NEPAL ELECTRICITY AUTHORITY
Medium Voltage Grid Development Department, Transmission Directorate

BIDDING DOCUMENT

For

Package-1: Design Build Plant and Works for Construction of Birauta 132/11kV Substation and Associated Transmission and Distribution Lines in Pokhara

(Bid Identification No.: ICB/NEA/UTDSIP/82/83-01)

Volume 3 of 4

Employer's Requirements
For Transmission Line Work

Employer: Nepal Electricity Authority

Country: Federal Democratic Republic of Nepal

Loan No.: NE-P13

Project: Urban Transmission and Distribution System Improvement Project

Contract: Package-1: Design Build Plant and Works for Construction of Birauta 132/11kV Substation and Associated Transmission and Distribution Lines in Pokhara

October 2025

नेपाल विद्युत प्राधिकरण
NEPAL ELECTRICITY AUTHORITY
ESTD. 1985

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EMPLOYER'S REQUIREMENTS FOR TRANSMISSION LINE WORK

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SECTION VI.B1: SCOPE OF WORK

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1 GENERAL

(1) Project Background

The Japan International Cooperation Agency (hereinafter referred to as “JICA”) conducted an “information gathering/confirmation survey on urban transmission and distribution network development in Nepal” (hereinafter referred to as "Data Collection Survey") in 2019 and a Preparatory Survey on the Transmission and Distribution System Improvement Project in Urban Areas (hereinafter referred to as "Preparatory Survey") in 2021, respectively. The government of Nepal has received a loan from JICA to finance the “Urban Transmission and Distribution System Improvement Project” (hereinafter referred to as “the Project”) to improve and upgrade the transmission and distribution system in urban areas in Nepal.

The objective of the Project is to improve the transmission and distribution system in urban areas by developing new and/or upgrading the existing transmission and/or distribution system, including grid substations and related equipment, thereby contributing to economic growth in Nepal. The targeted cities for improving the transmission and distribution system under this project are Pokhara and Kathmandu, as detailed below.

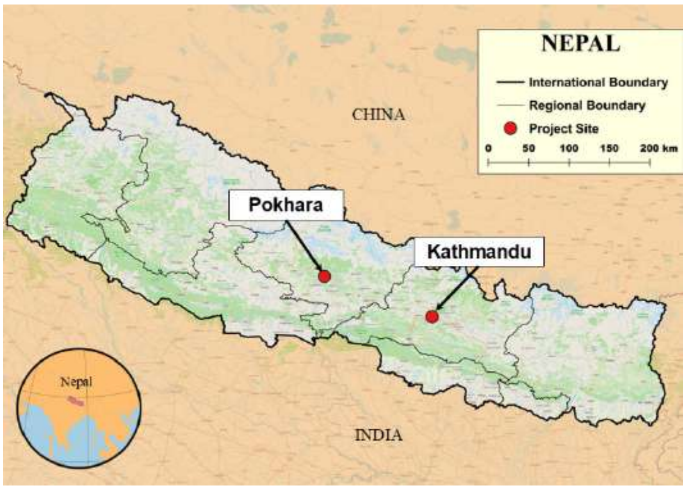

Fig B1-1 Project Site Location

(2) Background of Pokhara Project for Package No.1

The project site for Package No.1 under the Project is located in Pokhara. Pokhara is a major tourist zone and the second most populated city next to Kathmandu. The power demand is rapidly increasing due to the development of tourism, and the new Pokhara international airport has commenced operation as a gateway to worldwide tourism. The power consumed in Pokhara city is currently supplied by the 132/11kV Pokhara substation (transformer capacity: 2 units x 30MVA = 60MVA in total) alone, which will not be able to meet the rapidly increasing power demand in the near future, making this Subproject the first priority.

Under these circumstances, a new 132/11kV substation (60MVA = 30MVA x 2 units transformer capacity) will be constructed at Birauta to increase the power supply capacity to Pokhara city and to extend new 11kV distribution feeders from the new Birauta substation. This new substation will be connected to the existing 132kV single circuit overhead transmission line from Lekhnath substation to Syangja substation through 132kV underground cables by LILO connection. Therefore, a new LILO branch tower will be erected under the existing 132kV overhead line to connect with the new Birauta substation.

The following drawing shows the diagram for connection of the new 132/11kV substation at Birauta.

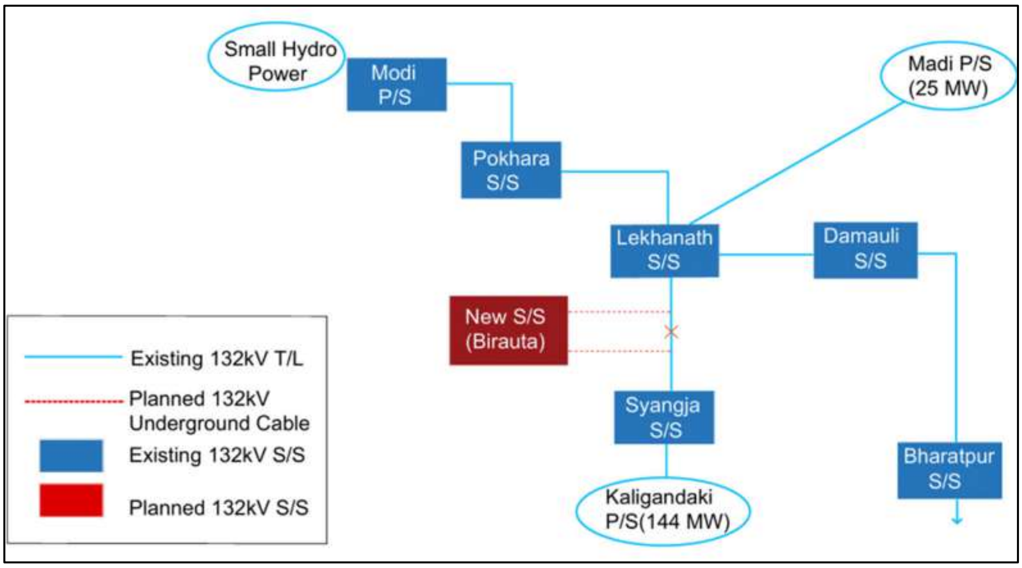

Fig B1-2 Diagram for Connection of New Birauta Substation

The location of construction site is shown in the map below.

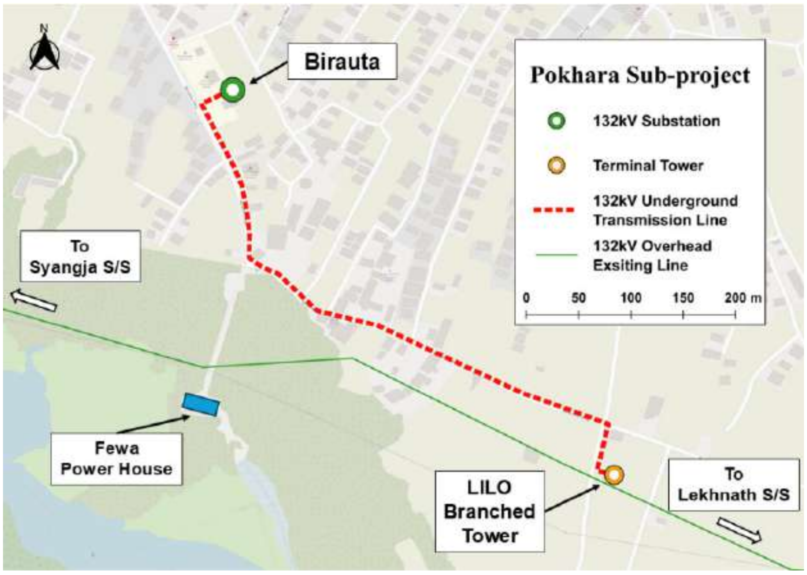

Fig B1-3 Site Location Map of Pokhara Project

The scope of the Project shall include the following three (3) sections, i.e.
(1) Substation Work,
(2) Transmission Line Work, and
(3) Distribution Line Work.

Volume-3 of the Bidding Documents mainly stipulates the Employer's requirements for Transmission Line Work.

The Scope of Work is described in the following clauses and in the respective Chapters of the Specification of Section VI-B2. All works not expressly called for in the Specification, but necessary for the completion of the Works shall be performed and furnished by the Contractor at no additional cost to the Employer on lump sum basis.

The Contractor shall prepare a sufficiently flexible and realistic work schedule that takes into full account the seasonal characteristics and monsoon conditions specific to Nepal. The Contractor is required to strictly adhere to the Time for Completion as stipulated in the Contract. Any delay in Taking Over due to the impact of the monsoon season on construction activities shall not be accepted as a valid reason for extension of time.

2 SCOPE OF WORK

The existing 132kV overhead transmission line between Lekhnath substation and Syangja substation will be cut and connected to new Birauta substation by two underground cables through loop-in and loop-out (LILO) connection.

The scope of work for Transmission Line Work under the Project includes:

(a) 132 kV underground transmission line from new Birauta substation to LILO connection point at the new special branch tower,

(b) One (1) special branch tower for connection of new 132kV underground transmission line for Birauta substation by LILO connection,

(c) Fibre optic cables and OPGW for connection of telecommunication system to Birauta substation,

(d) Distributed Temperature Sensors (DTS) and necessary devices for monitoring 132kV cables

(e) Provision of spare parts and special tools, and

(f) Training

Necessary site surveys, including GPR (ground-penetrating radar) survey, topographic and geotechnical survey, design, manufacture, testing, supply, insurance, delivery to site, erection/installation in appropriate manners, training, setting to work, underground XLPE power cable, optical fiber cable, cable joint, cable sealing end, lightning arrester, associated accessories, and the replacement and/or adjustment of defective material and workmanship for the duration of the 12-month defect liability period of the transmission line, are also included.

Besides, the Contractor shall follow the Employer's requirements stated in detail in the Section VI-B2 Technical Specification, and shall fully comply with the JICA Standard Safety Specification (JSSS) and Particular Safety Specification, as stipulated in the relevant Chapter in the Technical Specification.

2.1 132 kV Underground Transmission Line from New Birauta Substation to LILO Connection Point at Special Branch Tower

Turnkey construction of an approximate 0.7km route length of a 132kV double circuit underground triplex type XLPE power cable line by laying one (1) no. of three-single-core triplex type XLPE cables per circuit (totaling 2 nos. of three-single-core Triplex cables) from the connection point at a special branch tower to Birauta substation shall be constructed as shown in Fig B1-3.

This special branch tower will be located between the suspension tower #159 and the tension tower #160 of the existing 132kV single circuit overhead transmission line of Lekhnath substation to Syangja substation, referring to the bid drawing No. BIR-UG-E-0002. The Contractor shall install the 132kV cable outdoor sealing ends for connection of the new underground lines to the existing overhead conductors and shall terminate the cables by indoor cable sealing ends and connect the sealing ends to the 132kV GIS in Birauta substation. The Scope of Work includes the supply and erection of outdoor sealing ends, lightning arrestors, conductors, insulator assemblies, and all other necessary materials and equipment.

The Contractor shall design, supply, and install the necessary cable joints for the underground transmission line to be installed in a manhole(s).

2.2 One (1) Special Branch Tower for Connection of New 132kV Underground Transmission Line for Birauta Substation by LILO Connection

Turnkey construction of a 132kV special branch tower, i.e. a lattice-type steel tower of single circuit with additional crossarms facing the line direction on the tower, shall be constructed under the existing 132kV overhead transmission line between the existing suspension tower #159 and the existing tension tower #160. The new special branch tower and other outdoor equipment shall be installed within the acquired land by the NEA. The plot plan of the special branch tower is shown in Drawing No.BIR-OH-E-0002 for reference only, which the Contractor shall design and propose to the Employer at their own responsibility. The earthwork, land formation of the Employer's premise for erection of the branch tower and outdoor equipment, such as cable sealing ends and lightening arresters, the construction of the boundary wall surrounding the premise and other necessary works are included in the Scope of Work.

The existing 132kV overhead line conductors between tower No. 159 and No. 160 shall be cut at the position of the branch tower and re-connected to the special branch tower crossarms for LILO connection to the 132kV underground cables to the Birauta substation. This re-stringing work of the overhead conductors is included in the Scope of Work.

To avoid a long period of power shutdown, earthwork, foundation work and installation of equipment on the ground shall be carried out under the line conditions wherever feasible without the shutdown. Appropriate live line safely precautions must be implemented with prior approval from the Engineer.

2.3 Fibre Optic Cables and OPGW for Connection of Telecommunication System to Birauta Substation

The telecommunication equipment at Birauta substation shall be properly connected to the existing optic telecommunication system.

The Scope of Work shall include two fiber optic underground cables (48 cores for each cable line) to be installed along with the 132 kV underground transmission line from Birauta substation to the special branch tower.

The existing Optical Fiber Ground Wire (OPGW) of both sides of the branch tower on the existing overhead transmission line shall be properly connected to the new two (2) optic underground cables (48 cores for each cable) through new splicing boxes on the towers in the following manner:

(1) The existing OPGW from tower No. 160 shall be cut at the branch tower and terminated in the splicing box on the branch tower.

(2) A new OPGW shall be supplied and installed between tower No. 158 and the branch tower, with one end terminated in the existing splicing box at tower No. 158 and the other end terminated in the splicing box at the branch tower.

The supply and erection of a new OPGW and necessary materials for the above works shall be included in the Scope of Work.

2.4 Distributed Temperature Sensors (DTS) and Necessary Devices for Temperature Monitoring of 132kV Cables

The Contractor shall provide the DTS system with the necessary devices to monitor the temperature of all 132kV power cable lines to be constructed under the Project. The Contractor shall be fully responsible for the design, provision and installation of necessary devices, and testing, including temperature sensors for the power cables.

2.5 Provision of Spare Parts and Special Tools

The Contractor shall supply the spare parts and special tools required in the Specification or listed in the Price Schedule. Those spare parts and special tools shall be delivered to the Employer’s storage in Pokhara.

2.6 Overseas Training

The overseas training required in the Contract is given below.

As for the overseas training, the cost of transportation (international air ticket and inland transportation), accommodation, meals and incidental expenses for overseas training such as VISA cost, daily allowance (USD 70 per day), etc. for each trainee from the Employer shall be borne by the Contractor.

(1) Training Item: 132kV triplex power cable (including DTS system)

(2) Training outline :

   (a) Duration of training: ten (10) days including travel days

   (b) Number of trainees from the Employer: Two (2) engineers and/or cable workers

   (c) Training Program: To be proposed by the Contractor subject to approval by the Engineer

   (d) Place of training: At the manufacturer's factory

2.7 Site Training

The training at site required in the Contract are given below, while the other field/local training shall be carried out as per the relevant clauses in the Specification. The necessary materials for the trainings shall be provided by the Contractor.

(1) Items to be trained: Underground transmission line systems (for equal and more than 132kV line voltage), including cable joint & termination, and Distributed Temperature Sensing (DTS)

(2) Training details:

   (a) Duration: Three (3) days

(b) Participants: Five (5) engineers/technicians nominated by the Employer

(c) Training Program:

- General procedures for the design, installation, site testing, operation, and maintenance of underground transmission lines.
- Practical hands-on training for 132kV cable termination and jointing. (Therefore, the Contractor shall provide one set of 132kV sealing end for termination and cable joint, and necessary length of 132kV cables for the site training.)
- The detailed training program shall be proposed by the Contractor and is subject to approval by the Engineer.

(d) Training location: At the project site and/or at a location designated by NEA in Pokhara.

2.8 Factory Acceptance Test (FAT) witnessed by the Employer and the Engineer

The Contractor shall arrange for the Employer and the Engineer's representatives to witness tests on the following items at the manufacturer's shops:

- 132kV Triplex Cable and DTS system (10days)
- 132kV Cable Sealing Ends and Cable Joints (10days)
- 132kV Special Branched Tower (7 days)

For FAT for each item, two (2) inspectors nominated by the Employer and one (1) inspector from the Engineer will attend the factory inspection. The cost of transportation (international air ticket and inland transportation), accommodation, meals, and incidental expenses for the Employer's representative such as VISA cost, daily allowance (USD 100 per day), etc. for the period mentioned in the above (including the travel days) shall be included in the Contract Price.

3 EXTENT OF SUPPLY

3.1 Scope

The extent of supply comprises the design, manufacture, testing, supply, insurance, shipping, loading and unloading, delivery to site of XLPE power cables, cable joints, cable sealing ends, special branch tower, optical fibre cables, optical fiber cable termination kits and accessories, check the proposed route alignments, and laying the cables as per specified manner, installation of cable joints, cable sealing ends, OPGW/optical fibre cable, branch tower and other accessories. To make security, testing and commissioning of the same and supply of spares, tools, equipment (if any) as set out in this Bidding Document and at prices stated in the schedule or at such other prices or unit prices as may from time to time be agreed.

3.2 Final Quantities on Re-measurement Basis

The actual length of 132kV triplex power cables shall be finalized based on the site survey and design of the Contractor, subject to the approval of the Engineer, as per Clause 12 of the Preamble for Price Schedule, i.e., the payment amount shall be adjusted for the designated item only.

Meanwhile, the prospective route length of the 132kV underground line under the Project is not a long distance, which is approximately 0.7km in total, and the required tower for the 132kV overhead line is only one. Hence, the Bid price shall include all the costs for necessary materials as well as their installation costs for the Scope of Work, as a lump sum contract.

3.3 Modifications

The transmission line(s) shall be completely in accordance with the Specification and associated design and general arrangement/outline drawings. Any modifications thereto are subject to written confirmation by the Engineer.

4 TERMINAL POINTS

The terminal points for the scope of transmission line are mentioned below. Some of terminal points are mentioned to define the scope of Substation, Transmission Line and Distribution Line works under this Contract for better understanding the individual scope to be applied for the payment conditions to the Contractor.

4.1 132kV Underground transmission Line in Birauta Substation

Termination work (male side), testing 132kV power cables, connection to 132kV GIS switchgear equipment at Birauta substation shall be conducted by this section in cooperation with another section (Substation section) of this Project.

Fiber optic underground cable shall be terminated at the termination box inside the control room building at Birauta substation. The termination boxes shall be supplied and installed under this section of the Project.

The works of excavation/filling inside the substation for the direct buried 132kV outgoing and the fibre optic cables are scope of this section of the Project. However, if a concrete trench is used within substation premise, the design and construction of cable trench shall be handled under Substation section, meanwhile the cable installation works and civil works shall be coordinated by the Contractor.

4.2 132kV Underground Cables and Optic Fibre Cables from Birauta Substation at Connection Points to Existing Overhead Line and OPGW

The terminal point for the 2 circuits of new 132kV underground cable line from Birauta substation shall be the connection points of the existing overhead line conductors at the special branch tower crossarms. Tension insulator assemblies required for connection of conductors to the crossarms including connectors of line conductors and jumper conductors shall be included in the Scope of Work. All other necessary materials to complete the loop-in loop-out connection of the transmission lines shall be also included in the Scope of Work.

The terminal point of two (2) underground optic fiber cables from Birauta substation shall be the splicing boxes to be installed on the special branch tower, in which the fibre cores of the existing OPGW from both Lekhnath substation and Syangja substation are to be terminated. Terminal point of OPGW from tower No. 160 will be a splicing box installed on the branch tower. The existing OPGW from tower NO. 160 shall be cut at the branch tower and terminated in the splicing box installed on the special branch tower. Terminal point of the other side of OPGW will be the existing splicing box on the tower No. 158. A new OPGW shall be installed from tower No. 158 to the special branch tower and terminated in the splicing boxes on the both ends.

4.3 Distributed Temperature Sensors (DTS) and Necessary Devices for Temperature

Monitoring of 132kV Cables for Transmission Line

The monitoring system of cable temperature for 132kV transmission lines shall be furnished, and the DTS controller shall be set up at Birauta substation. The exact location of the DTS controller in the substation shall be discussed with the Employer and the Engineer during the design stage.

4.4 Repairing Work on Damaged Existing Utility

The Contractor shall be solely responsible for any damage to public or private utilities/facilities caused during the execution of the works. The Contractor shall repair or restore the damaged utility to its original or better condition at its own cost, without delay, and in compliance with all applicable regulations and technical standards.

If a utility is found to be damaged during the site works and it is unclear whether the damage was caused during the Project or was pre-existing, the Contractor shall still repair the utility at its own cost and notify the Employer and relevant utility authority immediately.

The Contractor shall take all necessary precautions, including the use of **appropriate utility detection technologies (e.g., GPR, cable locators)** and coordination with utility service providers, to avoid such damages.

PART – 2B:

EMPLOYER'S REQUIREMENTS FOR

TRANSMISSION LINE WORK

SECTION VI.B2: TECHNICAL SPECIFICATION

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NEPAL ELECTRICITY AUTHORITY

SECTION VI.B2: TECHNICAL SPECIFICATION

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CHAPTER 1:

GENERAL REQUIREMENTS

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CHAPTER 1: GENERAL REQUIREMENTS

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CLAUSE NO. TITLE PAGE

1.1 GENERAL

1.1.1 Extent of Contract

This Contract is based on a turnkey basis and includes all activities related to site survey, design, manufacturing, inspection and testing, insurance, export packing, shipment, customs clearance, delivery to site, unloading, complete erection, finishing, painting, site testing, training, and commissioning of the Plant as described herein.

The Contractor shall be responsible for rectifying any defects in materials, design, or workmanship for a period of twelve (12) months following the date of taking over, referred to as the Defect Notification Period.

The Contractor shall cooperate with other contractors and NEA operating staff as necessary.

The Contractor is responsible for the design, supply, and erection of all plant and equipment to ensure full functionality, without requiring any additional work to be initiated by the Engineer, unless specifically excluded in these Bidding Documents or agreed upon in writing. This includes, but is not limited to: protection and other studies, manufacturing, type testing, factory and site testing, insurance, packing, transportation, delivery to site, erection, and commissioning.

All works must be fully integrated and coordinated in every respect. Furthermore, they must properly interface with the works of other contractors wherever such interfacing is specified or referenced herein.

If the Contractor finds any part of these Specifications to be incomplete, contradictory, or defective, the Contractor shall immediately notify the Employer and submit a proposal for rectification, subject to the Employer’s approval, during the bidding stage. No additional cost shall be incurred by the Employer as a result of such rectification.

If the Contractor wishes to obtain a third-party opinion regarding the content of these Specifications during the design or construction stage, prior approval must be obtained from the Employer before seeking such consultation.

The main design data specified in these Specifications, along with the general transmission line routes, are provided in the Bid Drawings.

1.1.2 General Design of Equipment

In meeting the requirements of the Specification, the design shall conform to the best current engineering practices. Each component of the Equipment shall follow the manufacturer’s standard design, provided that such design is generally in accordance with the Specification.

All equipment and materials shall be in accordance with the International Electromechanical Commission (IEC) standards, International Standardization Organization (ISO) standards or standards especially indicated in the respective Chapters.

The applicable standards for this Contract shall be the latest editions (including amendments) valid as of the Bid closing date.

It is not the intent of this Specification to define all details of the design and manufacturing of cables and accessories. The norms and standards specified herein represent the minimum requirements. The cables and their accessories shall adhere to the highest standards of engineering design and workmanship and shall be capable of continuous commercial operation within the parameters guaranteed by the Supplier, in a manner acceptable to the Engineer.

Wherever the requirements stated in these Specifications exceed those of the referenced standards, the Specifications shall be considered as additional requirements beyond the standard.

The design shall emphasize simplicity and reliability to ensure long-term continuous service with high efficiency and low maintenance costs.

Special attention shall be given to both internal and external accessibility to facilitate inspection, cleaning, and maintenance.

The design, dimensions, and materials of all components shall be such that they can withstand stresses under the most severe service conditions without damage..

Detailed specifications of all component parts of the Plant shall be submitted, clearly describing the materials to be used.

Any works shown in the drawings but not mentioned in the Specifications, and any works described in the Specifications but not shown in the drawings, shall nonetheless be deemed to be included in this Contract. Their execution shall be covered by the Contract Price as if they had been expressly shown in the drawings and described in the Specifications.

The materials used in the construction of the plant shall be of the highest quality and selected particularly to meet the duties required to them. Mechanisms shall be constructed to avoid sticking due to rust or corrosion.

Workmanship and general finish shall be of the highest standard throughout. All similar parts of the Plant shall be fully interchangeable. All apparatus shall operate without undue vibration and with minimal noise. All equipment shall be designed to minimize the risk of fire, and any damage resulting from fire shall be kept to an absolute minimum.

All apparatus shall be designed to prevent the risk of accidental short circuit, malfunction, or damage due to vermin. All items of equipment, which may have to be lifted for erection or maintenance, shall be provided with lifting eyes, jacking pads or alternative handling facilities.

