ERM)
Resettlement Action Plan (RAP) and Livelihood Restoration Plan (LRP)	Construction	Implementation Consultant
	Operation	
Stakeholder Engagement Plan (SEP) (existing)	Construction	NEA (prepared by ERM)
	Operation	
Traffic Management Plan	Construction	Contractor
Vehicle Machinery and Inspection Programme	Construction	Contractor
Water Management Plan	Construction	Contractor
Waste Management Plan (WMP)	Construction	Contractor
	Operation	NEA

10.2 ESMMP for the Project – Design/Planning Phase

The following Table 10-2 shows the measures required to be implemented during the design/planning phase as well as prior to start of construction. In this phase NEA, the Contractor as well as the IC are each responsible for the implementation of certain measures as indicated in the table.

Table 10-2 ESMMP for the Project – Design/Planning Phase

No [17]	Item	Mitigation, Management and Enhancement Measures	Responsible[18]	Timeline	Means of Verification	Monitoring Procedure	Source
B.	**Protection of the Environment**						
B.10.	Protection of adjacent areas	Biorestoration and permanent erosion control measures to maintain the slope integrity will be reflected in the design documents. Bioengineering with combination of retaining structures as well as proper landscaping at each tower site (restoration of the tower footprint) will be reflected in the design documents.	Contractor	During design	Plans and other documents Observation	Monitoring of effected works By IC	IEE Nov 2017, A IEE Nov 2019, A IEE Jan 2020, A
		Quantify the required water amounts, water sources and the availability of water in terms of the volume that can be provided from the watercourses envisaged as water source. Permits will be obtained prior to usage of any water resources. Nearby water users (communities) will be engaged in order to not affect their water availability. Downstream impacts on residents to be considered.	Contractor	Prior to construction	Development of Water Management Plan Water permit obtained	Regular monitoring of adjacent natural resources By IC	Standard / Best practice
B.11.	Selection of borrow areas, backfill material stockpile sites	Approve quarries and borrow pits with appropriate E&S certification (eg. no gravel abstraction from river) for construction. Prepare IEE/EIA for quarry/borrow area for approval by Ministry of Environment.	Contractor	Prior to construction	IEE/EIA Permit	Permit review By IC Final approval By NEA	Standard / Best practice

[17] Numbering is not continuous because it refers to the items of KfW standard bidding documents.
[18] In case several entities are responsible for implementation, a lead entity is defined in this format: **Lead Entity**.

No [17]	Item	Mitigation, Management and Enhancement Measures	Responsible[18]	Timeline	Means of Verification	Monitoring Procedure	Source
	and access road	In the detailed design phase, prepare access road maps detailing the proposed access routes to all towers of the line. The various access types shall be identified and mapped showing length and terrain features. The types of new access tracks to be constructed shall be shown on maps. Type(s) of Contractor's heavy machinery which shall traverse the access routes shall be indicated and will also be included in the Traffic Management Plan. Access maps shall be submitted together with the final detailed routing design (at least 12 months before the physical construction commencement date). Appropriate measures such as avoidance of tree cutting, avoidance of agriculture areas, and avoidance of impacts on communities shall be implemented in design phase. If land needs to be acquired it has to be included in the RAP. If private lands are traversed by temporary access roads, compensations have to be paid to land users. For a detailed approach for identifying access road types and details to be included follow the instruction in Appendix A.	Contractor	During design, prior to construction	Review Written approval	Review By IC Final approval By NEA	Internal Document prepared by IC, received 17.11.2021
		The Contractor is required to minimise the need for new access roads by: ■ Using existing roads as much as possible; ■ Create short 'finger' roads from existing roads to tower locations instead of long roads along the line route where possible; and	Contractor	During design	Review Written approval	Review By IC Final approval By NEA	Internal Document prepared by IC, received 17.11.2021

No [17]	Item	Mitigation, Management and Enhancement Measures	Responsible[18]	Timeline	Means of Verification	Monitoring Procedure	Source
		■ Consider alternate means of transportation described earlier instead of constructing long roads through forested hilly/mountainous areas. Selection criteria for types of access roads in order of priority are defined in Appendix A.					
		Once the access maps have been approved, the Contractor shall not make use of any other access routes without the prior approval of NEA and IC.	Contractor	During design	Review Written approval	Review By IC Final approval By NEA	Internal Document prepared by IC, received 17.11.2021
		Culverts and bridges shall be installed for the purpose of crossing existing watercourses. Culverts shall also be installed where required for effective drainage systems. The locations and types of culverts and bridges shall be proposed by the Contractor and approved by NEA.	Contractor	Prior construction	Observations on site	Review By IC Final approval By NEA	Internal Document prepared by IC, received 17.11.2021
B.12.	Pollution prevention	Develop an Emergency Preparedness and Response Plan (EPRP) for spill containment and clean-up, engineering contingencies, collisions, natural hazards and other emergencies to include: ■ The emergency response in the event of spills, fire, accidents, earthquakes, floods; ■ Procedure for staff and subcontractors to report any incidents; and ■ Emergency response training; ■ Emergency communication procedure.	Contractor	Prior to construction	Review Written approval	Review By IC Final approval By NEA	Standard / Best practice
B.15.	Noise and vibration	The transmission line emits some noise, especially during wet weather conditions, due to the so-called corona effect. The corona effect can be reduced through design, which should be applied in the detailed design phase.	IC	During design	Design to reduce corona effect Written approval	Final approval By NEA	Standard / Best practice

No [17]	Item	Mitigation, Management and Enhancement Measures	Responsible[18]	Timeline	Means of Verification	Monitoring Procedure	Source
		Develop a Vehicle Machinery and Inspection Programme of own and subcontractor / third party trucks and other machinery. This should be dealt with according to specific H&S procedures of the Contractor.	Contractor	Prior to construction	Review Written approval	Review By IC Final approval By NEA	Standard / Best practice
B.16.	Waste Management	Develop an effective Waste Management Plan (WMP) to ensure that all wastes (hazardous, non-hazardous, wastewater) are disposed of in an environmentally sound manner. This plan shall describe procedures to ensure that waste generation is minimised, transportation is monitored, storage is safe and disposal methods are sound and do not cause negative impacts to the environment or communities.	Contractor	Prior to construction	Review Written approval	Review By IC Final approval By NEA	IEE Nov 2017, A IEE Nov 2019, A IEE Jan 2020, A Standard / Best practice
B.17.	Vegetation clearing	Government forest area falling under TL alignment is 0.88 ha and CF area falling under the tower pad and TL alignment is 21.9947 ha. Purchase of 0.54 ha of land as replacement of permanently acquired forestland.	**NEA,** MoFSC, Contractor	Prior to construction	Records of purchased land	Review By IC Final approval By NEA	IEE Jan 2020, B (slightly different Numbers IEE Nov 2017, B, IEE Nov 2019, B)
		Removal of 4,723 private trees (ToF). Cash compensation	**NEA,** MoFSC, Contractor	Prior to construction	Transaction register	Monitoring of effected works By IC	IEE Nov 2019, B IEE Jan 2020, B
		As far as practicable, towers will be placed on ridges to avoid the forest clearance to the extent possible.	**NEA**, Contractor	During design	Design approval	Review By IC Final approval By NEA	IEE Jan 2020, B
		Avoid trees on slopes and valley from felling as far as possible. In such area, it is proposed that the minimum forest clearance that are needed for the laying and stringing of conductor will be	**NEA,** Contractor	Prior to construction	Records of trees felled	Observations on site by ECoW	IEE Jan 2020, B

No [17]	Item	Mitigation, Management and Enhancement Measures	Responsible[18]	Timeline	Means of Verification	Monitoring Procedure	Source
		maintained and remaining trees of the RoW will be kept intact. Overspanning of trees where safety distances can be respected.					
B.18.	Biodiversity	As a compensatory measure for the loss of trees due to the site clearance, plantation in 1:25 ratio will be carried out in the area provided by the concerned Community Forest User Groups (CFUG) and DFOs, as per the provision made in Working Procedure for the Use of National Forest Land for National Priority Project, 2074.	**NEA,** MoFSC, DFOs, Contractor	Prior to construction	Observations	Observations on site by ECoW	IEE Jan 2020, B
		14,238 trees from CF will be felled. 356,814 number of seedlings will be planted as a compensatory plantation. Plantation of 864 seedlings will be done on 0.540 ha of government and CF area to be permanently acquired by NEA (at the standard ratio of 1600 seedlings per ha).	**NEA,** MoFSC, DFOs, Contractor	Prior to construction	Observations	Observations on site by ECoW	IEE Jan 2020, B
		Measures to minimise bird injury and death associated with the TL will be considered in line design as far as possible.	IC	During design	Review of final design	Final approval By NEA	BAP, 2021
C.	**Health and Safety**						
C.22.	Health and Safety Plan	Develop occupational H&S plans and procedures and/or update the existing documents in line with Project standards as required. Develop Community Health and Safety Management Plan.	Contractor	Prior to construction	H&S Plans and Procedures in place Community Health and Safety Management Plan	Review By IC Final approval By NEA	Standard / Best practice
C.31.	Emergency scenarios prevention	Take the necessary measures to ensure that pollution to air, water or land is prevented or, where this is not possible, reduced and mitigated as far as practicable during the construction phase. In doing so the Contractor	Contractor	Prior to construction	Review Written approval	Review By IC Final approval	Standard / Best practice

No [17]	Item	Mitigation, Management and Enhancement Measures	Responsible[18]	Timeline	Means of Verification	Monitoring Procedure	Source
		will need to develop a EPRP which clearly outlines the measures for managing e.g. atmospheric emissions and dust, e.g. noise and vibrations, e.g. waste (specified in ESHS Specifications including 15 and 16 below). Please provide specific details on how to handle for example the following aspects: a) liquid effluents b) air emissions and dust c) noise and vibration management d) vehicle and equipment maintenance and selection e) fuel, oil and chemical storage and handling Develop an EPRP for spill containment and clean-up, engineering contingencies, collisions, natural hazards and other emergencies to include: ■ The emergency response in the event of spills, fire, accidents, earthquakes, floods; ■ Procedure for staff and subcontractors to report any incidents; ■ Emergency response training; ■ Emergency communication procedure.				By NEA	
C.40.	Hygiene, accommodatio n and food	Provide adequate accommodation for workers, in line with international Standard / Best practice. Develop a Worker Accommodation Plan as per IFC/EBRD Guidelines on Worker Accommodation[19], whenever planning to establish a labour camp/colony. The Worker	Contractor	Prior to construction	Accommodation to meet international standards Worker Accommodation Plan and	Campsite inspection prior to accommodation of the workers. By IC	Standard / Best practice

[19] IFC/EBRD (2009) Guidelines on Worker Accommodation. Available at: https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/publications/publications_gpn_workersaccommodation

No 17	Item	Mitigation, Management and Enhancement Measures	Responsible[18]	Timeline	Means of Verification	Monitoring Procedure	Source
		Accommodation Plan shall also include risks and mitigation linked with gender-based violence and trafficking in persons as well as communicable diseases, for sexually transmitted diseases and pandemic diseases such as Covid-19.			Monitoring Checklist		
D.	**Labour and relations with local communities**						
D.42.	Labour conditions	Adopt and implement human resources policies and procedures consistent with the requirements of national labour laws, IFC PS 2 and the ILO Conventions. Provide workers with documented information that are clear and understandable, regarding their rights under national labour and employment law and any applicable collective agreements, upon beginning working relationships and when any material changes occur. Ensure wage rates are not be lower than established for the sector where the work is carried out or for a similar industry. There should be no wage disparity (for similar work and skill levels) between males and females, or migrant workers and local workers. Ensure Contractor and any subcontractor will not interfere with workers' rights to form or join a workers' organisation. The Contractors engaged for the Project (including supply chain) will not use child or forced labour, or discriminate against vulnerable groups. Ensure all workers have the same rights and are treated equally.	Contractor	Prior to construction	Human Resources Management Plan Sample contract Worker Accommodation Plan and Monitoring Checklist Audit	Review By IC Final approval By NEA	Standard / Best practice

No [17]	Item	Mitigation, Management and Enhancement Measures	Responsible[18]	Timeline	Means of Verification	Monitoring Procedure	Source
		These measures will be laid out in Human Resources Management Plan. The Project will audit contractors to ensure they are abiding by the Human Resources Management Plan. Failure to meet these standards will result in consequences up to and including termination of contract, to be decided on a case-by-case basis.					
D.43.	Local recruitment	Ensure that the assigned contractor gives capable members, as well as unskilled labour of the affected communities and villages priority in recruitment, throughout the construction and operation phases of the Project. The assigned contractor will prioritise the procurement of goods, construction materials and services from within the affected District, or in case this is not possible, preference should be given to suppliers within the Region.	Contractor	Prior to construction	Local procurement and employment rules and records Appropriate code of conduct	Review By IC Final approval By NEA	Standard / Best practice
		For the RoW clearance in community forests, the preference will be given to the users of concerned community forest user groups rather than outside labourers which will help the conservation of forestland indirectly and will provide work opportunity to locals as well.	Contractor	Prior to construction	Observation	Observation By ECoW	BAP, 2021
D.47.	Community interaction	Update the existing Stakeholder Engagement Plan[20] (SEP), including FPIC requirements throughout the project life cycle, designed to support the development of strong, constructive and responsive relationships, which includes inter alia: ■ Endorsement and implementation of a SEP;	**NEA**, Contractor	Prior to construction	SEP developed and implemented Grievance mechanism and grievance log	Monitoring of effected works By IC	Standard / Best practice

[20] Stakeholder Engagement Plan of the Lekhnath-Damauli Transmission Line Project, Nepal (2017)

No [17]	Item	Mitigation, Management and Enhancement Measures	Responsible[18]	Timeline	Means of Verification	Monitoring Procedure	Source
		■ Implementation of a grievance mechanism so that communities can share their concerns; and ■ Consultation to inform local communities of the risks of trespassing onto sites.			Public awareness programme and documentation		
		Prepare a Resettlement Action Plan and Livelihood Restoration Plan (RAP and LRP). All details are provided in the RPF and the RAP.	**NEA**, IC	Prior to construction	RAP and LRP SEP Grievance mechanism	RAP and LRP Implementation and Completion Audits By IC Final approval By NEA	Standard / Best practice
		Ensure that the RAP and LRP includes consideration of permanent loss of livelihoods, and develop and implement a Livelihood Restoration Plan for all affected households. This should include compensation for loss of land (preference to like for like else cash compensation), compensation for crops and trees (based on replacement value) as well as development of alternative livelihood strategies if replacement land cannot be provided. The Livelihood Restoration Plan should include consideration of land users and owners. The LRP should also include identification of potential LRP implementation partners i.e. NGOS, government bodies, cooperatives etc.	IC	Prior to construction	RAP and LRP	RAP and LRP Implementation and Completion Audits. By IC Final approval By NEA	IEE Nov 2017, C IEE Nov 2019, C IEE Jan 2020, C
		Undertake stakeholder engagement in a timely manner to inform people about the construction and operation activities including the timing of such activities and restrictions on land use. Implement a grievance mechanism so that communities can share their concerns regarding the Project and if activities are having significant	**NEA**, Contractor	Prior to construction	RAP and LRP	RAP and LRP Implementation and Completion Audits. By IC Final approval By NEA	IEE Nov 2017, C IEE Nov 2019, C IEE Jan 2020, C

No [17]	Item	Mitigation, Management and Enhancement Measures	Responsible[18]	Timeline	Means of Verification	Monitoring Procedure	Source
		negative impacts on livelihoods. Transition Allowances and other forms of allowances – land development, land improvement, transportation etc.					
		The RAP and LRP also cover impacts on Indigenous Peoples (IP) including impacts on land under traditional ownership or customary use of IPs, natural resources, cultural sites, and physical displacement.	IC	Prior to construction	RAP and LRP SEP Grievance mechanism	RAP and LRP Implementation and Completion Audits By IC Final approval By NEA	Standard / Best practice
		IPs are triggered and thus need to be considered in the SEP and the RAP which fall under the responsibility of NEA but will be assisted in their development by ERM (SEP) and the IC (RAP)	**NEA**; IC	Prior to construction	FPIC Documentation SEP Grievance mechanism	RAP and LRP Implementation and Completion Audits By IC Final approval By NEA	Standard / Best practice
D.48.	Damage to people and property	The Nepali standard requires RoW distances of 30 m in total /15 m to each side, as proposed for this Project. During the detailed design, NEA shall provide evidence that the technical design and RoW of the transmission line ensure the adherence to the ICNIRP (International Commission on Non-Ionizing Radiation Protection) EMF limits at the buildings close to the Project. Average and peak exposure levels should remain below the ICNIRP recommendation for general public exposure of	**NEA**, IC	During design	Evidence ensuring the adherence to ICNIRP EMF limits. If this cannot be proven, a wider than 30 m RoW needs to be selected or the line routing needs to be adjusted.	During design revision Review By IC Final approval By NEA	Standard / Best practice

No [17]	Item	Mitigation, Management and Enhancement Measures	Responsible[18]	Timeline	Means of Verification	Monitoring Procedure	Source
		5 kV^{m-1} for the electric field and 200 µT for the magnetic field.[21] If this cannot be proven, a conservative approach shall be selected in form of a RoW wider than 30 m.					
		Effective gender mainstreaming and integration of consistent gender perspective in all Project activities. This relates to both labour management and community health and safety. Promotion of opportunities, growth, gender equality and positive gender dynamics, recognising different needs and impacts for men and women, as well as management and mitigation of adverse gender risks such as gender-based violence (GBV), including sexual harassment and bullying. The Contractor will develop and implement awareness training for workers, to integrate gender issues into overall project E&S management, ensuring workers understand code of conduct expectations and required compliance. This includes but is not limited to: ■ A Human Resources Management Plan and Code of Conduct, which includes fair treatment, equal opportunities without discrimination based on political affiliations, age, sex, race, ethnicity and sexual orientation, as well as no tolerance for any form of sexual harassment, discrimination, bullying or violence; ■ Associated provisions in the Plan and Code of Conduct concerning employment and workforce behaviour (including but not	Contractor	Prior to construction	Human Resources Management Plan Code of Conduct	Review of Human Resources Management Plan and Code of Conduct Interviews Review of grievance log By NEA	Standard / Best practice

[21] International Commission on Non-Ionizing Radiation Protection (ICNIRP) (2010) Fact sheet: Guidelines for limiting exposure to time-varying electric and magnetic fields. Published Health Phys 99(6): pp. 818-836.

No [17]	Item	Mitigation, Management and Enhancement Measures	Responsible[18]	Timeline	Means of Verification	Monitoring Procedure	Source
		limited to safety rules, zero tolerance for substance abuse, environmental sensitivity and stewardship for the Project area, acknowledgment of the dangers of sexually transmissible diseases and HIV/AIDS, respect for the beliefs and customs of the populations and community relations in general). ■					
D.49.	Land acquisition and land take	Provide compensation for affected land and structure (full compensation for permanent land and 10% of land utilisation).	**NEA**, CDC	Prior to construction	RAP SEP Grievance mechanism	Cross checking the compensation list By IC Final approval By NEA	IEE Nov 2017, C IEE Nov 2019, C IEE Jan 2020, C
		Compensation will be provided to PAPs for standing crops at FRC. Compensation to be provided to owner of crops, trees and assets and not land owner necessarily.	**NEA,** CDC	Prior to construction	RAP and LRP	RAP and LRP Implementation and Completion Audits By IC Final approval By NEA	IEE Nov 2017, C IEE Nov 2019, C IEE Jan 2020, C
		Compensation for the hindrance due to use of land, agricultural extension program, livelihood skill training programs, maximise job opportunities.	NEA	Prior to construction	RAP	RAP and LRP Implementation and Completion Audits By IC Final approval By NEA	IEE Nov 2017, C IEE Nov 2019, C IEE Jan 2020, C
D.50.	Traffic management	Develop a Traffic Management Plan, including but not limited to:	Contractor	Prior to construction	Traffic Management Plan development	Review By IC	Standard / Best practice

No 17	Item	Mitigation, Management and Enhancement Measures	Responsible[18]	Timeline	Means of Verification	Monitoring Procedure	Source
		■ Speed limits (of approximately 30 km/h or less depending on the risk analysis to be conducted by the Contractor) when travelling through communities by all Project related traffic and signalisation; ■ Driver qualifications and selection (e.g. defensive driving courses, accident history and 'practical' interviews to test skills); ■ Driver education and training (awareness raising, information on required standards and review of incidents); ■ Vehicle inspection and maintenance (in line with manufacture requirements for vehicle roadworthiness and Project standards); ■ Accident/ incident reporting and investigation; ■ Passing spaces on narrow village road; ■ Cover of trucks when transporting sand to prevent dust; and ■ Road damages and degradation to be reinstated, time planning etc. Undertake consultation with communities along key transport routes to inform them about the potential for increased traffic movements prior to any changes and train them on road safety awareness. A grievance procedure shall be established whereby any complaints by neighbours or affected parties related to road traffic can be submitted, recorded and responded to.			disclosed to local authorities Records of Public Awareness Sessions and Documentation EPRP Grievance mechanism logbook Training records	Final approval By NEA	
D.51.	Fossils/ Archaeological Chance Finds	Obtain clearance by competent authority. Develop a Chance Finds Procedure taking into account local legislation. The Chance Finds Procedure will include:	Contractor	Prior to construction	A Chance Finds Procedure is in place and approved by NEA management	Review By IC Final approval By NEA	Standard / Best practice

No [17]	Item	Mitigation, Management and Enhancement Measures	Responsible[18]	Timeline	Means of Verification	Monitoring Procedure	Source
		■ Training of all site personnel in the recognition and proper handling and custody of archaeological finds; ■ Establishment of protocols for responding to chance finds including cessation of works for finds and notification of NEA, who will advise the appropriate authorities (Antiquity Department, see Antiquities Act); and ■ Expedited procedures for evaluation and treatment of significant chance finds in order to limit impacts to important resources while limiting construction delays.			Contractor and employees are familiar with the Chance Finds Procedures		

10.3 ESMMP for the Project – Construction Phase

The following **Error! Reference source not found.** shows the measures required to be implemented during the construction phase. In this phase mainly the C ontractor is responsible for the implementation of the measures as indicated in the table.