The Contractor shall also comply with the project procedures outlined in the General Conditions and Particular Conditions, or as otherwise agreed during the kick-off meeting between the Contractor, the Employer, and the Engineer. These procedures include project organization, correspondence and document handling (including a numbering system), meeting protocols, document approval processes, and guidelines for quality assurance, scheduling, progress monitoring, and related matters.

The Contractor shall assign all personnel nominated in the Technical Bid (EQC Clause 1.1.1). All such positions and personnel shall be listed in the project organization. If the Contractor needs to replace any nominated personnel, the replacement shall possess equivalent or greater experience, subject to the Engineer’s approval.

1.1.3 Quality Assurance

The quality of the design, manufacturing and erection processes shall be assured by the Contractor in accordance with the ISO9000 series standards. The Contractor shall provide his possession of the respective certificates.

The Bidder shall prove that the quality of the design, manufacturing and erection would be done in accordance with the ISO9001. The Bidder shall submit respective certificates issued by an International Organization at least for the equivalent list below.

(a) XLPE power cables

(b) XLPE power cable accessories

(c) Optical fiber cables & accessories

(d) Steel tower

(e) OPGW

(f) Insulators

1.1.4 Quality Assurance Plan

A manual shall be given by the Contractor indicating the sequence of procedures followed in all activities in the project including manufacturing, purchasing, testing, and commissioning to ensure the quality assurance as per Sub-clause 1.1.3. The Contractor shall ensure that the activities involve in the project are according to the quality assurance standards specified in the Bidding document. This document shall be used for supervisory and monitoring purpose during the Contract by the Contractor and the Engineer.

1.1.5 Units of measurement

In all correspondence, in all technical schedules and on all drawings metric systems International Units (SI) units shall be used. On drawings where imperial or other units have been used it will be in order if the equipment SI units are suitably marked in addition.

1.1.6 Compliance with Specification

Notwithstanding any descriptions, drawings or illustrations which may have been submitted with the Bidder, all details other than those shown on the schedule of departures will be deemed to be in accordance with the Specification and the standard specifications and codes referred to therein.

No departures from the Specification except those shown on the schedule of departures and approved by the Employer are to be made without the written approval of the Engineer.

All exceptions shall be clarified and separately itemized. It shall not be necessary for the Employer to examine the standard literature and documents of the manufacturer to determine the existence and extend of any exceptions or deviations from specification.

1.1.7 Contractor's Documents

(1) General

Before the work is put in hand, five (5) hard-copies of general drawings and diagrams showing all details of the Plant and Materials shall be submitted to the Employer and the Engineer for approval. In addition, soft copy in pdf format shall be uploaded to a cloud server to share with the Employer and the Engineer for the purpose of smooth operation. The cost of cloud server operation is deemed to be included in the Contract Price, and the Contractor's documents for all approval status and the Engineer's comments on the Contractor's documents shall well be maintained in the cloud server by the Contractor throughout the Contract period.

Five (5) sets of detailed drawings shall be submitted as soon as possible after the Commencement

Date and in any case in sufficient time to permit modifications to be made, if such are deemed necessary by the Engineer, without delaying the delivery of the contract work. The drawings submitted shall be modified as requested by the Engineer and re-submitted for approval.

Prior to the commencement of construction/erection work, the Contractor shall distribute copies of the approved drawings and documents (for work drawings) as directed by the Engineer, to the Employer in two (2) sets and to the Engineer in two (2) sets. In addition, soft copy in pdf format shall be uploaded to the cloud server to share the Employer and the Engineer for the purpose of smooth operation.

Any documentation submitted by the Contractor for approval shall only be in sizes A2, A3 or A4 (210 x 297mm), preferably A3 and A4. A2 shall only be used if absolutely required. All drawings shall be prepared using “Computer Aided Drafting”. All documents shall bear a drawing or document title in a form and with a numbering system, which will be explained to the Contractor by issuing him a project manual, which will be handed over after signing of the Contract.

The following documentation shall definitely be included in the documents to be submitted by the Contractor for approval by the Engineer before construction or erection of the respective part of the works may start.

(a) Detailed cable route drawings

(b) Detailed cross sectional drawings for all type of trenches

(c) Detailed drawings for joint bay arrangements

(d) Detailed drawings for link box pits and earthing arrangements

(e) Detailed drawings for HDD/Pipe jacking methods (if necessary)

(f) Detailed drawing for cable bridge for crossing the river (if necessary

(g) Schematic diagrams for each cable routes Codes

(h) All design calculation drawings

(i) Detailed drawings for Cables, cable joints, cable terminations and optical fiber cables and associated accessories, etc.

(j) Detailed construction schedule in form of bar chart

(k) Codes and standards to be adopted in the design

(l) Description of design method and theories to be adopted

(m) Test items and test procedures for factory tests and Tests on Completion

(n) Layout and sectional drawing of Special Branch Tower and the associated outdoor equipment at the tower site

(o) Outline drawing of special branch tower

(p) Detailed drawing of insulator assemblies

(q) Detailed drawing of OPGW assemblies

The Contractor shall submit a complete list of Contractor’s Documents, within one month after the Contract commencement date, listing the drawing number and title, together with the expecting first issue date that the drawing is planned to be submitted for approval, and the date it is required on site. In the same list the actual dates of submission of each revision as well as date and status of approval. The Contractor shall update the list at monthly interval, and submit the latest drawing lists to the Employer/the Engineer with the monthly progress report.

The Contractor shall also submit the list of test items and test procedures for factory tests and Tests on Completion as required in the GC Clause 9.1 for approval.

The Engineer's review of the Contractor's documents shall generally not exceed 24 working days of the Employer, calculated from the date on which the Engineer receives Contractor's documents / drawings and Contractor's notice in writing. If the Contractor requires urgent approval on parts of documents / drawings to avoid delay in the delivery of the Contract Works, he shall advise the Engineer of such effect when submitting the drawing.

The Employer's approval does however not in any way relieve the Contractor of his full responsibility for the correctness of his documentation and the proper functioning, quality and compliance with the Specifications of all plant and equipment supplied by him. The Employer's approval shall not relieve the Contractor from full responsibility from mistakes or omissions therein or therefrom (including any resultant mistake or error in the Works) or for any discrepancy or deviation from the technical specifications and other drawings.

After all items of plant have been manufactured and erected, data file on Auto CAD format or reproducible digitized drawing file, of each drawing previously approved shall be provided together with five (5) prints on heavy gauge white paper from such drawings as may be required to show the detailed and arrangement of the plant as made and installed.

All Contractor's Documents submitted by the Contractor or by any Sub-Contractor shall have the following particulars in the lower right hand corner in addition to the Contractor's name, date, scale, number and title of the drawings.

Project Name	URBAN TRANSMISSION AND DISTRIBUTION SYSTEM IMPROVEMENT PROJECT
Employer	NEPAL ELECTRICITY AUTHORITY
Description of Apparatus	
Contract No.:	
Engineer's Serial No.	

The Engineer's serial No. shall be inserted by the Contractor before submission of the Contractor's Documents. The serial number and index system, detailed below will be agreed at the first contract meeting (Kick-off Meeting) between the Contractor and the Employer/Engineer.

The Contractor shall when submitting drawings provide an indexing system for all the drawings divided into sections for each transmission line and sub-divided for each type of equipment.

The index shall contain the following information for each drawing.

(r) Drawing number

(s) Revision

(t) Engineer's serial number

(u) Title

(v) Date submitted for approval

(w) Date return for correction

(x) Date approved for construction

(y) Date final drawings submitted

(z) Number of copies

(aa) Remarks/distribution column for use by the Engineer.

The Contractor shall keep on site accurate and up to date drawings and records and shall provide the Engineer with one set of copy each. At the end of every week the Contractor shall submit to the Engineer schedules of labor, plant and materials employed on the site during that week.

During site test and commissioning, if there is any correction on the drawing, the Contractor shall inform the Employer/Engineer and take approval from the Engineer.

All documentation approved by the Engineer and any documents used during erection or commissioning shall be updated at the end of the commissioning period to show the as built status

This updating and modifications shall be clearly indicated in red color for easy reference. Three (3) sets of complete drawings at least shall be prepared under the responsibility of the Contractor's chief commissioning engineer. Two sets shall remain with the Employer/Engineer while the other set is sent to the Contractor's office where all modifications will be included in new neat As Built documents which shall be distributed to the Employer and to the Engineer.

From the beginning of site work the Contractor shall keep on providing photographs of the works, from positions which can be selected by Employer/Engineer, at monthly intervals.

The soft copy of all photographs shall be uploaded in the cloud server, numbered and handed over to Employer/Engineer on completion of the Contract with As Build documents.

The Contractor shall provide a number of selected photographs for submission with the Monthly Progress Report as required by Employer/Engineer. The Contractor shall provide additional photographs of the Contract Works to record or illustrate specific events at the request of Employer/Engineer.

Type of Documents to be submitted

The Contractor shall submit the number of hard copies of the Documents as specified in each respective Chapter. In addition, the Contractor shall establish a cloud server at his own expense, where soft copies of all Documents and submittals shall be uploaded for sharing the documents and drawings with the Employer and the Engineer.

Microsoft SharePoint is recommended as the cloud server platform, unless otherwise approved by the Engineer. Access authorization and control shall be managed by the Contractor, and the number of authorized personnel shall be minimized to ensure information security.

1.1.8 As-Built Documentation

(1) General

AS BUILT documents shall be submitted to the Employer in five (5) sets and to the Engineer in one (1) set in accordance with GC Clause 5.6. In addition, the soft copy of AS BUILT documents in PDF format and Auto-CAD/excel/word (editable soft-copy) shall be uploaded to the cloud server.

The supply of AS BUILT documents shall comprise but not be limited to all drawings for construction and installation, calculations, instructions for operation, maintenance, repair and adjustment, apparatus lists, spare parts lists containing information needed for ordering for all equipment supplied under the Contract.

(2) Plant Design Documents

The following documents shall be delivered.

(a) All layout, diagrams, construction and installation drawings.

(b) All calculations regarding civil, building, electrical and mechanical design for all Plants.

(3) Apparatus Documentation

Documents for approval shall be delivered before the work is started but shall also be included in the AS BUILT documents as follows.

(a) Type test reports and certificates for important equipment. Data Specifications on other equipment.

(b) Routine test reports and certificates.

(c) Data lists with by the Employer/Engineer required amendments incorporated. The contents of the lists shall correspond to the schedules of this document. Data lists will be regarded as binding for the manufacturer.

(d) Dimension drawings. They shall be regarded as binding for the manufacturer and shall contain measures, weights and features of the apparatus.

(e) Detail drawings as required by the Employer.

1.1.9 Access to site

The Contractor shall make his own arrangements for handling and transport and off loading at site so as no facilities being available for him.

The Contractor is to make his own enquiry as to the suitability, availability and charges for railway cranes, suitability of available wagons for the transport of any loads and any restrictions imposed by clearance gauges.

The highways, road and bridges have widely varying load limits, and the Contractor shall be responsible for determining the load limits existing at the time and ensuring that his plant does not exceed such limits.

The Contractor shall be deemed to have included in his costs any temporary measures necessary to allow the transport of the plant over existing roads and bridges.

Before moving any heavy traffic on to highway, road and bridges, the Contractor shall make suitable arrangements with the appropriate government authorities and obtain their approval for the passage of such traffic.

In the event that any permanent reinforcement of road and bridges may be considered necessary for transport of the plant, the Bidder shall obtain an estimate of the costs from the Government department concerned and include this as a provisional sum in the Schedule of Prices.

The Contractor shall not use tracked vehicles or plant on any bituminous sealed road surface. Rubber tyred vehicles conforming to applicable load restrictions will be permitted to use bituminous sealed roads.

It shall be the Contractor's responsibility to ascertain the availability in Nepal of suitable transport vehicle for the plant and arrange for the provision of such vehicles as may be necessary.

Within the site areas, the Employer will maintain existing roads and the Contractor will be given use of the roads essential to his operations free of charge for normal traffic. Any damage caused by the Contractor's abnormal traffic shall be repaired at his own expense.

The Contractor shall take into account the fact whether the restricted areas for security are located or not, where access is strictly controlled. The Contractor shall follow all security procedures adapted at these installations.

1.1.10 Packing

Each item of plant shall be packed properly and protected for shipment and transport from the place of manufacturer to site and in addition for storage for a minimum of three months under the site climate conditions. The recommendations of the BS1133 Packaging code or equivalent international standard shall be observed with particular reference.

Tube ends and other similar open ends shall be protected from both, external damage and ingress of dirt and moisture during transit and while awaiting erection at site. Flanged pipes shall have their open ends protected by adhesive tape or jointing and then be covered with a wooden blank flange secured by service bolts.

Precautions shall be taken to protect shaft and journals where they rest on wooden or other supports likely to contain moisture. At such points, wrappings impregnated with anti-rust composition or vapor phase inhibitors shall be used of sufficient strength to resist chafing and indentation due to movement, which is likely to occur in transit. Protective wrappings and impregnation shall be suitable for a period of three months.

Where practicable, all indoor item such as electric motors, switch and control gear, instruments and panels, machine components, etc., shall be cocooned or covered polyethylene sheeting, sealed at the joints and the enclosure provided internally with desiccators.

All delicate equipment e.g., relays and instrument shall be removed form panels and packed separately for transport in the same consignment as the associated panels. The packing shall contain all equipment destined for the same location.

Each crate or package shall contain a packing list in a waterproof envelope. All items of material are to 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 to them to the appropriate shipping documents. Stencil marks on the outside of casings shall be indelible.

The Engineer may be required to inspect and approve the packing before the items are dispatched but the Contractor shall be entirely responsible for ensuring that the packing is suitable for transit and such inspection will not exonerate the Contractor from a loss or damage due to faulty packing.

1.1.11 Installation, Operating and Maintenance Instructions

When the general arrangements and details of the Plant have been finalized and not later than the erection commences, the Contractor shall submit five (5) sets of fully detailed installation instructions for approval of Employer/Engineer.

The details shall cover the main plant and all associated ancillary equipment as supplied under the

Contract. It will not be sufficient to incorporate manufacturer's standard brochures as part of the text unless they refer particularly to the equipment supplied and are free of extraneous matter.

The information provided shall include general arrangement and detailed drawings of the installation make mention of special materials, erection apparatus and tools where used and include schedules of lubricants employed on the plant. The drawings and diagrams, which may be approved existing drawings reduced to a convenient size, shall be bound into the volume and not inserted into cover pockets. List of contract record drawings shall be included.

If the complete text is unduly bulky, then the manual is to be appropriately sub-divided and produced in multi-volume form. When approved, five (5) copies of the complete text, diagrams and drawings as made up in draft form are to be handed to the Engineer for distribution at site and these are to be provided not later than the erection commences.

Handing over of the originals of Operating and Maintenance Instructions shall be as per Clause 5.7 of General Condition

Further five (5) copies shall be reproduced as a book or books of approximately A4 size and bound into durable covers inscribed in permanent form upon the front generally in the form of the title page to this document except that the references to Specification, General Conditions and Particular Conditions, Drawings, etc., will be replaced by the Operating and Maintenance Instructions. In addition, the soft copy in PDF format shall be uploaded to the cloud server.

The name of main contractor and that of any sub-contractor shall also be inscribed upon the cover after the description of the Plant.

The name of the Employer and other identification followed by a classification of the plant shall be inscribed upon the spine of the cover and, if the instructions are contained in several books, these are to be marked with the appropriate volume number.

1.1.12 Cleaning and Painting

All iron and steel structures shall be protected against corrosion in accordance with Chapter 8.

Where painting is carried out at the manufacturer's works and where erection at Site is the responsibility of the Contractor, any damage during delivery or erection at Site shall be made good to the requirements of the Engineer including, where deemed necessary, application of a complete finishing coat of an approved color and quality paint. Such works need to be done also in line with the paint manufacturer's instructions.

1.1.13 Topicalization

In choosing materials and their finishes, due regard shall be given to the design considering humid tropical conditions, and the recommendations of British Standard Code of Practice 1014 or equivalent IEC/ISO should be observed unless otherwise approved. Some relaxation of the provisions mentioned above may be permitted where equipment is hermetically sealed, but it is preferred that tropical grade materials should be used wherever possible:

(1) Metals:

Iron and steel are generally to be painted or galvanized as appropriate.

(2) Screws, Nuts, Springs, etc.:

Steel screws are to be zinc, cadmium or chromium plated, or when plating is not possible owing to tolerance limitations, are to be of corrosion-resisting steel. Springs are to be of non-rusting material, e.g., phosphor bronze or nickel silver, as far as possible.

(3) Rubbers:

Neoprene and similar synthetic compounds, not subject to deterioration due to the climatic conditions, shall be used for gaskets, sealing rings, diaphragms, etc. The rubber material must not produce any corrosive or resting gases.

1.1.14 Tools

Where specified, the Contractor shall supply in steel boxes, complete with keys, any normal tools that are required for adjusting equipment during normal operation or maintenance.

Any special tools required for erection, commissioning, operation and maintenance of the equipment should be indicated in the price schedule with individual quantities, minimum time for delivery, and prices including the cost of delivery to the Employer's store.

These special tools shall be made of alloy steel. All tools shall be stamped with an approved identification.

1.1.15 Inventory Records for Plants and Materials

The Contractor shall forward his inventory records for plant and material at the end of each month to the Employer.

1.1.16 Procedure for Delivery of Documentation

The Contractor shall submit the following documentation/information to Employer/Engineer for review and approval.

(1) Within 21 days after the Commencement Date of the Contract

(a) Detailed project specific Quality Plans and associated procedures.

(2) Within 30 days after the Commencement Date of the contract

(a) Detailed contract programme containing design, approval of design, ordering of materials, manufacture, shop testing, delivery, civil construction, erection, site testing and commissioning.

(b) Detailed list of documentation submittals with documentation classification plan.

(c) Detailed breakdown of the Contract Price into Cost Items.

(d) Detailed proposal of the Monthly Progress Report format.

(e) Contractor's safety and security programme.

(3) Within 60 Days after the Commencement Date of the Contract

(a) A programme of performance, material and workshop test to be carried out.

(b) Particulars about presentation and form to be used for the test programme shall be agreed and approved by Employer/Engineer.

(4) Within 90 Days after the Commencement Date of the Contract

(a) One set of all applicable standards / codes / specifications, etc.

(b) Copies of all orders placed with Subcontractors.

(c) Safety programme.

(d) Fire prevention and protection programme.

(e) Outline drawings of the equipment.

(f) Loading of foundations for all items of equipment to be supplied, and details of anchoring and supporting.

(g) Delivery of all drawings related to civil works.

(h) Preliminary drawings and schemes of connections to the part supplied under other contracts.

(i) Preliminary assembly drawings of the equipment with details of material intended to be used (if applicable).

(j) Principal electrical diagrams (if applicable).

(k) Detailed information (type, make, formula) of products employed to carry out the factory paints.

(l) RAL colour code for finish paint of all equipment.

(m) Detailed training programme.

(5) Before commencement of site works

(a) Approved construction Drawings/Document

(6) Before beginning of manufacture

(a) Detailed manufacture drawings/documentation and giving full information about principle of operation, cabling and wiring diagrams.

(7) During manufacture

(a) Monthly progress reports,

(b) Notice of material tests and shop inspections,

(c) Certificate of inspections,

(d) Certificate of tests,

(e) Information concerning delays, claims, etc.

(8) At least 30 days before Shipment

(a) Notice to Employer giving identification, symbol, description, weight and dimensions of material in shipment.

(b) Bill of lading for each consignment just prior shipment.

(c) Instructions for loading, unloading, handling and special precautions to be observed for storage at Site.

(9) At least 90 days before commencement of erection

(a) Erection instructions for approval.

(b) Method statement of installation works for approval

(c) Approved erection instructions.

(d) Complete sets of approved drawings.

(e) Detailed erection programme for each component for approval.

(f) Site testing and inspection programme during and at the end of erection for approval.

(g) Site test procedure for approval

(10) At least 30 days before commencement of erection

(a) Three (3) copies of Certificates of Policy of Insurance related to the site works.

(11) During erection

(a) Monthly Progress Report

(b) Weekly Programme

(12) 90 days prior to Taking Over Certificates of equipment/facilities

(a) Operating and Maintenance Instructions for approval.

(13) 90 days before commencement of commissioning

(b) Detailed programme and site test proposal (commissioning tests) for each section.

(14) Before Taking Over

(a) Spare parts storage instructions

(b) Final commissioning report

(c) Final operating and maintenance instructions

(d) "As-built" drawings, soft copy of as-built documentation .

(15) Within 15 days after any occurrence

(a) Report on any damage/accident (the first brief report on the occurrence on any damage/ accident shall be submitted not later than within 24 hours).

(b) Any error discovered by the Contractor in his own design.

(c) Test certificates or test reports unless otherwise agreed upon.

(d) Any failure of material and equipment.

(e) Any delays against schedules.

The durations, time schedules, approval procedures, and other related matters shall be finalized and confirmed during the kick-off meeting following the award of the Contract..

1.1.17 Approval Procedure

(1) Number of Copies Required

Five (5) copies of each drawing/documentation shall be submitted by the Contractor to Employer/Engineer for the approval/re-approval and construction purposes.

One (1) copy will be returned to the Contractor marked "Approved", "Approved with Comments",” Return for correction” or "Not Approved" with comments made either on the drawing itself or in the accompanying letter, and the drawing/documentation shall be amended and resubmitted for approval, clearly identifying the amendments.

(2) Review and Approval of Documents

The Contractor shall ensure that all documentation for approval are forwarded to the Employer/Engineer in sufficient time. The Contractor shall also ensure that documentation are submitted at least four (4) weeks prior to the date required for approval to permit amendments to be made and the drawings re-submitted for approval without delaying the programmed deliveries or the guaranteed completion dates of the works.

Drawings marked "Approved" and "Approved with Comments" authorize the Contractor to proceed with construction or fabrication of equipment covered by such drawings with corrections, if any, indicated thereon. Approved drawings must be available before any equipment is workshop tested or before any erection/construction work has started at Site.

1.2 MECHANICAL

1.2.1 Nuts, Bolts, Studs and Washer

Nuts and bolts for incorporation in the plant are preferably to conform to ISO metric coarse to ISO68, 261, 262, 272, 724, 885, 888 and 4759 or BS3643, 3692 and 4190. Other sizes or threads are permitted for threaded parts not to be disturbed in normal use or maintenance.

Bolts shall fit in the reamed holes they occupy, they shall have the screwed portion of a diameter such that it will not be damaged in driving and are to be marked in a conspicuous position to ensure correct assembly at Site.

On equipment all bolts, nuts and washers shall be non-rusting material where they are in contact with non-ferrous parts in conductor clamps and fittings and elsewhere where specifically required by the Engineer.

All washers are to be included under this Contract, including devices and anti-vibration arrangements, which are to be subject to the approval of the Engineer. Taper washers are to be fitted where necessary.

Where there is risk of corrosion, bolts and studs shall be finished flush with the surface of the nuts and electro-chemical corrosion shall be avoided by bimetallic plates.

1.2.2 Rivets

Rivets shall conform to the appropriate ISO and general use pan heads are preferred. Rivets on bearing surfaces are to be flat counter-sunk, driven flush. Whenever practicable, riveting is to be done by hydraulic tools and the rivets must completely fill the holes when closed. If loose, or if the heads are badly formed, cracked or eccentric to the shank or do not bear truly on the plate or bar, such rivets are to be cut out and replaced. All surfaces to be riveted must be in close contact throughout.

1.2.3 Forging

All-important forging is to be examined by the latest methods for the detection of defects.

1.2.4 Castings

All castings are to be free from blowholes, flaws and cracks as is practicable. No welding, filling or plugging of defective parts is to be done without the sanction of the Engineer and then only with his approval in writing.

All cast-iron is to be of close-grained quality and is to be corrosion-resistant for those parts in contact with seawater. Cast-iron is not to be used for any part of the equipment which is in tension, or which is subject to impact stresses. This clause is not intended to prohibit the use of suitable grades of cast-iron for parts where service experience has shown it to be satisfactory. When casting material is used for the electrical connection such as joint of power conductor, the surface shall be cleaned up to make fine conductivity before connection.

1.2.5 Welding

Where fabrication weld are liable to be highly stressed, the Contractor is to satisfy the Engineer before such welding commences, that the welders or welding operators are qualified in accordance with the requirements of the appropriate section of BS4872, part 1 or equivalent IEC/ISO standard specification.

The Engineer will inform the Contractor of the stages at which inspection will be required. It will be the Contractor's responsibility to notify the Engineer when one or more of the inspection stages will be reached and no further work is to be carried out until the specified stage has passed the Engineer's inspection.

In addition to the above, the Engineer reserves the right to visit the Contractor's Works at any reasonable time during fabrication of the items of the Plant and to familiarise himself with the progress made and the quality of the work to date.