Table 10-3 ESMMP for the Project – Construction Phase

No [22]	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
B.	**Protection of the Environment**						
B.10.	Protection of adjacent areas	Set back distances of 15 m will be maintained along all watercourses, and vegetation will not be removed from these areas. If it is necessary to maintain line clearance in these areas, vegetation will be cut back by hand.	Contractor	During construction	Observations on site	Observations during construction By ECoW	BAP, 2021
		Re-vegetation, slope maintenance will be carried out in the disturbed areas to avoid erosion. Bioengineering with combination of retaining structures will be done as per the requirement. Proper landscaping will be done at each tower site.	Contractor	During construction	Observations/ visual inspection on site	Regular monitoring By IC	IEE Nov 2017, A IEE Nov 2019, A IEE Jan 2020, A
B.11.	Selection of borrow areas, backfill material stockpile sites and access road	Use only approved quarries and borrow pits with appropriate E&S certification (eg. no gravel abstraction from river).	Contractor	During construction	E&S audit at quarries	Regular site inspection By IC	Standard / Best practice

[22] Numbering is not continuous because it refers to the items of KfW standard bidding documents.

No 22	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
		After obtaining permission for the construction of access roads, the Contractor shall undertake all necessary measures to make the access suitable for use and shall take all precautions to avoid damage to existing properties. The access tracks shall be constructed in such a way as to minimise damage to property, land, crops, and vegetation and shall be adequately drained to prevent washouts or soil erosion. Ensure slope stabilisation, replanting, erosion prevention, drainage measures, dust prevention etc are required, which shall be defined in an approved Earthwork, Erosion and Reinstatement Management Plan.	Contractor	During construction	Observations on site	Regular monitoring By IC	Internal Document prepared by IC, received 17.11.2021
		Once the access maps have been approved, the Contractor shall not make use of any other access routes without the prior approval of NEA and IC.	Contractor	During construction	Observations on site	Regular monitoring By IC	Internal Document prepared by IC, received 17.11.2021
		Brought filling material for construction of platform shall be stored in designated storage areas to be used for site reinstatement after completion of construction. Topsoil layer shall be removed and stored separately from subsoil. Procedures for transport and storage of excavated material and site reinstatement shall be defined in an approved Earthwork, Erosion and Reinstatement Management Plan.	Contractor	During construction	Earthwork, Erosion and Reinstatement Management Plan Observations on site	Regular monitoring By IC	Internal Document prepared by IC, received 17.11.2021
		Any residual material shall be disposed of in accordance with approved Waste Management Plan (WMP) after completion of the construction.	Contractor	During construction	Observations on site	Regular monitoring By IC	Internal Document prepared by IC, received 17.11.2021

No 22	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
		Disposal or storage of excavated soil on the slopes above or below access roads shall be strictly prohibited. Appropriate safety measures (e.g. anchored barriers) shall be installed below excavation sites to prevent accidental rockfall down the slopes.					
		The access tracks shall be constructed in such a way as to minimise damage to property, land, crops, and vegetation and shall be adequately drained to prevent washouts or soil erosion. All watercourses shall be crossed by means of bridges or culverts covered with stone material and suitable grading. Drainage shall be provided by swales and appropriately placed culverts. Access route maps shall include location of all bridges, culverts, and swales. The drainage systems and surface of new access tracks for the duration of the works (and leave the measures in place for the time after works e.g. erosion prevention measures, drainage etc.) shall continuously be maintained.	Contractor	During construction	Observations on site	Regular monitoring By IC	Internal Document prepared by IC, received 17.11.2021
		Access roads that will not be used for maintenance shall be replanted especially in forest areas or not-cultivated slopes. If located in RoW this can be done with low growing bushes and grass to stabilise slopes.	Contractor	Prior to operation	Observations on site	Regular monitoring By IC	Standard / Best practice
		Culverts and bridges shall be installed for the purpose of crossing existing watercourses. Culverts shall also be installed where required for effective drainage systems. The locations and types of culverts and bridges shall be proposed by the Contractor and approved by NEA/IC.	Contractor	During construction	Observations on site	Regular monitoring By IC	Internal Document prepared by IC, received 17.11.2021

No 22	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
B.12.	Pollution prevention	Take the necessary measures to ensure that pollution to air, water or land is prevented or, where this is not possible, reduced and mitigated as far as practicable during the construction phase. In doing so the Contractor will need to develop a EPRP which clearly outlines the measures for managing e.g. atmospheric emissions and dust, e.g. noise and vibrations, e.g. waste (specified in ESHS Specifications including 14, 15 and 16 below). Please provide specific details on how to handle for example the following aspects: ■ liquid effluents; ■ air emissions and dust; ■ noise and vibration management; ■ vehicle and equipment maintenance and selection; and ■ fuel, oil and chemical storage and handling. Ensure all works carried out minimise pollution risk (e.g. liquid effluents, air emissions, noise and vibration management, vehicle and equipment maintenance and selection, fuel, oil and chemical storage and handling) including the whole duration of the Project.	Contractor	During construction	Ensure that potential pollutants are not stored and handled within 50 m of sensitive receptors (particularly watercourses)	Regular monitoring Review of grievance records By IC	Standard / Best practice
B.13.	Effluents	Ensure appropriate containment and storage of construction wastewater, including sanitary water. No untreated effluent is discharged. All platforms where generators, hydrocarbon storage tanks and refuelling stations are installed have impervious and chemical resistant surfaces are drained separately and equipped with an oil removal treatment (oil-water-separator) to prevent pollution.	Contractor	During construction	No untreated wastewater discharge	Regular monitoring Review of grievance records By IC	Standard / Best practice

No 22	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
		Discharges shall be in line with local and international standards. No effluent is discharged into water courses (streams, rivers, ponds, lakes ect.) or to the ground surface or infiltrated into subsoils, without prior treatment and without monitoring quality of the treatment's performance to guarantee the absence of pollution in the effluent. Effluent discharge and flow rates into natural water bodies will be managed to control erosion/sediment freight. Ensure workers and subcontractors are prohibited from bathing or washing clothes and vehicles/equipment in rivers or watercourses.					
B.14.	Air emissions and dust	Water spraying will be done to control dust pollution. See also IFC General EHS Guidelines (1.1 Air Emissions and Ambient Air Quality).	Contractor	During construction	Community Health and Safety Management Plan Grievance log No complaint	Regular monitoring Review of grievance records By IC	Standard / Best practice
B.15.	Noise and vibration	Regular maintenance will be done for all equipment as per manufacturer's specifications. Implement a Vehicle Machinery and Inspection Programme of own and Contractor/third party trucks and other machinery. Noise prevention and mitigation measures should be applied where predicted or measured noise impacts from the construction exceed the applicable noise level guideline at the most sensitive point of reception.	Contractor	During construction	Inspection log books for vehicles and machinery. Confirmed through regular inspections and monitoring reports.	Regular monitoring Review of grievance records By IC	IEE Nov 2017, A IEE Nov 2019, A IEE Jan 2020, A Standard / Best practice

No [22]	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
		Locate stationary equipment (such as power generators and compressors) as far as possible from nearby receptors (e.g. worker resting areas, populated areas and environmentally sensitive areas). Equipment known to emit noise strongly in one direction, whenever possible, will be orientated so that the noise is directed away from sensitive receptors Standard noise abatement equipment shall be fitted to equipment by the Contractor, used and maintained in accordance with manufacturers' instructions. Working hours will be limited in sensitive areas (e.g. near settlements). Ensure that construction activities are only undertaken during the day and local communities are informed of the construction schedule to comply with National Ambient Noise Standards/ IFC standards (i.e. the threshold value of noise for day time in Industrial/commercial area is 70 dB(A) and that of in Residential/ Institutional/Educational area is 55 dB(A) respectively. Plan high noise generating works (e.g. pile driving, blasting, rock clearing, drilling, percussion drilling) in line with national regulations. Ear mufflers or plugs will be provided to labour force working in the areas susceptible to noise pollution. For guidance please follow the IFC EHS Guidelines for Noise management.[23]					

[23] IFC (2007) Environmental, Health, and Safety (EHS) General Guidelines: Noise Management.
Available at: https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/policies-standards/ehs-guidelines

No 22	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
B.16.	Waste Management	Implement an effective Waste Management Plan (WMP) to ensure that all wastes (hazardous, non-hazardous, waste water) are all disposed of in a sound manner. This plan shall describe procedures to ensure that waste generation is minimised, transportation is monitored, storage is safe and disposal methods are sound and do not cause negative impacts to the environment or communities. Good construction practices and site management will be adopted to avoid impacting soil and ground water, and pollution of water bodies. Waste oils and chemicals will be collected and stored in suitable storage tanks and disposed of by a certified company. Fuel and hazardous chemical storage areas shall not be allowed within 30m of a minor watercourse, within 100m of a major watercourse, within a floodplain or where there is the potential for spilled fuel to enter groundwater. Provide training for the workers in order to ensure adequate waste management. Establish and maintain a waste register. This register will record all waste management operations: production, collection, transport, treatment. It will be available as of the Contractors mobilisation to any Project Area. Waste shall be categorised according to the following definitions:	Contractor	During construction	WMP exists and employees are aware Observations on site Training records Monitoring records Grievance mechanism logbook	Regular monitoring Review of grievance and training records By IC	IEE Nov 2017, A IEE Nov 2019, A IEE Jan 2020, A Standard / Best practice

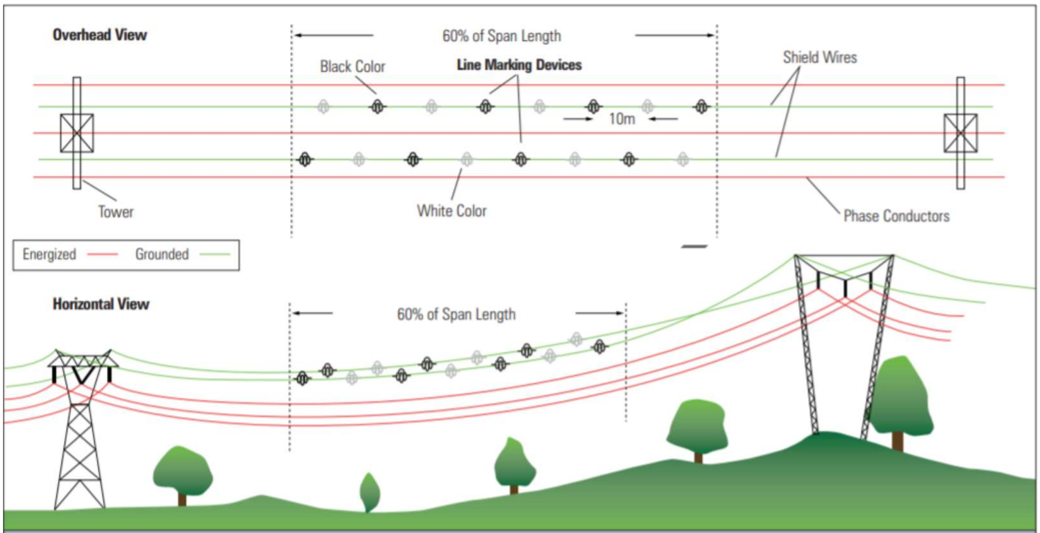
No 22	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
		a) Non-hazardous solid waste generated at construction and decommissioning sites includes excess fill materials from grading and excavation activities, scrap wood and metals, and small concrete spills. Other non-hazardous solid wastes include office, kitchen, and dormitory wastes when these types of operations are part of construction project activities. b) Hazardous solid waste includes contaminated soils, which could potentially be encountered on-site due to previous land use activities, or small amounts of machinery maintenance materials, such as oily rags, used oil filters, and used oil, as well as spill clean-up materials from oil and fuel spills. c) Hazardous liquid waste includes effluents and waste material containing "free liquids" (e.g. used cutting oil or wastewater mixed with oil after cleaning machinery).					
B.17.	Vegetation clearance	Government forest area falling under TL alignment is 0.88 ha and CF area falling under the tower pad and TL alignment is 21.9947 ha. Purchase of 0.54 ha of land as replacement of permanently acquired forestland.	**NEA**, MoFSC, DFOs, Contractor	During construction	Observations on site	Observation during construction by ECoW	IEE Jan 2020, B (slightly different Numbers IEE Nov 2017, B, IEE Nov 2019, B)
		Selective felling of trees in the RoW of the TL will be done to minimise the forest loss.	**NEA**, MoFSC, DFOs, Contractor	During construction	Records of trees felled	Observations during construction by ECoW	IEE Jan 2020, B
		RoW vegetation clearance will be carried out manually. Adopt a methodology to minimise loss of saplings during construction to the extent possible.	Contractor	During construction	Records of loss of saplings	Observations during construction by ECoW	IEE Jan 2020, B

No 22	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
		During clearance of the RoW, epiphytic orchids on felled trees will be removed and translocated to suitable host trees in similar habitats along the RoW.	**NEA**, MoFSC, DFOs, Contractor	During construction	Observations	Observations during construction by ECoW	BAP, 2021
B.18.	Biodiversity	Trees that are likely to be removed will be counted, marked and harvested with the proper forest techniques by involving technical staffs from the respective DFOs.	**NEA**, MoFSC, DFOs, Contractor	During construction	Records of trees felled, Observations	Observations during construction by ECoW	IEE Jan 2020, B
		Any nationally or globally threatened species identified within the RoW during coordination with the DFO and community forest user groups will be marked in the field and vegetation clearance micro-sited around individual plants where practicable.	**NEA**, MoFSC, DFOs, Contractor	During construction	Observations	Observations during construction by ECoW	BAP, 2021
		Construction camps and lay-down areas will be not be located in forest areas and sensitive habitats.	Contractor	During construction	Observations	Observations during construction by ECoW	BAP, 2021
		Invasive species will be cleared from forest areas within the RoW during regular vegetation clearance.	Contractor	During construction	Report from maintenance teams	Annual report by ECoW	BAP 2021
		NEA will implement awareness programs for local people and members of forest users group of the Project Area about the forest management, techniques and methods of forest management, forest conservation, tree plantation, economic importance of forest, its role in rural society and other relevant forest management matters.	NEA	During construction	Records of number of awareness raising events held/ awareness raising materials produced and distributed	Regular reporting until awareness programme is closed. By IC	IEE Jan 2020, B
		Project workers will strictly be prevented from hunting and poaching and any other kind of illegal activities related to hunting and poaching.	NEA, MoFSC, DFOs, **Contractor**	During construction	Observations	Observations during construction By ECoW	IEE Nov 2017, B IEE Nov 2019, B IEE Jan 2020, B

No 22	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
		Ensure that all personnel are informed and aware of the importance to protect species, habitats, fauna and flora and are informed about wildlife encounter procedures. Information and awareness training is documented. a) The Contractor´s personnel shall not approach, injure, hunt, capture, possess, feed, transport, rear or trade wild animals and/or collect birds' eggs on the Project Areas; b) The Contractor´s personnel shall avoid where possible breeding, feeding and nesting sites of endangered species; c) The Contractor personnel shall not collect flora or fauna species on the Project Areas; d) The Contractor shall report any sighting or finding of dead wildlife killed by the works to NEA/IC immediately; e) The Contractor shall protect excavations with temporary fencing to prevent injury to animals; f) The Contractor shall release any trapped uninjured animals immediately; g) The Contractor shall report injured endangered and/or larger animals to NEA/IC who will inform the appropriate Environmental Authority; h) The Contractor shall not disturb natural habitats outside the Project Areas; i) The Contractor shall only use designated roads or paths and abide by speed limits; j) The Contractor shall not start forest fires; and k) The Contractor shall not introduce Invasive Alien Species (IAS)	Contractor	During construction	Observations	Observations during construction By ECoW	Standard / Best practice

No 22	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
		Awareness for wildlife conservation will be implemented to minimise the adverse impacts on local wild fauna. This will include the importance of wildlife conservation, existing rules and regulation with respect to wildlife, benefits associated with the wildlife conservation and other relevant topics. The awareness programme will be provided to the selected executive members and users of CFUGs. Such programs will be implemented at 4 different places of the Project Affected Area (two in each Project Affected District as defined in the IEE). The programme will be implemented in close coordination with DFOs, local NGOs, CBOs and other concerned agencies. Organisation of lectures, field visits, documentary shows, distribution of informative materials will be the methods to be utilised for awareness program.	NEA	During construction	Records of awareness raising events held/ awareness raising materials produced and distributed.	Regular reporting until awareness programme is closed. By IC	IEE Jan 2020, B
		If vegetation clearance takes place within the bird breeding season (October – April), trees will be checked for nests of raptors or other large birds prior to felling. If active nests are identified, an exclusion zone will be established around the nest to avoid disturbance until the young have fledged.	**NEA**, Contractor	During construction	Observations/ records kept	Quarterly reporting during construction by ECoW	BAP, 2021
		Markers will be attached to conductors to improve line visibility for bird wherever it is necessary and technically feasible.	Contractor	During construction	Confirmation that markers have been installed	Observation/ keeping records on birds killed in the vicinity of TL annually during operation By ECoW	IEE Nov 2017, B IEE Nov 2019, B IEE Jan 2020, B

No 22	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
		Markers will be attached to conductors to improve line visibility for birds wherever it is necessary and technically feasible. The January 2020 IEE recommend the use of the coloured ball design of flight diverters, however this should be revised and more cost effective and robust options for flight diverters selected, including hanging or spiral flight diverters. Specifically, line markers/flight diverters will be installed along sections AP 1 - AP 10 (now AP1 – AP 16), AP 22 - AP 27 (now AP 38 – AP48) and AP 35 - AP 41 (now AP 61 – AP 67). At least 60% of each span should be marked and spacing guidance should be in line with Standard / Best practice guidance (e.g. APLIC 2012). The 60% refer to the middle section of each span between towers. They should be marked with a maximum 10 m gap between diverters on the earth wires, with diverters offset on adjacent lines to give overall smaller gaps. For a 5 km stretch of line, diverters need to be install on approximately 3 km of that (depending on exactly how the number/placement of towers goes), and 300 diverters to cover that distance at 10 m spacing per earth wire. The Figure shows an example for bird diverter installation (APLIC 2012).	Contractor	During construction	Installation report, photographic evidence	Confirmation that flight diverters have been installed By ECoW	BAP, 2021

No 22	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
		 FIGURE 6.3: Positioning of line marking devices on the central portion of two shield wires on transmission lines (after Eskom Transmission [South Africa] 2009).					
		Construction will avoid unnecessary machinery disturbances and lighting.	Contractor	During construction	Observations	Observations during construction by ECoW	IEE Jan 2020, B
		Avoid construction activity at AP 23 (now AP 41) during the early part (October – January) of the white-rumped vulture breeding season when birds are establishing nests and incubating eggs.	Contractor	During construction	Observations	Observations during construction by ECoW	BAP, 2021

No 22	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
B.19.	Erosion control measures	Cut-off drains and soakaways will be installed on access tracks on steep slopes to minimise sediment run off in the watersheds of the Pokhara Valley lakes and Madi River Valley.	Contractor	During construction	Observations	Observations during construction by ECoW.	BAP, 2021
		Carry out re-vegetation and slope maintenance in the disturbed areas to avoid erosion. Bioengineering with combination of retaining structures will be done as per the requirement. Proper landscaping will be done at each tower site.	Contractor	During construction	Construction site restored to previous conditions, no erosion	Regular monitoring By IC	IEE Nov 2017, A IEE Nov 2019, A IEE Jan 2020, A
		For the RoW clearance in community forests will be carried out in the area provided by the concerned Community Forest User Groups (CFUG) and DFOs, as per the provision made in Working Procedure for the Use of National Forest Land for National Priority Project, 2074.	**NEA**, MoFSC, DFOs, Contractor	During construction	Observations	Observations during construction by ECoW.	IEE Jan 2020, B
B.20.	Site rehabilitation	Attention will be paid to plant local species suitable to the area, species cut down by the Project as far as possible, species preferred by the local communities and species which contribute to improvement of habitats for available wildlife. NEA will take care of planted site for the period of 5 years and handover to the respective CFUGs and DFOs. Also, land area equal to 0.540 ha will be bought by the Project and handed to respective DFOs in replacement to the permanently acquired forest land for construction of tower pads.	**NEA,** MoFSC, DFOs,	During construction	Observations	Observations during construction by ECoW	IEE Jan 2020, B
		The sites for compensatory plantation will be finalised after discussion with the members of concerned CFUGs and officials of respective DFOs. The proponent will request to DFOs and CFUGs to locate the land for plantation.	**NEA**, MoFSC, DFOs, Contractor	During construction	Observations	Observations during construction DFO with oversight from **NEA**	IEE Jan 2020, B

No 22	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
		Plantation designs for each specific identified sites will be developed after consultation and interaction with the concerned stakeholders. The initial discussion made with DFOs and concerned CFUGs reveals that the plantation area is available in the affected CFs and its vicinity for compensatory plantation.					
		For the purpose of plantation work, the seedlings required may be purchased from the plant nurseries / DFO or there may need to establish a nursery in the Project site. If it is determined to establish a nursery, the appropriate location for the nursery will be finalised in consultation with the concerned stakeholders. There shall also be the provision of replacement plantation after one year of tree plantation based on the mortality rate of seedlings.	**NEA**, MoFSC, DFOs, Contractor	During construction	Observations	Observations during construction by ECoW	IEE Jan 2020, B
		All trees felled as part of the construction of access for the RoW will be marked and recorded. Compensation planting requirements will be updated following the completion of construction to include all trees felled for the Project (including RoW and access).	**NEA**, MoFSC, DFOs, Contractor	During construction	Records of trees felled	Observations during construction DFO with oversight from **NEA**	BAP, 2021
		Prohibit project workers from the collection of Non-Timber Forest Products (NTFPs). Informative and warning sign at each construction sites located in and around the forest area will also be placed.	**NEA**, MoFSC, DFOs, Contractor	During construction	Observations	Observations during construction by ECoW	IEE Jan 2020, B
		Training for cultivation of NTFPs, especially medicinal aromatic plants and other herbs and/or agro forestry, will be given to selected members and users of affected CFUGs. Appropriate agro-forestry models using suitable NTFP species will be developed for different land types in consultation with the concerned communities.	NEA	During construction	Records of number of training events held/ number of agro-forestry models developed and distributed	Review records once after completion of the programme By IC	IEE Jan 2020, B

No 22	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
C.	**Health and Safety**						
C.22.	Health and Safety Plan	Implement occupational H&S plans and procedures and updated as required. It will include mandatory health and safety training for workers and contractors. Training attendance will be recorded. Implement Community Health and Safety Management Plan.	Contractor	During construction	H&S Plans and Procedures in place Training records Community Health and Safety Management Plan	Regular monitoring By IC	Standard / Best practice
		Ensure prevention measures are in place for managing OHS risk of working on live power lines. For guidance see IFC (2007) EHS Guidelines for Electric Power Transmission and Distribution[24] Workers may be exposed to occupational hazards from contact with live power lines during construction, maintenance, and operation activities. Prevention and control measures associated with live power lines include eg.: ■ Only allowing trained and certified workers to install, maintain, or repair electrical equipment; ■ Deactivating and properly grounding live power distribution lines before work is performed on, or in close proximity, to the lines;	Contractor	During construction	H&S Plans and Procedures in place	Regular monitoring By IC	Standard / Best practice

[24] Available at: https://www.ifc.org/wps/wcm/connect/7b65ce6b-129d-4634-99dc-12f85c0674b3/Final%2B-%2BElectric%2BTransmission%2Band%2BDistribution.pdf?MOD=AJPERES&CVID=jqeI4Rs&id=1323162154847

No 22	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
		■ Ensuring that live-wire work is conducted by trained workers with strict adherence to specific safety and insulation standards. Qualified or trained employees working on transmission or distribution systems should be able to achieve the following[25]. a) Distinguish live parts from other parts of the electrical system; b) Determine the voltage of live parts; c) Understand the minimum approach distances outlined for specific live line voltages; d) Ensure proper use of special safety equipment and procedures when working near or on exposed energised parts of an electrical system; ■ Workers should not approach an exposed energised or conductive part even if properly trained unless: a) The worker is properly insulated from the energised part with gloves or other approved insulation; or, b) The energised part is properly insulated from the worker and any other conductive object; or c) The worker is properly isolated and insulated from any other conductive object (live-line work).					