All tests are to be carried out in accordance with the relevant ISO or other approved standards. Where required by the Engineer, non-destructive examination of the finished weld shall be made. If the examinations be by radiograph means, then the recommendations of BS EN 1435 or equivalent IEC/ISO where applicable are to be followed and the resulting negatives are to be made available to the Engineer.

When copper wires are connected underground, the hermetic welding shall be used for connection, any bolt connection or compression terminal is not permitted.

1.2.6 Chromium Plating

The chromium plating of those components of the Plant where specified and where offered by the Contractor is to comply with the requirements of ISO 1456 & 1458 or BS 1224.

1.2.7 Hot dip Galvanizing

Galvanizing shall be applied by the hot dipped process generally in accordance with ASTM A 123 for structural steel and ASTM A 153 for iron and steel hardware.

For structural steel galvanizing shall average not less than 0.61kg/m2 (no individual specimen shall show less than 0.55kg/m2 except for 7.35mm and heavier materials in which case galvanized shall average not less than 0.702kg/m2 (no individual specimen shall show less than 0.61kg/m2.

For iron and steel hardware, galvanizing shall be in accordance with Table 1 of ASTM A 153.

The zinc coating shall be smooth, clean, of uniform thickness and free from defects. The preparation for galvanizing and the galvanizing itself shall not adversely affect the mechanical properties of the coated material.

For structural steel galvanizing shall average not less than 0.61kg/m2 (no individual specimen shall show less than 0.55kg/m2 except for 7.35mm and heavier materials in which case galvanized shall average not less than 0.702kg/m2 (no individual specimen shall show less than 0.61kg/m2.

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For iron and steel hardware, galvanizing shall be in accordance with Table 1 of ASTM A 153.

The zinc coating shall be smooth, clean, of uniform thickness and free from defects. The preparation for galvanizing and the galvanizing itself shall not adversely affect the mechanical properties of the coated material.

1.3 TECHNICAL STANDARDS

The standards which shall be used in this Contract are listed below. Any standards proposed in place of or in addition to those specified shall be submitted for the Engineer’s approval

1.3.1 General Technical Specification

-BS EN1435	Methods for radiographic examination of fusion welded butt joint in steel and circumference joint in steel
-BS 1461	Hot dip galvanizing
-BS182/184	Galvanized wire
-BS443	Thickness of coating for galvanized wire
-BS1224	Chromium plating
-BS1134	Packaging code

1.3.2 132kV Triplex Type XLPE Cable

-IEC60093	Method of test for volume resistivity and surface resistivity of solid electrical insulating materials
-IEC60183	Guide of the selection of high voltage cables
-IEC60230	Impulse tests on cables and their accessories
-IEC60270	Partial discharge measurements
-IEC60840	Power cables with extruded insulation and their accessories for rated voltages above 30kV (Um = 36kV) up to 150kV (Um = 170kV)
-IEC60853	Calculation of the cyclic and emergency current ratings of cables
-IEC62271-209	High-Voltage switchgear and control gear, Part 209: Cable Connections for gas-insulated metal-enclosed switchgear for rated voltage above 52kV
-IEC60949	Calculation of thermally permissible short circuit currents, taking into account non-adiabatic heating effects

-IEC61238	Compression and mechanical connector for power cables with copper and aluminum conductor
-IEC62067	Power cables with extruded insulation and their accessories for rated voltages above 150kV (Um = 170kV) up to 500kV (Um = 550kV)
-DIN EN50180	Plug-in terminations
-IEEE48	Standard test procedures for AC HV cable terminations
-IEEE Std575	Sheath-Bonding Methods for Single-Conductor Cables and the Calculation of Induced Voltages and Currents in Cable Sheaths

1.3.3 Fiber Optic Cable

-IEC60793	Optical Fibers
-IEC60794	Optical Fiber Cables
-IEC61300	Fiber Optic Interconnection Devices & Passive component – Basic Test and Measurement Procedures
-IEC61315	Calibration of fiber optic power meters
-ITU-T,G650	Definition and test methods for the relevant parameters of single-mode fibers
-ITU-T,G652	Characteristics of a single-mode optical fiber cable
-ICEA S-66-524	Minimum Weights of Zinc Coating (galvanized steel wire armour)
-ANSI/EIA-A359	Color Coding

1.4 ELECTRICAL DESIGN CRITERIA AND SITE CONDITION

1.4.1 Site Environmental Condition

Site environmental condition and design value is as follows;

Altitude of site above sea level not exceed		1,500m
Average air temperature		18℃
Lowest air temperature		0℃
Maximum air temperature		40℃
Average isokeraunic level		60 days
Relative humidity	Maximum	100%
	Minimum	20%
Design wind speed		34.4 m/s
Rainfall		3,474mm/annum
Monsoon season		June-August
Atmospheric pollution		Light

1.4.2 System condition and withstand level

The basic parameters on the network are set out as follows;

Nominal System Voltage	132 kV
1. Maximum system voltage	145 kV
2. Rated impulse voltage withstand (peak)	650 kV
3. Rated short time current duration 1 sec.	40 kA
4. Rated peak short circuit current (peak value)	80 kA

1.4.3 Minimum substation clearance

The layout of plant and equipment on substation sites shall provide for ready access for operation and maintenance whilst the remaining sections of equipment are alive. Working clearance provided between isolated equipment and nearest live metal work shall be not less than those stated as follows;

Nominal System Voltage	132kV	11 kV
1. Minimum clearance between live metal and earth	1,350mm	200mm
2. Minimum clearance between live metal of different phase	1,350mm	250mm
3. Minimum safety clearance between the nearest point not at earth potential of an insulator to ground (pedestal access)	2,300mm	2,300mm
4. Minimum safety clearance between live metal and positions to which access is permissible with other conductive equipment	3,650mm	2,590mm

Notes; Applied for outdoor switchgear

1.4.4 Creepage distance

The site is classified as light pollution level (C4 ISO12944) with a creepage distance of 34.7mm/kV.

1.4.5 Earthing system

The 132kV cable system is to be earthed with cross bonding, single point bonding or solid bonding system.

1.4.6 Power supplies

The electricity supplies available for auxiliary plant shall be;

- 400V 3 phase 50Hz 4 wire for power
- 230V single phase for lighting and indication
- 110V DC for essential indication and circuit breaker closing and tripping supplies
- 48V DC for telecommunication system

The equipment provided under the Contract shall be capable of operating reliability within the following voltage ranges;

(a) DC equipment

From 80% nominal voltage up to 120% nominal voltage

Notes: circuit breakers are required to carry out tripping operation at 70% of nominal voltage

(b) AC equipment

Voltage:	Single phase	230V rms AC +10%, -20%
	Three phase	400V rms AC +10%, -20%
Frequency:	Nominal	50Hz
	Maximum	51Hz
	Minimum	48.5Hz

1.4.7 Type Approval Test

The proposed cables and its accessories shall have satisfactorily passed type approval tests as per current and latest applicable standards. If satisfactory evidence of such type testing is not available, the same are to be carried out in the presence of NEA/Engineer. The costs if any for such tests are deemed to be included in the contract price.

The proposed manufacturers of 132kV XLPE cables & accessories and Optical fiber cables & accessories are required to be certified on their conformity to ISO 9001 by an accredited certification agency.

1.4.8 Design Criteria

The standard ratings for 132 kV cable circuits are 160 MVA, laid in one cable per phase & sizes (800sqmm) based on project scope requirements with appropriate bonding arrangement for sheaths.

All cables & accessories shall be suitable for operation, at the guaranteed continuous ratings throughout all seasons of the year with the prescribed ambient conditions, nominal system voltages, fault withstand requirements and other design data as specified in relevant sections

1.4.9 Current Carrying Capacity

The maximum continuous current carrying capacity and maximum permissible conductor temperature, and the factors for determining such rating and temperature shall be based on IEC 60287 and subsequent amendments, and all conditions obtained on Site. Due account shall be taken of the layout and proximity effects of adjacent power cable circuits and or any other thermal sources (water mains etc.) when proposing cable sizes and ratings.

For the purpose of tendering the following conditions shall be assumed:

(a) Cable laid direct in ground or in duct banks:

i)	Ground or duct temperature	30 °C
ii)	Soil thermal resistivity	1.2 °C m/W
iii)	Depth of laying to top of cable	1.2 m (132kV cable)

(b) Cables in air:

i)	Maximum ambient temperature	40 °C

Bidder shall confirm in his offer that the proposed cables sizes are adequate for the required circuit ratings based on the foregoing parameters, and he shall also confirm that the cables he is offering are able to withstand the short circuit requirements specified in relevant sections. The Contractor shall submit calculations and other information to substantiate that the proposed cable sizes and method of installation are adequate and meet the requirements of NEA. Technical Particulars shall be filled with values of proposed cables.

The Contractor shall carry out at his own expense soil analysis for moisture content, water table level, and soil thermal resistivity tests along the 132kV cable routes and such other tests as he may consider necessary, sufficiently in advance before manufacture of any cable, to satisfy himself that the conditions on site and his proposed arrangement of cables and method of installation are such that the maximum current carrying capacity can be maintained. If the Contractor considers that the conditions and the proximity to other power cables, spacing and method of installation are likely to reduce the maximum current carrying capacity below the declared value he shall immediately notify the Engineer as to what the maximum current carrying capacity would be under these conditions and shall not proceed with the work on that portion of the route affected until the Engineer has given their permission.

1.4.10 Calculations and Soil Measurements

The cables and their accessories shall be designed and manufactured to meet the requirements when operating with full load. The Contractor shall submit at least the following calculations and records to the Engineer for approval.

(a) Report of own site measurements of the actual soil electrical resistivity along each cable route. Report of own site measurements of the actual soil thermal resistivity in accordance with IEEE 442.Report of own site measurements of moisture content and water table.

(b) Calculation results of the continuous current rating (as indicated in the offer) of the proposed cables and their accessories and short circuit capacity of the main conductor and metallic screen in accordance with system design requirements.

(c) Calculation of zero sequence impedance and positive/negative sequence impedance of the power cables.

(d) Calculation of induced voltages in the metallic screen. Sizing calculations for the proposed coaxial & bonding cables.

(e) Report of density, grain size distribution, cement/sand ratio and thermal characteristics of proposed bedding and backfilling material of power cables.

1.4.11 Voltage Marking and Identification

The color of outer sheaths shall be black unless otherwise specified by the Engineer and shall be embossed continuously along the length of the cable in English as follows to the approval of the Engineer.

The letters and figures shall be raised and shall consist of upright block characters arranged along two or more lines approximately equally spaced around the circumference of the cable. The maximum height of the characters shall be 13 mm and the minimum size 15 % of the approximate overall diameter of the cable or 5 mm whichever is the greater. The space between the end of one set of embossed characters and the beginning of the next shall be not greater than 150 mm.

(a) Nominal Voltage

(b) Property of NEA

(c) Size and type of cable

(d) Year of Manufacture

(e) Manufacture's name and country

For example for 132kV cable:

ELECTRIC CABLE 132000 VOLTS, PROPERTY OF NEA, 3 CORE, 800MM2 COPPER, XLPE, YEAR, "MANUFACTURER'S NAME" Country of Manufacturer.

1.4.12 Sealing, Drumming and Packing

Immediately after completion of the Works Tests both ends of every length of cable shall be sealed by means of a metal cap fitted over the end. Other cables shall be sealed by enclosing the ends in suitable caps, tightly fitted, sealed and adequately secured to prevent ingress of moisture.

For all cables the inner & outer ends of the cable shall be brought out and suitably protected and fixed to the drum flange to avoid any damage during handling or pulling operations.

Power cables shall be wound on strong drums made of steel and circumferentially covered with suitable wooden battens or steel plates to protect the cables from damage. Drumming & packing shall also be suitable for storage in the open air without any other additional protection for a storage period of at least two years. The top most layer of wound cable on drum shall be covered and protected suitably with a wrap of bubble film or felt sheet.

For all other cables the drums shall be of steel make suitable for chemical protection.

The proposed type of drums, drum size & dimensions are subject to approval of NEA/Engineer.

Each drum shall have a distinguishing number, either printed or neatly chiseled on the outside of one flange with the following details.

Contract No., particulars of the cable, i.e. type, voltage, conductor size, number of cores, finish, length, gross and net weights, shall be clearly shown on one flange of the drum. In addition, the words "Running End" shall be marked on the flange and the direction for rolling shall be indicated by an arrow. The method of drum marking shall be to NEA/ Engineer's approval.

All cables and accessories shall be carefully packed for transport and storage on site in such a manner that they are fully protected against all climatic conditions, particular attention being paid to the possibility of damage during transport to the Site by sea and or overland and to the conditions prevailing on the Site.

1.4.13 Cable Length on Drum

Where applicable, cables shall be supplied in maximum permissible drum lengths bearing in mind the transport limitations and access to the Sites. No drum shall contain more than one length. Cables shall be installed in maximum possible lengths and straight through jointing shall be kept to bare minimum and the same if any shall be with the prior written approval of the Engineer

1.4.14 Cable Routes and Quantities

The cable routes on the drawings attached with the tender are provided for information only, and it is Contractor's responsibility to establish the exact routing and associated quantities of cables and accessories required to complete the whole of the works as described elsewhere in the Contract Documents.

1.4.15 Surplus Cable

All the surplus cut power & optical fiber cable lengths shall be owner's property and therefore shall be returned to the Employer's stores. The Contractor shall clear the completed cable route and remove all cable scrap and other surplus materials from work area preferably on the same day but not later than the next day after particular work completion and the costs thereof shall be deemed to be included in the Contract Price

1.5 PROTECTION OF ENVIRONMENT

1.5.1 The Adherence to the Environmental Acts, Regulations and / or Guidelines

It is necessary that the Contractor shall work in accordance with the environmental and pollution control laws and regulations prevailing in Nepal. The Contractor shall comply with the recommendations made in the Environmental Management Plan and Environmental Monitoring Plan which is part of the Contract Document.

The Contractor shall be fully aware of environmental and pollution control regulations of Nepal and shall adhere those requirements fully. Key legislative instruments for environmental management in Nepal and JICA guideline include below but not limited to;

- Environmental Protection Act, 2076 B.S
- National Environmental Policy, 2076 B.S
- Environmental Protection Rule, 2077 B.S
- JICA Guidelines for Environmental and Social Considerations, 2022 A.D.
- Land Use Act, 2076 B.S
- Land Acquisition Act, 2034 (1977)
- Labour Act, 2074 (2017)
- Child Labour (Prohibition and Regulation) Act. 2056
- Soil and Watershed Conservation Act, 2039 (1982)
- Water Resources Act, 2049 (1992)
- Solid Waster Management Act, 2068 (2011)
- Electricity Act, 2049 (1992)
- Local Government Operation Act, 2074

In addition to the legislations listed above, there are other legislations that indirectly aim at environmental protection and pollution control which have to be adhered by the Contractor.

In order to provide safe and healthy environment for workers and the public, during construction and installation works, the Contractor shall achieve mitigating environmental impacts and risk minimization by appropriate safeguards through planning and implementation of the works.

The outlines of the environmental requirements of the Project are mentioned in the following documents;

(a) Environmental Management Plan (EMP) and;

(b) Environmental Monitoring Plan (EMoP)

The Contractor shall comply with all the requests.

The Contractor is required to submit Environmental Management Plan (Construction/Installation) for the construction and installation works upon award of the Contract. The following key areas have to be considered in preparation of EMP (Construction/Installation);

(a) Potential environmental impacts and risks generally applicable to all sites and specific to particular sites

(b) Propose measures to minimize or avoid and mitigate those impacts

(c) Implementation arrangement of mitigation measures that will ensure the compliance

(d) Monitoring of implementation of mitigation measures; Methods or tests used for assessment of environmental impacts and effectiveness of proposed measures including locations of monitoring and frequency of monitoring and reporting arrangement

(e) The Contractor’s staff shall have adequate knowledge of EMP (Construction/Installation) through educating and training.

The Contractor shall appoint a qualified Environment officer at construction sites to oversee the implementation of the EMP (Construction/Installation). The Environment officer shall be approved by the Employer.

The Bidders shall also take into consideration the relevant costs that will be incurred for the strict adherence of above safeguard measures and all the requirements stipulated in the environmental approvals, if any and the relevant documents forming part of such approvals obtained under the Nepal law with respect to the Project.

1.6 CONTRACTOR’S RESPONSIBILITY

1.6.1 Safety of Personnel

The Contractor shall ensure the highest level of safety for all personnel directly involved in this Contract, in accordance with the requirements specified in Chapter 16.

1.6.2 Contractor’s Employees

The Contractor shall provide adequate transportation, accommodation, meals, and medical facilities for all personnel under his employment. The Contractor shall also comply with all applicable labor laws of Nepal. Furthermore, the Contractor shall be fully responsible for the conduct of all personnel employed by him at the site.

1.6.3 Progress Report

The Contractor shall submit to the Employer, at monthly intervals, detailed written progress reports (in triplicate) in a format approved by the Employer. These reports shall indicate the current status of design, material procurement, manufacturing, delivery, and supervision of erection for all plant components, and shall include S-curves and photographs. Any deviations from the agreed schedule must be reported promptly.

The reports shall be submitted in a timely manner to ensure that, upon receipt by the Employer, the information is no more than seven days old. Copies of the reports shall also be provided to the Employer’s representative at the site.

Additionally, the Contractor shall submit weekly reports to the Employer detailing, for each section of the works, the number and classification of workers employed on site. The Employer shall be granted reasonable access to the Contractor’s and Subcontractor’s work at all times for the purpose of monitoring progress..

1.6.4 Progress Meetings

The Contractor shall attend regular formal site progress meetings with the Employer, where progress and construction related issues will be reviewed. If required by the Employer the Contractor shall prepare for issue the day before the meeting detailed schedules showing separately the erection, fixing, concreting, commissioning or other work activities planned for the next two week as well as progress achieved over the preceding week.

The Contractor shall also be required to attend other meetings from time to time on special subjects.

1.6.5 Site Sign Boards during Construction Works

(1) Sign Board at Construction Site for Underground Transmission Line

The Contractor shall provide temporarily site sign boards at each construction site that is movable for construction site. The text and pictures/symbols to be indicated on the sign boards shall be subject to the Engineer's approval.

(2) Sign Board at Construction Site of the new Steel Tower

The Contractor shall install a site signboard at the construction site of the branch tower during the construction works. The content (including text and any images or symbols displayed on the signboard) and the size of sign board shall be subject to the Engineer's prior approval.

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CHAPTER 2:

132 kV XLPE CABLE

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CHAPTER 2: 132 kV XLPE CABLE

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2.1 GENERAL

The 132kV triplex type cables shall comprise a circular stranded copper conductor (or milliken type construction if conductor cross section is 800mm² or greater) insulated by continuous vulcanization, triple extrusion process, simultaneously applying a semiconducting conductor screen, a thermosetting insulating dielectric and a semiconducting core screen. The extruded core shall be cured using a dry curing process and the byproducts of cross linking removed by a prolonged degassing process. The core shall be screened overall with copper wires having a suitable cross sectional area to withstand the specified earth fault current and protected with a continuously extruded polymeric outer sheath. A thin layer of graphite or semi-conducting polymer shall be applied overall and firmly bonded to permit testing of the cable outer sheath. 132 kV XLPE insulated cables shall comply with the requirements of IEC 60840 plus any additional requirements specified hereafter.

The cable shall be designed for a reliable service life of at least 30 years. Since the 132kV triplex cable is a critical item of equipment under the Project, any Bidder who fails to comply with the requirements mentioned in EQC Subclause 1.1.3 for 132kV XLPE triplex power cable may be deemed technically non-responsive.

2.2 CONDUCTOR

The conductor shall consist of plain annealed high conductivity copper wires in accordance with class 2 requirements of IEC 60228. To lower the skin effect coefficient, the conductors for 800sqmm and above shall consist of stranded segments (Milliken Type). Milliken copper conductor with 4-6 segments in accordance with IEC 60228. The conductor shall be protected against water penetration in the longitudinal axis. This shall be achieved by the application of water swelling material between conductor strands and application of water swelling tapes around each layer of conductor wires.

Not more than two joints shall be allowed in any of the single wires forming each length of conductor and no joint shall be within 300 mm of any other joint in the same layer. The jointing of wires shall be by brazing, silver soldering, cold welding or electrical welding. No joint shall be made in the wire after it has been formed up into the required length."

2.3 CONDUCTOR SCREEN

The conductor screen shall consist of a binder tape applied over the conductor and a layer of black extruded super-smooth semi-conducting thermoset compound which shall be compatible with insulation and firmly bonded to the inner surface of the insulation.

The thickness of the extruded conductor screen shall be as specified in the Technical Data Sheets and same shall have allowable operating temperature equal or higher than that of the insulation.

The outer surface of the conductor screen shall be cylindrical, smooth and free of protrusions and irregularities. The semiconducting conductor screen shall have minimum spot thickness of 0.8mm

The outer surface of the conductor screen shall be firmly and continuously bonded to the inner surface of the insulation and shall have no tendency to separate from the insulation due to the effect of bending during installation, load cycling and short circuits under service conditions.

The volume resistivity of the extruded semi-conducting screen shall not exceed 1000 Ohm-m at 90°C.

2.4 INSULATION

The insulation shall consist of a homogeneous extrusion of ultra-clean cross-linked polyethylene (XLPE) complying with the requirements specified in IEC-60840.

The cross-linked polyethylene insulation shall be free from micro voids, contaminants, protrusions and moisture content as specified in the above standards. The manufacturing process of vertical continuous vulcanization (VCV) is preferred however cables manufactured with CCV lines can also be considered.

The insulation thickness shall be specified as minimum average value measured according to IEC 60840. Justification for specified insulation thickness along with conductor screen stress calculations shall be submitted. The insulation thickness shall be subject to approval of NEA/Engineer. The bidder shall furnish separately the material properties of XLPE such as Physical properties, Electrical properties, Ageing properties, Anti hygroscopic properties, Heat distortion properties along with original certificates from raw material from manufacturers.

2.5 INSULATION SCREEN (NON-METALLIC)

The insulation screen shall consist of an extruded layer of black, thermo setting semi-conducting super-smooth material applied directly over the insulation. An insulation screen which requires heating for its removal is not acceptable.

The thickness of the insulation screen shall be as specified in the Technical Data Sheets. The inner surface (facing the insulation) of the insulation screen shall be smooth and free of protrusions and irregularities.

The inner surface of the insulation screen shall be firmly and continuously bonded to the outer surface of the insulation and shall have no tendency to separate from the insulation due to the effect of bending during installation, load cycling and short circuits under service conditions. The volume resistivity of the extruded semi-conducting insulation screen shall not exceed 500 Ohm-m at 90°C.

2.6 MANUFACTURING PROCESS OF CONDUCTOR SCREEN, INSULATION & INSULATION SCREEN

The conductor shall be covered with three layers (screen, insulation, screen) the insulation being of super-clean HV insulation compound, extruded under high pressure and heat treatment.

The conductor screen, the insulation and the insulation screen shall be mutually compatible and shall, in the same manufacturing process, be continuously extruded (triple extrusion) and completely dry cured by a common head (simultaneously).

For insulation raw material handling, DIRECT FEED SYSTEM and for cooling after vulcanization, dry cooling is preferred. To reduce the methane content of XLPE a heat treatment after curing shall be carried out.

The extruded conductor screen, insulation and insulation screen shall be manufactured to the highest standards of concentricity, diameter roundness and longitudinal diameter stability. The Bidder/Contractor shall provide a detailed description on the extrusion, curing, cooling and heat treatment after curing processes.

2.7 METALLIC SCREEN

A copper wire screen of suitable cross sectional area if required with binding equalizing copper tape shall be applied over the semi-conducting bedding layer / screen.

The metallic screen shall be designed to withstand the specified earth fault current. The dimension of the copper wire screen shall be fully compatible to the respective design of the overall cable construction.

The Bidder/Contractor shall prove by calculation that the metallic screen of the cable can withstand not less than the system short time current rating specified in the Technical Data Sheets.

When carrying the short-circuit current, the integrity and performance of any part of the cable shall not be deteriorated due to the rise of the surrounding temperature. The metallic screen temperature under specified short circuit conditions shall comply with IEC 61443.

2.8 LONGITUDINAL WATER BLOCKING

Means shall be provided to prevent the longitudinal ingress of water in the space between the insulation screen/ copper wires metallic screen and the inside of the aluminum laminated water barrier tape. Any material used shall be sufficiently conducting to prevent the development of harmful voltages between the aluminum laminated water barrier tape and insulation screen/ copper wires metallic screen of the cable under all operating conditions of the cable system.

The longitudinal water barrier shall consist of a semi-conducting water swellable tape applied over the extruded insulation screen/ copper wires metallic screen.

The water barrier shall be applied such that the complete cable will meet the requirements of water penetration test as per the relevant latest IEC recommendations.

2.9 WATER BLOCKING MATERIALS

The proposed longitudinal water blocking materials shall be effective for blocking of water of saline & salty nature. Further materials which exhibit color change or other signal on moisture absorption are preferable.

2.10 ALUMINUM LAMINATED WATER BARRIER TAPE

The water impervious metallic layer shall consist of the layer of aluminum laminated water barrier tape, which shall be of best quality and shall be tightly fitted over the water blocking layer.

The aluminum laminated water barrier tape shall be impervious to moisture and free from defects and impurities such as oxides that could give rise to failure under working conditions.

The aluminum laminated water barrier tape shall be firmly and continuously bonded to the inner surface of the over sheath and shall have no tendency to separate from the over sheath due to the effect of bending during installation, load cycling and short circuits under service conditions.

The aluminum laminated water barrier tape shall be bedded on tapes providing electrical continuity between screen and water barrier tape and designed to absorb thermal expansion. The whole construction shall prevent longitudinal water penetration in the event of cable damage.

2.11 OUTER SHEATH

The outer covering shall be of high-density polyethylene with hardness shore D of not less than 58% (type PEST7 as per IEC 60502-1), suitably prepared against cracking and decomposition under the prevailing service conditions at site, it shall be termite resistant & vermin proof.

The outer sheath shall be coated with a black semi-conductive layer as specified in the Technical Data Sheets to serve as electrode for the voltage tests on the outer sheath. The anti-termite chemical treatments if any shall be accomplished using only the permitted chemicals as per IEC 60502.

On the outer sheath, the voltage marking and identification shall be embossed continuously (laser or hot pressed) along the length of the cable in English with following details and comply with IEC 60502-1 Clause 17.

- Nominal Voltage
- Property of NEA
- Size and type of cable
- Year of manufacture
- Manufacturers name and country

2.12 ASSEMBLY

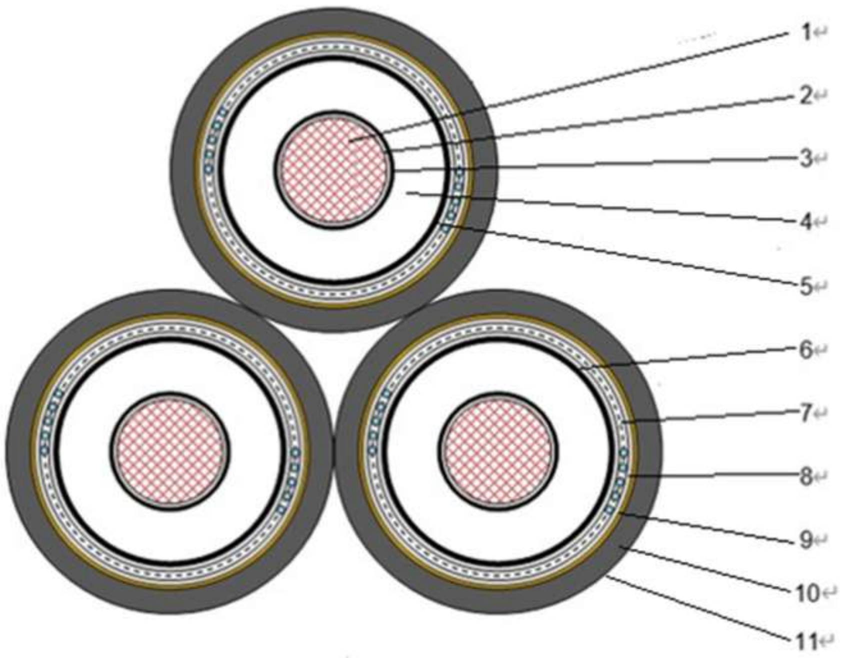
Three outer sheathed cable cores shall be twisted together as a form of triplex cable.

Twisted pitch of cable cores shall be less than 25 times of pitch diameter.

2.13 CABLE CONSTRUCTION

The sectional drawing of construction of triplex cable shall be as illustrated below, while the

Distributed Temperature Sensor (DTS) as per the Sub-Clause 4.6 of Technical Specification shall be considered in the design of cable construction. Bidder shall submit the sectional drawing of cable construction considering DTS with the Bid proposal.



1. Copper conductor
2. Water swelling binder tape
3. Conductor screen
4. XLPE insulation
5. Insulation screen
6. Water swelling bedding layer
7. Copper wire screen
8. Water swelling binder tape
9. Aluminum laminated tape
10. HDPE outer sheath
11. Graphite coating

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CHAPTER 3:

BONDING & EARTHING OF HIGH VOLTAGE CABLES

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CHAPTER 3: BONDING & EARTHING OF HIGH VOLTAGE CABLES

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3.1 GENERAL

To neutralize or minimize the induced voltages and circulating currents the sheaths of triplex type 132 kV cables shall be cross bonded or single point bonded if applicable.

The proposed sheath bonding scheme are subject to the approval by NEA/the Engineer.

Details of sheath bonding systems and design of the related accessories shall be subject to the approval of the NEA/the Engineer. Insulated sheath sectionalizers at each joint are required. The sheath standing voltages at rated full load current of cable for unearthed locations shall be limited to 65 Volts, in exceptional circumstances induced voltages up to 120 volts may be accepted at sole discretion of NEA. The Bonding system shall be provided with provisions for periodic sheath integrity tests.

For cross bonding systems, cable sheaths shall be directly earthed through link boxes at every third joint bay. At the intermediate joints the sheaths shall be earthed through voltage limiters to limit steep-fronted transient over-voltages to a value which can be safely withstood by the sheath insulation, (i.e. in addition to the cable outer sheath this includes external joint insulation, terminal base insulation, joint and sheath sectionalising insulation - if any - as well as the insulation of the bonding leads and link boxes appropriate to cross-bonded or single point bonded systems). The voltage limiters shall be of non-linear type.

For single point boding systems, the earth continuity cable shall be provided for minimizing sheath induced voltage potential to the surrounding medium in case of flowing fault current in metallic sheath.

The bond connection shall be able to carry the normal sheath current as well as the maximum fault current without undue heating. The completed bonding system shall be subject to a test in the presence of the NEA/Engineer. The cables used for cross- bonding leads shall be of a concentric design with an inner insulation of PE and an outer insulation of PVC.

Earthing at each joint location shall comprise tinned copper wires or copper weld earth rods and insulated copper earth connections of sufficient copper cross section, all supplied and installed by the Contractor with waterproof cast iron or stainless steel link boxes at each joint and cross-bonding location. Link boxes shall be housed in reinforced underground concrete pits designed for easy access and link disconnection to facilitate periodic serving tests.

After all earth cable connections to link boxes are made, the link boxes are to be filled with suitable compound up to earth cable top level so as to prevent moisture/water entry through cores of earth cables.

The link bars inside the link box shall be made of tin-coated copper. The removable copper links in the link boxes shall be so designed that there is no possibility of putting back the removable links in the wrong positions. The contact resistance shall be below 10 Micro Ohm. The removal of the link bar for operation and testing on the cable sheath shall be done on a per-phase basis and will not impose unnecessary work in the connections or disconnection of the other phases connection and components inside link box.

Lids of concrete pits shall have two strong recessed handles, which shall move freely and not project after the lid is placed in position. They shall be designed for heavy traffic loading but as light weight as possible.

The size of copper earth connections shall be adequate to carry the full expected fault current for the cable system.

All steelwork not subject to the full fault current shall be earthed with adequate insulated copper conductor or equivalent bare copper earth tape/bar.

The individual ground resistance at each earthing point shall not exceed 5.0 Ohm. Where necessary, additional earth rods shall be provided to obtain this value.

Insulated links placed in suitable boxes shall be included for easy disconnection at indoor terminations to facilitate periodic cable anti-corrosion protection tests. Weatherproof link boxes mounted on support structures shall be provided at outdoor terminations.

For the single point boding system, earth continuity cable shall be provided for minimizing induced voltage potential to the surrounding medium.

CHAPTER 4:

CABLE ACCESSORIES

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CHAPTER 4: CABLE ACCESSORIES

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4.1 GENERAL

This Chapter mentions the technical specifications for:

(a) Cable joints

(b) Cable sealing ends / terminations

(c) Lightning arrestors

(d) Distributed Temperature Sensing (DTS) system

(e) Other accessories and materials

Cable joints and terminations (sealing ends) shall be supplied by the same manufacturer, and must possess electrical, mechanical, and thermal properties that are at least equivalent to those of the cable. The overall design shall take into account harsh environmental conditions. The expected service life of the joints and terminations shall be no less than that of the power cable. The proposed joints & terminations must have been in satisfactory commercial operation for at least 15 years continually in similar environments as of South Asia or/and Southeast Asia.

The selection of the manufacturer for cable joints and sealing ends shall be confirmed by the cable manufacturer, based on successful integration and operation in previous projects. Preference may be given to bidders who propose power cables, joints, terminations, and other accessories from the same manufacturer to ensure compatibility, reliability, and accountability. However, the Engineer reserves the right to specify different manufacturers for joints and terminations at either end or in different sections of the same cable circuit to enhance overall system reliability.

Joints and terminations shall include provisions for conducting periodic sheath integrity tests without interrupting the main circuit.

4.2 JOINTS

The Bidder shall propose both straight through and Sheath sectionalizing Joints as per scope requirements. However, the Employer/the Engineer reserves its right to instruct Contractor to install only sectionalizing joints which need to be utilized for both straight through as well as cross bonding purposes.

The conductors shall be spliced by means of compression ferrules or by means of torque break fasteners. Conductors jointing by plug in, slip off or welding mode are not acceptable. In exceptional cases the Employer/Engineer may permit splicing by welding subject to satisfactory evidence of certifications for weld quality & jointers and on evidence that the high weld temperatures have no effect on intended characteristics of various cable components The intended method shall be proposed with the Bid.

The denuded conductor screen, insulation, insulation screen and water barrier films may be remade with applicable taping materials as per manufacturer’s standard practice.

The electrical stress control shall be done by utilizing a suitably designed stress relief cone.

The joint shall be protected by a copper sleeve or body with suitable sectionalization insulator as per the joints intended design (Insulated or straight through) with suitable openings for compound filling if any and proven arrangement for connecting bonding leads. A protective glass fiber box casing or outer shell is required to be provided to protect the joint which shall be filled with water-proof compound (such as bitumen or epoxy resin etc.).

The outer shell shall have sufficient number of openings with suitable dimensions for compound filling & venting and the fasteners or clamps meant to hold the parts of shell shall be made of suitable non corrosive materials preferably of stainless steel.

Any alternative design of joint which is equivalent in performance to the conventional design may be considered subject to the Tenderer submission of full information to demonstrate the performance and experience with this.

The cable joints shall be designed to be accommodated in reinforced concrete pits / troughs with reinforced concrete covers. The design and the dimensions of the joint pits / troughs shall be as per the recommendations of the cable and joint manufacturers and subject to the approval of the Employer /Engineer.

A complete and detailed list of tools and equipment required for jointing the proposed cables shall be submitted with the Tender.

4.3 SEALING ENDS/TERMINATIONS (FOR INDOOR GIS CONNECTION)

Sealing ends shall be suitable for termination of triplex type XLPE cables as specified in data sheets at 132kV GIS or Transformer/ Reactor cable chambers. The insulator shall have blind ended construction to eliminate the possibility of SF6 gas leaking into the cable termination through conductor connection.

The terminations for GIS shall be either plug in type (dry type) or conventional (wet) type and as per project requirements and as applicable at site. The GIS terminations shall comply with IEC 62271-209 (IEC 60859) & IEC 60840.

All terminations shall consist of two part metal housing, porcelain or epoxy resin insulator and stress relief cone made of silicone rubber or EPDM. The stress control cone material shall have the same thermal expansion coefficient as the cable. The sealing ends designed to contain oil shall be filled with high viscosity silicone oil, or equivalent and suitable expansion device shall be provided. The expansion vessel / conservator with watch glass for oil level monitoring would be preferable.

The sealing end metal base shall be designed to be plumbed to the cable metallic screen and the same shall have necessary provision to terminate earth bonding cable. The housing body flange shall be insulated from the GIS or transformer / reactor cable chamber. The non-conductive metallic bodies of cable termination & GIS at interface point shall be provided with equalizing earth bonds or suitable LV surge arresters to neutralize the transient ground potentials.

The Contractor shall be responsible for necessary coordination between this section

(Transmission) and another section (Substation), i.e. among GIS manufacturer, arranging GIS manufacturer's supervision, gas handling equipment and other tools/tackles, test bushing/adopter, necessary flanges, seals, gaskets etc. for GIS, De-gassing and re-gassing of sealing end chambers for termination and testing of the cables.

Further the transmission section of the Contractor shall also be responsible for necessary co-ordination with substation section of the Contractor for ascertaining the suitability of the proposed terminations to the type of GIS, requirement & adequacy of fixing arrangement, supports for termination & earth link boxes. This proposed arrangement shall be subject to the approval by the Employer / the Engineer.

4.4 OUTDOOR SEALING ENDS

The outdoor sealing ends shall be designed for installation in vertical position, on metallic support structures or on transmission line tower platforms. The insulation housing shall be made of porcelain or dry and composite type. The housing is to be designed with creepage length as specified in NEA specifications for design fundamentals & quality requirements and suitable for hot line washing. The service reliability of the housing shall be demonstrated by having carried out the type tests for full scale aging, thermal mechanical tests, tightness tests & pressure relief tests if the type test report(s) is not available.

The termination base shall preferably made of corrosion proof alloy, designed for easy draining & filling of oil and easy dismantling & re-assembly of housing. The terminal shall be of cylindrical shape & of material suitable for connection with copper conductor.

The sealing ends shall be equipped with a bronze terminal for earthing and the entire sealing end shall be mounted on support structure through porcelain or silicon rubber insulators.

All metal parts shall be made of stainless steel or of suitable metal with proper plating.

Arcing horns with reduced gap for insulation coordination shall be provided.

Supply and installation of the necessary hot-dip galvanized steel structures and non-magnetic clamps to support and fasten the cables at the gantries shall be included in the Contract Price. Where applicable, these structures shall be designed to allow simple installation of down-droppers to the terminations. Clause 7.6 of Chapter 7 “Power and Control Cables” in Volume 2, The arrangement of the terminations, the supporting structures, including the cable fastening, shall be subject to the approval of the NEA/Engineer.

4.5 LIGHTNING ARRESTERS

Surge arresters shall be of the gap less metal oxide type. Except where approved the use of organic materials is not permitted. Arresters shall be housed in porcelain containers sealed against the entry of moisture and oxygen. All internal components shall be designed to minimize internal corona and also to ensure minimal capacitive coupling with any conducting layer of pollutant on the outside of the porcelain housing.

Arresters shall comply in all respects with IEC 60099 shall be entirely suitable for operation under the system conditions specified including system voltage rises on unloading long transmission lines and shall have sufficient capacity to discharge system charging currents without damage.

Each surge arresters shall be fitted with a surge counter of an approved type. Primary clamps and connectors suitable for "hot line" maintenance shall be fitted on surge arresters. The surge arresters shall be capable of resealing against the maximum TOV. The active elements shall be housed in suitable gas tight insulators of brown glazed porcelain with a creepage distance as specified in Sub-Clause 1.1.4 of Chapter 1 "General Requirements" in Volume 2 based on the rated voltage of the switchgear, to cater for the site conditions of polluted air. The surge arresters shall be equipped with a grading ring. If necessary, an internal grading system may control the voltage distribution along the metal oxide resistor stack.

A pressure relief device shall prevent damage by overpressure and discharge counters shall be provided to indicate the number of operations for each surge diverter. Surge arresters shall be of the heavy-duty type. Connection to ground shall be by copper bars of adequate section connected to the termination general grounding grid. The surge arresters shall be constructed and tested in accordance with IEC 60099

4.6 DISTRIBUTED TEMPERATURE SENSING (DTS) SYSTEM

The DTS system shall be suitable for temperature monitoring in entire underground transmission lines. The system shall be capable of detecting temperature variations with high accuracy and spatial resolution.

The requirements of specifications are mentioned in the following paragraphs, meanwhile the DTS system recommended by the 132kV triplex cable's manufacturer is acceptable which shall be subject to the approval of the Engineer. Bidder shall submit the cable manufacturer's proposal of suitable DTS system to this Project with the Technical Bid.

The cable manufacturer shall be responsible for the performance of DTS system (but the manufacturer's standard specifications may be applicable), which may consist of :

(a) Fiber Optic Sensor: The sensing fiber shall be based on multimode fibers.

(b) DTS Control Unit: The controller shall analyze the backscattered light to calculate the temperature and location of the event with an accuracy of ±1°C and a spatial resolution of 1 meter. Real-time temperature data from the DTS system and alarm settings shall be indicated on a monitor in the substation control room.

The system shall be capable of measuring temperatures from -20°C to +150°C with a temperature resolution of less than 1°C.

The system shall comply with relevant international standards for temperature sensing and monitoring systems, including IEC 60730-2-9:2015+AMD1:2018+AMD2:2020: Automatic electrical controls for household and similar use - Part 2-9: Particular requirements for temperature sensing controls, and IEC 62828-3:2018: Reference conditions and procedures for testing industrial and process measurement transmitters - Part 3: Specific procedures for temperature transmitters.

The factory acceptance test (FAT) shall be conducted at the power cable manufacturer with presence of the Employer's representative. The test items and procedures shall be detailed and agreed upon with the Engineer before FAT.

4.7 JOINTING / TERMINATION MATERIALS

Unless and otherwise specified elsewhere the primary make up materials & consumables shall have properties or characteristics as specified below.

4.7.1 Stress Relief Cones

The material for stress relief cones shall have high thermal stability with respect to electrical and mechanical properties with highest bonding energy. They shall have long life with very little aging. The material shall be of low shore A hardness preferably made of RTV grade silicon rubber or EPDM. The entire stress relief cone manufacturing shall be done in clean room facilities.

The stress relief cones shall be subjected to Routine & Factory witness sample tests as per relevant clauses of IEC 60840. For the cases where the design of joint has stress relief cone in constant contact with silicon oil in service, the stress relief cone should have been subjected to aging tests in presence of hot oil.

4.7.2 Tapes

The various taping material such as vinyl tapes, semi conductive tapes, self fusing silicon rubber or rubber tapes, Mastic tapes shall be of high quality with high thermal stability and near zero thermal expansion. The arc & track resistant tapes shall be with highest thermal rating (not less than 180ºC).

Material data sheets & catalogs with suggested shelf life shall be supplied.

4.7.3 Other Accessories

The 132 kV high voltage cables sheath bonding system shall be accomplished with the materials designed, manufactured and tested as detailed below.

(1) Bonding leads

Necessary sheath bonding leads and coaxial cable leads to be installed between joints and various types of link boxes and the ground continuity conductors shall be proposed according to IEEE 575 and CIGRE recommendations – Electra 28, 47 & 128. These shall be of XLPE insulated stranded annealed copper conductors and PVC outer sheathed complying with IEC 60502-1or BS 6346. The size of these cables shall be adequate to carry the full expected fault current of the concerned cable circuit.

The bonding lead by coaxial bonding cable shall have low surge impedance not exceeding 30 ohm and the insulation between inner & outer conductors shall have dielectric strength matching with that of the joint sleeve sectionalizing insulator and insulation level between outer conductor & ground shall have half of this value.

(2) Link boxes

The cable sheaths and or bonding leads shall be earthed via earthing link boxes of suitable design. The link boxes shall be made of stainless steel of sufficient mechanical strength and indoor, outdoor or buried type of installation.

The buried type link box shall be designed suitable for water proof sealing arrangement for horizontal installation in shallow pits of depth not exceeding 1.5 meters. For above ground link box it shall be weather proof design suitable for mounting indoors or outdoors on suitable structure or wall. The cross bonding link boxes shall be designed to withstand the impacts due to bursting apart of SVLs.

The terminal posts & links shall be suitable for the specified short circuit requirements and the links shall be made of tinned copper & arrangement of links shall be so designed that refixing of removed links in wrong position is not possible. The contact resistance of the links shall be less than 10 Micro Ohms

(3) Sheath Voltage Limiters

The surge voltage limiters shall be designed with the purpose of limiting sheath surge voltages under switching or fault conditions. The rating, size, class shall be in accordance with guide lines and recommendations of IEEE 575, CIGRE –Electra 28, IEC60099-5. The SVLs shall be of metal oxide, non linear resistor type.

CHAPTER 5:

OPTICAL FIBRE CABLES

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CHAPTER 5: OPTICAL FIBRE CABLES

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5.1 TYPE OF CABLE/FIBRE

The Optical Fibre cable details are furnished so as to choose the suitable splicing kits and distribution frames.

The optical fibre cable shall have 48 fibres of single-mode type, suitable for transmitting light signals.

The fibre shall be made of ultrapure fused silica glass suitable for operation at 1310 and 1,550 nm wave lengths. The design shall be as per recommendations and specifications made by International Committees/Organizations such as ITU-T (G. 651 and G.652) and IEC 60793 and IEC 60794, and all updated versions of both.

It shall provide very low dispersion values for the entire wave length range from 1310 to 1550 nm (so called dispersion flattened or dispersion compensated fibres). The Tenderer shall submit along with his Tender Proposal supporting documents comparing test conditions and measurement results. Complete type test reports for proposed cables, accessories & panels shall be submitted by the tenderer

A coating over the cladding shall be provided to protect the fibre from external influences. This coating shall be made in such a way that it is very easy to perform stripping at Site thermally or mechanically.

5.2 OPTICAL FIBRE CABLE CONSTRUCTION

The optical fibre cables shall be designed to suit both, laying in ducts/PVC pipes and direct burying in the ground or troughs. The fibre shall be laid loose in buffer tubes filled with compound.

5.2.1 Buffer Tube

Twelve fibres per loose buffer tube type shall be provided. The buffer must hold its shape, be tough, not susceptible to ageing and be very flexible, so that it can be handled without noticeable stressing of the optical fibres.

The buffer tube shall be composed of an inner layer with very low friction coefficient and an outer layer to shield the fibre against mechanical influences. The design of the Loose buffer shall be in such a way that the elongation of the cable under normal operating conditions does not result in attenuation increases beyond the limits specified by the above mentioned standards.

For the technical requirements of loose buffer tubes reference shall be made to DIN VDE 0888 in connection with dimensions, color codes and temperature range.

5.2.2 Buffer Tube Filling Compound

The buffer tube and the interstices shall be filled with a slightly thixotropic and chemically neutral compound. This is to prevent water from entering the buffer and running through it which may affect the fibre and result in attenuation increases. This compound shall not corrode the fibre or cause it to swell. It also shall not drip out at the temperature range of: -10°C to + 70°C and shall be easy to wipe and wash off without leaving residue that would make it difficult to connect the fibres.

The compound shall not contain highly inflammable materials and shall have relatively low thermal coefficient. The compound must have a composition such that it is not detrimental to the properties of other cable elements and shall have relatively low thermal coefficient.

5.2.3 The Cable Core

The buffer tubes with the fillers - if any - shall be stranded around a GRP (glass- reinforced plastic) central member. The GRP member shall serve both, as a support (buckling protection against kinking) and as a strain relief member.

The stranding shall be in such a way, that the bending radius will be as low as possible and the optical fibres having a well-defined free space within which strain, buckling, pressure and bending stresses will have no influence on the transmission characteristics.

The stranded buffer tubes/fillers around the GRP member with the moisture resistant compound in the empty interstices among them are wrapped by the core covering which consists of at least one layer non-hygroscopic tape, applied helically or longitudinally with an overlap.

5.2.4 Inner Sheath

A PE sheath layer shall be extruded above the core covering with a thickness of not less than 1.5 mm.

5.2.5 Aramid Layer (strength Member)

An aramid yarns layer is laid above the PE inner sheath layer to serve mainly as strength member.

5.2.6 Intermediate Sheath

The intermediate sheath shall consist of high density polyethylene compound (black) with a thickness of not less than 1.0 mm.

5.2.7 Armoring

The armoring shall consist of a corrugated steel tape applied longitudinally with an overlap. The tape thickness shall not be less than 0.18 mm.

5.2.8 Outer Sheath

The outer sheath shall be HDPE with a semi-conductive layer. The thickness of the outer sheath shall not be less than 1.8 mm

5.2.9 Color Coding of the Fibre/Buffer Tube

The color coding shall be generally in compliance with the standard EIA-A-359 (or IEC 60304). However a mutual agreement between NEA and Bidder/Contractor may still have to be considered.

5.2.10 Marking

The outer sheath of the fibre cable shall have the following marking, repeated every1.00 m.

OPTICAL FIBRE CABLE - 48 FIBRES PROPERTY OF NEA “Year of Manufacturing, Manufacturer” Country of Manufacturer.

5.2.11 Installation Practice

A great care shall be paid when laying the optical fibre cable either directly buried in the ground, in troughs or into cable conduits.