[25] Further information is available from the Occupational Safety and Health Administration (OSHA). Available at: https://www.osha.gov/laws-regs/regulations/standardnumber/1926/1926.950

No 22	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
		■ Where maintenance and operation is required within minimum setback distances, specific training, safety measures, personal safety devices, and other precautions should be defined in a health and safety plan. (Table 2 in Section 2.2 of the IFC EHS Guidelines provides recommended minimum safety setbacks for workers); ■ Workers not directly associated with power transmission and distribution activities who are operating around power lines or power substations should adhere to local legislation, standards, and guidelines relating to minimum approach distances for excavations, tools, vehicles, pruning, and other activities; ■ Minimum hot stick distances may only be reduced provided that the distance remaining is greater than the distance between the energised part and a grounded surface.					
		Ensure prevention measures are in place for managing OHS risk of working at height on poles and structures. For guidance see IFC (2007) EHS Guidelines for Electric Power Transmission and Distribution[26] Workers may be exposed to occupational hazards when working at elevation during construction, maintenance, and operation activities. Prevention and control measures for working at height include eg.: ■ Testing structures for integrity prior to undertaking work;	Contractor	During construction	H&S Plans and Procedures in place	Regular monitoring By IC	Standard / Best practice

[26] Available at: https://www.ifc.org/wps/wcm/connect/7b65ce6b-129d-4634-99dc-12f85c0674b3/Final%2B-%2BElectric%2BTransmission%2Band%2BDistribution.pdf?MOD=AJPERES&CVID=jqeI4Rs&id=1323162154847

No 22	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
		■ Implementation of a fall protection program that includes training in climbing techniques and use of fall protection measures, inspection, maintenance, and replacement of fall protection equipment, and rescue of fall-arrested workers, among others; ■ Establishment of criteria for use of 100 percent fall protection (typically when working over 2 meters above the working surface, but sometimes extended to 7 meters, depending on the activity). The fall protection system should be appropriate for the tower structure and necessary movements, including ascent, descent, and moving from point to point; ■ Installation of fixtures on tower components to facilitate the use of fall protection systems; ■ Provision of an adequate work-positioning device system for workers. Connectors on positioning systems should be compatible with the tower components to which they are attached; ■ Hoisting equipment should be properly rated and maintained and hoist operators properly trained; ■ Safety belts should be of not less than 16 millimetres (mm) (5/8 inch) two-in-one nylon or material of equivalent strength. Rope safety belts should be replaced before signs of aging or fraying of fibres become evident; ■ When operating power tools at height, workers should use a second (backup) safety strap; ■ Signs and other obstructions should be removed from poles or structures prior to undertaking work;					

No 22	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
		■ An approved tool bag should be used for raising or lowering tools or materials to workers on structures.					
C.24.	Accident reporting	Ensure all H&S related incidents (e.g. observations, accidents) on site are recorded and followed up properly.	Contractor	During construction	Incident recording process in place	Check incident/accident records By IC	Standard / Best practice
C.28.	Personal protective equipment	Provide PPE such as helmets, ear mufflers or plugs, safety boots and other safety equipment to the construction workers.	Contractor	During construction	Records of accidents Documentation of safety training for staff	Regular monitoring By IC	IEE Nov 2017, C IEE Nov 2019, C IEE Jan 2020, C
C.31.	Emergency scenarios prevention	Implementation of an EPRP for spill containment and clean-up, engineering contingencies, collisions, natural hazards and other emergencies to include: ■ The emergency response in the event of spills, fire, accidents, earthquakes, floods; ■ Procedure for staff and subcontractors to report any incidents; ■ Emergency response training; ■ Emergency communication procedure.	NEA	During construction	EPRP in been formally approved by NEA management	Regular monitoring By IC	Standard / Best practice
C.33.	First-aid	Provide workers with primary health care and basic first aid at construction camps / worksites. Agreements should be entered into with health care facilities around emergency care.	Contractor	During construction	Suitable first aid kits on site Presence of first aid helpers in all shifts First aid certificates	Regular monitoring of first aid kits Review of first aider certificates	Standard / Best practice

No [22]	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
						Review of number of first aiders required by local legislation By IC	
C.37.	Access to health care	Ensure the workforce has access to primary healthcare on site, providing prescriptions and vaccinations	Contractor	During construction	Healthcare available on site Medical surveillance records	Regular monitoring By IC	Standard / Best practice
C.40.	Hygiene, accommodation and food	Provide adequate accommodation for workers, in line with international Standard / Best practice. Implement a Worker Accommodation Plan as per IFC/EBRD Guidelines on Worker Accommodation[27], whenever planning to establish a labour camp/colony. The Worker Accommodation Plan should also include risks and mitigation linked with gender-based violence and trafficking in persons.	Contractor	During construction	Worker Accommodation Plan and Monitoring Checklist	Regular monitoring By IC	Standard / Best practice
		Avoid increasing local demand for firewood and timber, provide kerosene/LPG to the extent possible to project workers staying at temporary/permanent labour camps. If the use of alternative fuel is not possible, haphazard collection of fuel wood from the nearby forest will be controlled in coordination with the Forest User Groups, Sub-Division Forest Office and DFOs.	NEA, MoFSC, DFOs, **<u>Contractor</u>**	During construction	Observations	Observations during construction by ECoW	IEE Nov 2017, B IEE Nov 2019, B IEE Jan 2020, B BAP, 2021

[27] IFC/EBRD (2009) Guidelines on Worker Accommodation. Available at: https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/publications/publications_gpn_workersaccommodation

No 22	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
		Establish guidelines in a Workers Code of Conduct for engagement with communities to limit and prevent transmission of disease. Ensure regular health screening will be provided for all employees (including contractors and subcontractors). This will be undertaken at least every six months and will be undertaken by the Projects in-country medical personnel. The contractors will make all necessary efforts to avoid possible community exposure to health and safety risks, including developing a Health and Safety Management Plan. All employees including employees of contractors and subcontractors should undergo pre-employment screening which will include testing for Tuberculosis and other communicable diseases and voluntary testing for sexually transmitted diseases. No worker will be denied employment on the basis of the testing (as long as they are fit to work), but in the case of TB will need to commence treatment and be non-infectious before taking up their post.	Contractor	During construction	Workers Code of Conduct Health screenings for employees Disease control strategies Training records Community Health and Safety Management Plan	Regular monitoring By IC	Standard / Best practice
		Develop disease control strategies including environmental controls and implementing health awareness training (including HIV/AIDS awareness), to be provided to all employees covering good health practices, health risks and preventive measures for diseases to be aware of, including pandemic diseases like Covid-19.	Contractor	During construction	Records of health awareness training (including HIV/AIDS and Covid-19) and attendance documentation	Review By IC	Standard / Best practice
		Ensure measures are in place to minimise the chances and contain the spread of the Covid-19 virus as a result of the movement of workers.	Contractor	During construction	Records of Contingency Planning for Project Site	Review By IC	Standard / Best practice

No [22]	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
		Ensure project sites are prepared for an outbreak, and develop and practice contingency plans so that personnel know what to do if an outbreak occurs and how treatment will be provided. Follow the World Bank Group Guidance for EHS Response to Covid-19[28] and IFC Interim Advice for IFC Clients on supporting Workers in the Context of Covid-19[29].			Observations		
D.	**Labour and relations with local communities**						
D.42.	Labour conditions	Adopt and implement human resources policies and procedures. Consistent with the requirements of national labour laws, IFC PS 2 and the ILO Conventions. Provide workers with documented information that are clear and understandable, regarding their rights under national labour and employment law and any applicable collective agreements, upon beginning working relationships and when any material changes occur. Ensure wage rates are not be lower than established for the sector where the work is carried out or for a similar industry. There should be no wage disparity (for similar work and skill levels) between males and females, or migrant workers and local workers. Ensure Contractor and any subcontractor will not interfere with workers' rights to form or join a workers' organisation.	Contractor	During construction	Human Resources Management Plan Sample contract Worker Accommodation Plan and Monitoring Checklist Audit	Review of Inspection reports (also from labour authorities) By IC	Standard / Best practice

[28] Available at: https://www.worldbank.org/en/who-we-are/news/coronavirus-covid19
[29] Available at: https://www.ifc.org/wps/wcm/connect/b27193d8-b024-4830-83cf-f93e931b240a/Tip+Sheet_Interim+Advice_Supporting+Workers_COVID19_April2020.pdf?MOD=AJPERES&CVID=n9s.6RO

No 22	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
		The Project (including supply chain) will not use child or forced labour, or discriminate against vulnerable groups. These measures will be laid out in Human Resources Management Plan. The Project will audit contractors to ensure they are abiding by the Human Resources Management Plan. Failure to meet these standards will result in consequences up to and including termination of contract, to be decided on a case-by-case basis.					
		Establish a worker grievance mechanism for directly employed, contractors and subcontractors of the Project. It will be publicly advertised to the workforce. It will be easily accessible by workers, free of retaliation and should allow anonymous complaints to be raised and addressed.	Contractor	During construction	Grievance mechanism for workers in place and grievances recorded Training records	Review of grievance register Review of training records By IC	Standard / Best practice
		Ensure no child or forced labour to be used in the Project supply chain, at a minimum by first tier suppliers and contractors.	Contractor	During construction	Requirement to be set out in supply contract documents Supply contract	Review of requirements By IC	Standard / Best practice
D.43.	Local recruitment	Give capable members, as well as unskilled labour of the affected communities and villages priority in recruitment, throughout the construction and operation phases of the Project. The assigned contractor will prioritise the procurement of goods, construction materials and services from within the affected District, or in case this is not possible, preference should be given to suppliers within the Region.	Contractor	During construction	Local Procurement and Employment Records Ensure that appropriate code of conduct will be adopted.	Review procurement and employment rules and records Review of grievance register By IC	Standard / Best practice

No [22]	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
		For the RoW clearance in community forests, the preference will be given to the users of concerned community forest user groups rather than outside labourers which will help the conservation of forestland indirectly and will provide work opportunity to locals as well.	Contractor	During construction	Observation	Observation during construction By ECoW	BAP, 2021
		Ensure local communities are preferred for the supply of goods and services to the Project and Project personnel, where appropriate.	Contractor	During construction	Local Procurement and Employment Records	Review procurement and employment rules and records Review of grievance register By IC	Standard / Best practice
D.47.	Community interaction	Implement Stakeholder engagement throughout the project life cycle based on Project SEP designed to support the development of strong, constructive and responsive relationships, which includes inter alia ■ Endorsement and implementation of a SEP; ■ Engage/communicate/inform communities; ■ Initiate an efficient Grievance Mechanism to allow potentially affected individuals to raise their concerns; ■ Engage with the local community and potential affected households to understand their needs and identify the risk of damage to their livelihood basis through the Project; and ■ Consultation to inform local communities of the risks of trespassing onto sites. ■ Stakeholder engagement will take place in a timely manner to inform people about the construction activities, construction sites including the timing of such activities and restrictions on land use.	**NEA**, Contractor	During construction	SEP Grievance mechanism and grievance log Minutes of Meetings Public awareness programme and documentation	Quarterly Reporting during construction Logs to date and grievances treated Minutes of consultation meetings By IC	Standard / Best practice

No 22	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
		Assign an ESHS person with respective community liaison tasks as well as public outreach activities, such as sign posts, flyers etc. In addition, the Contractor needs to have in place a Contractor-GRM to resolve construction-related grievances, especially with PAPs.	Contractor	During construction	Records of engagement activities Grievance mechanism	Review By IC	Standard / Best practice
		If special circumstances for FPIC are triggered, Project to go through the FPIC process (as outlined in the SEP).	NEA	During construction	FPIC Documentation SEP Grievance mechanism	Monitoring FPIC Process, if applicable By IC	Standard / Best practice
D.48.	Damage to people and property	Inform local communities of the risks of trespassing onto sites, the meaning of signs, dangers of playing on or near equipment or entering fenced areas. Records of the meeting and attendees should be kept.	**NEA,** Contractor	During construction	Community Health and Safety Management Plan Warning signs at construction sites, near equipment or fenced areas Adequate fencing Adequate storage of materials and equipment	Regular monitoring By IC	Standard / Best practice
		Ensure that warning signs are put up around work fronts and construction sites advising people of the risks associated with trespass. All signs should be in diagram form to ensure those with low levels of literacy understand the signs.	Contractor	During construction	Community Health and Safety Management Plan	Regular monitoring By IC	Standard / Best practice

No 22	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
		Ensure that there is adequate fencing around lay down yards and other similar facilities to minimise the risk of trespass. Fencing will be checked daily to ensure that it is in good condition and to look for any signs of entry. Materials and equipment will be stored in such a way that it is only accessible by authorised staff. Ensure adequate compensation in case of accidents.			Warning signs at construction sites, near equipment or fenced areas Adequate fencing Adequate storage of materials and equipment		
		The Contractor will implement awareness training for workers, to integrate gender issues into overall project E&S management, ensuring workers understand code of conduct expectations and required compliance. This includes but is not limited to: ■ A Human Resources Management Plan and Code of Conduct, which includes fair treatment, equal opportunities without discrimination based on political affiliations, age, sex, race, ethnicity and sexual orientation, as well as no tolerance for any form of sexual harassment, discrimination, bullying or violence; ■ Associated provisions in the Plan and Code of Conduct concerning employment and workforce behaviour (including but not limited to safety rules, zero tolerance for substance abuse, environmental sensitivity and stewardship for the Project area, acknowledgment of the dangers of sexually transmissible diseases and HIV/AIDS, respect for the beliefs and customs of the populations and community relations in general);	Contractor	During construction	Human Resources Management Plan Code of Conduct	Review of Human Resources Management Plan and Code of Conduct Interviews Review of grievance log By NEA	Standard / Best practice

No 22	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
		■ Worker awareness training for transmissible diseases and GBV; ■ Implementation of policies to ensure gender equality in opportunities, skill-building and training as part of livelihood programs; ■ Implementation of an accessible grievance mechanism and reporting process for sexual harassment, exploitation, abuse and GBV provide appropriate actions in case of reported incidents; and ■ Provisions for prevention and management of related community health and safety issues as they may arise.					
		Temporary impacts resulting from construction-related losses and damages require to be carefully assessed and addressed in line with national laws and IFC PS 5. The contractor is required to plan its activities in ways to avoid damaging property and/or activities that could significantly reduce the income sources of people during construction activities. Where damages deliberately or accidentally do occur, the contractor will be required to repair any physical damages to private property to its former condition immediately upon completion of civil works and at his own cost. Compensation must be paid at replacement cost value for permanent impacts as well as for all temporary disturbances e.g. damages to crops, prepared soil, etc. during construction. All other affected assets that will be encountered during corridor preparation or construction will also have to be compensated by the construction contractor. This could be illustrated in a tabular format such as the following:	Contractor	Prior to construction	RAP SEP Grievance mechanism	Final approval By IC	Standard / Best practice

No 22	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source

Type of loss / impact	Description	Category of project affected persons	Number of affected individuals / HHs	Entitlements	Responsibility
Permanent damages to (or losses of) any assets (land, structures, crops, trees, etc.) during construction	Damages or losses that may occur as a result of construction related activities, which were not previously foreseen and compensated.	Persons using any of the affected assets with or without legal basis	Any persons whose land/assets are damaged or who experience losses resulting from construction activities	• Repairs of any damages to assets and restoration to their former condition; OR • Cash compensation for any affected assets (crops, trees, structures, etc.) at full replacement cost.	Construction contractors

No	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
		The Contractor shall have a dedicated Social Expert on part of the Contractor's team to facilitate the calculation of losses and the payment of compensation especially for the private land that is overspanned by the TL and the construction impacts due construction of towers and stringing. This also covers access roads and all other work sites outside the corridor.	Contractor	During construction	Records	Review By IC	Standard / Best practice
D.50.	Traffic management	Implement the Traffic Management Plan. Undertake consultation with communities along key transport routes to inform them about the potential for increased traffic movements prior to any changes and train them on road safety awareness. Implement an EPRP, including training on workers on how to control and mitigate any unexpected situations, including spills or road accidents. A grievance procedure shall be established whereby any complaints by neighbours or affected parties related to road traffic can be submitted, recorded and responded to.	Contractor	During construction	Traffic Management Plan disclosed to local authorities Public Awareness Sessions and Documentation EPRP Grievance mechanism Training records	Review of training records Inspection if traffic routes Review of grievance register By IC	Standard / Best practice

No 22	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
D.51.	Fossils/ Archaeological Chance Finds	Implement Chance Finds Procedure taking into account local legislation.	Contractor	During construction	A Chance Finds Procedure is in place and approved by NEA management Training records Records about chance finds	Regular monitoring By IC	Standard / Best practice

10.4 ESMMP for the Project – Operational Phase

The following Table 10-4 shows the measures required to be implemented during the operational phase. In this phase NEA is responsible for the implementation of the measures as indicated in the table.