In the concrete trenches between substation buildings optical fibre cables shall be installed in suitable galvanized iron heavy-duty conduits.

Optical fibre cables within cities shall be laid in separate cable conduits, at the same depth of the power cable and adjacent to them.

The recommended method is to lay by hand into cable conduits in such a way to have the maximum possible continuous length to minimize the number of joints.

5.2.12 Splicing/Non-Permanent Joints/Straight Joints

Splicing of the optical fibre cable either along the route or at the terminals shall be carried out in such a way to have minimum losses (< 0.2dB).

The non-permanent connectors are located at the route ends only. These connectors shall have a minimum attenuation (losses of connector and bulkhead together with the pigtail splice loss shall not be more than 0.5dB) and shall comply with the latest technology at the time of contract agreement date.

Straight joints shall be made and buried in the ground at suitable locations and in such a way as to match the soil conditions at Site. Fusion splicing shall be adopted. Average optical loss shall not exceed 0.1dB per splice. No single splice shall have loss exceeding 0.8dB.

The optical fibre joints shall be straight, embedded in reinforced nylon/glass fibre sleeves. The joints shall be complete with cable clamps, inner split sleeve, protecting sheet, fibre guide, adaptor core, outer sleeve, auxiliary heat shrinkable sleeve, self- bonding tape, etc.

5.2.13 Distribution/Termination Boxes

The optical fibre cables shall be terminated at easily accessible terminal blocks inside fibre optic distribution/termination boxes. The fibres shall be terminated in low loss ferrule type of connectors suitable for withstanding high voltage hazards.

The connectors shall be fixed inside the termination box on connector holder, which shall allow easy access to each of the connectors. The Patch cord cable's length shall be 10m and shall be provided with suitable male connector in order to form screw-on type. The loss of connector bulkhead and pig tail splice shall not be more than 0.5 dB.

For new stations in general the Cable Contractor shall provide dedicated floor mounted Fibre optic 19'' panel of sufficient size & dimensions to cater to FO cables associated with Cable & OH line feeders of the substation for which it is designed. The panel shall be of sufficiently large size to give easy access & space for present or future FO related work in the panel. The panel shall match in dimensions, size & color with other proposed or existing OT equipment panels in Telecom room.

For existing stations where there are no spare frames sufficient to accommodate the terminations including spare spaces for the proposed optical fibre cable, the cable Contractor shall provide the FODP as specified above subject to availability of such space as required in Telecom room. If no sufficient space is available, the Contractor may propose wall mounting panel.

The Fibre Optic Distribution panel (FODP) shall be insect-proof and water-tight with protection degree of IP55W (weather proof) made of hot-dip galvanized steel and shall be designed such as to form an extremely rigid structure. The doors shall be of hinged construction with self-locking 3 position padlocking arrangement. The Optical termination boxes shall be designed to be suitable for either wall mounting or floor mounting in telecommunication room adjacent to optical terminal equipment / panels with which the optical link is associated. The panel shall be provided with suitable door operated panel lamp with necessary wiring & MCBs along with cable troughs, cable managers of suitable size & material.

Not with standing any earlier project approvals for the proposed make & type of panel, the Contractor has to propose and obtain fresh and specific approval for his proposed equipment on case to case & station to station basis. The proposal shall include necessary test certificates and certificates of origin for the metallic panel/cabinet & associated equipment inside. In case of 19'' rack mountable Optical distribution frame, the frame height shall not exceed 3U.

5.2.14 Termination of the Fibres

Termination of the fibres shall be such that the sheath and any armoring shall be stripped and then affixed to the termination box. Finally, the buffer fibres are affixed in special fibre splice trays (plastic or metal) and stripped with sufficient extra length. The fibres are stored on these trays and spliced to the departing fibres. The number of splice slots shall not be less than 40. Designs which have separate sub- frames/cassette on buffer tube basis are preferred.

The cable contractor shall provide and install necessary flexible cable conduits to facilitate routing of patch cords from FDP/ FOTB to telecom & SCADA panels as required. Also suitable cable clamping glands shall be provided at the base for cable entry.

Each fibre shall be fitted with demountable FCPC connectors at the termination of each optical link. All patch cords and FOC shall be clearly marked.

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CHAPTER 6:

DRUMMING AND PACKING

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CHAPTER 6: DRUMMING AND PACKING

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6.1 TYPE OF CABLE/FIBER

The Optical Fiber cable details are furnished so as to choose the suitable splicing kits and distribution frames.

The optical fiber cable shall have 48 fibers of single-mode type, suitable for transmitting light signals.

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It shall provide very low dispersion values for the entire wave length range from 1310 to 1550 nm (so called dispersion flattened or dispersion compensated fibers). The Tenderer shall submit along with his Tender Proposal supporting documents comparing test conditions and measurement results. Complete type test reports for proposed cables, accessories & panels shall be submitted by the tenderer

A coating over the cladding shall be provided to protect the fiber from external influences. This coating shall be made in such a way that it is very easy to perform stripping at Site thermally or mechanically.

6.2 DRUM/PACKAGE MARKING

Each cable drum or package shall be identified with permanently attached nameplate of approved material/design. Inscriptions on these plates must coincide with the data given in the respective documents/drawings.

The drums shall be marked in English as given below:

(a) Nepal Electricity Authority

(b) Project Name

(c) Contractor's / Sub-Contractor's Name

(d) Port of Destination

(e) Consignment/Drum Serial No.

(f) Gross Weight

(g) Net Weight

(h) Size of Drum/Box or Bundle (Length X Width X Height)

(i) Brief Indication of Contents

6.3 PACKING

Immediately after tests at the Bidder/Contractor's premises, both ends of every length of cable hall are sealed with suitable end caps to prevent ingress of moisture/foreign particles.

All cables on drums shall be seaworthy.

All packings shall be suitable for transport from factories to the port of embarkation, sea/air freight, and rough handling at the port of destination and movement to and on the Site.

All cables and conductors shall have the inner ends brought out and suitably fixed to the drum to avoid any damage during handling or pulling operations.

The cables shall be rolled on drums as specified in the technical data sheets. The drums shall also be suitable for storage in the open air without additional protection by casing or shutters for a period of at least two years.

All markings shall be legible. Weatherproof tags where used, shall be durable, securely attached.

All accessories, together with the applicable instruction books, packing lists and special site storage instructions shall be carefully created or otherwise adequately protected for overseas shipment.

All bright parts liable to rust shall be treated by using an anti corrosion coat and shall be suitably protected. Surfaces of Flanges, Studs etc., shall be properly protected before shipment.

Accessories items susceptible to damage by water or high humidity shall be encased in watertight and/or airtight, rugged containers.

6.4 INFORMATION TO BE PROVIDED WITH THE BID

Technical descriptions, data sheets, colored catalogues and other material submitted with the Bid must be sufficient to enable the Engineer / NEA to thoroughly evaluate the proposal as to its compliance with the requirements of these Specifications. Where applicable the drawings shall be in A3 or A4 Size.

Minimum Requirements;

(a) Detailed summary of deviations from the Specification

(b) All data sheets duly filled-in and signed

(c) Detailed cross sectional drawings showing all the FO cable components

(d) Quality control system and handling procedure

(e) Sales record of cables/cable accessories proposed of the same design

(f) Brochures and catalogues containing outline dimensions, optical data and installation details

(g) List of accessories included in the proposal

(h) Applicable design specifications

(i) Tests carried out on the offered FO cables/ FO cable accessories

6.5 AS BUILT & PROJECT DOCUMENTATION

The FO cables / FO cable accessories supplied under this specification shall be documented to the extent as to enable the end user to understand the product, its theory of operation, its application, performance and maintenance.

Unless agreed otherwise all the drawings & documents shall be in A3 or A4 size sheets with title blocks approved by NEA. At times as agreed the information regarding vendor details with reference list, completely filled in data sheets and testing Schedules and procedures shall be submitted for approval of NEA / Engineer prior to manufacturing

Furthermore, it must enable NEA to efficiently communicate with the manufacturer about all aspects of operation, maintenance and servicing/spare parts ordering.

The following documents must be submitted to the Engineer/ NEA:

(a) Bill of equipment showing complete re-ordering information for all replaceable parts

(b) Spare parts location, identification and price list in accordance with the Contract price tabulation sheets

(c) Installation, operation and maintenance instructions

(d) Prior to shipment, copies of all routine test certificates shall be made available to NEA. If, during testing, changes are made to any of the cable accessories if approved by NEA, the deviations must be corrected in the relevant submitted drawings to reflect the exact status on delivery. These corrections must be completed immediately following the actual changes

The format, standards, and quality and quantities of drawings may be as per manufacturer's standard, however, subject to the Engineer / NEA approval.

Language in all documents and drawings shall be in English and the dimensions shall be in metric SI-units.

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CHAPTER 7:

UNDERGROUND CABLE INSTALLATION WORKS

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CHAPTER 7: UNDERGROUND CABLE INSTALLATION WORKS

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7.1 GENERAL

This part of the technical specification describes the requirements of the civil works and cable installation works for the 132kV underground cable system and optical fiber cables.

The scope of civil and cable installation works shall include, but not be limited to, the following:

(a) Construction Site Mobilization

(b) Cable Route Survey

(c) Soil Survey

(d) Ground Penetrating Radar (GPR) Survey

(e) Excavation of Trenches

(f) Cable duct under the Roads

(g) Concrete Troughs and Covers

(h) Excavated Material

(i) Methods of Cable Laying

(j) Backfilling and Reinstatement

(k) Safeguarding

(l) Trenchless excavation

(m) Channel Crossing

(n) Route Plan

(o) Diaries

(p) Reports and Certificates

(q) Jointing Instructions

(r) Cable Jointing and Termination

(s) Joint Bays

(t) Route Marker Tapes

(u) Joint and Route Markers

(v) Labelling

(w) Special Tools and Appliances

(x) Verification of Length

The objective of this specification is to define the required engineering and construction services to current technical standards for all of civil and cable installation works of this Project. As the Contract is of a turn-key contract, all items required for satisfactory completion and operation of the transmission system are deemed to be included in the Contract Price, even if all the items required to complete the Plant are not expressly listed or required in the Employer's Requirement.

The Works shall be executed in compliance with all currently valid technical regulations, recognized technical codes, standards, etc. as well as various local regulations in relation to the Works.

7.2 REQUIREMENTS ON CONTRACTOR

The installation of 132 kV cables shall be implemented under the supervision of supervisor authorized/dispatched by the cable manufacturer. Local skilled and unskilled laborers employed by the Contractor for excavation, installation of pipes, cable bedding, cable laying, backfilling and for civil & other miscellaneous work shall be adequately supervised by the Contractor's personnel. Jointing and termination work shall be carried out only by the respective manufacturer’s personnel or personnel evaluated, certified by the manufacturer and approved by the Engineer.

The optic fiber cables shall be installed and tested by the Contractor’s staff subject to the condition that the manufacturer accords a written approval to that effect which will be subject to approval of the Engineer. Jointing, termination and testing works shall be carried out by the supplier or supplier’s approved/authorized agency. The proposed subcontractor / agency is subject to approval of the Engineer.

Excavation, installation of pipes, cable bedding, cable laying, backfilling operations or civil works shall not be subcontracted to a Subcontractor without the written approval of the Engineer.

The installation and handling of the cables shall be undertaken at all times by staff who are provided with all the necessary plant, equipment and tools. The arrangement of the cables and all methods of laying shall be subjected to the approval by the Engineer and shall be planned to provide an orderly formation, free from unnecessary bends and crossing.

Every precaution shall be taken to ensure that cables and accessories are not installed in a manner or under conditions likely to cause electrolytic or other corrosive action or damage to, or be detrimental to the performance of the cables during operation.

Where required by the Engineer, the cables installed within buildings shall be protected against fire in an approved manner. Cables passing through floors shall be installed in the manner specified and where required shall be sealed into bushings employing fire resisting material to minimize the risk of spreading fire. 132kV cables, to be laid on basement within buildings are to be applied with fire retardant coating, the proposed fire retardant coating shall be chemically compatible to cable outer sheath material & acceptable to 132kV cable manufacturer and approved by Engineer.

The Contractor shall be fully responsible for obtaining the exact approved routes and locations from local authorities. He shall execute a ground penetrating radar (GPR) survey at approved positions to determine the most suitable detailed final route and position for the trenches. The width of the GPR survey shall be sufficient to determine the cable route, but not smaller than that of the cable trench. The GPR system used for the survey shall be the latest model approved by the Engineer. The Contractor shall obtain final route approval from the concerned authorities after completing the route survey and execution of the GPR survey or open trial pits.

The cables shall be laid along the routes and in the locations as finally approved by the Employer (NEA) and other relevant authorities. The approving Authority reserves its right to alter the cable routes and locations, where considered necessary, to avoid obstructions, or to suit already finalized reserves allocated by the related Authorities, at the locations of such as future stations.

The Employer/Engineer will, as far as possible, furnish drawings showing the proposed cable routes and the locations of proposed circuits. Further, the Engineer may also furnish available records of existing power cables, the accuracy of which, however, cannot be guaranteed and the Bidder/Contractor has to do his own study, analysis and explorations.

Before starting work on site, the Contractor shall be fully responsible for obtaining the exact approved routes and locations from local authorities and he shall open trial pits at approved positions, to determine the most suitable detailed final route and position for the trenches. The width of trial pit shall be sufficient to determine the cable route, but not smaller than that of cable trench. The Contractor shall obtain the final route approval from the concerned authorities after completing the route survey and execution of the trial pits.

The Contractor shall furthermore obey all relevant rules as applied by the concerned authorities with reference to traffic signs, diversions, safety guards, restoration of road etc. during the performance of his work.

The Contractor shall be responsible for obtaining from the concerned authorities any latest & correct information and details regarding the final levels, road center lines, reserves for cables and other services and any other work in connection with his work.

The Contractor shall take all necessary precautions to prevent damage to existing services and electric cables, and he shall be liable for any costs for repairing damages caused by him during execution of the contracted work, over and above the any penalties.

All the proposed arrangements of cables in major / minor sections between the joints / joint bays and at the stations, the methods of laying & installation, and all arrangements of bonding schemes, link boxes, etc. shall be subject to the approval of the Engineer.

Cable installation bending radii shall be as large as possible, and the minimum shall be in accordance with the manufacturer’s recommendation in each case.

No concreting shall be commenced in any portion of the work until the preparations and the concrete mix design have been approved, and permission been granted by Engineer

Generally, the Contractor may be allowed to execute the works on the transmission routes during the daytime. If the Contractor necessarily needs to work at night on trenching, pipe laying and cable laying where required to minimize the effect on local traffic disturbances and comply with local authority restrictions. Such nighttime work for civil and construction activities shall not cause any additional cost to the Employer and is deemed to be included in the bid for civil works.

The Contractor shall ensure that all excavation machinery and heavy equipment used for civil works on the road are of low-noise type. The Contractor shall provide documentation proving compliance with these standards prior to commencing work.

7.3 CONSTRUCTION SITE MOBILIZATION

Storage and working areas, including temporary storage of topsoil, as well as access tracks shall be furnished in agreement with NEA of the property owner and subsequently maintained, with all costs borne by the Contractor.

The required connections to water, wastewater, electricity and telephone lines etc. shall be procured by the Contractor. This includes submitting applications under his own responsibility to the relevant service utilities.

Upon completion of construction works, the construction plant and equipment shall be removed, the site tidied up and cleaned, and roads, paths, ditches, green areas etc. restored to their previous condition.

7.4 CABLE ROUTE SURVEY

All surveying needed in connection with execution of the contractual works shall be undertaken by and shall be under the responsibility of the Contractor.

Surveying of the cable route shall provide all information on the cable network and all information on structures of the related Authorities which are needed for detail planning and preparation of site plans and sections

The survey/site plans shall show all above-ground objects, such as buildings, masts, trees, footpaths, fences, flower beds, manholes, covers for underground supply lines (water, electricity, telecommunication etc.) and installations along the route to a minimum distance of 10 m on either side of the cable route centerline, as well as all underground facilities of other existing installations in a strip up to 5 m wide from the two trench walls. For property boundaries, road names, premises numbers and names of property or house owners shall be shown.

Longitudinal sections shall show existing and planned structures, bottom of cable trench, ground surface, ground cover etc. They must be prepared on the basis of accurate surveying, to include both the existing level of the ground surface as well as the position of the cables in the trench, and in particular pipeline and cable intersections of other utility services with the cable route.

The GPR survey shall investigate the extent of excavation of the planned transmission line route. The latest model of measuring equipment with adequate performance shall be utilized. Detailed methods and report forms shall be approved by the engineer.

7.5 SOIL SURVEY

The Contractor shall carry out a soil investigation at each joint-bay location along the proposed/designed underground cable routes in order to obtain Soil Strata Profile/Geological Longitudinal Section along the cable route, and the chemical composition of the subsoil and ground water to be used in subsequent designs. Additional locations of significance (e.g. areas of Trenchless Excavation and Cable Support Bridge) shall be investigated by the Contractor as directed by the Engineer, without making additional cost to the Employer.

The locations to be investigated shall be submitted for the Engineer's approval before the commencement of work. GPS position of each auguring point shall be recorded and included in maps with the soil investigation report.

Bore hole Investigations shall be carried out for designing foundations of cable support structures/ bridges as per relevant standards.

The Contractor shall carry out a detailed survey on the thermal conditions along the cable route. This survey include cable sections with thermal stable backfill material in the trenches for direct burying and laying in ducts , laying in special troughs and others suggested by the Contractor. The number of measuring points and measuring methods shall be submitted to the Engineer for approval prior to the commencement of the works.

The results shall confirm that the thermal conditions of the different laying methods and surrounding media at any point along the route meet the minimum requirements which have been assumed for the calculation of the cable rating. Most critical conditions such as drying out of the soil due to minimum ground water table, dry season, maximum ambient temperature, maximum load, etc. have to be taken into account.

After finalizing the survey works the basic data bank, developed AutoCAD files and survey report including drawings shall be made available to the Engineer.

7.6 DOCUMENTATION WORK FOR PERMISSION PROCEDURE

Prior to the commencement of any excavation or trenching works (i.e. for any construction works on public road), the Contractor shall prepare and submit for approval a comprehensive Temporary and Permanent Road and Pavement Restoration Plan to the Employer/Engineer and the relevant Road/Urban Authority (e.g., DoR).

This plan shall include but not be limited to the following:

(a) Detailed methodology for both temporary (emergency) and permanent restoration of all cut road surfaces, sidewalks, and other affected infrastructure

(b) Type, grade, and specification of materials to be used for:

Temporary surface reinstatement (e.g., cold mix asphalt, metal plates)

Permanent reinstatement (e.g., bituminous concrete, GSB/WMM, paving blocks)

(c) Sequence of operations and construction procedures for restoration

(d) Workmanship standards and reference to relevant national and international codes (e.g., Nepal Road Standards)

(e) Traffic management and public safety measures during restoration activities

(f) Schedule of restoration works in line with overall cable laying progress

The restoration plan shall ensure that:

(g) Temporary restoration allows safe and unobstructed passage of vehicles and pedestrians during the construction period.

(h) Permanent restoration restores the road or pavement to its original or better condition, as per the standards and requirements of the relevant authority.

The Contractor shall bear full responsibility for maintaining the restored surfaces until final completion and shall execute all restoration activities at no additional cost to the Employer.

The Contractor shall be fully responsible for the quality, stability, and durability of both temporary and permanent restoration works carried out on roads, pavements, and other affected infrastructure.

In the event of any settlement, surface deformation, cracking, or any other defect or failure observed in the restored areas—whether during the construction phase or within the maintenance period—the Contractor shall:

(i) Immediately investigate the cause of the issue

(j) Promptly implement corrective measures to restore the affected area to the specified standard and original condition

(k) Coordinate with the Engineer and concerned authorities for inspection and approval of the rectified work

No additional cost shall be claimed or paid by the Employer for such corrective works. All labor, materials, equipment, and associated expenses required for rectification shall be entirely borne by the Contractor.

7.7 EXCAVATION OF TRENCHES

Before submitting the Proposal, the Bidder shall satisfy himself concerning the nature of the ground likely to be encountered during construction. The Bidder shall include in his prices provisions for dewatering, shoring and strutting, excavation of ground of any nature and all types of soil likely to be met with and shall quote uniform flat rates. No claims for extra work on any account whatsoever shall be accepted. No increase in price for excavation in hard ground or rock, pumping water, cutting and reinstatement of any asphalt surfaces or any other cause shall be granted.

All relevant costs shall be included in the Contract Price.

All reinstatement of the cable route in connection with this Contract must be carried out by the Contractor. Method statement to carry out the works will be approved by the related Authorities and the works shall be done in presence of representatives of the above, if required.

The exact location of each trench and joint bay shall be subject to the approval of Engineer.

Prior to the start of the works it shall be determined whether road traffic, existing supply pipes, trees, towers and/or similar things will allow the use of construction machinery such as excavators. In the immediate area of supply pipes/lines for sewage, water, telephone, electricity etc., the final excavation of trenches up to the laying open of such pipes/lines shall be performed by manual excavation only. In the performance of the earthworks the Contractor shall thus decide in consultation with the Engineer, in consideration of the local conditions, whether such earthworks are to be carried out by machine or by hand. Proper asphalt cutter shall be used to cut the asphalt surface of the roads without causing much damage. Follow-up claims for payment on account of the impossibility of using machines will not be entertained. The Bidder shall, before costing his bid, familiarize himself with the local circumstances and determine the possibility of using machines.

The Contractor shall ensure that not more than two adjacent sections of excavated trench will be open at any given time.

The trenches shall be located exactly within the approved reservation, the sides shall be free from any sharp material/edges which may likely to injure the cable or accessories. The bottom of the trenches shall be firm and of smooth contour and shall be free from any sharp materials/pebbles, etc. which may likely to damage the cables. Trenches shall be timbered or otherwise secured where necessary so as to avoid earth pressure, subsidence and damage. Whenever trench excavations are completed, cables laying operations shall be started immediately. Where trenches pass from a footway to a roadway or at other positions where a change of level is necessary, the bottom of the trench shall rise and fall gradually.

The Contractor shall take all precautions necessary to prevent damage to the road or ground surface due to a slip or breaking away from the side walls of the trench.

The Contractor shall deal with and dispose of water so as to prevent any risk of the cables and other materials which are to be laid in the trenches being detrimentally affected. He shall provide all pumps, well points and appliances required, and shall carry out all necessary pumping and bailing. The Contract Price shall allow for all such equipment and operations.

The Contractor shall be responsible for public safety and hence shall provide picket fences and ropes along the routes of open trenches, as well as danger notices, barriers and red warning lights during the hours of darkness. A watchman shall be provided for every span of open trench during the night and all the working hours.

Unless otherwise agreed, provision shall be made during excavation for reasonable access of persons and vehicles to property or places adjacent to the route. This provision shall be maintained until interim restoration has been completed.

Excavation in paved roads/side-walks shall be carried out with special care. When removing paving slabs, the Contractor shall take the necessary precautions to avoid breakage. All slabs removed during performance of the work shall be re-established or replaced.

Whenever trenches run parallel to existing services, cables, etc., the Contractor shall maintain a required statutory distance between the existing services, cables, etc. and the edge of the new trench. The Contractor shall cross existing services with the utmost care and shall ensure that the cables are adequately protected and maintain required statutory clearance. The contractor shall obtain approval of Engineer concerning the method of crossing existing services in advance.

7.8 CABLE DUCT UNDER THE ROADS

Under the roads, trenches with duct lines shall be constructed by means of cutting and ducts installation.

Care shall be taken to make the bends of duct lines as easy as practicable and in no case the radius is less than 10 meters. Where approved, split pipes may be used on bends, the pipes being fitted round the cable after laying.

Where trenches with duct lines under the roads is applicable, the Contractor shall provide the ducts for each circuit separately. Ducts shall consist of 230 mm minimum internal diameter for 132kV cables, high density polyethylene (HDPE) pipes or hard uPVC pipes of class C set (PN6). The duct pipes shall be provided with end bells on both ends to prevent abrasions to cables during pulling operations.

The ducts shall be laid on previously prepared controlled bedding backfill soil, then carefully connected and aligned, and consolidated with controlled bedding backfill soil, to be suitably compacted. Ducts shall extend to a required statutory distance beyond road curbstones / edges or to a distance as stipulated by authorities concerned and the ends of the ducts shall be fixed with suitable end bells.

The Contractor shall be responsible for all work involved, including breaking-up of road surface and subsequent reinstatement in accordance with the requirements of the Municipality/ related Authorities.