Table 10-4 ESMMP for the Project – Operational Phase

No.[30]	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
B.	**Protection of the Environment**						
B.11.	Protection of adjacent areas	Re-vegetation, slope maintenance will be carried out in the disturbed areas to avoid erosion. Bioengineering with combination of retaining structures will be done as per the requirement. Proper landscaping will be done at each tower site (Visual Impacts).	NEA	During operation	Observations/ visual inspection on site	Annual observations By NEA	IEE Nov 2017, A IEE Nov 2019, A IEE Jan 2020, A
B.12.	Pollution prevention	Ensure all works carried out minimise pollution risk (e.g. liquid effluents, air emissions, noise and vibration management, vehicle and equipment maintenance and selection, fuel, oil and chemical storage and handling) including the whole duration of the Project.	NEA	During operation	Ensure that potential pollutants are not stored and handled within 50 m of sensitive receptors (particularly watercourses).	Regular site inspection Review of grievance records By NEA	Standard / Best practice
B.13.	Noise and vibration	The transmission line emits some noise, especially during wet weather conditions, due to the so-called corona effect.	NEA	During operation	Grievance log (operation)	Review of grievance, monitoring if applicable By NEA	Standard / Best practice
B.16.	Waste Management	Implement an effective Waste Management Plan (WMP) to ensure that all wastes (hazardous, non-hazardous, waste water) are all disposed of in a sound manner. This	NEA	During operation	WMP Observation on site	(external) Monitoring and progress controls	Standard / Best practice

30 Numbering is not continuous because it refers to the items of KfW standard bidding documents.

No.[30]	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
		plan shall describe procedures to ensure that waste generation is minimised, transportation is monitored, storage is safe and disposal methods are sound and do not cause negative impacts to the environment or communities. Establish and maintain a waste register. This register will record all waste management operations: production, collection, transport, treatment. It will be available as of the Contractors mobilisation to any Project Area. Waste shall be categorised according to the following definitions: a) Non-hazardous solid waste generated at construction and decommissioning sites includes excess fill materials from grading and excavation activities, scrap wood and metals, and small concrete spills. Other non-hazardous solid wastes include office, kitchen, and dormitory wastes when these types of operations are part of construction project activities. b) Hazardous solid waste includes contaminated soils, which could potentially be encountered on-site due to previous land use activities, or small amounts of machinery maintenance materials, such as oily rags, used oil filters, and used oil, as well as spill clean-up materials from oil and fuel spills. c) Hazardous liquid waste includes effluents and waste material containing "free liquids" (e.g. used cutting oil or wastewater mixed with oil after cleaning machinery). Garbage and solid wastes generated in the Project area will, where practicable, be				By NEA	

No.[30]	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
		converted into compost. Where this is not possible, it will be buried in designed landfill areas. Good site management will be adopted to avoid impacting soil and ground water, and pollution of water bodies from accidental spills from fuels and lubricants etc.					
B.17.	Vegetation clearing	Ensure that no chemicals/pesticides are used, burning of vegetation is restricted. No excessive cutting of trees. Limit cutting of trees to safety distances	NEA	During operation	Observations on site	Site inspection prior to commencement of activities By NEA	Standard / Best practice
B.18.	Biodiversity	Awareness for wildlife conservation will be implemented to minimise the adverse impacts on local wild fauna. This will include the importance of wildlife conservation, existing rules and regulation with respect to wildlife, benefits associated with the wildlife conservation and other relevant topics. The awareness programme will be provided to the selected executive members and users of CFUGs. Such programs will be implemented at 4 different places of the Project Affected Area (two in each Project Affected District as defined in the IEE). The programme will be implemented in close coordination with DFOs, local NGOs, CBOs and other concerned agencies. Organisation of lectures, field visits, documentary shows, distribution of informative materials will be the methods to be utilised for awareness program.	NEA	During operation	Records of number of awareness raising events held/ awareness raising materials produced and distributed	Review records once after completion of the programme By NEA	IEE Jan 2020, B
		The white-rumped vulture colony close to AP 23 (now AP 41) will be monitored annually for the first 2 years post-	**NEA**, Appointed Specialist	During operation	Monitoring surveys undertaken by	Quarterly and Annual Reports	BAP, 2021

No.[30]	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
		construction of the closest section of the alignment to confirm that the line has not affected the success of the colony. If effects are identified, (decrease in size or abandonment of the colony) adaptive management measures will be implemented to restore a successful breeding population and longer term monitoring will be implemented in year 5.			specialist contractor appointed by NEA	By Pokhara Bird Society (PBS) or other specialist organisation on behalf of **NEA**	
		Carcass monitoring will be undertaken along the marked sections (AP 1 – AP 10, AP 22 – AP 27 and AP 35 – AP 41 (now AP1 – AP 16, AP 38 – AP48, AP 61 – AP 67) once a month during the first 2 years post-construction of the marked sections (after stringing in the relevant sections is completed). If one or more carcasses of threatened or protected species are recorded during the surveys, or carcasses or injured birds are reported by local communities, additional mitigation will be developed (e.g. retrofitting of flight diverter devices) and offset targets will be amended accordingly. The requirement for longer term monitoring will be determined at the end of 2 years, based on thresholds set as part of the monitoring plan.	**NEA**, Appointed Specialist	During operation	Monitoring surveys undertaken by specialist contractor appointed by NEA	Quarterly and Annual Reports By Pokhara Bird Society (PBS) or other specialist organisation on behalf of **NEA**	BAP, 2021
		NEA will take care of planted site for the period of 5 years and handover to the respective CFUGs and DFOs. Also, land area equal to 0.540 ha will be bought by the Project and handed to respective DFOs in replacement to the permanently acquired forest land for construction of tower pads.	**NEA,** MoFSC, DFOs,	During operation	Observations	Observations during construction by ECoW	IEE Jan 2020, B
		Invasive species will be cleared from forest areas within the RoW during regular vegetation clearance.	NEA	During operation	Report from maintenance teams	Annual report By ECoW	BAP 2021

No.[30]	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
		The project proponent will implement awareness programs for local people and members of forest users group of the Project Area about the forest management, techniques and methods of forest management, forest conservation, tree plantation, economic importance of forest, its role in rural society and other relevant forest management matters.	NEA	During operation	Records of number of awareness raising events held/ awareness raising materials produced and distributed	Review records once after completion of the programme By NEA	IEE Jan 2020, B
B.20.	Site rehabilitation	Training for cultivation of NTFPs, especially medicinal aromatic plants and other herbs and/or agro forestry, will be given to selected members and users of affected CFUGs. Appropriate agro-forestry models using suitable NTFP species will be developed for different land types in consultation with the concerned communities.	NEA	During operation	Records of number of training events held/ number of agro-forestry models developed and distributed	Review records once after completion of the programme By IC	IEE Jan 2020, B
		A plantation success rate should be defined (to be discussed with the DFO, which needs to be achieved before the replantation areas can be handed over to the DFO).	**NEA,** MoFSC, DFOs,	During operation	Records of trees felled. Defined success rate	Observations DFO with oversight from **NEA**	BAP, 2021
C.	**Health and Safety**						
C.22.	Health and Safety Plan	Implement occupational H&S plans and procedures and updated as required. It will include mandatory health and safety training for workers and contractors. Training attendance will be recorded and monitored by the Project. Implement Community Health and Safety Management Plan.	NEA	During operation	H&S Plans and Procedures in place Training records Community Health and Safety Management Plan	Monitoring and progress controls By NEA	Standard / Best practice
		Ensure prevention measures are in place for	Contractor	During	H&S Plans and	Regular	Standard / Best

No.[30]	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
		managing OHS risk of working on live power lines. For guidance see IFC (2007) EHS Guidelines for Electric Power Transmission and Distribution[31] Workers may be exposed to occupational hazards from contact with live power lines during construction, maintenance, and operation activities. Prevention and control measures associated with live power lines include: ■ Only allowing trained and certified workers to install, maintain, or repair electrical equipment; ■ Deactivating and properly grounding live power distribution lines before work is performed on, or in close proximity, to the lines; ■ Ensuring that live-wire work is conducted by trained workers with strict adherence to specific safety and insulation standards. Qualified or trained employees working on transmission or distribution systems should be able to achieve the following[32]. e) Distinguish live parts from other parts of the electrical system; f) Determine the voltage of live parts; g) Understand the minimum approach distances outlined for specific live line voltages;		construction	Procedures in place Training records	monitoring By IC	practice

[31] Available at: https://www.ifc.org/wps/wcm/connect/7b65ce6b-129d-4634-99dc-12f85c0674b3/Final%2B-%2BElectric%2BTransmission%2Band%2BDistribution.pdf?MOD=AJPERES&CVID=jqeI4Rs&id=1323162154847

[32] Further information is available from the Occupational Safety and Health Administration (OSHA). Available at: https://www.osha.gov/laws-regs/regulations/standardnumber/1926/1926.950

No.[30]	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
		h) Ensure proper use of special safety equipment and procedures when working near or on exposed energised parts of an electrical system; ■ Workers should not approach an exposed energised or conductive part even if properly trained unless: d) The worker is properly insulated from the energised part with gloves or other approved insulation; or, e) The energised part is properly insulated from the worker and any other conductive object; or f) The worker is properly isolated and insulated from any other conductive object (live-line work). ■ Where maintenance and operation is required within minimum setback distances, specific training, safety measures, personal safety devices, and other precautions should be defined in a health and safety plan. (Table 2 in Section 2.2 of the IFC EHS Guidelines provides recommended minimum safety setbacks for workers); ■ Workers not directly associated with power transmission and distribution activities who are operating around power lines or power substations should adhere to local legislation, standards, and guidelines relating to minimum approach distances for excavations, tools, vehicles, pruning, and other activities; and ■ Minimum hot stick distances may only be reduced provided that the distance remaining is greater than the distance					

No.[30]	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
		between the energised part and a grounded surface.					
		Ensure prevention measures are in place for managing OHS risk of working at height on poles and structures. For guidance see IFC (2007) EHS Guidelines for Electric Power Transmission and Distribution[33] Workers may be exposed to occupational hazards when working at elevation during construction, maintenance, and operation activities. Prevention and control measures for working at height include: ■ Testing structures for integrity prior to undertaking work; ■ Implementation of a fall protection program that includes training in climbing techniques and use of fall protection measures, inspection, maintenance, and replacement of fall protection equipment, and rescue of fall-arrested workers, among others; ■ Establishment of criteria for use of 100 percent fall protection (typically when working over 2 meters above the working surface, but sometimes extended to 7 meters, depending on the activity). The fall protection system should be appropriate for the tower structure and necessary movements, including ascent, descent, and moving from point to point; ■ Installation of fixtures on tower components to facilitate the use of fall protection systems;	Contractor	During construction	H&S Plans and Procedures in place	Regular monitoring By IC	Standard / Best practice

[33] Available at: https://www.ifc.org/wps/wcm/connect/7b65ce6b-129d-4634-99dc-12f85c0674b3/Final%2B-%2BElectric%2BTransmission%2Band%2BDistribution.pdf?MOD=AJPERES&CVID=jqeI4Rs&id=1323162154847

No.[30]	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
		■ Provision of an adequate work-positioning device system for workers. Connectors on positioning systems should be compatible with the tower components to which they are attached; ■ Hoisting equipment should be properly rated and maintained and hoist operators properly trained; ■ Safety belts should be of not less than 16 millimeters (mm) (5/8 inch) two-in-one nylon or material of equivalent strength. Rope safety belts should be replaced before signs of aging or fraying of fibers become evident; ■ When operating power tools at height, workers should use a second (backup) safety strap; ■ Signs and other obstructions should be removed from poles or structures prior to undertaking work; and ■ An approved tool bag should be used for raising or lowering tools or materials to workers on structures.					
C.24.	Accident reporting	Ensure all H&S related incidents (e.g. observations, accidents) on site are recorded and followed up properly.	NEA	During operation	Incident recording process in place	Check incident/accident records By NEA	Standard / Best practice
C.31.	Emergency scenarios prevention	Implement an EPRP for spill containment and clean-up, engineering contingencies, collisions, natural hazards and other emergencies to include: ■ The emergency response in the event of spills, fire, accidents, earthquakes, floods; ■ Procedure for staff and subcontractors	NEA	During operation	EPRP in been formally approved by NEA management.	Monitoring and progress controls By NEA	Standard / Best practice

No.[30]	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
		to report any incidents; ■ Emergency response training; ■ Emergency communication procedure.					
D.	**Labour and relations with local communities**						
D.42.	Labour conditions	Adopt and implement human resources policies and procedures. Consistent with the requirements of national labour laws, IFC PS 2 and the ILO Conventions. Provide workers with documented information that are clear and understandable, regarding their rights under national labour and employment law and any applicable collective agreements, upon beginning working relationships and when any material changes occur. Ensure wage rates are not be lower than established for the sector where the work is carried out or for a similar industry. There should be no wage disparity (for similar work and skill levels) between males and females, or migrant workers and local workers. Ensure Contractor and any subcontractor will not interfere with workers' rights to form or join a workers' organisation. The Project (including within the supply chain) will not use child or forced labour, or discriminate against vulnerable groups. These measures will be laid out in Human Resources Management Plan. The Project will audit contractors to ensure they are abiding by the Human Resources	NEA	During operation	Human Resources Management Plan Sample contract Grievance mechanism for workers	Monitoring and progress controls By NEA	Standard / Best practice

No.[30]	Item	Mitigation, Management and Enhancement Measures	Responsible	Timeline	Means of Verification	Monitoring Procedure	Source
		Management Plan. Failure to meet these standards will result in consequences up to and including termination of contract, to be decided on a case-by-case basis.					
		Establish a worker grievance mechanism for directly employed, contractors and subcontractors of the Project. It will be publicly advertised to the workforce. It will be easily accessible by workers, free of retaliation and should allow anonymous complaints to be raised and addressed.	NEA	During operation	Grievance mechanism for workers	Monitoring and progress controls By NEA	Standard / Best practice
D.47.	Community interaction	Implement Stakeholder engagement throughout the project life cycle, designed to support the development of strong, constructive and responsive relationships, which includes inter alia: ■ Endorsement and implementation of a SEP; ■ Implementation of a grievance mechanism so that communities can share their concerns.	NEA	During operation	SEP developed and implemented Grievance mechanism and grievance log	Monitoring and progress controls Logs to date and grievances treated By NEA	Standard / Best practice
D.48.	Damage to people and property	Likely impact due to crossings on power cables/communication lines/ roads etc. Maintenance of ground clearance, Avoidance of infrastructures as far as possible, placement of signboard where necessary, public awareness programme at critical location.	NEA	During operation	Observation of signboard Records of public awareness program	Cross checking during the operation phase By NEA	IEE Nov 2017, C IEE Nov 2019, C IEE Jan 2020, C

11. MITIGATION AND COMPENSATION COSTS

This chapter presents a rough estimate of the mitigation and compensation costs, calculated for the following measures:

- Physical Impact Measures;
  - **River Training Structures;**
  - **Retaining Structure;**
- Biodiversity Measures;
- Potential Biodiversity Offset Measures;
  - **Retrofitting line markers and insulation of other power lines;**
  - **Vulture rehabilitation centre to be built at the location of an existing safe vulture feeding site;**
  - **Community Education Initiative on Vulture Conservation; and**
  - **Stock Management and Protection Scheme.**
- Land Acquisition and Structure Loss;
- Physical and Economic Displacement; and
- Skill Development.

Mitigation measures presented in the ESMMP (e.g. development of Management Plans etc.), which are deemed as standard / Standard / Best practice have not been considered in this calculation. Same applies for costs for planting of trees (if not part of land acquisition costs for crops), as there are too many uncertainties at the moment, which can be addressed in a tree inventory once the detailed design is available. Land requirement costs are based on the IEE, since the design and route lining changed the updated land acquisition costs will be updated in the RAP. NEA is responsible to cover the mitigation and compensation costs listed in this section.

Physical Impact Measures

The Updated IEE, 2020 has calculated cost estimates for mitigation measures of physical impacts[34]. AP 43 (now AP 69) and Damauli Substation need protection from flooding. Some of the APs which are located below or above the existing rural road are vulnerable to landslide due to excavation of tower foundation and need appropriate mitigation measures, see Table 11-1.

Table 11-1 Costs for Flooding and Landslide Risk Mitigation Measures

Mitigation Measures	Indicative Budget (USD)[35]
River training structures	45,700
Retaining structure	8,300
Total	**54,000**

Source: NEA, Updated IEE 2020

[34] Since the updated of the IEE 2020, minor modifications in the detailed design may imply changes in the costing.

[35] The IEE originally stated the cost in Nepalese rupees. The ESMMP gives the costs all in USD.

The following exchange rate was used: 1 NPR = 0.0083 USD.

Biodiversity Measures

The Updated IEE, 2020 has calculated cost estimates for biodiversity mitigation measures as outlined in Table 11-2[36].

The compensatory plantation includes the plantation of 356,814 seedlings (including seedling purchase/preparation, site preparation, pitting, transplanting, composting, mulching and replacement plantation based on mortality of seedlings), management of planted site for 5 years, support for fencing, compensation cost for the loss of private trees, placement of informative and warning signs regarding forest management and wildlife conservation, cost of buying land in place of permanently acquired tower pad area of CF for handing to DoF.

Table 11-2 Costs for Biodiversity Mitigation and Enhancement Measures

Mitigation Measures	Indicative Budget (USD)[37]
Compensatory plantation (including land cost)	561,300
Awareness on forest management and wildlife conservation (4 programmes)	8,300
NTFPs training (4 training programmes)	14,500
Awareness programme for DFO/Area Forest Office staff (2 programmes)	1,300
Total	**585,400**

Source: NEA, Updated IEE 2020

Costs for flight diverters are listed below (Table 11-3).

Table 11-3 Costs for Biodiversity Mitigation Measures

Mitigation Measures	Indicative Budget (USD)[38]
Flight diverter devices for 16 km, along sections AP 1 - AP 10 (now AP1 – AP 16), AP 22 - AP 27 (now AP 38 – AP48) and AP 35 - AP 41 (now AP 61 – AP 67) plus installation costs	50,000

Biodiversity Offset Measures

As the Project is predicted to result in residual minor significant impacts on critical habitat features and a protected and internationally recognised area, compensation measures are required to allow the Project to align with the mitigation hierarchy and deliver a biodiversity net gain for the affected features. This section sets out the approach to achieving net gain.

The following four options were considered most likely to achieve net gain, be achievable in the short-term and sustainable in the long-term:

- Retrofitting measures to existing power lines remove electrocution risk (e.g. through insulating lines or towers, increasing the gap between lines re-designing poles or adding effective electrocution guards) or reducing collision risk (e.g. through installing line markers;
- Creation of a rehabilitation centre for vultures and other raptors or injured birds;
- Community education initiative on vulture conservation; and

36 Since the updated of the IEE 2020, minor modifications in the detailed design may imply changes in the costing.

37 The IEE originally stated the cost in Nepalese rupees. The ESMMP gives the costs all in USD.
The following exchange rate was used: 1 NPR = 0.0083 USD.

38 The IEE originally stated the cost in Nepalese rupees. The ESMMP gives the costs all in USD.
The following exchange rate was used: 1 NPR = 0.0083 USD.

- Stock management and protection scheme.

Each potential offset activity has pros and cons in relation to feasibility, including ease of implementation, likely stakeholder buy in and cost. Depending on the level of mortality associated with the Project that operational monitoring identifies, not all of the identified offsets may be required.

The final budget required to deliver the biodiversity commitments set out in the BAP and is presented in Table 11-4 below, will be determined by which conservation actions are taken forward, as well as the duration of these projects, as informed by the results of operational monitoring. An indicative budget is presented in Table 11-4 below for implementing each offset for 25 years for comparison. In reality, the duration of each activity will be determined by operational monitoring. Final budgets should be developed further once the preferred offset projects are confirmed by NEA.

Table 11-4 Indicative Budget for Offset Measures defined in BAP

BAP Action	Indicative Budget (USD)
1. Retrofitting line markers and insulation of other power lines	
■ Monitoring of other TLs to identify those that pose significant risk of raptor collision. Also informed by consultation on raptor casualty locations. ■ Cost to retrofit line markers and/or insulation to existing power lines (per km).	Indicative cost is between $1,000-$1,600 per km per conductor or earth wire for flight diverter devices, plus installation costs.
■ **Performance Monitoring**: Monitoring raptor casualties from TL collisions where line markers/insulation have been retrofitted to compare to pre-mitigation levels.	Approximately $2,000 for 5 days of survey per year. Surveys that are more frequent might be deemed appropriate depending on level of collision or electrocution detected.
	Total Indicative Budget for Activity over 25 years: $100,000 - $160,000 for flight diverter devices along 16 km of power line, plus installation and maintenance
2. Vulture rehabilitation center to be built at the location of an existing safe vulture feeding site	
■ Centre design and project management. ■ Building of the centre. ■ Resources required to run the centre (initial outlay then annual budget to maintain resources). ■ Staff fees. ■ Training and Management.	$50,000 to build the centre if established at an existing safe feeding site One vet (part time) at $3,000 per year plus $1,800 travel and living allowance. One programme officer (full time) $4,200 per year plus $1,800 travel and living allowance.
■ **Performance Monitoring**: Monitoring the number of individual birds rehabilitated and released back to the wild.	Included in staff costs (see above).
	Total Indicative Budget for Activity over 25 years: $320,000
3. Community Education Initiative on Vulture Conservation	
■ Run 10 awareness camps facilitated by local vulture conservation experts.	Cost for each awareness camp around $1,000 (includes daily rate for experts, food and accommodation, travel and materials). Total camps = 10, to be run every 2 years. Total expected cost = $1,000 x 10 = $10,000.
■ **Performance Monitoring**: The effectiveness of education in itself is difficult to measure; however, a pre and post-education initiative questionnaire	Annual reporting on success of education initiative – approx. $1,000.

BAP Action	Indicative Budget (USD)
could be used to gauge the level of change in views on and behaviours towards vultures.	
	Total Indicative Budget for Activity over 25 years: $138,000
4. Stock Management and Protection Scheme	
■ Scheme set up and administration. ■ Initial consultation with individual farmers/representative body to gauge interest/scale of the scheme. ■ Identify and cost up the preferred measures such as stock protection, advice or monitoring of predators. ■ Budget to implement measures.	Programme office/Vulture Protection Officer: (full time) $4,200 per year plus $1,800 travel and living allowance including office space and admin support (role and budget would include community consultation and identification of fund applicants). Fund for stock protection measures - $3,000 per ward (assume 10 wards).
■ **Performance Monitoring**: The measures implemented as part of the scheme can be monitored and post scheme interviews can be conducted to see whether there are changes in practice that will benefit vultures. ■ Vulture casualties can also be monitored before and during the scheme to look at causes of death to see whether the scheme has an effect on the numbers of vultures becoming victim to incidental poisoning.	Annual reporting on success of uptake of measures and change in perception/awareness of issues and approaches to wildlife conflict– included in staff costs.
	Total Indicative Budget for Activity over 25 years: $180,000

Source: BAP, 2021

Land Acquisition and Displacement

Further, the Updated IEE, 2020 has calculated cost estimates for land acquisition and displacement mitigation measures for Package A as outlined in Table 11-5[39].

Table 11-5 Costs for Compensation and Social Enhancement Measures

Mitigation Measures	Indicative Budget (USD)[40]
Compensation for land	136,750
Compensation for restricted land (RoW)	672,700
Compensation for structure	85,400
Compensation for crops loss	40,900
Safety training*	4,200
Displacement and transportation cost*	28,100
Farming training, skill development and social awareness program*	38,000
Total	**2,467,200**

** Costs combined for Package A and Package B.*

Source: NEA, Updated IEE 2020

[39] Since the updated of the IEE 2020, minor modifications in the detailed design may imply changes in the costing.

[40] The IEE originally stated the cost in Nepalese rupees. The ESMMP gives the costs all in USD.
The following exchange rate was used: 1 NPR = 0.0083 USD.

The costs in the above Table 11-5 cover the compensation costs according to the design included in the IEE. Since the design has changed afterwards, the RAP will include cost estimations for land acquisition and displacement mitigation measures based on the revised design of the route, which may differ from the above mentioned figures.

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APPENDIX A INTERNAL NOTE PREPARED BY FICHTER 2021

Access roads

The Contractor shall at an early stage of the Contract assess the line route and prepare access road maps detailing the proposed access routes to all towers of the line for Employer's/Engineer's review and approval.

The various access types shall be identified and mapped (showing length and terrain features):

- sections of existing public roads to be used (without enlargement or other modification)
- existing roads not maintained by local authorities (which may need upgrade and stabilization works)
- Existing community tracks (which will need to be enlarged and stabilized, thus creating environmental and social impacts)
- proposed new access tracks which can be restored to natural condition after construction
- Proposed new access tracks which will require cutting of slopes or terraces and cannot be restored to natural condition and thus need to be stabilized with roadside stabilization, erosion protection and drainage to prevent degradation and negative environmental impacts.
- Tower locations that cannot be accessed by road and need to be accessed by animal, cable, or aerial (e.g. helicopter) transport. This category also includes tower locations where the construction of access roads would require excessive environmental damage.

The types of new access tracks to be constructed shall be shown on maps. Type(s) of Contractor's heavy machinery which shall traverse the access routes shall also be indicated.

Access maps shall be submitted together with the final detailed routing design (at least 12 months before the physical construction commencement date). The maps will also show the following details:

- Locations for storage of topsoil
- Locations for storage of excavated material (undersoil)
- Laydown areas for material and work equipment storage
- Workers camps
- Locations of the work areas required for positioning of the stringing equipment
- Access to the work areas required for positioning of the stringing equipment

Once the access maps have been approved, the Contractor shall not make use of any other access routes without the prior approval of the Employer and Engineer.

The Contractor is also required to assist the Employer in the implementation of the Resettlement Action Plan. The envisaged assistance mainly consists of accurate identification of all private properties that will be affected by the construction activities, including modification of existing and construction of new access roads. Further details and detailed procedures are provided in the Project ESMP.

After obtaining permission for the construction of access roads, the Contractor shall undertake all necessary measures to make the access suitable for use and shall take all precautions to avoid damage to existing properties.

The Contractor is required to minimise the need for new access roads by:

- using existing roads as much as possible
- create short 'finger' roads from existing roads to tower locations instead of long roads along the line route where possible
- consider alternate means of transportation described earlier instead of constructing long roads through forested hilly/mountainous areas.

Selection criteria for types of access roads in order of priority shall be as follows:

1. Existing roads (without the need for modifications)

Any damages to existing roads shall be fully rehabilitated so that condition of the roads is equal to that at the start of the Project. Environmental and social impacts shall be avoided.

2. Existing roads with modifications

Necessary modifications (e.g. widening, side stabilisation) shall be shown on access maps and shall be the subject of the Employer's/Engineer's approval. The Contractor is responsible for maintenance of the roads during construction and reparation of any damages. Environmental and social impacts shall be avoided where possible or minimised.

3. New access roads on flat terrain

All new access roads required over reasonably firm and level terrain shall be located, where possible, within the OHL easement (RoW). The Contractor is responsible for restoration of affected ground to initial condition before handing over. If traversing agricultural lands all losses shall be compensated until the full restoration of the productive capacity of the land (if temporary impact). If permanent impact, the lands shall be acquired and PAPs compensated for permanent losses. Cutting of trees for new access roads shall be avoided where possible or minimized.

4. New Access roads in hilly terrain

Adjustment of access road geometry to existing terrain features is of crucial importance. Cutting into steep slopes (which might lead to slope destabilization and cannot be restored to natural condition) shall be avoided as much as possible. Where this cannot be avoided, alternative means of access shall be considered (e.g. aerial or animal transport). In case alternative transport is not a feasible option, adequate slope stabilization measures (retaining walls, roadside stabilization, drainage, or other measures as appropriate) shall be installed during construction of the access roads. These measures shall be designed as permanent structures with consideration of long-term impacts. Necessary maintenance measures shall be included in the Operations and Maintenance Manual. Identification and installation of appropriate erosion prevention measures is the sole responsibility of the Contractor and shall be monitored by the Employer /Engineer.

The Contractor shall endeavour to minimise the environmental and social impacts by implementing the following:

a) Measures to avoid environmental and social impacts

Appropriate measures such as avoidance of tree cutting, avoidance of agriculture areas shall be implemented in design phase.

b) Measures to mitigate environmental and social impacts

Measures to mitigate environmental and social impacts shall be implemented for the remaining/residual environmental and social impacts. Some examples of appropriate measures are listed below. For detailed requirements reference shall be made to Environmental and Social Management Plan (ESMP).

- Excavated material shall be stored in designated storage areas to be used for site reinstatement after completion of construction.
- Topsoil layer shall be removed and stored separately from undersoil.
- Procedures for transport and storage of excavated material and site reinstatement shall be defined in approved CESMP.
- Any residual material shall be disposed of in accordance with approved Waste Management Plan after completion of the construction.

- Disposal or storage of excavated soil on the slopes above or below access roads shall be strictly prohibited. Appropriate safety measures (e.g. anchored barriers) shall be installed below excavation sites to prevent accidental rockfall down the slopes.
- The access tracks shall be constructed in such a way as to minimize damage to property, land, crops, and vegetation and shall be adequately drained to prevent washouts or soil erosion.
- All watercourses shall be crossed by means of bridges or culverts covered with stone material and suitable grading. Drainage shall be provided by swales and appropriately placed culverts. Access route maps shall include location of all bridges, culverts, and swales.
- The Contractor shall continuously maintain the drainage systems and surface of new access tracks for the duration of the works (and leave the measures in place for the time after works e.g. erosion prevention measures, drainage etc.).
- Replantation of access roads that will not be used for maintenance shall be considered especially in forest areas or not-cultivated slopes. If located in RoW this can be done with low growing bushes and grass to stabilize slopes.

4.1.1 Use of existing roads without the need for modifications

Where Contractor uses existing roads maintained by the local authorities, he shall ensure that the drains (culverts) are properly maintained, protected and/or reinforced. Drains shall not be blocked for the duration of the Contract. Any damage to the road surface, drainage facilities, or any road accessories (e.g. signs, markings) caused by the Contractor shall be urgently repaired.

When the Contractor has approval to use existing community roads which are not maintained by local authorities, he shall get the consent from the concerned local community and shall maintain the road during the construction period to such a standard that its use by the customary traffic is not impeded in any way. This requirement also applies to roads described in 4.1.2.

All existing roads shall be restored at least to a condition equal to that before the construction activities commenced. Such restoration shall be completed before the issue of the Taking-Over Certificate. This requirement also applies to roads described in 4.1.2.

Specific procedures for use of existing roads, including measures for minimizing disruption to local communities shall be defined in approved Traffic Management Plan.

4.1.2 Use of existing roads/tracks with modifications

Widening or any other modification (e.g. stabilisation, installation of drainage systems) of existing access roads/tracks may only be done with Employer's/Engineer's approval.

Widening of existing access tracks will almost invariably impact the properties of local residents e.g. agriculture areas, forest areas etc. The Contractor will need to get consent for widening and upgrade of the tracks and all affected assets will need to be compensated. The terrain needed for widening of access roads shall have to be acquired and be part of the Resettlement Action Plan (RAP). Modifications (e.g. drainages, retaining walls) shall be suitable for long term use.

4.1.3 New Access Roads Construction

The land needed for new access roads will have to be acquired from private owners or allocated by the responsible government organizations / municipalities. The land acquisition will be part of the RAP. Houses shall be avoided, thus preventing any additional physical displacement by way of construction of access roads.

The first earthworks operation shall be the removal and separation of topsoil. Topsoil shall be kept separate from other material and stock-piled for site reinstatement.

Access roads shall be made in two layers (load bearing and cover layer) with a minimum width of 3.0 m or maximum vehicle width plus 0.5m. The load bearing layer and cover layer shall be made for heavy transports with a maximum axle load of 12 t and a maximum total weight of 60 t.

Load-bearing layer shall be based on a surface with in-situ value of California Bearing Ratio (CBR) of at least 7%. In poor soil areas where this CBR value cannot be achieved at shallow excavation depth, replacement of soil layer (ca 1m thickness) with crushed rock, or alternative method of soil reinforcement shall be considered.

Proper turning angles and light slopes shall be provided for safe turning and access for heavy vehicles. The safety of the access roads shall additionally be ensured by means of side protections (safety barriers) above dangerous slopes. Passing places shall be incorporated where necessary to ensure safe operation of the access road.

During heavy rains and adverse weather conditions the viability and practicability of access roads must be guaranteed. For loose and unsustainable clay, marl, loam or soggy soil layers, the use of a geotextile is recommended to avoid an entry of fine-grain components in the base and to stabilize the subsoil.

During the construction of the access roads, the Contractor shall grade and slope the roads to prevent any unnecessary water flow across the road and to minimize soil erosion. Appropriate measures shall be provided to ensure continuity of flows of existing watercourses (e.g. by installation of culverts) and surface run-off. Surface protection and erosion mitigation measures (drainage, stone pitching, gabions, etc.) shall be installed.

4.1.4 Access Roads Maintenance

Contractor shall be responsible for maintaining all new (maintenance requirements for existing roads are specified in 4.1.1) access roads in usable condition for the duration of the Contract. Usable condition is to be understood as safely passable for all 4WD vehicles and fully loaded construction machinery.

In particularly difficult terrain, and with agreement of the Employer/Engineer, limited usability roads- defined as safely passable for 4WD vehicles with use of gear reduction system and partially loaded construction vehicles - may be accepted. In such cases, limited usability sections of the access roads shall be clearly marked with appropriate safety warnings.

Care shall be taken to ensure the roads are free from ice and mud during wet seasons. Drainage systems must be regularly inspected and cleared from any blockages.

In case the roads are damaged or considered unsafe after heavy rainstorms, access to hazardous sections of the roads shall be prevented by means of temporary barriers until corrective works are completed and appropriate road condition restored.

Local population shall not be put to any inconvenience in gaining safe and timely access to their properties.

All necessary measures connected with the access, transport and maintenance are Contractor's responsibility. These measures shall include, but not be limited to:

- provision of all necessary means of transport, preparation of access roads and tracks associated with levelling, gravelling, safety measures, bridges, culverts etc.
- clearing and establishing of storage facilities, traffic control, making good of damages, as well as obtaining necessary approvals from authorities where applicable
- regular maintenance of access roads, including installed stabilisation and erosion protection facilities (e.g. drainage swales, retaining walls).

4.1.5 Culverts and Bridges

Culverts and bridges shall be installed for the purpose of crossing existing watercourses. Culverts shall also be installed where required for effective drainage systems.

The locations and types of culverts and bridges shall be proposed by the Contractor and approved by the Employer/Engineer.

4.1.6 Reinstatement of new access roads

After completion of the works, access roads shall be reinstated, and the topsoil placed in its original position to ensure full reinstatement of the area to the original / natural condition. Same requirement also applies to the storage areas used for excavated materials and topsoil, as well as all platforms used for stringing equipment.

Reinstatement of access roads and other listed areas shall be the responsibility of the Contractor. A method statement and programme for reinstatement works shall be submitted to Employer/Engineer for approval.

Reinstatement works, shall include all necessary actions such as soil restoration (backfilling and compaction), topsoil restoration and preparation for hydro-seeding and planting of shrubs and trees to a standard at least equal to the condition of the site prior to construction.

The sequence of work shall ensure establishment of all native plant species to achieve successful replanting at site.

Ruts and scars shall be removed, damage to ditches, terraces, roads, and other features of the land shall be corrected, and the land shall be restored to its original condition.

All such work shall be completed to the full satisfaction of the Employer/Engineer and the relevant regulatory authorities before the issue of the Taking-Over Certificate.

4.1.7 Access Roads Adaptation for Long-Term Use

In case the Employer indicates that any access road(s) should be preserved for OHL maintenance or full area reinstatement is not possible for any other reason, the Contractor shall propose, for Employer’s/Engineer’s approval, any additional measures necessary for adaptation of the roads for long-term use and prevention of long-term erosion as appropriate. These roads and associated adaptation measures shall be considered a part of the Permanent Works as defined by the Clause 1.1.5.4 of the GCC.

Based on assessment of the needs for future maintenance access and assessment of the local geotechnical and hydrological conditions, additional works shall be executed to ensure safe use and durability of access roads which shall be preserved beyond Project completion. Such works shall typically include, but are not limited, to:

- widening of the road to 4.0m
- widening and further compaction of the load-bearing layer

- replacement and compaction of the cover layer (gravel or crushed rock)
- Increase of the thickness of the cover layer to min. 40 cm
- upgrade of the drainage system (e.g. underground pipe installation, geotextile and riprap lining, culverts)
- installation of permanent safety features (e.g. signs, fences, safety barriers) as required by the Employer
- installation of long-term erosion protection systems (e.g. erosion mats, retaining structures).

Other appropriate actions as may be required on site-specific basis.

The compaction procedure and plant shall be proved by trials at the commencement of the works. The weight, type, and number of passes of compaction plant shall be varied to determine the optimum compaction.

Long-term stability of earth retaining structures shall be confirmed by an appropriate geotechnical design method prepared by the Contractor and approved by the Employer/Engineer.

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The business of sustainability

VII-5

Specifications for Environmental, Social, Health and Safety Management (ESHS) of the Works

Section VII-5 - ESHS

Specifications for Environmental, Social, Health and Safety Management (ESHS) of the Works

Projects financed by KfW are categorized in categories A, B+, B or C depending on their adverse environmental and social impacts and risks. This categorization takes place at an early stage and applies to the overall Project. However, typically, projects comprise several components and specific individual contracts are awarded to consultants, contractors, firms or suppliers. The categorization of these individual contracts may differ from the categorization of the overall project (e.g. a separate supply contract for computers, or a separate small works contract for the rehabilitation of a guard house etc. may be categorized as minor, whereas the overall project may be a large hydro power project categorized as A).

Throughout the ESHS Specifications, a reference to the Conditions of Contract (CC) means a reference to both the General Conditions of Contract and the Particular Conditions of Contract. Readers should apply due care, when referring to a specific Clause or Sub-Clause, and:

a) Read first the Clause or Sub-Clause text from the General Conditions of Contract;

b) Then check whether this text has been amended by the Particular Conditions of Contract, and if so, to which extent.

As per CC Sub-Clause 1.5, when interpreting the Contract, the terms of the Particular Conditions of Contract prevail over those found in the General Conditions of Contract.

Any term in these ESHS Specifications which is identical to a term in the Conditions of Contract shall have the same meaning as the one defined in the Conditions of Contract.

Any term in capital letters in these ESHS Specifications is defined in CC Sub-Clause 1.1 – Definitions.

Table of Contents

A. Environmental, Social, Health and Safety Management

1. Responsibilities and liabilities	1.1. In conjunction with his obligations defined under the Contract, the Contractor will plan, execute and document construction works pursuant to the present Environment, Social, Health and Safety specifications (ESHS). 1.2. The Contractor is liable for all damages to the environment and people caused by the execution of the works or the methods used for execution, unless it is established that the execution or methods were necessary, according to the provisions of the Contract or an Engineer's instruction. 1.3. Under the Contract and as introduced by the present ESHS Specifications, the term "Project Area" means: a) The land where work will be carried out; or b) The land necessary for the implantation of construction facilities (work camp, workshops, offices, storage areas, concrete production plants) and including special access roads; or c) Quarries for aggregates, rock material and riprap; or d) Borrow areas for sand and other selected material; or e) Stockpiling areas for backfill material or other demolition rubble; or f) Any other location, specifically designated in the Contract as a Project Area. The term "Project Area" encompasses any individual Project Area or all Project Areas. For the sake of clarity, Project Area is a different concept than Site under CC Sub-Clause 1.1.6.7. Project Area defines an area within which the Contractor is to comply with environmental, social, health and safety obligations defined in the present ESHS Specifications. Site is the places where the Permanent Works are to be executed and to which Plant and Materials are to be delivered, and where right of access to, and possession of, is to be given by the Employer to the Contractor. The Employer is under no similar obligation for any area located outside the Site, even if within the Project Area, where access is at Contractor's risk. In term of physical footprint, the CC Sub-Clause 1.1.6.7 Site is included in the Project Area. The Project Area is then of greater geographical extent than the Site. 1.4. The ESHS Specifications refer to: a) Protection of the natural environment (water, air, soil, vegetation, biological diversity) in areas within any

	Project Area and its surroundings, i.e. including but not limited to access roads, quarries, borrow areas, stockpiling of backfill material, camps or storage areas; b) Health and safety conditions to be maintained for the Contractor's personnel and any other person present on the Project Areas, or along access routes; c) Working practices and the protection of people and populations living near the Project Area, but exposed to the general disturbance caused by works. 1.5. Subcontractors The Contractor shall ensure that all Subcontractors and Suppliers (in particular those for major supply items) are familiar with the ESHS requirements and guidelines valid on Site and Project Area. 1.6. Applicable regulations The Contractor must identify all applicable laws, permits and regulations in relation to the protection of the environment (water, air, soils, noise, vibration, vegetation, fauna, flora, waste, groundwater) and, pursuant to Clauses 4 and 6 of the CC, the protection of people (labour law, indigenous populations, standards on occupational exposure, other). The Contractor must list all texts, standards and other regulatory limitations in its Project Area Environmental and Social Management Plan (PA-ESMP as specified in ESHS Specifications Sub-Clause 2.1) and specify the means taken for compliance.
2. ESHS Planning Documents	2.1. The Contractor prepares and ensures prior validation by the Engineer, implementation and regular update of the Project Area Environmental and Social Management Plan (PA-ESMP), which includes Health and Safety aspects. 2.2. The PA-ESMP represents the unique reference document in which the Contractor defines in detail all organisational and technical provisions implemented to satisfy the obligations of the present ESHS Specifications. 2.3. The Contractor defines in the PA-ESMP the number, the locations and the type of Project Area as defined in ESHS Specifications Sub-Clause 1.3. For each Project Area, unless otherwise agreed by the Engineer, the Contractor establishes site specific management strategies and implementation and monitoring plans (Site-ESMP) to manage and monitor Environmental, Social, Health and Safety (ESHS) risks, depending on the type, scope and risks of the project and as assessed in the project´s Environmental and Social Impact Assessment (ESIA). These sub-plans shall be included in the PA-ESMP and include: • e.g. Health and Safety Plan • e.g. Traffic Management Plan (to ensure safety of local communities from construction traffic)

	• e.g. Water Resource Protection Plan (to prevent contamination of drinking water) • e.g. Boundary Marking and Protection Strategy (for mobilization and construction to prevent offsite adverse impacts) • e.g. Biodiversity Action Plan • e.g. Worksite Management Plan • e.g. Site Emergency Plan • e.g. Accommodation Plan • e.g. Waste Management Plan • e.g. Hazardous Materials Management Plan • e.g. Specific mitigation plan for endangered species in the wider area • e.g. Emergency plan • e.g. Community Interaction plan 2.4. The PA-ESMP (and the sub-plans) are structured according to the plan specified in Appendix 1 of the present ESHS Specifications. 2.5. PA-ESMP covers the entire period from the Contract Agreement signature date to the date of issue of the Performance Certificate by the Engineer. 2.6. Unless agreed otherwise by the Engineer, the PA-ESMP is written in the language of communication defined under Sub-Clause 1.4 of the CC. 2.7. The first draft version of the PA-ESMP is to be provided by the Contractor to the Engineer within 28 days from the date of execution of the Contract Agreement. 2.8. The Contractor shall proceed in accordance with the programme, subject to the Engineer's approval of the PA-ESMP. The Employer's Personnel shall be entitled to rely upon the programme when planning their activities. 2.9. No physical work or activity shall commence on any Project Area until such time when the PA-ESMP, and the annexed Site-ESMP corresponding to the Project Area, are approved by the Engineer. 2.10. During the execution of the works, whenever instructed by the Engineer, the PA-ESMP will be updated by the Contractor and reissued to the Engineer. The revised version shall highlight the new elements incorporated in the document. Such approval shall only be withheld if the PA-ESMP shows substantial deficits. 2.11. Related to the PA-ESMP, the Contractor will be responsible for: a) communicating the contents of the ESMPs to their Subcontractors and Suppliers (in particular those for major supply items) and workers and training them to ensure that they understand their respective responsibilities b) ensuring that adequate resources are mobilised to implement the specific Plans, including input from any

	specialist resources necessary to ensure effective planning and implementation of measures c) ensuring that the procedures established in the PA-ESMPs are complied with by their workers and Suppliers (in particular those for major supply items) d) implementing effective monitoring measures listed in the PA-ESMP to ensure that the effectiveness of the activities are assessed and any issues are promptly detected and addressed e) ensuring that lessons are learned and corrective actions are taken f) keeping the Engineer fully informed of any Project Area ESHS issues.
3. Management of Non Conformities	3.1. In application of Clause 5, non-conformities detected during inspections carried out by the Engineer are subject to a process adapted to the severity of the situation. The non-conformities will be defined as deviations from the requirements of the applicable regulations, the present ESHS Specifications, the ESMP, and the Worksite - ESMP. Non-conformities are divided into 4 categories as follows: a) Notification of observation of minor non-conformities. The non-conformity results in a notification to the Contractor's Representative, followed-up by a signed notification of observation prepared by the Engineer. The multiplication of notifications of observation at the Project Area, or absence of corrective actions by the Contractor, can result in the severity of the non-conformity being raised to that of level 1. b) Level 1 non-conformity: Non-conformities that do not represent a serious immediate risk for health, environment, social or safety. The non-conformity is the subject of a report addressed to the Contractor and which shall be resolved within five (5) days. The Contractor addresses to the Engineer a report explaining how the non-conformity has been corrected. Further to an inspection and a favourable evaluation of effectiveness of the corrective action, the Engineer signs a close-out report for the non conformity. In all cases where a non conformity of level 1 is not resolved within one (1) month, the severity of the non-conformity is raised to level 2. c) Level 2 non-conformities: applies to all non conformities that represent a risk with major consequences to health and/or the environment, social or safety. The same procedure as for level 1 non-conformities is applied. Corrective action shall be taken by the Contractor within three (3) days. The Contractor addresses a report explaining the corrective actions implemented. All level 2 non conformities, which are not resolved within one (1) month, are raised to level 3.