7.9 CONCRETE TROUGHS AND COVERS

The inner dimensions of trough shall be 600mm in width, 600mm in height without cover and the reinforced concrete cover shall be of sufficient strength. The following words shall be engraved on the outer surface of each cover “NEA - HIGH VOLTAGE CABLES”. Suitable lifting holes shall be provided at suitable locations for covers. Any special tools required for lifting the covers shall be supplied at free of cost. The drawings of required reinforced concrete troughs and covers are furnished in the tender drawings.

Troughs shall be installed on the leveling concrete in the prepared excavation. Until all the cables in the troughs have been covered with their trough covers, no sharp tools such as spades, pick-axes or fencing stakes shall be used in the trench or shall be placed in such a position that they may fall into the trench.

Finished surface of the cable trough shall be made true to lines. Any defective concrete finish will result in rejection of the trough by Engineer. In the case of small defects, proposal for surface repair may be considered, subject to approval of material and method for repair prior to cable installation.

When the Contractor uses the factory production goods, the proposed manufacturers of trough and covers shall be prequalified, after proving their previous experience on production of the same.

The Contractor must submit concrete strength test reports (e.g., 28-day compressive strength as per Nepal Standards (NS)) and get required approval from the Engineer.

7.10 EXCAVATED MATERIAL

The materials excavated from each trench/joint bay/trough shall be placed so as to avoid nuisance or damage to adjacent ditches, drains, fences, gateways and other property or structures. Excavated material shall be stacked so as to avoid undue interference with traffic. Where, owing to traffic or for reasons of safety or other considerations, this is not permissible, the excavated material shall be removed from the Site and returned for refilling the trench on completion of laying.

Surplus material shall be disposed of by and at the cost of the Contractor in accordance with the local authority's regulations.

The Contract Price shall cover and provide for all such transportation of the excavated materials, due to changes of cables routes and/or ground conditions as well as protection/support to the existing adjacent structures during excavation, filling, compaction works and removal of concrete plates, beams, floors, boulders, rocks, large stones or existing foundations etc.

7.11 METHODS OF CABLE LAYING

Cables shall be drawn into ducts or laid in formed trenches or troughs as required by the Engineer. Where cables are laid in formed trenches the installation cost shall include for the removal and recovering of the trench covers where temporary trench protective covers are applied and for the provision of temporary covers on the trenches where they cross access ways

Where triplex cables are laid into pipes or laid in formed trenches, they shall be laid spaced apart in adequate separations for 2 circuits depending on the rating and permissible standing voltage unless otherwise agreed.

Rates for cable installation and laying shall be with respect to the manner and method of installation as mentioned in Price Schedules and corresponding drawings (e.g. ordinary trench, cable duct, direct bury, troughs, trenchless excavation method if applicable, road/pavements cutting etc.).

Each cable circuit comprising triplex power cables and associated optical fiber cables shall be laid at the minimum depth below the road level given in the typical trench and ducts bank cross section drawings. The levels and relative particulars shall be ascertained by the Contractor from the authorities concerned. The Bidder shall satisfy himself concerning the levels before submitting his Proposal.

In general, the depth of the cable trench from the existing ground level shall be 1.2m (top of cable ducts) for 132 kV cables.

Where trenches pass from a roadway to a sidewalk or at other positions where a change of level is necessary, the bottom of the trench shall change gradually.

After the trench has been excavated to the necessary depth, a minimum 100 mm for 132 kV cables of approved controlled bedding backfill soil shall be placed to form a smooth bedding before the cables are laid. The controlled bedding backfill soil shall be suitably rammed with compactor and with sufficient water spraying before cable laying. The excavated trench may sometimes have cracks and sand may leak from the trench. In such a case, any of suitable countermeasures shall be taken by Contractor, such as the backfill sand may be wrapped by geotextile fabric, and so on.

Pulling-in of cables shall not commence until the Engineer has inspected and approved the depth of the trench.

Cables shall be laid directly from the drums into the trenches and special rollers placed at close intervals (maximum 2 meters) shall be employed for supporting the cables while pulling and laying. Rollers used during the laying of cables shall have no sharp projecting parts which are likely to damage the cables.

Proposed method of cable laying and calculation of estimated pulling tension and sidewall pressure shall be approved by Engineer in advance.

After the cables have been laid they shall be covered with the controlled bedding backfill soil well tamped down to a level of 100 mm for 132 kV cables above the top of the triplex cables. Protective covers shall be carefully centered over the cables forming each circuit, each cover being closely placed with the adjacent covers throughout the length of the cable.

The covers shall be of adequate width to protect the cables and provide a minimum thickness of 75 mm.

Cable ducts shall have watertight joints and watertight duct seals provided at each end. Special care shall be taken to ensure that all cable entries to joint pits, substations and at all fire partition walls and sections, whether utilized or not, are durably and permanently sealed against water penetration, to the satisfaction of Engineer.

Where in the opinion of the Engineer, the soil on Site is unsuitable for riddling or backfilling, the Contractor shall arrange for the importation of material with suitable thermal properties which shall be of approved type and quality.

The Contractor shall be solely responsible for ascertaining whether the soil is chemically active and for taking special precautions to protect the cables against chemical action. The Contractor shall take precautions to avoid electrolytic and/or electro-chemical action occurring in situations where the cable and accessories are likely to be installed in close proximity to other dissimilar metals in the presence of moisture.

7.12 BACKFILLING AND REINSTATEMENT

Filling in of trenches shall not be commenced until Engineer has inspected and approved the installed cables and accessories at site.

After the cables have been laid, the Contractor shall backfill the trench with the controlled bedding backfill soil in 100 mm layers.

On top of these layers, the cable protection concrete cover tiles shall be carefully centered over the cables and further up to the ground level, the approved soil shall be well compacted, watered if necessary, and consolidated.

The restoration of roadway and footway surfaces shall be carried out by personnel expertized on such works, and those personnel shall be subjected to prior approval by the Engineer.

After completion of the works, the Contractor shall restore entire road structure, including carriageway, pedestrian walkways and shoulders and any additionally used adjoining areas to their original state.

The reinstatement of all excavated roads shall be carried out by the Contractor in strict accordance with the conditions agreed upon with the relevant governing authority of the road without making any additional cost to the Employer.

Each refilled trench shall be maintained in a good safe condition by the Contractor at his expense until such time as he can carry out permanent reinstatement of the upper level and surface to their original condition, or to the level of the surrounding curb stones, respectively, whichever is higher.

All slabs being removed during performance of the work shall be re-established or replaced. All excess excavation products shall be removed without making any additional cost to the Employer.

The Contract Price shall include the required works for eliminating material fills, and if necessary, mixing of different soil material, spreading and compaction in specified layers.

7.13 SAFEGUARDING

The Contractor shall provide and maintain at his own expense all lighting, guarding, temporary fencing and watching when and where necessary or required by Engineer for the protection of the work and for the safety and convenience of the public.

In the case of excavation close to structures or already laid cables, pipes or other objects, the Contractor shall undertake suitable safeguards to ensure that these structures, cables, pipes and other objects incur no damage. The Contractor shall be fully liable for any damage caused.

7.14 TRENCHLESS EXCAVATION

There may be several specific big drainage/water pipe crossings to be carried out in the proposed cable route. All these crossings shall be considered trenchless excavation methods (e.g. Jacking pipe, Horizontal Directional Drilling etc.).

The Bidder shall submit with the Bid the detailed technical proposal for Trenchless excavation method of crossing of the existing big drainage pipes if any. The Bidder shall survey and investigate the site to collect necessary information for preparation of his technical proposal.

Contractor shall submit proposed design with necessary design calculations after carrying out necessary detailed investigation at each site. All such works, including preliminary investigation and design works, impact assessment, status recording, construction methodology, workmanship, etc.

shall be as per the internationally accepted standards.

The contractor shall include this construction cost in the contract price.

Contractor shall contact local Authorities and obtain drawings showing existing services and structures that interfere with proposed underground pipe jacks route as to avoid damage to any property.

Contractor shall survey and submit for approval design profiles of underground conduits, showing all existing services and structures as well as proposed temporary methods. This design profile shall be approved by the concerned local Authorities before site execution takes place.

During operation, Contractor shall maintain the designed and approved profile, particularly level of cable pipes and accuracy of alignment. As built profile, shall be checked to be in line with proposed one.

In case of trenchless excavation methods under asphalted road, Contractor shall obtain instructions and approval for trenchless methods from Municipality / related Authorities prior to execution. Contractor shall monitor road levels before and after installing trenchless methods. The result of asphalt level measurements shall be reported at the end of monitoring period to Municipality / related Authorities and Employer/Engineer. If settlement occurs due to trenchless methods under asphalted road is found to be more than 5mm, Contractor shall report this finding immediately to the Engineer.

Contractor shall recommend the pavement (asphalt, concrete, etc.) without any additional cost to the Employer.

Before starting work on site, Contractor shall submit for approval detailed method statement on proposed installation method.

7.15 CHANNEL CROSSING

There may be a specific channel crossing to be carried out in the proposed cable route. This crossing shall be channel over-crossings.

Contractor shall submit the design with necessary design calculations after carrying out necessary investigation at the site. Proposed design shall be aesthetically compatible to existing environment of the site.

The structure design shall be as follows:

(a) Super Structure: Hot dip galvanized steel Lattice Girder braced suitably to support the transmission line with spare ducts & distribution lines

(b) Sub Structure: Suitable type of reinforced concrete abutment designed based on the findings from Geotechnical Investigation at the location, supported on piles if necessary

(c) Erosion protection: Foundation backfill forming the canal bank and the area damage due to construction operation shall be protected from erosion by stone gabions with Geo textile.

The structure shall be designed to withstand Ultimate Limit State considering the additional loads at events of maintenance and other loading as per the relevant design standards. Such design shall withstand the Serviceability Limit State determined as per the relevant design standards.

7.16 ROUTE PLAN

During the progress of the Work the Contractor shall record on a set of route plans and cross-section drawings of an approved form, such particulars that will allow an accurate reference to be made in the case of any fault or projected modification. These marked up records shall show, amongst other data, both indoors and outdoors the exact position of every joint, link box, earth electrode and connections thereto and also particulars of the depth of the trench, the arrangement of the cables and the position of all obstructions revealed during the course of excavations.

Two copies of the marked up cable route records shall be submitted by the Contractor (one copy to Employer, one copy to Engineer) within 10 days after completion of installation works.

Final route As Installed drawings shall be handed over not later than 15 days prior to commissioning of each particular circuit. The above requirements will be a part of the conditions for the payment certification of the cable installation and commissioning works.

7.17 DIARIES

The Contractor shall provide suitable diaries of an approved type (to which at all times the Employer/Engineer shall have access) and shall enter in these diaries all the measurements of the Work on the Site as completed on the day on which the measurements are taken, together with full particulars and details of all obstructions, modifications, extra works and incidents and the number and grades of men employed in each of the several portions of the work in progress.

The diaries shall be presented for the Engineer’s examination and approval on a daily basis. The diaries shall, when signed by both parties, be deemed to be a true record of the work executed. A signed copy of diary record will be retained by the Engineer.

7.18 REPORTS AND CERTIFICATES

As each section of the Works is completed, the following reports in duplicate shall be submitted to Employer/Engineer for record purposes and shall be incorporated in the 'As-Constructed Records'.

(a) Jointing Reports detailing the date, weather conditions, jointers and supervising Engineer's names, details of type of cable and type of joint or termination, location and joint bay number, ambient temperature and any other information relative to the jointing process.

(b) Electrical Test Certificates shall be submitted detailing the test results of insulation resistance and any other electrical tests required by Employer/Engineer together with similar detail as required for Jointing Reports.

(c) Full written reports will be required of any damage occurring to cable or equipment together with remedial action proposed which will be subject to the approval of Employer/Engineer.

7.19 JOINTING INSTRUCTIONS

As soon as possible after the commencement of the Contract and before materials are dispatched, copies of the jointing instructions applicable to the joints, sealing ends and terminations to be supplied shall be submitted to Employer/Engineer for approval, together with details of the physical and electrical characteristics of the filling medium proposed.

Jointing/termination instructions shall be comprehensive and fully illustrated to enable any qualified jointing team to use the instructions. A fully dimensioned true to scale drawing shall accompany the instructions together with a complete list of all special tools employed and an indication of their use together with a description of any precautions necessary.

7.20 CABLE JOINTING AND TERMINATION

The Contractor shall be responsible for necessary coordination and for obtaining drawings of all cable jointing boxes or apparatus into which cables are to be terminated and shall ensure that the design is suitable for use with the cables supplied under this Contract.

No cable joint shall be installed without the agreement of Employer/ Engineer.

The Contractor shall submit drawings showing the types of joints, cable sealing end, terminal box or gland that he proposes to supply under this Contract.

During jointing the joint location (joint bay) shall be adequately covered with tents or other water and dust proof shelters. Proper precautions shall be taken to guard against fire and to ensure temperature and humidity conditions suitable for jointing operations.

7.21 MANHOLES

The Contractor shall submit drawings of the detailed layout and construction of manholes, which shall be designed. Precast manhole or manhole in situ construction of required width, height and length shall be provided. In particular, special attention shall be provide to the water leakage/prevention of the manhole, especially at the connection point between the pipes and the wall, etc., when designing and constructing manholes.

7.22 JOINT BAYS

The Contractor shall submit drawings of the layout and construction of joint bays, which shall be designed. Precast trough or trough in situ concrete joint bays of required width and length shall be provided. On completion of joints, the same shall be filled with the controlled bedding backfill soil compacted and covered with precast cover. Suitable approved concrete boxes shall be provided for link boxes. Joint bay arrangement with proposed joint location shall be as per the recommendations of the cable manufacturer to confirm the required space for making a joint.

Arrangement and location of 132kV Cable joints shall be subject to the approval of Employer/ Engineer

7.23 ROUTE MARKER TAPES

Cable route warning/marker tapes for use during installation shall be continuously installed 900 mm below the ground level.

The tape shall have a thickness not less than 0.1 mm gauge, shall be 200 mm wide and manufactured from high grade polyethylene pigmented in bright colors.

The following message in Nepali and English shall be continuously printed in a contrasting color in characters not less than 40 mm high and the pigments/inks used for text printing are not prone for deterioration and fading.

DANGER
HIGH VOLTAGE CABLES BELOW

The tape shall be supplied in rolls of suitable lengths on stout reels. Tapes shall be in yellow color with black lettering.

7.24 JOINT AND ROUTE MARKERS

Cable markers for 132 kV cables shall be provided along each route of buried cables and erected after the reinstatement has been carried out.

Markers shall be installed at all joint positions, at all places where the route changes the direction, and on straight routes at distances not exceeding 50 meters. The location of the markers shall be approved by the Engineer.

Samples with details of all markers proposed to be used shall be submitted for Employer/Engineer's approval before cable installation work commences. The joint bay markers shall visibly differ from the markers for the cable routes and where required by Employer/Engineer, link boxes, pits, etc. shall, after installation, be protected and marked at each box location by suitable designed markers approved by Employer/Engineer.

7.25 LABELLING

All cables shall be identified below the termination at each end, in cable pits and at approved positions by means of identification plates engraved with the cable number, feeder name, size of cable, number of cores, phase color etc., or such lettering as the Engineer may require. The termination end identification plates shall be securely fastened in a permanent manner, and shall be made of material able to resist corrosion, damp and mechanical damage.

7.26 SPECIAL TOOLS AND APPLIANCES

Special tools which are not listed in the relevant schedule by the Contractor during the tendering stage, but which are used by the Contractor during the erection or testing works shall be supplied to the Owner free of charge. A minimum of one set of such special tools shall be handed over to the Owner. However supply of free tools & test equipment for works is not envisaged.

7.27 VERIFICATION OF LENGTH

The Contractor shall notify Engineer once the cables are laid and ready for verification of installed lengths by Engineer. The Contractor shall not backfill the trench unless Engineer completes verification of route/cable lengths.

While doing measurements, the following aspects shall be taken into consideration.

(a) Looping for joints

(b) Looping for terminations

A format for recording cable measurements shall be proposed by Contractor subject to approval of Engineer.

CHAPTER 8:

TOWER

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CHAPTER 8: TOWER

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8.1 GENERAL

The scope of work comprises of supply and erection of steel lattice single circuit tower for new 132kV special branch tower to terminate the existing 132 kV transmission line conductors between Lekhnath substation and Syangja substation to make LILO connection to Birauta substation by new double circuits underground cables.

Bidders must offer the tower from a reputed and experienced in accordance with the qualification criteria mentioned in Section III of the Bidding Documents.

8.2 DESIGN SPANS

The design shall provide for basic, wind and weight spans given in Clause 15.4.

The term basic span shall mean the horizontal distance between centres of the adjacent towers on level ground.

The term wind span shall mean half the sum of adjacent horizontal span lengths supported on any one support.

The term weight span shall mean the equivalent length of the weight of conductor supported at any one support at maximum temperature in still air.

8.3 CONDUCTOR AND EARTH-WIRE CLEARANCES

For the support clearances from conductors, arc horns, jumper loops and all live metal to the structure or earthen steel work shall not be less than those specified in Technical Schedule 15.3. Where uplift condition occurs at tension tower positions, details should be provided to show that the above requirements are not infringed.

The length of angle structure cross-arm shall be such as to ensure that the distances between conductors from straight-line structures are maintained in plain normal conductors.

For the tower crossarms shall generally be so proportioned that live metal clearances are maintained under all conditions without the use of jumper suspension insulators.

The phase distance: the minimum distance between testing point at insulators shall set as per standard practice at IEC or any other standards. Allowance shall be made for increasing or decreasing the length and varying the arrangement of tower crossarms to enable span connections to be made in any desire phase sequence.

The maximum angle of the shade protection of the earthwire to any top conductor shall not be greater than 30 degrees to the vertical at the support and at any point in the span.

The clearance between the line conductors and ground in still air under the maximum specified temperature and final tension shall not be less than the figure stated Clause 15.3. An additional clearance of 0.5m is required to allow for long-term conductor creep which shall be included in the calculation of tower heights.

Where obstruction of other types is met requiring special clearance, the clearance shall be approved by the Employer. If any factors likely to cause infringement of clearance become apparent the Contractor shall inform the Employer immediately.

The sag of the earth wire for the basic span at the severest condition, shall be 80 percent of the phase conductors.

Clearance between phases: The distance between conductors belonging to different circuits shall be 1.20 times the distance belonging to the same circuit. However, the distance shall not be less than 3.0 m.

8.4 ASSUMED NORMAL WORKING LOADING

The assumed maximum simultaneous working loading on special branch tower shall be as follows:

(a) Vertical loadings - The weights of insulators and all other fittings and the actual dead weight of specified span lengths of line conductor and OPGW.

(b) Transverse loadings - The specified wind pressure at right angles to the conductors on the whole projected area of the conductor, insulators and OPGW.

In addition, the transverse and horizontal components of the maximum conductor and OPGW tensions stated in Clause 15.4 resolved for the maximum angle of deviation concerned.

(c) Longitudinal loading - the full maximum longitudinal conductor and OPGW tensions given in Clause 15.10 and 15.11 on one side only of the tower in longitudinal direction and no conductors and OPGW strung on the other side of tower, together with a plan angle of entry on the line side up to 15 degree equivalent to 30 degree line deviation.

8.4.1 Erection loads

Tenderers shall fully consider the loading conditions for the towers and provide adequate margins of strength in the designs for unbalanced erection loading. The Tenderer shall indicate on Tender drawings to which points on the towers to be proposed to use back stays when stringing conductors and shall state what factors of safety are obtained under these conditions.

8.4.2 Design

The design of support, conductors, insulators and fittings shall be such as to minimize the risk of damage or deterioration in service of any part of the transmission lines due to vibration.

The calculation procedures applied for support and foundation design shall be submitted by Tenderer in his tender.

8.4.3 Broken wire conditions

Towers shall be designed for vertical and transverse loads plus the full unbalanced longitudinal forces at maximum working tensions due to the breakage of;

(a) Any one phase conductors and the earth wire at the same time

or

(b) Any two conductors of the same circuit/ opposite circuit at the same time

Calculation of stresses in support members under broken wire conditions shall be made for the severe condition of loading of that particular member for the range of loading for which the support may be employed.

8.4.4 Factor of safety of towers

Each type of tower shall be designed such that no failure or permanent distortion shall occur when tested with applied loading equivalent to the maximum working loading multiplied by the specified safety factors as listed in Clause 15.6.

8.5 CONSTRUCTION OF TOWER STEELWORK

All designs shall be such that no trouble shall arise in service from vibration or excessive deflection due to the use of very light section.

Bolt holes shall not be more than 1.5 mm larger in diameter than the corresponding bolt diameter. The distance from the center of bolt holes to the edge of any steel section shall not be less than 1.5 times the diameter of the bolt.

All tower member joints or joints between prefabricated panels to be made at Site shall be secured with bolts, nuts and washers. As far as conveniently possible, bolt heads, rather than nuts, shall be on the outer or upper faces of support joints.

Structure cross arms shall be so arranged that they can be disconnected from the body without disturbing main structure body members.

The conductor landing points on cross-arms shall be so arranged that an additional hole for the attachment of conductor erection and maintenance tackle is provided adjacent to each hole for tension shackles. It shall be possible to apply full conductor tension and weight safely to these additional attachment points.

Mild steel when stored in the fabricators stockyard prior to fabrication and galvanizing shall be marked continuously throughout its length with a light blue water paint line. In addition, the grade number of the steel shall be painted on and ringed around with paint.

Members that are capable of being fitted in more than one position on the structure shall all be of the grade of steel suitable for the most onerous loading conditions.

8.5.1 Design stresses

Support members shall comply rigidly with the following design requirements:

(1) Unit Stresses:

(a) All parts of structure shall be so proportioned that the unit stresses in all the members and their connections for the design loading specified in the drawings multiplied by the respective overload factors or factor of safety (F.O.S) shall not exceed the ultimate values in kg. Per square centimetre specified as per latest IS 802 (part). Tenderer may however offer economical design, based on any other strut formula conforming to approve equivalent standards. But in no case the maximum stresses in members, including factor of safety, shall exceed the following value for

(i) Member	MS (Mild Steel)
Tension based on net sectional area	2600 Kg/cm2

Axial compression based on gross sectional area	2550 kg/cm2

(ii) Connection bolts

Shear on gross area	2220 Kg/cm2
Bearing (on mild steel)	4440 Kg/cm2
Tension on net area of threaded portion	1980 Kg/cm2

(b) In calculating net sectional area of member, the diameter of bolt hole shall be assumed to be 3 mm larger than that of nominal bolt diameter. Net sections shall be figured on both straight and zigzag sections across the member as specified in British Standard BS 449 or approved equivalent standards.

(c) Bolts with threads shall be of such length that the threaded portion does not extend beyond 3 mm into the ply portion of the members connected. In this condition full diameter of bolt may be considered as effective for bearing and shear. If threads extend into the ply portion of the members connected, the permissible stresses for bolts given above for shear and bearing shall be reduced by twenty (20) percent. The full diameter shall be the nominal diameter of bolt and the gross area shall be that computed based on the nominal diameter.

8.5.2 Slenderness Ratio:

(a) Slenderness ratios for members shall be limited as follows:

Tower legs, main compression members In cross-arm, ground wire peak	- 150
Other compression members carrying Computed stresses	- 200
Redundant members or members carrying Nominal stresses	- 250
Members subjected to tension only	- 375

(b) In determining the slenderness ratios for various members' suitable provisions shall be taken into consideration for various types of end connections, eccentricity of load transfer in the members, etc. The unsupported length 'L' shall be considered from centre to centre of intersections or working lines at both ends of members. A single bolt connection shall not be considered as offering restraint against rotation. A multiple-bolt connection, with minimum two (2) bolts, properly detailed to minimise eccentricities shall be considered to offer partial restraint if such connection is to a member having adequate flexural strength to resist rotation of joint. Points of intermediate supports shall not be considered as offering full restraint to rotation, if the same is provided only on one flange of the member. The Tenderer shall clearly indicate the percentage of restraint assumed by him in such cases.

(c) For members of double-diagonal web system which are bolted at their point of intersection, the maximum L/r shall be determined from the following criteria:

(i) 'L' is the greatest distance from the point of the intersection to either of the end connections and 'r' is the minimum radius of gyration of the member.

(ii) 'L' is equal to 0.75 times the distance between the end connections and 'r' is the radius of gyration of the member for its axis parallel to the plane of connected leg.

8.5.3 Step-bolts

Two diagonally opposite legs of all structures shall be equipped with galvanized step bolts (M16 x 160mm) on the leg at intervals not exceeding 380mm commencing immediately above the anti-climb device and extending to within one meter of earthwire. Step-bolt design shall be to the approval of the Employer or the Employer's Representative. Holes for removable step-bolts below the anti-climbing device shall be provided at not more than 380mm centres on the legs to which the permanent step-bolts are fitted.

8.5.4 Workmanship

All work shall be in accordance with the best modern practice in the manufacture and fabrication of materials covered by this specification. The Contractor shall be responsible for the correct fitting of all parts, shall replace free of cost any defective material discovered during erection and pay all costs of field corrections for such replacement. All parts of the structure shall be neatly finished and free from kinks, twists or bends. All holes shall be made with sharp tools and shall be clean cut without torn or ragged edge. The fabrication shall be in strict accordance with the shop drawings prepared by the Contractor and approved by the Employer or the Employer's Representative.

Structural materials shall be straight and cleaned of all rust and dirt before laid out or worked in any manner. Shearing and cutting shall be performed carefully. Manually guided cutting torches shall not be used.

All bolt holes in steel members shall be punched, subpunched, reamed or drilled before galvanizing. Holes shall be drilled instead of being punched if the thickness of the metal exceeds the diameter of the hole. All holes shall be clean-cut and without torn or ragged edges. All holes shall be cylindrical and perpendicular to the member.

The diameter of the finished bolt hole shall not be greater than the normal diameter of the bolt plus 1.5mm. Plugging, welding or slotting of mispunched, misreamed or misdrilled holes will not be permitted. The holes shall be located accurately so that when the members are in position the holes will be lined up before being bolted.

8.5.5 Member fabrication-galvanising

All galvanising shall be carried out by the hot dip process and shall conform in all respects with BS 729.

All surface defects in the steel including cracks surface laminations, laps and folds shall be removed in accordance with BS 4360. All drilling, cutting, welding, forming and final, fabrications of unit members and assemblies shall be completed before the structures are galvanised. The surface of the steelwork to be galvanised shall be free from welding slag, paint, oil, grease and similar contaminants.

The preparation for galvanising and the galvanising itself shall not distort or adversely affect the mechanical properties of the material.

For all parts other than steel wires the coating shall consist of at least 610 grams of zinc per square meter of surface and be not less than 0.086mm in thickness.

On removal from the galvanising bath the resultant coating shall be smooth continuous free from gross surface imperfections such as bare, spits, lumps, blisters and inclusions of flux, ash or dross.

During off loading and erection of supports the use of nylon or braided slings shall be used. Galvanised steel work which is to be stored in the works or on site shall be stacked properly to provide adequate ventilation to all surfaces to avoid wet storage staining.

Small areas of the galvanised coating damaged in any way shall be restored in accordance with the requirements of item 1.7 of General technical specifications.

Tests on samples shall be carried out to BS *729.*

8.5.6 Bolts and nuts

No bolt of diameter less than 16mm shall be used. No screwed threads shall form part of shearing plane between members.

When in position all bolts or screwed rods shall project through the corresponding nuts by at least one full thread but such projection shall not exceed 10mm.

Bolts shall be galvanised after thread cutting to the same specified coating weight as specified in BS 729.

Nuts and heads of all bolts shall be hexagonal.

All bolts, nuts and washers shall be hot dip galvanised and subsequently centrifuged (according to BS 729). Nuts shall be tapped after galvanising and the threads oiled to permit the nuts to be finger turned on the bolt for the full depth of the nut.

After fixing, bolt heads, washers and nuts shall receive two coats of zinc rich paint. Only one type of bolt for the whole project, either mild steel or high tensile steel will be permitted in order to prevent inadvertent misuse. The Contractor shall state clearly which type of bolt his designs are based upon.

All bolts supplied for this contract will be provided with one nut and one spring washer of approved design. Taper washers and packers are to be fitted where necessary.

The Contractor will instruct his supplier to select two samples of each type of bolt and nut to be used on the Contract and send these samples to the Employer or the Employer's Representative for approval within one month of the date of issuing the order. The Employer or the Employer's Representative will then reject bolt consignments, which in his opinion fall in any respect below the standard of samples submitted and approved.

8.6 TOWER EARTHING

In addition to the mechanical earth wire termination requirement, all steel towers shall be fitted with separate earth bonds for earth wire continuity and the Contractor shall provide all necessary connecting facilities.

All the four legs of the tower shall be connected to the earth through electrode as shown in Drawing BIR-OH-E-0004.

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.

Steel towers need not be fitted with a separate earth bond and earthing continuity throughout the support will therefore depend upon surface contact between members.

Tower shall be provided with means for connecting an additional earthing device as required by the Employer or the Employer's Representative. Holes are to be provided in all supports near ground level to take bolts for earth lead connections.

All legs of every tower shall be equipped with galvanized steel wire and cast into the foundation concrete to be readily available for the connection of additional earth electrodes in the event of the initial footing resistance exceeding 10 ohms. Tenderers rates for the structures shall include for such additional works.

Galvanized steel rods shall be driven where necessary in sufficient number to ensure the combined structure footing and earth electrode resistance does not exceed 10 ohms. Where it is necessary to drive more than one earth electrode at any support, the locations shall be to the approval of the Employer or the Employer's Representative. All earth electrodes shall be electrically bonded together using galvanized steel wire.

The tops of all electrodes shall be at least 500 mm below the surface of the normal reinstated ground level.

Connection of earth wires to the structure stub angles shall be by bolting. Tenderers shall submit details of his proposals in this regard.

8.6.1 Payment for Grounding Materials

Payment for grounding materials shall be included in the price of special branch tower including all the costs incurred in furnishing all materials, equipment, labours and other operational related to the scope of work of earthing as specified.

8.6.2 Phase, and Number Plate

All structures shall be equipped with a suitable framework mounted to accommodate support number plate in a conspicuous position. One plate is to be supplied for tower, except for phase identification plates.

All terminal structures shall be equipped with additional frameworks, mounted to accommodate a set of three phase colour plates as Drawing BIR-OH-E-0003.

All plates shall be affixed to the framework by means of galvanized bolts, nuts and lockouts. Washers should be of such material and so positioned that damage to the enamel will be prevented.

All plates shall be manufactured from mild steel sheet with vitreous enamelled finish. A detail drawing for such plates shall be prepared by the Contractor subject to the Employer's approval.

Line color-coded vitreous enamel identification plates should be fitted to the climbing legs of every structure in accordance with line colour code scheme to be supplied to the successful Tenderer. Each plate shall be approximately 70mm wide and shall be applied one immediately below the anti-climb device, one halfway up the towers and one immediately below the lowest cross arm.

8.6.3 Payment for Plates

Payment for phase and number plates shall be included in the price of special branch tower including all the costs incurred in furnishing all materials, equipment, labours and other operational related to the scope of work as specified.

CHAPTER 9:

LINE CONDUCTORS AND ACCESSORIES

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CHAPTER 9: LINE CONDUCTORS AND ACCESSORIES

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9.1 GENERAL

The scope of work comprises of supply and stringing of ACSR "Duck" conductor for new 132kV special branch tower to cut existing 132 kV transmission line between Lekhnath substation and Syangja substation and branch to new double circuits underground cables.

9.2 PORCELAIN AND GLASS INSULATORS AND FITTINGS

The porcelain and glass insulators, hardware fittings and general arrangement of the insulator string shall be as indicated in the Drawing BIR-OH-E-0005. These insulator strings shall meet all technical requirements as per standard.

9.2.1 Porcelain and Glass Insulators

Tension insulator units shall comply with IEC/ANSI/BS or such other standards as may be approved.

Bidder must offer Porcelain or Glass insulators from reputed and experienced manufacturers in compliance with the qualification criteria mentioned in Section III.

The technical characteristics of the insulators shall be as stated in Clause 15.9.

Retaining pins or locking devices for the insulators units shall be of an approved material. The pins and locking devices shall be such that when set under any condition of handling for service, nothing but extreme deformation shall allow separation of the glass insulator units or fittings or shall cause any risk of the retaining pins or locking devices being accidentally displaced. The design shall be such as to allow easy removal for replacement of insulator units or fittings without the necessity to remove the insulator strings from the crossarms. Retaining pins or locking devices shall be incapable of rotating when in position. Fittings shall comply with the requirements of BS 3288.

All ball and socket joints on insulator sets shall be lightly coated with grease approved by the Employer/ Employer's representative.

9.2.2 Porcelain or Glass Insulator set fittings

The insulator units shall be assembled to insulator strings and insulator sets with appropriate fittings as the Drawing BIR-OH-E-0005. Conductor clamps and shackle for fixing the insulator sets to the towers are part of the insulator sets.

On tension insulator sets vernier plates or other appropriate elements shall be installed to allow adjustment of conductor sags.

132 kV insulator sets shall be suitable for application of hot line maintenance techniques.

9.2.3 Arcing Horns

The design of all insulators set line and earth end fittings shall be suitable for mounting of arcing horns. Arcing horns shall be provided in accordance with the drawings attached.

Tension string arcing horns shall provide a single arc path above the upper surface of the porcelain or glass insulator string. The design of arcing horns shall be such as to prevent cascading of the arc over the line and insulator units in the events of flashover. The life and general shape of the arcing horns shall be such as to give a maximum value of impulse flash over voltage consistence to the above requirements. Insulator strings and arc fittings shall be subjected to such tests as the

Employer/Employer's representative may require proving compliance with the requirements without extra cost to the Employer.

9.3 CONDUCTOR ACCESSORIES AND HARDWARE-FITTINGS

9.3.1 Down Dropper Conductors

All aluminum conductor (AAC) shall be applied for down dropper conductors between each phase and line arrestor on the ground that shall be satisfied with same transmitted capacity power as ACSR “Duck” conductor in Clause 15.10.

9.3.2 Shackles

Shackles shall be of malleable iron to BS 3288 and supplied with shackle pin, washer and retaining split-pin and shall be of such dimensions as to ensure the factors of safety specified in Clause 15.6 are maintained.

9.3.3 Conductor-end metal work

All conductor-end metalwork such as socket-tongue adapters, yoke plates, conductor clamps, socket clevises, tension clamps etc., shall be of approved design and shall comply with the requirements of this specification.

9.3.4 Joint

Conductor joints and clamps shall be designed in accordance with BS 3288. The electrical conductivity and current carrying capacity of each joint or complete clamp assembly shall not be less than the equivalent length of conductor.

Tension joints shall be of approved design and shall be made so as not to permit slipping of or cause damage to or failure of the complete line conductor or any part thereof at a load less than 95% of the ultimate strength of the conductor with which they are to be used.

Tension joints shall be of the tubular compression type requiring only one set of dies. All aluminum compression joints shall be of at least 99.5% pure aluminum.

Tension joint sleeves shall be supplied complete with grease. Dies shall be plainly marked with size and type and only those approved by the Employer/Employer's representative shall be used with each individual joint or conductor. The make and type of hydraulic jointing compressor shall be approved by the Employer/Employer's representative.

The design of joint and clamps and any special tools to be used in their assembly shall be such as to reduce to a minimum the possibility of faulty assembly or erection.

Non ferrous alloys shall be such as to withstand atmospheric conditions without painting or other protection. The Contractor shall submit certificates of analysis for the various parts.

9.3.5 Tension clamps

Tension dead end clamps shall be of aluminum alloy compression type and shall be equipped with an integral jumper lug. This lug shall have at least four bolt holes for connection of the non tension compression jumper end.

The mechanical efficiency of any tension clamp shall not be affected by method of erection involving the use of "come- along" or similar erection clamps before, during or after assembly and erection of the tension clamp itself.

9.3.6 Vibration dampers

Each conductor including the earth wire shall be fitted with vibration dampers. Except for particularly long spans, two dampers per conductor and one damper for earth wire shall be erected in one side of each span at suspension and tension positions.

The dampers shall be of an approved type, shall have conductor clamps of aluminum alloy, and shall be attached to the conductors in such a manner as will prevent damage to the conductors and to individual strands thereof.

Evidence of the adequacy of the dampers shall be provided by copies of typical Vibration Recorder Tests carried out by the damper manufacturer.

The manufacturer shall calculate the number of dampers per span, the position and the maximum span length for each damper size. The calculation shall be based on the following data:

(a) Conductor and conductor arrangement, armor rods

(b) Equivalent span lengths

(c) Conductor height above ground

The calculations shall be made for the following three terrain conditions, if not indicated otherwise or instructed by the Employer:

(d) Hilly terrain, with trees and obstructions

(e) Flat terrain, no trees, and no obstructions

(f) Undulating, relatively open country with some trees

9.3.7 Armor rod

Armor rod shall be of the preformed type and shall be made of a material compatible to that of the conductor and shield wire. Rod shall be shaped in such a way that they will grip the conductor and shield wire tightly. The rod shall be capable of being installed by hand without the use of special tools. The length of the rod shall be determined by the manufacturer of vibration dampers.

9.3.8 Corona and radio interference

The design of all conductor fittings, vibration dampers etc., shall avoid sharp corners or projections, which would produce high electrical stress in normal working. 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.

Particular care should be taken during manufacture of conductors and fittings and during subsequent handling to ensure smooth surfaces free from abrasion.

Radio interference noise of insulator and conductor fittings shall be within the limits of IEC or BS recommendations.

9.4 PAYMENT FOR INSULATORS, THE FITTINGS AND ACCESSORIES

Payment for the supply and delivery for the contract item, conductors, insulators and accessories, will be made at the unit bid price. Therefore, in the Price Schedule, the unit bid price shall include full compensation for all the costs incurred in furnishing all materials, equipment, labours and all other operations related to insulators, the fittings and conductor accessories fabrication, delivery etc.

CHAPTER 10:

TOWER FOUNDATION AND ASSOCIATED CIVIL WORKS

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CHAPTER 10: TOWER FOUNDATION AND ASSOCIATED CIVIL WORKS

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10.1 GENERAL

The Contractor shall furnish all materials, equipment and labor and perform all operations required for the design and construction of all the concrete foundations as shown on the drawings and other relevant civil works, as specified herein and as evidently necessary to complete the work.

10.2 FOUNDATION DESIGN

10.2.1 General

The Contractor shall design the foundation types specified on the bid drawings for the structure type used in the line to produce an economical family drawings and calculation for the approval of the Employer or Employer's representative before commencement of construction. Upon completion of detail soil test, the Contractor shall select the most economical foundation subject to the approval of the Employer or Employer's representative. The general foundation design parameters are given in Clause 15.13 and Conceptual Drawing is given in Drawing No. BIR-OH-E-0006.

10.2.2 Submittal

The Contractor shall submit the foundation design and calculations, detail drawings and reinforcing steel and concrete schedules to the Employer or Employer's representative for review and comment before construction commences. Review of the foundation designs by the Employer or Employer's representative in no way relieves the Contractor from his responsibility for an adequate foundation design, even though this specification sets forth the basic foundation design criteria. Upon receiving the Employer's or Employer's representative's comments, the Contractor shall submit to the Employer one set of electronic copy and set of drawings of all foundation details, including reinforcing steel schedules on drawing sheet sizes, form, heading, etc., as required by the Employer for record file.

10.2.3 Design loads

The loads used to design the foundations shall be actual working loads applied to the foundations by the towers.

The foundations shall be designed in such a manner that the factors of safety shall not be less than the following requirements:

Type of Foundation	Type of Stability	Normal Condition	Broken wire Condition
Pad or Rock	Direct soil pressure against compression Loads	2.0	1.5
	Uplift against	2.0	1.5
Raft	Soil pressure against overturning moment and compression loads	2.0	1.5
	Uplift against over turning moment	2.0	1.5

10.2.4 Compression loads

The Contractor shall use the following parameters in the design of the foundations for bearing loads.

(a) The foundations shall be designed such that all allowable soil bearing capacities are not exceeded by the greatest bearing loads from the loaded foundation. The allowable soil bearing values for the foundation types shall be the values given in the "Foundation Application Schedule” given in Clause 15.13 and Drawing No. BIR-OH-E-0006. But these are only reference values, which may change after detail soil test by the Contractor.

(b) Bearing loads shall include the weight of the soil directly above the foundation.

(c) The bearing area of concrete spread footings shall be the actual area at the bottom of the mat.

(d) The following unit weights shall be used in the foundation design calculations when determining the bearing capacity:

Soil	1,600 kg/Cum
Concrete	2,400 kg/Cum

10.2.5 Uplift loads

The uplift loads on concrete spread footings shall be resisted by the weight of a volume of earth in the form of an inverted frustum of a cone or pyramid. The cone or pyramid shall have height that is 30 cm less than the depth from finish grade to the top of the concrete mat and with a bottom area that is the same as the top area of the mat and with a top that is determined by this intersection of planes starting at the mat edges and sloping outward at the specified cone angle from the vertical and the horizontal plane 30cm below finish grade. For special foundations supporting river-crossing structures, the assumed cone will have a height, which is 75 cm below finish grade. Assumed cone of earth angles for each foundation type area listed in the "Foundation Application Schedule" of the foundation bid drawings.

10.2.6 Units weights for uplift and lateral loads

The following unit weights shall be used in the foundations design calculations when determining the uplift and lateral load capacity:

Soil	1,200 kg/Cum
Concrete	1,600 kg/Cum

Unless specified otherwise, design and details shall comply with the latest published editions of BS or with other official standard specifications provided they are of equal or higher standard where such standard exists with accepted national or international good practice. Support foundation designs as detailed in the specification which in the opinion of the Employer or Employer's representative do not demonstrate an acceptable type of foundation for the type of soil condition so described will be rejected.

10.2.7 Foundation type

In the presence of high water table, the foundation shall be designed for a maximum depth of 1.5 meter below the existing ground level. The foundation is to be designed for fully submerged condition.

10.2.8 Concrete spread footing

The foundation shall be designed to carry maximum shear loads below ground level, that is, the stub legs are not to be considered as reinforcement. Allowance shall be made for the loss of uplift resistance due to overlap of frusta where applicable. Uplift foundations shall be cast against undisturbed soil for a minimum height of 250mm and 50mm lean concrete.

After award of contract the Contractor shall carry out detail soil test of support site and shall design the support foundation accordingly.

10.2.9 Foundation Design

The quantity of foundations in every type given in the Price Schedule is provisional only and may vary as per the result of the detail soil test.

Foundations should be designed for a working life of 50 years and the Contractor should comply in full with the requirements of these specifications in establishing his design. In all locations, all steelwork, whether part of the tower or part of the stub-angle foundations shall be completely encased in concrete to ensure a cover of 100mm from any part of the stub leg or tower from a point 300mm above ground down to the base of the main foundation block. All Stubs shall have cleats designed to carry the entire stub load.

The tower foundations shall be designed to take into account the most adverse combination of loading conditions. The bearing pressure under the foundations shall be calculated for the maximum vertical compression forces which can exist in any leg due to the over turning forces, dead weight and other imposed loads. To establish ultimate bearing pressures the working pressures derived from the severest combination of imposed loads shall be multiplied by the relevant factor of safety specified before.

Ultimate foundation loading per leg shall be calculated as follows:

(1) Straight line structures and towers

Compression - (Force due to overturning moment + 0.25 max. applied vertical loads + 0.25 support weight) x factor of safety

Uplift - (Force due to overturning moment   0.25 x 1/3 max. applied vertical loads   0.25 support weight) x factor of safety.

(2) Tension structures and towers

As above but zero applied loads in uplift case or special uplift loading for Section Towers. In computing compression ultimate bearing stresses, the weight of concrete shall be multiplied by the relevant factor of safety.

(3) Stub angle anchor

Stub angles shall be of galvanized steel and shall have cross-sectional area of not less than the structure leg member to which it will be attached. The stub angle shall not be included in the calculation of the steel reinforcement requirements against bending and tension forces in concrete foundation design.

Only those holes in the stub which have been previously punched and galvanized at the manufactures works will be used for the attachment of cleats. Site drilling will not be permitted.

10.3 EXCAVATION AND BACKFILLING

10.3.1 Scope

This specification covers the general requirements of earthwork in excavation in different materials, filling back around foundations, conveyance and disposal of surplus spoils or stacking them properly as shown on the drawings and as directed by the Employer or Employer's representative and all operations covered within the intent and purpose of this specification.

10.3.2 General

The Contractor shall furnish all tools, plants, instruments, qualified supervisory personnel, labor, materials, any temporary works, consumable, and everything necessary, whether or not such items are specifically stated herein, for completion of the job in accordance with specification requirements.

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

The excavation shall be done to correct lines and levels. This shall also include, where required, proper shoring to maintain excavations and also the furnishing, erecting and maintaining of substantial barricades on ground excavated areas and warning lamps at night for ensuring safety.

The item also includes for dumping of excavated materials in regular heaps, bunds, riprap with regular slopes as directed by the Employer or Employer's representative, within the lead specified and levelling the same so as to provide natural drainage. Rock/Soil excavated shall be stacked properly as directed by the Employer or Employer's representative. As a rule, all softer material shall be laid along the center of the heaps, the harder and more weather resisting materials forming the casing on the sides and the top. Rock shall be stacked separately.

(a) Clearing

The area to be excavated /filled shall be cleared of trees, plants, logs, stumps, bush, vegetation, rubbish, slush etc. and other objectionable matter. If any roots or stumps of trees are met during excavation, they shall also be removed. The materials so removed shall be burnt or disposed off as directed by the Employer. Where earth fill is intended, the area shall be stripped of all loose/soft patches, topsoil containing objectionable matter/materials before filling commence.

(b) Precious object, relics, objects of archaeological importance

All gold, silver, oil, mineral, archaeological and other findings of importance, trees cut or other materials of any description and all precious stones, coins, treasures, relics, antiquities and other similar things which may be found in or upon the site shall be the property of the Employer and Contractor shall duly preserve the same to the satisfaction of the Employer and from time to time deliver the same to such person or persons as the Employer may from time to time authorize or appoint to receive the found goods.

The Contractor shall excavate earth, rock, stumps and all other materials encountered as required for construction of each foundation. The Contractor shall place all suitable excavated material in backfill or in graded embankment in the immediate area at structures. Materials found to be unsuitable for foundation backfill or grading shall be wasted and disposed at Contractor's own cost.

The Contractor shall excavate each foundation hole to the nominal excavation depth for the applicable foundation type except in case where the material being excavated is not capable of supporting 0.5 kg/sq.cm.

At the nominal excavation depth, the foundation shall be carefully graded to a level plane and all loose or disturbed material shall be removed. The foundation excavation shall then be examined by the Contractor and a final determination will be made on the foundation type to be used.

Excavations shall be maintained in a clean, safe and sound condition until completion of the foundation construction and shall be diked to prevent flooding by surface runoff. Suitable pumping equipment shall be provided and used to dewater excavations so that all installation work and backfilling is performed in the dry state. Any previously prepared foundation bearing surface that is softened by water runoff or otherwise contaminated before placement of the structure foundation shall be excavated and replaced at the Contractor's expense.

Those excavations where the base is unstable, lies below groundwater level, or has been over excavated, the Contractor shall furnish and place a layer of crushed stone, or selected backfill, or borrow to stabilize the base for placement of foundation materials.

Topsoil and excavated material that is suitable for backfill around the foundations shall be stockpiled separately for use in backfill. Material that is unsuitable for backfill shall be disposed of. The stockpiles shall be sloped to drain and shall be protected from rainfall or other elements, which render the material unsuitable for backfill.

Backfill shall be placed in not greater than 20cm lifts before compaction. Each lift shall be thoroughly compacted before the following lift is placed. Pneumatic or equivalent tampers shall be used on cohesive materials; vibratory compactors shall be used on non-cohesive materials. Compaction shall achieve a density at least equal to that of the surrounding undisturbed earth. Large stones or rock fragments may be used in the backfill provided they do not interfere with proper compaction. Particles larger than 25 cm shall be placed not nearer than 0.5 m of the structure and at least 1.0m below ground surface.

Rock particles larger than 10 cm shall not be in contact with the concrete.

Following completion of 75 percent of the compacted backfill portion, the remaining backfill and topsoil shall be placed and the topsoil mounded 30 cm above the ground surface and sloped to drain. Compaction of this material will not be required. Before final acceptance of the Works, the Contractor shall refill any locations that settle below the surface of the surrounding ground.

Earth is defined as material which shall include all kinds of soil containing kankar, sand, silt, moorum or shingle, gravel, clay, loam, peat, ash, etc. which can generally be excavated with the aid of shovels and pick axes. This shall also include embedded rock boulders not longer than one meter in any direction and not more than 200 mm in any of the other two directions.

Rock is defined as material which shall include rock, boulders, shale, chalk, slate, hard mica, schist, laterite and all other materials which in the opinion of the Employer is rock and can be removed with picks, hammer, wedges, crowbars, pneumatic breaking equipment and blasting. This category shall also include excavation in macadam and tarred roads and pavements.

Rock excavation may be made by drilling, barring, wedging, or compressed-air tools. No blasting will be permitted. The Contractor shall furnish all material and equipment to perform all work required for excavation of rock.

For selection of rock type foundation for any tower location, the characteristics of rock shall be thoroughly investigated by the Contractor. Disintegrated rock or other types of rock such as soluble limestone, soft shale, slate, hard pan and organic rocks may not be suitable for construction of rock foundation.