	d) Level 3 non-conformities: applies to all non conformities that have resulted in damage to health or the environment, or which represent a high safety hazard or high social risk. The highest levels of the Contractor's and Engineer's hierarchies present in the Employer's country are informed immediately and the Contractor has twenty-four (24) hours to bring the situation under control. Pursuant to Clause 14.6 of the Particular Conditions of Contract (PC), a level 3 non conformity results in the staged reduction of interim payments until the non-conformity has been resolved. Following the resolution of the Level 3 non-conformity the reduction(s) will be included in the next Interim Payment Certificate for payment. No interest will be paid on any reductions or suspended payment amounts. If the situation requires, and in pursuance to Clause 8.8 of the PC, the Engineer can order the suspension of work until the resolution of the non conformity.
4. Resources allocated to ESHS management	4.1. ESHS supervisors and managers a) Pursuant to Sub-Section Specifications (c) Personnel Requirements, Sub-Clause 4.18 of the CC and in addition to the provisions of Sub-Clause 6.7 of the CC, the Contractor appoints at one or several competent Environment, Social, Health and Safety manager in charge of implementing the present ESHS Specifications. b) The appointment of the ESHS Manager shall include specific instruction to enforce regulations and delegated authority to take any action, measure or to issue instructions regarding their enforcement. All staff and labour within the Project Area shall be made aware of the name and authority of the ESHS managers and supervisors. c) The ESHS manager holds the power within the Contractor's organisation to suspend the works if considered necessary in the event of severe non-conformities, and allocate all resources, personnel and equipment required to take any corrective action considered necessary. The ESHS Manager speaks fluently the language of communication of the Contract, and the official language of the Employer's country, if the language of communication of the Contract is not the official language. d) If so required in accordance with Sub-Section Specifications (c) Personnel Requirements, ESHS supervisors represent the ESHS Manager within work teams. Their role is to ensure that the works are carried out pursuant to the present ESHS Specifications and notify the ESHS Manager of any detected non-conformities. 4.2. Personnel in charge of relations with external stakeholders

	a) If so required in accordance with Sub-Section Specifications (c) Personnel Requirements, the Contractor appoints an External Stakeholders Relations Manager responsible for relations local communities, administrative authorities, and representatives of economic activities located within one hour travel from the Project Area. In smaller projects, the person responsible for relations with external stakeholders can also be the ESHS Manager appointed under Sub-Clause 4.1.a) of the ESHS Specifications, providing that the latter speaks the local population language fluently. b) If so required in accordance with Sub-Section Specifications (c) Personnel Requirements, the Contractor shall appoint several subject specific Community Liaison Officers. c) Personnel in charge of relations with external stakeholders will be based on or near the Project Area on a permanent basis. d) Administrations and local authorities will be informed of the existence of this person as of the start of works and will be provided with telephone contact details so as to be able to contact this person if a problem arises during the execution of works, or concerning the behaviour of the Contractor's Personnel, inside or outside the Project Area. 4.3. The team, including the ESHS supervisors and manager, and the person in charge of relations with external stakeholders, will be equipped with the necessary resources to operate independently and get to all location of the Project Area without delay. Commensurate with the size and location of the project, this may include: a) A 4WD vehicle (unless otherwise instructed by the Engineer) and the necessary operating budget; b) A complete IT workstation: computer, printer, Internet access; c) Field equipment: GPS, digital camera; d) One communication equipment per person adapted to the context (mobile phone, satellite phone, or, should coverage not be adequate, a long-range two-way radio). e) Lists of equipment will be maintained on site for inspection by Employer.
5. Inspections	5.1. The ESHS Manager will carry out an ESHS inspection of the facilities and Project Area on a weekly basis. A written report of reasonable length will be drafted for each weekly inspection, in a format approved by the Engineer, addressing non-conformities detected on the Project Area as specified in the present ESHS Specifications.

	5.2. Any non-conformity shall be immediately addressed by corrective actions, which will be mentioned in the reports to the Engineer. 5.3. Each non conformity will be documented by a digital photograph with captions to provide a visual illustration, explicitly indicating the location, date of inspection and the non-conformity in question.
6. Reporting	6.1. The Contractor includes a summary of ESHS activities implemented in relation to the execution of the works during the reporting period in the monthly Progress Report (as specified in Sub-Clause 4.21 of the CC) to the Engineer. The Contractor shall report on compliance with applicable laws, permits and regulations and the project related ESHS requirements. E.G. key issues shall include: monitoring results, covering amongst other issues, safety issues, incidents/accidents, need for corrective measures, conflicts amongst construction workforce or with local residents, grievances of workforce or stakeholders, any other details related to the social and environmental management and performance. Issues related to Subcontractors and Suppliers (in particular those for major supply items) shall also be included. 6.2. The ESHS progress report is written exclusively in the language of communication defined under Sub-Clause 1.4 of the CC. 6.3. Specific reporting requirements related to Health and Safety are detailed in the respective section (e.g. Health and Safety, accident reporting)
7. Code of Conduct	7.1. A Code of Conduct is established by the Contractor for the Project Areas, addressing the following: safety rules, zero tolerance for substance abuse (as defined in Clause 41 of these ESHS specifications), environmental sensitivity of areas around the Project Areas, the dangers of STDs and HIV/AIDS, gender issues (in particular sexual harassment) and respect for the beliefs and customs of the populations and community relations in general (drawing special attention to the risks of prostitution and human trafficking). 7.2. The rules are clearly displayed at the different Project Areas and posted in the Contractor's vehicles and machinery driving cabs. 7.3. The rules confirm the Contractor's commitment to implementing the ESHS provisions provided for in the Contract. 7.4. New Contractor's Personnel and existing Contractor's Personnel are made aware and acknowledge their understanding of the rules of procedure and the associated provisions. Rules of procedure document are initialed by all Contractors' Personnel prior to the start of any physical work at any Project Area.

	7.5. Pursuant to Sub-Clauses 6.9 and 6.11 of the CC, the rules of procedure include a list of acts considered as serious misconduct and which must result in dismissal from any Project Area by the Contractor, or by the Engineer if the Contractor is not acting in due course, should a Contractor's Personnel repeatedly commit an offence of serious misconduct despite awareness of the rules of procedure, and this is without prejudice to any legal action by any public authority for non-compliance with applicable regulations: a) Drunkenness during working hours, leading to risks for the safety of local inhabitants, customers, users and personnel; b) Punishable statements or attitudes, and sexual harassment in particular; c) Violent behavior; d) Intentional damage to the assets and interests of others, or the environment; e) Repeated negligence or imprudence leading to damage or prejudice to the environment, the population or properties, particularly breaching provisions intended to prevent the spreading of STD and AIDS; f) Drug use; g) Possession and/or consumption of meat or any other part of an endangered animal or plant as defined in the Washington convention (CITES) and national regulations. h) Entering property of neighboring people without permission of the landowners or those cultivating/renting the land. 7.6. Serious misconduct, such as organization of sex trade (pimping), committing pedophilia, physical aggression, drug trafficking, deliberate and severe pollution, trading and/or trafficking in all or part of protected species, shall lead to immediate dismissal as of the first report of misconduct is detected, in application of the rules of procedure and labour laws. 7.7. The Contractor establishes a record for each case of serious misconduct, and a copy will be provided to the Contractor's Personnel in question, indicating all action taken to terminate the misconduct by the Contractor's Personnel in question and to bring the attention of other Contractor's Personnel to the type of incident detected. This record will be provided to the Engineer as an attachment to the ESHS progress report (see ESHS Specifications Sub-Clause 6.1.). 7.8. The Contractor shall without delay inform the Engineer who in case of serious misconduct shall immediately inform the Employer.

8. ESHS Training	8.1. The Contractor prepares a training programme adequate for the works to be performed within the Project Areas and the personnel engaged in the works. 8.2. The Contractor ensures that Employees with direct responsibility for activities relevant to the Project's ESHS performance are adequately qualified and trained so that they have the knowledge and skills necessary to perform their work. 8.3. Training sessions are two-fold: introductory sessions for starting work at the Project Area, and technical training as required in relation to the execution of the works. 8.3.1. Starting work sessions are organised for each Contractor's Personnel and shall cover as a minimum: a) Rules of procedure; b) Safety rules on Project Areas; c) Protection of areas adjacent to Project Area; d) Risks relating to sexually transmitted diseases (Sub-Clause 6.7 of the CC), prostitution, human trafficking, and sexual harassment; e) Basic health: combating malaria (if prevalent) and waterborne diseases, improving hygiene; f) HIV/AIDS sensitization training, g) Gender sensitization; h) Emergency response procedures or evacuation; i) Community relations training for workers interacting with local communities; j) Communication of the contents of the Employment, Training and Worksite Management Plans to workers and all Subcontractors and Suppliers (in particular those for major supply items) and training them to ensure they understand their responsibilities with respect to employment, training and worksite management, incident reporting and response. k) Health and Safety awareness training l) The Contractor shall be responsible for informing all workers of the Worker Grievance Mechanism at the time of hiring 8.4. The Contractor shall ensure that adequate resources are mobilised for these trainings, including input from any specialist resources necessary to ensure effective planning and implementation of measures and that trainings are delivered in a timely manner. 8.5. Technical training: a) Training in the skills needed for tasks requiring a work permit (see ESHS Specifications Clause 27) b) Training in first aid and transporting the injured

	c) If applicable: appropriate driving skills d) If applicable: the Contractor establishes and implements a transparent and binding Local Workforce and Supplier Training plan to enhance the capabilities of local people and companies, with a view to increasing local content e) a matrix of training requirements showing the training frequency and interval between refresher courses and covering: 8.6. The Contractor details in the training programme the actions and ESHS training for all Subcontractors and Suppliers (in particular those for major supply items) or personnel of a joint venture when applicable. 8.7. The Contractor prepares an awareness program for local communities on the risks of prostitution, human trafficking and other forms of illegal trafficking. 8.8. The Contractor shall develop means of confirming that the training system is effective.
9. Standards	9.1. The Contractor complies with all applicable norms, standards and discharge limit values defined in the national regulations of the Employer's country regulations and pursuant to Sub-Clause 1.6 of the present ESHS Specifications. 9.2. The Contractor complies with norms, standards and discharge limit values recommended by the specialised international organisations affiliated to the United Nations, as described in ESHS Specifications 9.3 below. In the event of discrepancies in between international standards and national regulations, the Contractor shall comply with the most stringent requirements. 9.3. The specialised international organisations affiliated to the United Nations referred to in ESHS Specifications Sub-Clause 9.2 include: a) World Bank, including the IFC and its Environmental, Health and Safety guidelines available from http://www.ifc.org/ehsguidelines; For matters not addressed in the above mentioned IFC document, the most stringent of the norms, standards and discharge limit values of the following institutions shall apply: a) World Health Organization (WHO); b) International Labour Organization (ILO) in particular in pursuance to Clauses 6.20, 6.21, 6.23 and 6.24 of the PC (Part B); c) International Maritime Organization (IMO).

B. Environmental and Social Management and Monitoring Plan

	This section is herewith enclosed as Appendix 3.

C. Health and Safety

	This section is herewith enclosed as Appendix 3.

D. Local labour and relations with local communities

	This section is herewith enclosed as Appendix 3.

Appendix 1
Example for the Contents of a PA-ESMP

1. Environmental policy	• Declaration of ESHS policy signed by the Managing director of the Contractor and clearly defining the commitment of the Contractor in terms of (i) ESHS management for its construction sites and (ii) compliance with the ESHS Specifications of the Contract.
2. PA-ESMP	• Target and content of the Project Area Environmental and Social Management Plan (including Health and Safety) • Preparation and updating schedule • Quality assurance and validation
3. ESHS resources	• Human resources: - ESHS manager - ESHS supervisors - Person in charge of relations with stakeholders - Medical personnel • Logistics & communications: - ESHS vehicles - IT stations - In situ noise, air and water measuring equipment - Analysis laboratory used • Reporting: - Weekly inspections - Monthly - Accident/ Incident
4. ESHS regulations	• Definition of standards for the applicable national ESHS regulations and the ESHS recommendations of institutions affiliated to the United Nations (WHO, ILO, IMO, IFC), applicable to the execution of works: - Environment..... - Noise and Vibration Soil Erosion - Air Quality - Solid Waste - Hazardous Materials - Wastewater Discharges - Contaminated Land - Occupational Health and Safety - Community Health and Safety - General Site Hazards - Disease Prevention - Traffic Safety - Discharge standards - Minimum wage - Day and/or night traffic restrictions - Other • Definition of ESHS standards for the industry applied
5. ESHS operational inspection resources	• Site tracking procedure: - Frequency - Personnel - Assessment criteria • Non conformity handling and detection procedure: - Distribution of information

	- Notification depending on the level of importance allocated to non conformities - Tracking of the closing of the non conformity • Management of data on tracking and non conformities : - Archiving - Use as a performance indicator
6. Project Areas	• Description of Project Areas (as per definition in ESHS Specifications Sub-Clause 1.3: - Number - Location on a topographical map - Activities - Opening & closing schedule - Access • Reference to the Appendix: a Site-ESMP for each Project Area.
7. Health and safety plan	• Identification and characterization of health and safety risks, including the exposure of personnel to chemicals, biological hazards and radiation. • Description of working methods to minimise hazards and control risks. • List of the types of work for which a work permit is required • Personal protection equipment • Presentation of the medical facilities at Project Areas: - Healthcare centre, medical equipment and allocation of medical staff - Medical treatments that can be carried out on site - Ambulance, communications - Referring hospital • Evacuation procedure for medical emergencies • Description of the internal organisation and action to be taken in the event of an accident or incident
8. Training plan	• Basic training for non qualified staff • Health and Safety inductions • Health & safety training
9. Labour Conditions	• Description of Human Resource Policy for construction works of direct and indirect workers
10. Local Recruitment	• Local labour requirements: - Job descriptions and the levels of qualifications required - Recruitment procedure and deployment schedule - Initial training to be provided by the Contractor for each job description • Location and management of the local recruitment office(s)
11. Project machinery and vehicle traffic	• Description of the fleet of vehicles/machinery used for the execution of the works and emission levels and safety requirements • Deployment (Project Area & schedule) and maintenance sites for each vehicle and machine • Mapping of itineraries, travel times, and areas where speeds are limited • Dust suppression: - Mapping or road sections where dust reduction initiatives apply - Water points identified or to be created for refueling tanker trucks

	- Capacity of the tanker trucks used and calculation of the number of trucks required - Width of the track to determine if one watering run or equivalent is adequate (narrow track) or if two runs are required (wide track) - Number of watering or equivalent operations proposed per day depending on the climate
12. Dangerous substances	• Inventory of dangerous substances per Project Area and per period • Transport and storage conditions and chemical incompatibility
13. Effluents	• Characterisation of effluents discharged to the receiving environment • Facilities for the treatment or pre-treatment of effluents including sufficient run-off • Measures for reducing the sediment content of rainwater runoff • Measures for monitoring the efficiency and performance of facilities for reducing sediment content of rainwater runoff • Resources and methods for monitoring effluent and rainwater runoff quality
14. Noise and vibrations	• Estimation of the frequencies, duration, days of the week and noise levels per Project Area
15. Waste	• Inventory of waste per Project Area and per period • Collection, intermediate storage, handling and treatment methods for ordinary or inert waste • Storage and handling methods for dangerous waste
16. Clearing and revegetation	• Methods & schedule for clearing vegetation and earthwork activities • Methods, species and schedule for the revegetation of Project Areas disturbed by the works
17. Biodiversity	• Schedule for adequate fauna and flora management • Measures for minimizing impact on fauna and flora species based on the Contracting Authority procedures • Measures for monitoring the efficiency and performance of the plan in place • Measures for limiting IAS • Measures for monitoring the efficiency and performance of the plan in place
18. Prevention of erosion	• Location of zones suffering from erosion • Methods and schedule for the implementation of anti-erosive actions, including topsoil storage
19. Documentation of site condition	• List and cover of viewpoints • Imaging method • Archiving photographs
20. Rehabilitation	• Method and schedule for Project Area rehabilitation
21. Appendices	• Site-ESMPs (number and location specified in Section 6 “Project Areas” above): - Marking out of the Project Area perimeter on a map - Definition of zones for vegetation clearing, zones for the storage of usable timber, zones for burning of green waste

	- Definition of on-site activities: construction, storage areas, accommodation areas, offices, workshops, concrete making units - Layout of activity areas on the Project Area: construction works, production/operation areas, rehabilitation and closure - Zones for the storage of topsoil, spoil from earthworks, materials - Access routes and checkpoints - Project Area occupancy schedule - Organisation of Project Area preparation - Liquid discharge outlet points - Proposed sampling points for monitoring water quality - Atmospheric emission outlet points - Location of the storage site for dangerous products - Location and mapping of waste treatment facilities when handled by an external service provider - Any other information relating to the environmental management of the Project Area • Emergency plan - Description of facilities - Characterisation of hazards - Emergency situations - Organisation structure - roles and responsibilities - Emergency procedures - Human and material resources - Triggering of the plan - Reporting

Appendix 2
Properties rendering a product dangerous

1. Explosive	substances and preparations which could explode in the presence of a flame or which are more sensitive to impacts and friction than dinitrobenzene.
2. Combustive	substances and preparations which, when in contact with other substances, particularly inflammable substances, undergo strongly exothermic reactions.
3. Easily inflammable	substances and preparations (i) in liquid phase (including extremely inflammable liquids), with a flash point below 21°C, or which can heat up to the extent of spontaneous combustion in ambient air; or (ii) in solid phase, which can burst into flames easily in the brief presence of a source of inflammation and which will continue to burn after the removal of the source of inflammation or (iii) in gaseous phase, which are inflammable in air at normal pressure; or (iv) – which, when in contact with moist air or water, produce dangerous quantities of gases which are easily inflammable.
4. Inflammable	liquid substances and preparations, with a flash point equal to or above 21°C and less than or equal to 55°C.
5. Irritant	non-corrosive substances and preparations which, when in immediate, extended or repeated contact with the skin and mucosa, can cause inflammation.
6. Harmful	substances and preparations which, in case of inhaling, swallowing or cutaneous penetration, can lead to risks of limited severity.
7. Toxic	substances and preparations (including highly toxic substances and preparations), which, in case of inhaling, swallowing or cutaneous penetration, can lead to serious, acute or chronic risks, and even death.
8. Carcinogenic	substances and preparations which, in case of inhaling, swallowing or cutaneous penetration, can lead to or increase the frequency of cancer.
9. Corrosive	substances and preparations which, in case of contact with living tissues, can destroy the latter.
10. Infectious	substances containing viable micro-organisms or their toxins, for which it is known or we have good reasons to believe that they cause disease in humans or other living organisms.
11. Harmful to reproduction function	substances and preparations which, in case of inhaling, swallowing or cutaneous penetration, can induce or increase the frequency of undesirable non-hereditary effects in offspring or have a negative effect on reproductive functions and abilities.
12. Mutagenic	substances and preparations which, in case of inhaling, swallowing or cutaneous penetration, can lead to hereditary genetic disorders or increase the frequency of these disorders.
13. React with water	substances and preparations which, in case of contact with water, air or an acid, release a toxic or highly toxic gas.
14. Sensitivising	substances and preparations which, in case of inhaling or cutaneous penetration, can lead to a hypersensitation, so that renewed exposure to the substance or preparation will cause characteristic harmful effects. This property can only be considered if test methods are available.

15. Ecotoxic	substances and preparations with inherent or potential immediate or deferred risks for one or several environmental components.
16. Dangerous for the environment	substances and preparations which are likely, after elimination, to lead to another substance, by any means, e.g. a lixiviation product, with one of the above characteristics.

d) Personnel Requirements

The Bidder must demonstrate that it has the personnel for the key positions that meet the following requirements:

Name	Designation, in accordance with Section VII, Scope of Works	Education/ Degree	Years of Professional Experience	Relationship with / Years within the Bidder[1]	Country/ Regional Experience	Relevant Project References	Name
	Environmental and Social, Health and Safety (ESHS) Manager		15				
	Construction Site HSE Manager		7				
	Social and Resettlement Expert		7				

ESHS Manager

The Contractor's ESHS Manager shall be responsible for the development and implementation of the project- and site-specific HSE Management Plan, including Occupational Health and Safety.

The ESHS Manager will work closely with the Contractor's Project Manager, advising on the performance of the contractors' (including all subcontractors) compliance with the requirements as provided in the ESMMP and Biodiversity Action Plan (BAP) and set site specific the Health, Safety and Environment Management Plan (HSEMP).

The ESHS Manager shall also ensure that all environmental and social as well as occupational health and safety requirements stipulated in the ESMMP, BAP and site specific HSEMP, together with the relevant local laws and regulations and the standards as listed above, are adhered to by the project team/personnel and shall ensure compliance with the same by subcontractors and suppliers.

The ESHS Manager shall be experienced in OHS- on construction sites, especially related to construction of Overhead Transmission Lines.

Construction HSE Manager

The Construction HSE Manager shall be responsible for the day-to-day implementation of ESMS elements, occupational health and safety management measures and the relevant activities on construction sites. He shall be reporting to the Construction Site Manager and the

[1] For freelance experts (e.g. with retainer contracts or formal agreements) indicate "FE" and how long the expert has been associated with the Bidder. For sub-consultant staff indicate "Sub". Staff from affiliated firms of the Bidder shall be considered as sub-consultant staff.

ESHS Manager. This person shall be establishing regular E&S Performance Reports and shall be in addition reporting on any HSE issues when these occur. Construction HSE Manager shall be fluent in local language (Nepalese)

Social and Resettlement Expert

Contractor's Social and Resettlement Expert shall be responsible for the communication and interaction with stakeholders, local communities, and Project Affected People. This expert shall supervise implementation of all mitigation / compensation measures defined by the site-specific HSEMP related to the social environment. This shall be done in compliance with the Project's Resettlement Action Plan (RAP) which is prepared by the Implementation Consultant in line with requirements of national and international standards and is implemented by NEA.

Requirements for this expert include: University degree in anthropology / sociology or related disciplines; Experience with conducting environmental & social risk assessments, preferably with a focus on the power / transmission sector. Excellent communication and reporting skills; fluent in English and Nepalese language.

e) Equipment Requirements

[Insert here the project-specific minimum equipment requirements.]

The Bidder must demonstrate that it can obtain (purchase, lease or rent) the key equipment listed hereafter:

[Specify requirements for each lot as applicable]

No.	Equipment Type and Characteristics	Minimum Number required
1		
2		
3		
4		
5		
…		

[Insert in the table (i) the list of the critical equipment required for project implementation and (ii) the minimum number of each of those equipment]

The Bidder shall provide further details of proposed items of equipment using Form EQU in Section IV, Bidding Forms.

Drawings

[Insert here the works drawings.]

Supplementary Information

Appendix 3
Environmental and Social Management and Monitoring Plan

Environmental and Social Management and Monitoring Plan

Lekhnath-Damauli 220kV Transmission Line Project, Nepal

Package A Transmission Line

8 February 2022

Project No.: 0529927

VII-6

Technical Data Sheets

Technical Data Sheets				
	Lekhnath - Damauli 220 kV D/C Line			
	Tanahu - Bharatpur 220 kV D/C Interconnection to Damauli S/S (LI-LO)			
	Old Damauli - Bharatpur 132 kV S/C Interconnection to Damauli S/S (LI-LO)			
BIDDER'S / CONTRACTOR'S GUARANTEED DATA				
No.	**Description**	**Unit**	**Data required**	**Data offered**
1	**General Data**			
1.1	**Basic Line Data**			
1.1.1	Lekhnath - Damauli 220 kV D/C Line			
1.1.1.1	Number of circuits (1 circuit = 3 phases)	-	2	
1.1.1.2	Number of conductors per phase	-	2	
1.1.1.3	Bundle Spacing	mm	450	
1.1.1.4	Number of OPGW	-	1	
1.1.1.5	Number of earth wires			
1.1.1.5.1	Lekhnath S/S to AP70	-	1	
1.1.1.5.2	AP70 to Damauli S/S	-	-	
1.1.2	Tanahu - Bharatpur 220 kV D/C Interconnection to Damauli S/S (LI-LO)			
1.1.2.1	Number of circuits (1 circuit = 3 phases)	-	4	
1.1.2.2	Number of conductors per phase	-	2	
1.1.2.3	Bundle Spacing	mm	450	
1.1.2.4	Number of OPGW			
1.1.2.4.1	Tanahu-Bharatpur 220 kV Line to AP70	-	1	
1.1.2.4.2	AP70 to Damaul S/S	-	1	
1.1.2.5	Number of earth wires	-	1	
1.1.3	Old Damauli - Bharatpur 132 kV S/C Interconnection to Damauli S/S (LI-LO)			
1.1.3.1	Number of circuits (1 circuit = 3 phases)	-	2	
1.1.3.2	Number of conductors per phase	-	1	
1.1.3.3	Number of OPGW	-	-	
1.1.3.4	Number of earth wires	-	2	
1.2	**Electrical Data**			
1.2.1	220 kV			
1.2.1.1	Highest system voltage (Us) /power frequency	kV/Hz	245/50	
1.2.1.2	Lightning impulse withstand voltage	kV, peak	1050	
1.2.1.3	Short-duration power frequency withstand voltage	kV, rms	460	
1.2.1.4	System neutral	-	Solidly earthed	
1.2.1.5	System highest 3-phase short-circuit current (1s)	kA	40	
1.2.1.6	Specific insulation creepage distance	mm/kV	25	
1.2.1.7	Radio noise limit for radio interference testing of insulator sets, fittings, etc.	dB above 1 mV	46	
1.2.2	132 kV			
1.2.2.1	Highest system voltage (Us) /power frequency	kV/Hz	145/50	
1.2.2.2	Lightning impulse withstand voltage	kV, peak	650	
1.2.2.3	Short-duration power frequency withstand voltage	kV, rms	275	
1.2.2.4	System neutral	-	Solidly earthed	
1.2.2.5	System highest 3-phase short-circuit current (1s)	kA	31.5	
1.2.2.6	Specific insulation creepage distance	mm/kV	25	
1.2.2.7	Radio noise limit for radio interference testing of insulator sets, fittings, etc.	dB above 1 mV	46	
1.3	**Climatic Data**			
1.3.1	Maximum ambient air temperature	°C	+50	
1.3.2	Minimum ambient air temperature	°C	0	
1.3.3	Every day temperature	°C	+32	
1.3.4	Temperature with maximum wind	°C	+32	
1.3.6	Basic wind velocity (V_{b0})	m/s	28	
1.3.7	Air density (ρ) - at 15°C and atmospheric pressure of 1013 hPa	kg/m^3	1.225	

Technical Data Sheets				
Lekhnath - Damauli 220 kV D/C Line				
Tanahu - Bharatpur 220 kV D/C Interconnection to Damauli S/S (LI-LO)				
Old Damauli - Bharatpur 132 kV S/C Interconnection to Damauli S/S (LI-LO)				
BIDDER'S / CONTRACTOR'S GUARANTEED DATA		**Unit**	**Data required**	**Data offered**
No	**Description**			
2	**Design Requirements**			
2.1	**Maximum conductor temperature**	°C	80	
2.2	**Partial factors**			
2.2.1	**Partial factors for actions (γ_F)**			
2.2.1.1	Permanent actions (dead weight)*		1.1 / 0.9	
2.2.1.2	Variable actions (climatic loads) in normal loading cases		1.35	
2.2.1.3	Exceptional loading cases		1.10	
2.2.1.4	Erection and maintenance loads		1.50	
2.2.1.5	Dynamic stringing loads		2.00	
2.2.1.6	*For compression loading cases, partial load factor for the tower dead weight is to be considered 1.1. In case of uplift loads, this factor shall be taken as 0.9 for cross-arms and foundations.			
2.2.2	**Partial material factors (γ_M)**			
2.2.2.1	Structural steel sections in compression, buckling		1.10	
2.2.2.2	Bolts and structural steel sections in tension		1.25	
2.2.2.3	Foundations			
2.2.2.3.1	- Reinforcing steel of concrete foundation		1.15	
2.2.2.3.2	- Concrete structure of in-situ concrete		1.50	
2.2.2.4	Soil properties			
2.2.2.4.1	- Angle of shearing resistance		1.35	
2.2.2.4.2	- Effective cohesion		1.35	
2.2.2.4.3	- Undrained shear strength		1.40	
2.2.2.4.4	- Unconfined strength		1.40	
2.2.2.4.5	- Weight density		1.00	
2.2.2.5	Conductors and OPGW		1.65	
2.2.2.6	Insulators		1.80	
2.2.2.7	All fittings, including joints and tension clamps		1.80	
2.3	**Minimun Internal Clearances**			
2.3.1	Minimum clearance between phase conductors, D_{pp} - still air	m	2.80	
2.3.2	Minimum clearance between live and earthed parts, Del			
2.3.2.1	in still air	m	2.50	
2.3.2.2	nominal wind load, mean wind velocity, with 3 year RP	m	1.70	
2.3.2.3	extreme wind load, mean wind velocity, with 50 year RP	m	0.85	
2.4	**Minimum External Clearances**			
2.4.1	Minimum vertical clearances from the line conductors at most detrimental loading:			
2.4.2	Residential Areas	m	8.50	
2.4.3	Cultivated and natural land	m	7.50	
2.4.4	Tree	m	5.00	
2.4.5	Road	m	8.00	
2.4.6	Highway and asphalted road	m	9.00	
2.4.7	River & water area	m	6.50	
2.4.8	Railway Track nonelectrified	m	18.00	
2.4.9	Railway Track electrified	m	4.50	
2.4.10	Power lines, Telecommunication lines	m	5.00	
2.5	**Mid-span wire clearances**			
2.5.1	As per EN 50531-1, Annex F, plus bundle spacing			
2.6	**Clearance condition for the OPGW**			
2.6.1	OPGW sag, compared to the conductor sag at every day temperature	-	10% less	
2.6.2	OPGW shielding angle	(°)	20	

Technical Data Sheets				
Lekhnath - Damauli 220 kV D/C Line				
Tanahu - Bharatpur 220 kV D/C Interconnection to Damauli S/S (LI-LO)				
Old Damauli - Bharatpur 132 kV S/C Interconnection to Damauli S/S (LI-LO)				
BIDDER'S / CONTRACTOR'S GUARANTEED DATA		**Unit**	**Data required**	**Data offered**
No	**Description**			
2.7	**Soils data / for bidding design only**			
2.7.1	Type 1 – Hard rock			
2.7.1.1	Density	kN/m^3	25	
2.7.1.2	Ultimate bearing capacity (kN/m^2)	kN/m^2	≥1230	
2.7.1.3	Angle of frustum	[°]	N/A	
2.7.2	Type 2 – Fissured rock (dry)			
2.7.2.1	Density	kN/m3	15	
2.7.2.2	Ultimate bearing capacity (kN/m^2)	kN/m^2	≥500	
2.7.2.3	Angle of frustum	[°]	20	
2.7.2	Type 2 – Fissured rock (in presence of subsoil water)			
2.7.2.1	Density	kN/m3	10	
2.7.2.2	Ultimate bearing capacity (kN/m^2)	kN/m^2	≥500	
2.7.2.3	Angle of frustum	[°]	10	
2.7.3	Type 3 – Normal Soil (dry)			
2.7.3.1	Density	kN/m^3	15	
2.7.3.2	Ultimate bearing capacity (kN/m^2)	kN/m^2	≥270	
2.7.3.3	Angle of frustum	[°]	25	
2.7.3	Type 3 – Normal Soil (in presence of subsoil water)			
2.7.3.1	Density	kN/m^3	10	
2.7.3.2	Ultimate bearing capacity (kN/m^2)	kN/m^2	≥135	
2.7.3.3	Angle of frustum	[°]	15	
2.7.3	Type 3 – Normal Soil (wet black cotton)			
2.7.3.1	Density	kN/m^3	-	
2.7.3.2	Ultimate bearing capacity (kN/m^2)	kN/m^2	≥135	
2.7.3.3	Angle of frustum	[°]	0	
2.7.4	Type 4 – Sandyl Soil			
2.7.4.1	Density	kN/m^3	15	
2.7.4.2	Ultimate bearing capacity (kN/m^2)	kN/m^2	≥250	
2.7.4.3	Angle of frustum	[°]	20	
2.7.6	Backfill			
2.7.6.1	Density	kN/m^3	18	
2.7.6.2	Angle of frustum	[°]	15	
2.8	**Design Spans for Towers**			
2.8.1	Normal Suspension Tower Type DA			
2.8.1.1	Nominal Span	m	350	
2.8.1.2	Wind Span	m	450	
2.8.1.3	Weight Span - min.	m	700	
2.8.1.4	Weight Span - max.	m	300	
2.8.1.5	Phase Span	m	600	
2.8.1.6	Line Angle	deg	0-2	
2.8.2	Light Angle Tower Type DB			
2.8.2.1	Nominal Span	m	350	
2.8.2.2	Wind Span	m	450	
2.8.2.3	Weight Span - min.	m	1500	
2.8.2.4	Weight Span - max.	m	-700	
2.8.2.5	Phase Span	m	600	
2.8.2.6	Line Angle	deg	15	
2.8.3	Medium Angle Tower Type DC			
2.8.3.1	Nominal Span	m	350	
2.8.3.2	Wind Span	m	450	
2.8.3.3	Weight Span - min.	m	1000	
2.8.3.4	Weight Span - max.	m	-700	
2.8.3.5	Phase Span	m	600	
2.8.3.6	Line Angle	deg	15-30	
2.8.4	Heavy Angle Tower Type DD			

Technical Data Sheets				
Lekhnath - Damauli 220 kV D/C Line				
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Old Damauli - Bharatpur 132 kV S/C Interconnection to Damauli S/S (LI-LO)				
BIDDER'S / CONTRACTOR'S GUARANTEED DATA		**Unit**	**Data required**	**Data offered**
No	**Description**			
2.8.4.1	Nominal Span	m	350	
2.8.4.2	Wind Span	m	450	
2.8.4.3	Weight Span - min.	m	2000	
2.8.4.4	Weight Span - max.	m	-700	
2.8.4.5	Phase Span	m	600	
2.8.4.6	Line Angle	deg	30-60	
2.8.5	Dead End Tower Type DE			
2.8.5.1	Nominal Span	m	250	
2.8.5.2	Wind Span	m	250	
2.8.5.3	Weight Span - min.	m	700	
2.8.5.4	Weight Span - max.	m	-300	
2.8.5.5	Phase Span	m	400	
2.8.5.6	Line Angle/Gantry	deg	0-45/0-45	
2.8.6	Under Crossing Gantry Type UCG			
2.8.6.1	Nominal Span	m	200	
2.8.6.2	Wind Span	m	200	
2.8.6.3	Weight Span - min.	m	500	
2.8.6.4	Weight Span - max.	m	-500	
2.8.6.5	Phase Span	m	200	
2.8.6.6	Line Angle	deg	0-10	
2.8.7	Angle Tension Tower Type 6T			
2.8.7.1	Nominal Span	m	350	
2.8.7.2	Wind Span	m	350	
2.8.7.3	Weight Span - min.	m	1500	
2.8.7.4	Weight Span - max.	m	-700	
2.8.7.5	Phase Span	m	375	
2.8.7.6	Line Angle	deg	0-50	

Technical Data Sheets				
Lekhnath - Damauli 220 kV D/C Line				
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Old Damauli - Bharatpur 132 kV S/C Interconnection to Damauli S/S (LI-LO)				
BIDDER'S / CONTRACTOR'S GUARANTEED DATA		**Unit**	**Data required**	**Data offered**
No	**Description**			
3	**Tower structures requirements**			
3.1	Corrosion protection measures			
3.1.1	All tower steel parts hot dip galvanized		yes	
3.1.2	Galvanizing for steel sections, fittings, etc	µm	85	
3.1.3	Galvanizing of bolts, nuts & washers	µm	55	
3.1.4	Quality and tests		EN ISO 1461	
3.2	Structural members material standard		EN10025	
3.3	Steel quality:			
3.3.1	main stressed parts	-	S355J2G3/G4, S235J2G3/G4	
3.3.2	for other parts		S355J2G3/G4 S235J2G3/G5	
3.3.3	maximum Carbon Equivalent Values (CEV)			
3.3.3.1	S235		0.35	
3.3.3.2	S355		0.45	
3.4	Bolts and nuts standard	-	ISO 898-1 and 2	
3.4.1	Bolts and nuts qualities:	-	5.6 or 8.8	
3.4.2	Permissible stresses of structural members, bolts and nuts)	-	ENV1993-1-1 EN50341-1-J	
3.4.3	Bolt connections to contain flat and spring washer		yes	
3.4.4	Minimum bolt diameter	mm	16	
3.4.5	Step bolt diameter (min.)	mm	16	
3.5	Minimum thickness (t) and size of steel members of towers			
3.5.1	Main leg, stub and main compression members in crossarm	mm	6	
3.5.2	All other members having computed stresses	mm	5	
3.5.3	Redundant members without computed stress	mm	4	
3.5.4	Gusset plates	mm	6	
3.6	Minimum angle bar size			
3.6.1	equal angle profile	mm·mm·mm	L45x45xt	
3.6.2	unequal angle profile		L45x30xt	
3.6.3	*The minimum connected leg of the angle section shall be such that the bolt head or nut does not bear on the fillet.			
3.7	Maximum length of structural member	m	9	
3.8	Tolerances of finished members:			
3.8.1	Members up to 3m length	mm	± 1.5	
3.8.2	3m to 6m	mm	± 2.5	
3.8.3	greater than 6m	mm	± 3	
3.9	Maximum slenderness ratio – L/r			
3.9.1	Main leg, stub and main compression members in crossarm	-	120	
3.9.2	All other members having computed stresses	-	180	
3.9.3	Redundant members without computed stressed	-	250	
3.9.4	Tension members only	-	300	
3.10	Tower accesories			
3.10.1	Step bolts	-	yes	
3.10.2	Signs	-	yes	
3.10.3	Anti-climb device	-	yes	
3.10.4	Anti-thef device	-	yes	
3.10.5	Bird protection guards	-	to be confirmed	
3.10.6	Latch-on maintenace safety system	-	to be confirmed	

Technical Data Sheets				
Lekhnath - Damauli 220 kV D/C Line				
Tanahu - Bharatpur 220 kV D/C Interconnection to Damauli S/S (LI-LO)				
Old Damauli - Bharatpur 132 kV S/C Interconnection to Damauli S/S (LI-LO)				
BIDDER'S / CONTRACTOR'S GUARANTEED DATA		**Unit**	**Data required**	**Data offered**
No	**Description**			
3.11	Tower earthing			
3.11.1	Material	-	round steel galvanized	
3.11.2	Minimun diameter	mm	11.5	
3.11.3	Zinc coat thickness	µm	>70	
3.11.4	Earth rods			
3.11.4.1	Material	-	round steel galvanized	
3.11.4.2	Length	m	>2	
3.11.4.3	Diameter	mm	15	
3.11.4.4	Zinc coat thickness	µm	70	
3.11.5	Type of connection	-		
3.11.5.1	Tower ground connector	-		
3.11.5.2	Bolt/nut/lock washer	-		
3.11.5.3	Compression type connector	-	Steel	

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BIDDER'S / CONTRACTOR'S GUARANTEED DATA		**Unit**	**Data required**	**Data offered**
No	**Description**			
4	**Conductor, Earthwire/OPGW and Insulator sets**			
4.1	**Phase conductor**			
4.1.1	**ACSR MOOSE**			
4.1.1.1	Manufacturer	-		
4.1.1.2	Standard	-	EN 50182	
4.1.1.3	Conductor type		ACSR	
4.1.1.4	Code		528-AL 1/69 - ST1A	
4.1.1.5	Aluminum area	mm^2	528.5	
4.1.1.6	Steel area	mm^2	68.5	
4.1.1.7	Total area	mm^2	597	
4.1.1.8	Conductor diameter	mm	31.8	
4.1.1.9	Conductor structure/ stranding:			
4.1.1.9.1	Aluminum:	No/dia (mm)	54/3.53	
4.1.1.9.2	Steel	No/dia (mm)	7/3.53	
4.1.1.10	Direction of outer layer	-	Z - right hand	
4.1.1.11	Rated Strength	kN	159.92	
4.1.1.12	DC resistance at 20°C	Ohm/km	0.0547	
4.1.1.13	Mass per unit length	kg/m	1.9973	
4.1.1.14	Grease mass per unit length	kg/m		
4.1.2	**ACSR BISON**			
4.1.2.1	Manufacturer	-		
4.1.2.2	Standard	-	EN 50182	
4.1.2.3	Conductor type		ACSR	
4.1.2.4	Code		382-AL1/49-ST1A	
4.1.2.5	Aluminum area	mm^2	381.7	
4.1.2.6	Steel area	mm^2	49.48	
4.1.2.7	Total area	mm^2	431.2	
4.1.2.8	Conductor diameter	mm	27.0	
4.1.2.9	Conductor structure/ stranding:			
4.1.2.9.1	Aluminum:	No/dia (mm)	54/3.0	
4.1.2.9.2	Steel	No/dia (mm)	7/3.0	
4.1.2.10	Direction of outer layer	-	Z - right hand	
4.1.2.11	Rated Strength	kN	120.9	
4.1.2.12	DC resistance at 20°C	Ohm/km	0.0757	
4.1.2.13	Mass per unit length	kg/m	1.4434	
4.1.2.14	Grease mass per unit length	kg/m		
4.1.3	**ACSR WOLF**			
4.1.3.1	Manufacturer	-		
4.1.3.2	Standard	-	EN 50182	
4.1.3.3	Conductor type		ACSR	
4.1.3.4	Code		158-AL1/37-ST1A	
4.1.3.5	Aluminum area	mm^2	158.1	
4.1.3.6	Steel area	mm^2	36.9	
4.1.3.7	Total area	mm^2	194.9	
4.1.3.8	Conductor diameter	mm	18.1	
4.1.3.9	Conductor structure/ stranding:			
4.1.3.9.1	Aluminum:	No/dia (mm)	30/2.59	
4.1.3.9.2	Steel	No/dia (mm)	7/2.59	
4.1.3.10	Direction of outer layer	-	Z - right hand	
4.1.3.11	Rated Strength	kN	68.91	
4.1.3.12	DC resistance at 20°C	Ohm/km	0.1829	
4.1.3.13	Mass per unit length	kg/m	0.7253	
4.1.3.14	Grease mass per unit length	kg/m		
4.2	**Earthwire**			
4.2.1	Manufacturer			
4.2.2	Type		93-A20SA	
4.2.3	Nominal Aluminum class steel (ACS) cross section	mm^2	93.3	
4.2.4	Diameter	mm	12.5	
4.2.5	Aluminum clad steel (ACS):	No/mm	19/2.5	
4.2.6	Rated tensile strength	kN		
4.2.7	DC resistance at 20°C	Ohm/km	0.9345	
4.2.8	Linear mass of conductor	kg/m	0.6249	

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BIDDER'S / CONTRACTOR'S GUARANTEED DATA		**Unit**	**Data required**	**Data offered**
No	**Description**			
4.3	**Optical Ground Wire (OPGW-48)**			
4.3.1	Manufacturer			
4.3.2	OPGW Type / mechanically equivalent to	-	OPGW 93 equivalent to 93-A20SA	
4.3.3	Fibre count		48	
4.3.4	Grade Aluminum alloy wires AA (EN 50183)	-	AL2 or AL3	
4.3.5	Aluminum clad steel (ACS) wires conductivity	% IACS	≥ 20.3	
4.3.6	Number/diameter AA wires outer layer	-		
4.3.7	Number/diameter AA wires inner layer(s)	-		
4.3.8	Number/diameter ACS wires outer layer	-		
4.3.9	Number/diameter ACS wires inner layer(s)	-		
4.3.10	Minimum diameter of the outer wire strands	mm	3.0	
4.3.11	Lay direction outer layer	-	Right (Z)	
4.3.12	Optical unit type:	-		
4.3.12.1	Central Al tube or stranded stainless steel tube(s)	-		
4.3.12.2	Diameter/thickness of the optical unit	mm		
4.3.13	Cable diameter	mm		
4.3.14	Nominal breaking load	kN		
4.3.15	Linear weight	kg/m		
4.3.16	Coefficient of linear thermal expansion	$x\ 10^{-6}\ °C^{-1}$		
4.3.17	Maximum DC electric resistance at 20°C	OHM/km	≤ 1.0	
4.3.18	Short - circuit capacity (initial temperature 40°C, final temperature 200°C)	$kA^2.s$		
4.4	**Optical Ground Wire (OPGW-24)**			
4.4.1	Manufacturer			
4.4.2	OPGW Type / mechanically equivalent to	-	OPGW 93 equivalent to 93-A20SA	
4.4.3	Fibre count		24	
4.4.4	Grade Aluminum alloy wires AA (EN 50183)	-	AL2 or AL3	
4.4.5	Aluminum clad steel (ACS) wires conductivity	% IACS	≥ 20.3	
4.4.6	Number/diameter AA wires outer layer	-		
4.4.7	Number/diameter AA wires inner layer(s)	-		
4.4.8	Number/diameter ACS wires outer layer	-		
4.4.9	Number/diameter ACS wires inner layer(s)	-		
4.4.10	Minimum diameter of the outer wire strands	mm	3.0	
4.4.11	Lay direction outer layer	-	Right (Z)	
4.4.12	Optical unit type:	-		
4.4.12.1	Central Al tube or stranded stainless steel tube(s)	-		
4.4.12.2	Diameter/thickness of the optical unit	mm		
4.4.13	Cable diameter	mm		
4.4.14	Nominal breaking load	kN		
4.4.15	Linear weight	kg/m		
4.4.16	Coefficient of linear thermal expansion	$x\ 10^{-6}\ °C^{-1}$		
4.4.17	Maximum DC electric resistance at 20°C	OHM/km	≤ 1.0	
4.4.18	Short - circuit capacity (initial temperature 40°C, final temperature 200°C)	$kA^2.s$		
4.5	**Optical fiber type ITU-T G.652D characteristics**			
4.5.1	Standard		ITU-T G.652D	
4.5.2	Fiber Structure Characteristics			
4.5.2.1	Mode Field Diameter @ 1310 nm	µm	9.2 ± 0.4	
4.5.2.2	Mode Field Diameter @ 1310 nm	µm	10.4 ± 0.8	
4.5.2.3	Mode Field Concentricity Error	µm	≤ 0.5	
4.5.2.4	Non Circularity of The Cladding	%	≤ 1.0	
4.5.2.5	Diameter of the Outer Coating	µm	245 ± 5	
4.5.2.6	Coating - Cladding Concentricity Error	µm	≤ 12	
4.5.3	Optical Characteristics			
4.5.3.1	Maximum attenuation @ 1310 nm	dB/km	0.35	
4.5.3.2	Maximum attenuation @ 1550 nm	dB/km	0.21	
4.5.3.3	Maximum attenuation @ 1625 nm	dB/km	0.24	
4.5.3.4	Maximum chromatic dispersion @ 1285 - 1330 nm	ps/nm.km	3.5	
4.5.3.5	Maximum chromatic dispersion @ 1550 nm	ps/nm.km	18	
4.5.3.6	Maximum zero-dispersion slope	$ps/nm^2.km$	0.093	
4.5.3.7	Maximum Polarisation Mode Dispersion (PMD) per individual fiber	$ps/km^{0.5}$	0.1	
4.5.3.8	Maximum point discontinuity @ 1550 nm in the OTDR trace	dB	0.05	
4.5.3.9	Maximum Cut-off wavelength	nm	1260	
4.5.4	Mechanical Characteristics			
4.5.4.1	Minimum proof test	GPa	1	
4.5.4.2	Bending test, additional loss at 1550nm, 100 turns on 60mm mandrel	dB	0.05	
4.5.4.3	Bending test, additional loss at 1550nm, 1 turn on 32mm mandrel	dB	0.5	

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BIDDER'S / CONTRACTOR'S GUARANTEED DATA		**Unit**	**Data required**	**Data offered**
No	**Description**			
4.5.4.4	Fiber Curl	m	≥ 4	
4.6	**Optical fiber count and grouping**			
4.6.1	220 kV line Lekhnath - Damauli	-	48 fibers type ITU-T G.652D	
4.6.2	220 kV line Tanahu - Damauli	-	24 fibers type ITU-T G.652D	
4.6.3	220 kV line Bharatpur - Damauli	-	24 fibers type ITU-T G.652D	
4.7	**Insulator sets**			
4.7.1	Insulator unit manufacturer	-		
4.7.2	Fittings manufacturer	-		
4.7.3	Insulator unit type	-	Composite	
4.7.4	Min. creepage distance per unit	mm		
4.7.5	Size of coupling	mm	20	
4.7.6	Min. electro-mechanical failing load	kN	180 - 220	
4.8	**Fittings and accessories**			
4.8.1	Manufacturer	-		
4.8.2	Material	-	Cast iron/steel	
4.8.3	All fittings/accessories are galvanized	-	yes	
4.8.3.1	Kind of galvanizing	-	hot dip	
4.8.3.2	Quality and tests	-	ISO 1461	
4.8.3.3	Galvanizing of all components min zinc coat)	µm	85	
4.8.3.4	Galvanizing of bolts ,nuts, washers (min zinc coat)	µm	55	
4.8.4	Phase Conductors			
4.8.4.1	Manufacturer	-		
4.8.4.2	Standard	-		
4.8.4.3	Quality and tests correspond with	-	IEC 61284	
4.8.4.4	For phase conductor tension clamps and tensioned connectors:			
4.8.4.4.1	· Minimum failing load referred to maximum tension load of conductors or	%		
4.8.4.4.2	· Minimum failing load referred to failing load of conductors	%		
4.8.4.5	For phase conductor suspension clamps minimum failing load referred to maximum simultaneous acting forces	%		
4.8.4.6	Slipping load	kN		
4.9	**Vibration Dampers for OPGW**			
4.9.1	Manufacturer	-		
4.9.2	Type	-		
4.9.3	Materials	-		
4.9.4	Iron and steel parts galvanized	-	yes	
4.9.5	Kind of galvanizing	-	Hot dipped	
4.9.6	Quality corresponds with	-		
4.9.7	Weight of damper to be installed in	kg		
4.9.8	Distance of damper fixing point from next clamp, and in case two dampers shall be fixed, required distance between damper fixing points	mm		
4.9.9	Clamping bolts			
4.9.10	Material:			
4.9.10.1	· stainless steel	-	Yes/no	
4.9.10.2	· galv steel	-	Yes/no	
4.9.10.3	· tensile strength	N/mm^2	80	
4.9.10.4	· tightning torque	Nm	<44	
4.9.11	Non metallic material temperature withstand	°C	0-40	
4.9.12	Drainage holes diameter	mm	min 6	
4.10	**Vibration Dampers for Earthwire**			
4.10.1	Manufacturer	-		
4.10.2	Type	-		
4.10.3	Materials	-		
4.10.4	Iron and steel parts galvanized	-	yes	
4.10.5	Kind of galvanizing	-	Hot dipped	
4.10.6	Quality corresponds with	-		
4.10.7	Weight of damper to be installed in	kg		
4.10.8	Distance of damper fixing point from next clamp, and in case two dampers shall be fixed, required distance between damper fixing points	mm		
4.10.9	Clamping bolts			
4.10.10	Material:			
4.10.10.1	· stainless steel	-	Yes/no	

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BIDDER'S / CONTRACTOR'S GUARANTEED DATA		**Unit**	**Data required**	**Data offered**
No	**Description**			
4.10.10.2	· galv steel	-	Yes/no	
4.10.10.3	· tensile strength	N/mm^2	80	
4.10.10.4	· tightning torque	Nm	<44	
4.10.11	Non metallic material temperature withstand	°C	0-40	
4.10.12	Drainage holes diameter	mm	min 6	
4.11	**Spacer dampers for Phase Conductor 2 x ACSR MOOSE**			
4.11.1	Manufacturer	-		
4.11.2	Type	-		
4.11.3	Bundle spacing	mm	450	
4.11.4	Material used for			
4.11.4.1	· Counter weights	-		
4.11.4.2	· Elastomer	-		
4.11.4.3	· Clamp body and keeper	-		
4.11.5	Quality corresponds with	-		
4.11.6	Weight of spacer damper	kg		
4.11.7	Maximum distance between two Spacer Damper	m		
4.11.8	Clamping bolts			
4.11.9	Material:			
4.11.9.1	· stainless steel	-	Yes/no	
4.11.9.2	· galv steel	-	Yes/no	
4.11.9.3	· tensile strength	N/mm^2	80	
4.11.9.4	· tightning torque	Nm	<44	
4.11.10	Non metallic material temperature withstand	^0C	0-80	
4.11.11	Max. bending stress of conductor	mm	<150	
4.12	**Spacer dampers for Phase Conductor 2 x ACSR BISON**			
4.12.1	Manufacturer	-		
4.12.2	Type	-		
4.12.3	Bundle spacing	mm	450	
4.12.4	Material used for			
4.12.4.1	· Counter weights	-		
4.12.4.2	· Elastomer	-		
4.12.4.3	· Clamp body and keeper	-		
4.12.5	Quality corresponds with	-		
4.12.6	Weight of spacer damper	kg		
4.12.7	Maximum distance between two Spacer Damper	m		
4.12.8	Clamping bolts			
4.12.9	Material:			
4.12.9.1	· stainless steel	-	Yes/no	
4.12.9.2	· galv steel	-	Yes/no	
4.12.9.3	· tensile strength	N/mm^2	80	
4.12.9.4	· tightning torque	Nm	<44	
4.12.10	Non metallic material temperature withstand	^0C	0-80	
4.12.11	Max. bending stress of conductor	mm	<150	
4.13	**Vibration dampers for Phase Conductor ACSR MOOSE**			
4.13.1	Manufacturer	-		
4.13.2	Type	-		
4.13.3	Material used for			
4.13.3.1	· Counter weights	-		
4.13.3.2	· Elastomer	-		
4.13.3.3	· Clamp body and keeper	-		
4.13.4	Quality corresponds with	-		
4.13.5	Weight of spacer damper	kg		
4.13.6	Maximum distance between two Spacer Damper	m		
4.13.7	Clamping bolts			
4.13.8	Material:			
4.13.8.1	· stainless steel	-	Yes/no	
4.13.8.2	· galv steel	-	Yes/no	
4.13.8.3	· tensile strength	N/mm^2	80	
4.13.8.4	· tightning torque	Nm	<44	
4.13.9	Non metallic material temperature withstand	^0C	0-80	
4.13.10	Max. bending stress of conductor	mm	<150	
4.13.11	Connection clamp (for OPGW connection to tower steel structures)			
4.13.11.1	Type			
4.13.11.2	Kind of clamping	-		
4.13.11.3	Material used for clamp body	-		
4.13.11.4	Bolts	-		

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BIDDER'S / CONTRACTOR'S GUARANTEED DATA		**Unit**	**Data required**	**Data offered**
No	**Description**			
4.13.11.5	Suitable for cross-section:	mm^2		
4.14	**Vibration dampers for Phase Conductor ACSR BISON**			
4.14.1	Manufacturer	-		
4.14.2	Type	-		
4.14.3	Material used for			
4.14.3.1	· Counter weights	-		
4.14.3.2	· Elastomer	-		
4.14.3.3	· Clamp body and keeper	-		
4.14.4	Quality corresponds with	-		
4.14.5	Weight of spacer damper	kg		
4.14.6	Maximum distance between two Spacer Damper	m		
4.14.7	Clamping bolts			
4.14.8	Material:			
4.14.8.1	· stainless steel	-	Yes/no	
4.14.8.2	· galv steel	-	Yes/no	
4.14.8.3	· tensile strength	N/mm^2	80	
4.14.8.4	· tightning torque	Nm	<44	
4.14.9	Non metallic material temperature withstand	^0C	0-80	
4.14.10	Max. bending stress of conductor	mm	<150	
4.14.11	Connection clamp (for OPGW connection to tower steel structures)			
4.14.11.1	Type			
4.14.11.2	Kind of clamping	-		
4.14.11.3	Material used for clamp body	-		
4.14.11.4	Bolts	-		
4.14.11.5	Suitable for cross-section:	mm^2		
4.15	**Vibration dampers for Phase Conductor ACSR WOLF**			
4.15.1	Manufacturer	-		
4.15.2	Type	-		
4.15.3	Material used for			
4.15.3.1	· Counter weights	-		
4.15.3.2	· Elastomer	-		
4.15.3.3	· Clamp body and keeper	-		
4.15.4	Quality corresponds with	-		
4.15.5	Weight of spacer damper	kg		
4.15.6	Maximum distance between two Spacer Damper	m		
4.15.7	Clamping bolts			
4.15.8	Material:			
4.15.8.1	· stainless steel	-	Yes/no	
4.15.8.2	· galv steel	-	Yes/no	
4.15.8.3	· tensile strength	N/mm^2	80	
4.15.8.4	· tightning torque	Nm	<44	
4.15.9	Non metallic material temperature withstand	^0C	0-80	
4.15.10	Max. bending stress of conductor	mm	<150	
4.15.11	Connection clamp (for OPGW connection to tower steel structures)			
4.15.11.1	Type			
4.15.11.2	Kind of clamping	-		
4.15.11.3	Material used for clamp body	-		
4.15.11.4	Bolts	-		
4.15.11.5	Suitable for cross-section:	mm^2		
4.16	**Spacer for Phase Conductor 2 x ACSR MOOSE**			
4.16.1	Manufacturer	-		
4.16.2	Type	-		
4.16.3	Bundle spacing	mm	450	
4.16.4	Material used for			
4.16.4.1	· Counter weights	-		
4.16.4.2	· Clamp body and keeper	-		
4.16.5	Quality corresponds with	-		
4.16.6	Weight of spacer	kg		
4.16.7	Maximum distance between two Damper	m		
4.16.8	Clamping bolts			
4.16.9	Material:			
4.16.9.1	· stainless steel	-	Yes/no	
4.16.9.2	· galv steel	-	Yes/no	
4.16.9.3	· tensile strength	N/mm^2	80	
4.16.9.4	· tightning torque	Nm	<44	
4.16.10	Max. bending stress of conductor	mm	<150	

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BIDDER'S / CONTRACTOR'S GUARANTEED DATA		Unit	Data required	Data offered
No	Description			
4.17	**Spacer for Phase Conductor 2 x ACSR BISON**			
4.17.1	Manufacturer	-		
4.17.2	Type	-		
4.17.3	Bundle spacing	mm	450	
4.17.4	Material used for			
4.17.4.1	· Counter weights	-		
4.17.4.2	· Clamp body and keeper	-		
4.17.5	Quality corresponds with	-		
4.17.6	Weight of spacer	kg		
4.17.7	Maximum distance between two Damper	m		
4.17.8	Clamping bolts			
4.17.9	Material:			
4.17.9.1	· stainless steel	-	Yes/no	
4.17.9.2	· galv steel	-	Yes/no	
4.17.9.3	· tensile strength	N/mm^2	80	
4.17.9.4	· tightning torque	Nm	<44	
4.17.10	Max. bending stress of conductor	mm	<150	
4.18	**Aircraft Warning System**			
4.18.1	Red /White painting of tower structure			
4.18.1.1	Primer and Touch-up Primer (epoxy zinc – phosphate primer)	-		
4.18.1.2	Type	-	Epoxy Polyamide-cured	
4.18.1.3	Total volume of solids (minimum)	%	50	
4.18.1.4	Dry film thickness	µm	40 - 80	
4.18.1.5	Color	color	Red / brown	
4.18.1.6	Color code RAL	code		
4.18.1.7	Flash Point (tag open cup)	°C		
4.18.1.8	Drying time of coating :			
4.18.1.8.1	- at 20° C	h		
4.18.1.8.2	- at 50° C	h		
4.18.1.9	Type of thinner	type		
4.18.1.10	Type of cleaner	type		
4.18.2	Intermediate Coat			
4.18.2.1	two – pack epoxy, micaceous iron oxide, polyamide cured	-		
4.18.2.2	Type	-	epoxy	
4.18.2.3	Total Volume of solids (minimum)	%	60	
4.18.2.4	Dry film thickness	µm	100	
4.18.2.5	Color	color	red and silver grey	
4.18.2.6	Flash point (tag open cup)	° C		
4.18.2.7	Drying time for coating :			
4.18.2.7.1	- at 20° C	h		
4.18.2.7.2	- at 50° C	h		
4.18.2.8	Type of thinner	type		
4.18.2.9	Type of cleaner	type		
4.18.3	Final Coat, Red and White			
4.18.3.1	two – pack acrylic resin, cured with linear isocyanate, high gloss	-		
4.18.3.2	Type	aliphatic urethane gloss gloss		
4.18.3.3	Total Volume of solids (minimum)			
4.18.3.3.1	- red	%	55	
4.18.3.3.2	- white	%	55	
4.18.3.4	Dry film thickness (minimum)			
4.18.3.4.1	- red (two coats)	µm	50 – 75	
4.18.3.4.2	- white (two coats)	µm	50 - 75	
4.18.3.5	Color			
4.18.3.5.1	- red	code	RAL 2002	
4.18.3.5.2	- white	code	RAL 9010	
4.18.3.6	Flash point (tag open cup)	° C		
4.18.3.7	Drying time of coating :			
4.18.3.7.1	- at 20°C	h		
4.18.3.7.2	- at 50°C	h		
4.18.3.8	Type of thinner	type		
4.18.3.9	Type of cleaner	type		

Technical Data Sheets

Lekhnath - Damauli 220 kV D/C Line

Tanahu - Bharatpur 220 kV D/C Interconnection to Damauli S/S (LI-LO)

Old Damauli - Bharatpur 132 kV S/C Interconnection to Damauli S/S (LI-LO)

BIDDER'S / CONTRACTOR'S GUARANTEED DATA		Unit	Data required	Data offered
No	**Description**			
4.18.4	Aircraft Warning Spheres			
4.18.4.1	- Fitted to OPGW/EW	-	Yes	
4.18.4.2	- Diameter	mm	600	
4.18.4.3	- Material	-		
4.18.4.4	- Color (non fadeable)	-	International orange	
4.18.4.5	- Drainage	yes/no	yes	
4.18.4.6	- Fitting materials	-	Mild steel galvanized	
4.18.4.7	- Max Separation	m	30	
4.18.5	Aircraft Lighting System			
4.18.5.1	Manufacturer	-		
4.18.5.2	Experience	years	≥ 10	
4.18.5.3	Rated voltage	V		
4.18.5.4	Temperature range	°C	0 to 80	
4.18.5.5	Humidity	%	100	
4.18.5.6	Obstruction lights type:	type	LED clustered	
4.18.5.7	ICAO Annex 14, low intensity	Cd		
4.18.5.8	Rated Power	W		
4.18.5.9	Photovoltaic modules:			
4.18.5.9.1	Type	-		
4.18.5.9.2	No. of modules per system	no.		
4.18.5.9.3	Rated voltage	V		
4.18.5.9.4	Bird protection	yes/no	yes	
4.18.5.9.5	No. of modules per system	no.		
4.18.5.10	Batteries:			
4.18.5.10.1	Type	type	sealed maintenance free	
4.18.5.10.2	Capacity	Ah		
4.18.5.10.3	No. of batteries per system	no.		
4.18.5.11	5 years guaranteed continuous operation	yes/no	yes	
4.18.5.12	Spare parts for 30 years maintenance	yes/no	yes	