All loose boulders, semi detached rocks (along with earthy mounds) not directly in the excavation area but so close to the area to be excavated as to be liable, in the opinion of the Employer, to fall or endanger the workman, equipment or the Works, shall be stripped off and removed away from the area of the works. Any material not requiring removal as contemplated in the work, but which in the opinion of the Employer is likely to become loose or unstable later, shall also be promptly and satisfactorily removed as directed by the Employer.

10.4 DEWATERING

10.4.1 Scope

This specification covers the general requirements of dewatering excavations in general.

(a) All excavations shall be kept free of water. Grading in the vicinity of excavations shall be controlled to prevent surface water running into excavated areas.

The Contractor shall remove by pumping or other means approved by the Employer or Employer's representative any water inclusive of rainwater and subsoil water accumulated in excavation and keeps all excavations/trenches free of water required for further work.

Method of pumping shall be approved by the Employer or Employer's representative; but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing-in due to differential head of water during pumping. Pumping arrangements shall be adequate to ensure no delays in construction.

(b) When there is a continuous inflow of water and quantum of water to be handled is considered in the opinion of the Employer as large, well- point system- single stage or multistage shall be adopted. The Contractor shall submit to the Employer his scheme of well-point system (dewatering) including the stages, the spacing number and diameter of well points, headers, etc., and the number, capacity and location of pumps for approval.

10.5 TIMBER SHORING

10.5.1 Scope

This specification covers the general requirements of timber shoring for open excavations for structure foundation.

Close timbering shall be done by completely covering the sides of the pits generally with short, upright members called polling boards. These shall be of minimum 25 cm x 4-cm sections or as directed by the Employer or Employer's representative.

The boards shall generally be placed in position vertically side by side without any gap on each side of the excavation and shall be secured by horizontal walling of strong wood at maximum 1.2 meters spacing, strutted with bellies or as directed by the Employer or Employer's representative. The length of the bellies struts shall depend on the excavation and supported by vertical walling, which in turn shall be suitably strutted. The lowest boards supporting the sides of the trench or pit shall remain exposed, so as to render the earth liable to slip out.

Timber shoring shall be 'close' or 'open' type, depending on the nature of soil and the depth of pit. The type of timbering shall be as approved by the Employer. It shall be the responsibility of Contractor to take all necessary steps to prevent the sides of excavations, pits, etc., from collapsing.

Timber shoring may be required to keep the sides of excavations vertical to ensure safety of adjoining structures or to limit the slope of excavations, or due to space restrictions or for other reasons. Such shoring shall be carried out, except in an emergency, only under instruction from the Employer.

10.6 SELECT BORROW

Where the material excavated for the foundation is unsuitable for backfill or is required for construction of embankment, the Contractor shall provide and compact select borrow. Excavated material shall be disposed at the Contractor's own expense.

Material for select borrow shall be well-graded bank-run gravel, relatively free from clay, loam or vegetation matter and with no stones over 10 cm in maximum dimensions, or materials of equivalent strength and characteristics. Representative sample from proposed borrow sources shall be submitted to the Employer for approval of the borrow source. Approval of borrow source shall not mean automatic approval of all materials obtained from that source.

The Contractor shall, at his option, use areas approved by the Employer or Employer's representative for production of select borrow or at his own expense, make arrangements for obtaining select borrow at other sources.

The select borrow shall be placed and compacted as specified for the backfill in the above-mentioned Article 10.3 “Excavation and Backfilling”.

10.7 FOUNDATION CONSTRUCTION

10.7.1 General requirement

All materials and labor required for the construction of foundations shall be furnished by the Contractor.

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

The Contractor shall furnish without any extra cost all materials the Employer require for testing. The cost of the tests shall be borne by the Contractor.

The final selection of the type of foundation footing to be actually constructed for each particular structure will be done by the Contractor after the results of the sub soil tests and shall be subject to the approval of the Employer.

10.7.2 Reference to standard specifications

Standards referred to in these specifications are as follows:

(a) ASTM referred to the latest edition of publications of American Society for the Testing and Materials, 1916 Race street, Philadelphia, Pennsylvania 19103.

(b) ACI refers to the latest edition of publications of American Concrete Institute, P.O. Box 19150, Redford Station, Detroit, Michigan 48219.

10.7.3 Measurement Standards

Measurement standards referred to in these specifications are as follows:

(a) Gallons - Wherever used in these specifications, gallons shall be understood to be U.S. gallons.

(b) Bag - Wherever used in these specifications, bag will be understood to mean 50-kg bag of Portland cement. Concrete shall be composed of cement, sand, coarse aggregate, water and admixtures, if required, all well mixed and brought to the proper consistency.

10.7.4 Concrete

The Contractor shall design and test concrete mixes, which have 28-day cubicle compressive strength of 210 kg/sq.cm.(approx. M200)

At least one month prior to the placement of any concrete, the Contractor shall make a set of test concrete compressive strength test cubes for each design mix under field conditions at the presence of the Employer or the Employer's representatives as required. The test cubes shall be made and tested in accordance with the applicable standards and will be witnessed by the Employer or the Employer's representatives.

The concrete mix shall be of such proportions as to produce a plastic and workable mix which will not separate during the placing and will finish well without using excessive quantities of mixing water. Addition of water to compensate for stiffening of concrete before placing will not be permitted. Uniformity in concrete consistency from batch to batch will be required.

After the test results are known for the field condition test cubes, the Contractor shall submit these result to the Employer or Employer's representative and the Employer or Employer's representative will notify the Contractor of the approval of test results and the acceptable design mixes.

When placing concrete in hot weather, the recommendations of the American Concrete Institute's publication "Recommended Practice for Hot Weather Concreting"(ACI 605) or equivalent shall be followed insofar as the Employer or Employer's representative may direct.

The use of set accelerators will be at the Employer's or Employer's representative's discretion. For concrete placed during extremely hot weather, the aggregate shall be cooled by frequent water spraying in such a manner as to utilize the cooling effect of evaporation. Concrete with a temperature of 35 degrees centigrade or higher before placement will be rejected and shall be wasted at the Contractor's expense.

(1) Submerge concrete

Concrete to be placed under water shall be deposited by tremie, and only after it has been determined by the Employer or Employer's representative that placing of concrete in an unwatered excavation cannot be practically accomplished by any other means. The tremie will not be allowed to drop below the level of water outside. Under no circumstances will concrete be allowed to drop through water within the tremie.

The tremie shall be watertight and sufficiently large to permit a free flow of concrete. The bottom of the tremie shall be as near to the surface against which the concrete is to be placed as practicable and the tremie shall not be raised until seal has been established by the concrete sufficiently to prevent the entry of water of the tremie. The discharge of the tremie shall be kept submerged in concrete at sufficient depth so as to maintain an adequate seal during underwater placement. Placing of concrete shall proceed without interruption until underwater placing in the foundation has been accomplished. As placing of concrete under water progresses, the Contractor shall remove water displaced by the concrete when the top of the concrete being placed by tremie reaches the elevation of the water table level; no further placement by tremie shall be performed.

10.7.5 Cement and Aggregates

In locations where conditions do not require high sulphate resistance, cement shall conform to the requirements of ASTM C150 Type I or equivalent.

In locations where, in the opinion of the Employer or Employer's representative, the conditions require the use of high sulphate resistance cement, cement conforming to the requirements of ASTM C150 Type V or equivalent shall be used.

The aggregates shall consist of clean, natural material or, subject to the approval of the Employer or Employer's representative, manufactured aggregates may be used.

Aggregates shall be separated into sand and coarse aggregate before being used. The Employer or Employer's representative will permit no pit or crusher run materials without prior approval.

Natural fine aggregate or sand shall be graded within the following limits and the fineness module be between 2.5 and 2.8:

Sieve size Laboratory U.S Std. Sieve)		Amounts Finer than Each weight Percent
3/8	(9.5 mm)	100
4	(4.75 mm)	95 to 100
8	(2.36 mm)	80 to 100
16	(1.18 mm)	50 to 85
30	(600 micron)	25 to 60
50	(300 micron)	10 to 30
100	(150 micron)	2 to 10

Natural coarse aggregate shall be graded within the following limits, depending upon the clear spacing between reinforcing bars.

U.S. Standard Sieve		Nominal 1-1/2”	Nominal 3/4” (19mm)
2”	(50.8 mm)	100	
1-1/2”	(25-38 mm)	95	
1”	(25 mm)		100
3/4”	(19 mm)	35-70	90-100
3/8”	(9.5 mm)	10-30	20-55
No.4	(4.75 mm)	0-5	0-10
No.8	(2.36 mm)		

10.7.6 Slump

All concrete used shall have a slump of maximum 120mm and minimum 75mm at the time of placing. The water cement ratio shall be determined by consideration of the specified strength, the water reducing admixtures, the slump required for proper placement, air entraining requirements the available and maximum allowable aggregate size and its specific gravity, and the amount of water carried on the aggregates.

The slumps and maximum sizes of aggregate as well as, the computation of trail mixes shall be as described in the America concrete Institute Recommended Practice for Selected Proportions for concrete (ACI 613). The minimum amount of cement used per cubic meter of concrete when using 38mm aggregate, shall be 6 bags (300kg) for a concrete strength of 210kg/sq.cm. But with this cement content if the 28 days concrete strength is less than 210 kg/sq.cm, extra cement should be added to get the required strength, without any extra cost to the Employer. The proportions of all materials in the concrete shall be subject to approval by the Employer or Employer's representative. The Contractor shall provide all plant and equipment necessary to determine and control the actual proportions of materials entering the batch.

(a) In calculating the total water content in any mix, the amount of water carried on the aggregate shall be included. The water on the aggregate shall be determined periodically by test and the amount of free water on the aggregate subtracted from the water added to the mix. In all cases, the amount of water to be used shall be the minimum amount required to produce a plastic mixture of the strength specified and of the required density, uniformity and workability. The consistency of any mix shall be that required for the specific placing conditions and methods of placement.

(b) Water used in mixing and curing concrete shall be tested and not contain more than 1,000 parts per million chlorides nor more than 1,300 parts per million sulphate, shall not have a turbidity count greater than 2,000 parts per million and shall also be free of objectionable quantities of oil and organic materials. Water source will be clearly identified and tested before using at the construction site.

10.7.7 Storage of material

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

(a) Cement that has been caked in storage is still usable only if, when pressed between the thumb and fingers, it powders readily. Otherwise, its use will not be permitted.

(b) When reinforcing steel is delivered to the job in advance of the Contractor's requirements, the Contractor shall provide suitable protection in order to prevent excessive rust developing on the reinforcing steel as it will be Contractor's responsibility to remove the excessive rust.

10.7.8 Concrete mixing and placing

Before any concrete mixing is begun, all equipment for mixing, transporting and debris shall be cleaned of all dirt and debris. All dirt and debris shall also be removed from the places to be occupied by the concrete.

All mechanical equipment shall be checked before starting a concrete pour to ascertain whether or not it is in good operating condition and if not shall be tuned-up, or repaired, or replaced to the satisfaction of the Employer or Employer's representative. Also the stock of construction material (cement, aggregate and sand) shall be checked before starting the concreting work to ascertain whether or not it is in sufficient quantity for one foundation work.

When a foundation location is ready for concrete placement, the Employer shall be notified with a check out list at least 24 hours prior to concreting so that he may inspect to assure that the excavation is free of water, mud and debris; that the bottom surface of the excavation is well leveled and compacted; and where required, a crushed stone sub-base has been placed; that the reinforcing steel is properly secured in place; and that the formwork is properly braced.

Rock surfaces shall be as flat as possible and projecting ridges shall be leveled off before the concrete is placed or spaces between the ridges shall have been previously filled with concrete to form a horizontal surface.

The Contractor shall see that all material that is to be embedded in the concrete has been placed before the concrete is placed. The Contractor shall be responsible for the accurate location of all embedded materials. Any work inaccurately or improperly set shall be relocated and reset at the Contractor's expense.

All batching components of the concrete shall be accurately measured. Measuring on a weight basis is preferred, however, measuring on a volume basis will be allowed as long as careful controls are maintained. Weight measurements shall be made using standard batching equipment for large quantities and wheelbarrow scales for small quantities. Volume measurements shall be made in batching boxes. The batching boxes shall be as large as is practical.

The batch mixer shall be rotated at a speed recommended by the manufacturer and mixing shall be continued for at least one to one-half (1-1/2) minutes after all materials are in the mixer, unless the size of the batch is over 1.2 cu.m. when additional mixing time shall be required as advised by the Employer. A mechanically-operated batch mixer shall be used for mixing unless otherwise approved by the Employer.

The tempering of concrete which has partially hardened, that is, remixing with or without additional cement, aggregate or water, will not be permitted.

Concrete shall be conveyed from the mixer to the place of final deposit within 30 minutes by methods which will prevent the segregation or loss of the materials. After 30 minutes of mixing the concrete shall be rejected and replaced by fresh concrete without any extra cost to the Employer.

Equipment for chute, pumping and pneumatically conveying concrete shall be of such size and design as to ensure a practically continuous flow of concrete at the delivery end without separation of the materials. The chutes shall never be on a slope that is steeper than two vertical to three horizontal. Conveying equipment shall not have any aluminum parts that come in contact with the concrete.

When the concrete is to be placed on hard rock or other concrete, after the existing surface has been properly cleaned and otherwise prepared, the existing surface is to be wetted until it is saturated. The first batch of concrete placed shall be a grout obtained by omitting the coarse aggregate from the mix and reducing the water as required. The grout shall be evenly spread on the water-saturated surface and then the concrete shall be deposited continuously and as rapidly as practicable.

The concreting shall be carried on at such a rate that the concrete is at all time plastic and flows readily into the spaces between the bars and so that each successive layer properly bonds with its predecessor. Successive layers shall be placed within 15 minutes of the preceding layer.

When placing foundations with drops over 2 meters, hoppers and trunks must be provided of a size to allow for proper placing.

Not less than four hoppers of any size shall be available and used, if requested, and a sufficient number of sections of trunk shall be furnished to reach within 500 mm of the bottom of the foundation.

The concrete shall be compacted during and after depositing by vibration. The concrete shall be thoroughly worked around embedded materials.

All concrete must be consolidated by means of internal vibration except where the Employer has given written permission to use some other method of consolidation. The type and make of vibrator must have a speed of at least 6,000 vibrations per minute (VPM) when the machine is being supplied at its rated voltage, air pressure, etc. The Contractor shall at his own expense, furnish sufficient transformers, compressors, etc. of approved type to operate all vibrators at the voltage, pressure, etc., specified by the manufacturer.

The Contractor shall always have at least two vibrators in operating condition at the location of the concrete placement.

The Contractor shall make one set of concrete compressive strength test cubes for each structure or as directed by the Employer or Employer's representative. There shall be three cubes to a set and the cubes shall be made in accordance with ASTM C31. Only one cube shall be made from any one batch containing less the 1/2 cubic meters of concrete. The Contractor shall also make one set of concrete compressing strength test cube for each new batch of cement purchased two week before using that cement.

After the cubes have aged at least 24 hours in the field, the Contractor shall deliver them to a location designated by the Employer where they will be tested in accordance with ASTM C39. If two of the cubes tested at 28 day tests indicate a compressive strength of 210kg/sq.cm (3,000 psi) or more, the remaining cubes shall be discarded. If the 28-day compressive strength indicates a compressive strength of less than 210kg/sq.cm., the Employer or Employer's representative will determine what remedial measures are necessary and the Contractor shall perform the remedial measures at his own expense. The remedial measures may include, but are not limited to, the replacement of the entire foundation.

10.7.9 Concrete formwork

Forms shall be used, wherever necessary, to confine the concrete for structures and shape it to the required lines, or to insure against contamination of the concrete by materials caving or sloughing from adjacent surfaces left by excavation.

Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of the concrete, and shall be maintained rigidly in position. Forms shall be sufficiently tight to prevent loss of mortar from the concrete. Molding strips shall be placed in the corners of forms so as to produce chamfered edges on permanently exposed concrete surfaces. All exposed surfaces may be formed with any material of adequate strength and tightness to hold the wet concrete in proper position and prevent the loss of mortar.

If plywood or steel forms are not readily available, the Contractor with Employer's special recommendation may substitute wood planking provided exposed surfaces are rubbed to remove ridges on exposed surfaces.

The Contractor shall provide templates, which firmly hold the stub angles within 10 mm of the horizontal side setting dimensions and within 5 mm of the required elevation during the placing of the concrete. Details of the templates shall be submitted to the Employer or Employer's representative at least one month before the commencement of any foundation construction. The bottom portion of the structure may be used for this purpose providing that adequate cribbing and bracing are supplied for support.

Before concrete is placed, the surfaces of all forms shall be oiled with form oil that effectively prevents sticking and will not stain the concrete surfaces. For wood forms, form oil shall consist of straight, refined, pale paraffin mineral oil. For steel forms, form oil shall consist of refined mineral oil compound.

Forms shall be removed only when the strength of the concrete is such that form removal will not result in cracking, spelling, or breaking of edges of surfaces or other damage to the concrete. Usually formwork shall be removed after 48 hours from concreting times. Any concrete damaged by form removal or otherwise shall be repaired immediately without any extra cost to the Employer.

10.7.10 Concrete finishing and curing

The exposed top surfaces of all concrete foundation piers shall be slightly sloped to prevent the accumulation of water.

Immediately after the removal of forms, the holes left by form tie rod fasteners shall be filled with mortar and all damaged or defective concrete shall be repaired or removed and replaced to the satisfaction of the Employer or Employer's representative. Improperly consolidated concrete shall be removed by chipping, and the chipped openings or recesses shall be of such depth and shape as required by the Employer or Employer's representative to insure that the patching material placed in the openings or recesses will be thoroughly keyed and bonded to the concrete. "Dry pack" mortar shall be used for filling relatively deep required for the replacement of defective concrete where surface dimensions of the chipped openings or recesses are relatively large. The depth of chipped recesses for concrete patches shall extend at least 25 mm beyond the nearest reinforcing steel.

To ensure proper curing, all concrete shall be kept moist for a period of at least 10 days. Burlap or an equivalent material or a curing compound shall be applied over exposed concrete surfaces. The burlap shall be kept moist at all times. If the foundation is backfilled before the one-week curing time has elapsed, the burlap protection shall remain on the exposed projection.

10.7.11 Membrane curing compound

Membrane curing compound shall be applied uniformly by spray, leaving no pinholes or gaps, at a rate not to exceed 4.91 square meters per liter. The curing compound shall be applied after finishing operations are completed and surface moisture has disappeared. If forms are removed prior to 7 days after placing the concrete, the uncovered surfaces shall be coated with the curing compound as specified herein.

Foundation shall not be backfilled before they have been inspected to see that they are free from surface defects and voids, or that the defects and voids have been properly repaired.

The foundations shall not be subjected to any loads in addition to those existing at the time of the placing of the foundation concrete until the curing period has elapsed.

10.7.12 Tore steel Reinforcing Bar

All tore steel-reinforcing bars shall conform to the requirements of Grade fe-415 and shall be fabricated in accordance with the " Manual of Standard Practice" of the Concrete Reinforcing Steel Institute.

Mill scale, rust, oil and mud shall be removed from reinforcing steel by firm rubbing with burlap or equivalent treatment before the reinforcing steel is placed.

The minimum center-to-center distance between parallel bars shall be two and one-half (2-1/2) times the diameter of the bars. In no case shall the clear spacing between bars be less than 25 mm nor less than one and one-third (1-1/3) times the maximum size of coarse aggregate. It is preferable to submit re-bar schedule for the said tower foundation.

All tore steel-reinforcing bars shall have a protective concrete cover of not less than:

(a) 80 mm - on the bottoms of footings and on any surface of concrete that will be exposed to salt water.

(b) 50 mm - concrete exposed to weather or ground.

Tore steel reinforcing bar shall be accurately located and shall be secured in position by the use of annealed iron wire of no less than No.16 gauge, and shall be supported in a manner that will keep the reinforcement away from the exposed concrete surfaces. Concrete blocks shall be used to support the reinforcing steel in the foundation mat; broken stones or wooden blocks shall not be used for supporting the reinforcing steel.

10.8 FOUNDATION PROTECTION WORKS

Structure foundation located near the bank of the river, and other unstable places as directed by Employer shall be protected by stone masonry works and/or gabion wall. The Contractor shall undertake detailed study of such requirements during check survey in close consultation with the Employer or Employer's representative and submit design of such protection works for Employer's or Employer's representative's approval.

10.8.1 Stone Masonry Works

The stone shall be hand placed with un-coursed close joints to the lines and grades as designed. The rubble stone shall be placed with 1:3 cement sand mortar after having joints thoroughly moistened. The surface joints shall be finished with 1:3 cement sand mortar.

After completion of masonry wall, it shall be cured with water for more than 10 hrs.

Weep-holes with Perforated Poly Vinyl Choride (PVC) pipes of 10 cm in diameter shall be placed in each 2 sq.m. of slope surface of the masonry wall or as required by site conditions. The upper surface of the masonry wall shall be finished smooth with concrete. The perforated pipe shall be extended at least 30 cm both ends from the stone masonry wall & in the backfilling end the perforated PVC shall be covered with gravel at least 30 cm in all-around insuring the filter zone.

10.9 FOUNDATION WORK WITHOUT POWER SHUTDOWN

Since the existing 132kV line between Lekhnath substation and Syangja substation is extremely important to supply power to Pokhara city and it is difficult to plan long term power shutdown, foundation work shall be carried out under existing line without power shutdown.

The Contractor shall submit appropriate work procedures including safety measures to the Employer and shall start the work after getting the approval of the Employer.

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CHAPTER 11:

PRELIMINARY WORK

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CHAPTER 11: PRELIMINARY WORK

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11.1 SOIL TEST

11.1.1 Scope

This specification covers all the work required for geotechnical investigation and preparation of a detailed report. The work shall include mobilization of necessary equipment, providing necessary engineering supervisors and technical personnel skilled and unskilled labor and others as required, to carry out field investigations and test, laboratory tests and analysis and interpretation of data and results, preparation of a detailed soil report including recommendations and providing technical services as and when called for by the Employer. The investigation method shall be as described herein or any other methods approved by Employer giving the same information as needed to ensure that soil parameters are sufficient for reliable foundation design. The location for the geo-technical investigation shall be approved by the Employer.

11.1.2 Codes and standards

All work shall be carried out strictly in accordance with the Technical Specifications unless otherwise approved by the Employer in writing. Where not specified, the latest edition of one or more of the following codes of practice or any other applicable code shall be followed.

BS 1377: Methods of Test for Soils for Civil Engineering Purposes
BS 1924: Methods of Test for Stabilized Soils
BS 5930: Code of Practice for Site Investigations
BS 6031: Code of Practice for Earthworks
CP 2004: Code of Price for Foundations

Codes equivalent to these in American/ DIN Standards can also be used.

11.1.3 Purpose

The purpose, in brief, of the proposed geotechnical investigation, is to ascertain the type of sub-strata such as soil, rock etc., their characteristics and their suitability for the structures proposed to be built and to decide on the choice of the type of foundation to be adopted for the type and magnitude of envisaged loading. All the tests that are considered necessary in the opinion of the Employer for this purpose shall be conducted. Any additional tests/ works change in the number and type of specified tests revision in the diameter, depth of bore holes, samples to be collected etc. shall be carried out as directed by the Employer.

11.1.4 Calibration of equipment

The Contractor shall ensure that all the equipment/instruments are properly calibrated, at the start of the work, to reflect actual values. If so demanded by the Employer, the Contractor shall have the instruments tested at an approved laboratory at his cost and the test reports shall be submitted to the Employer. If the Employer desires to witness such tests, the Contractor shall arrange for the same at his own cost.

11.1.5 Field work

(1) General

It is essential that personnel on this work of geotechnical investigation and laboratory testing should have the appropriate experience. The entire investigation shall be supervised by a suitably qualified and experienced engineer or engineering geologist. All field and laboratory work shall be executed by experienced technicians.

The Contractor shall have on site all required survey instruments as determined by the Employer to carry out the work accurately according to Specification and Drawings. All the specified locations for boreholes and field tests shall be set out at site by the Contractor. At each location of bore-hole, and other field tests the Contractor shall establish the ground level prior to commencing of the boring operation. The ground level shall be related to an established bench mark.

(2) Method of boring

(a) Boring in soil

In soil strata, boring may be carried out by auger or percussion tools or by method approved by the Employer or Employer's representative. Bentonite slurry or mud circulation process can also be used if permitted. However, for those boreholes, where water samples are to be collected for chemical analysis, bentonite slurry or mud circulation method shall not be used or shall be restricted as directed by the Employer or Employer's representative. The diameter of the boreholes, unless stated otherwise shall be such as to permit collection of undisturbed samples of 90mm diameter.

Where necessary boreholes shall be cased and whenever a borehole is cased, the bottom of the casing shall always be maintained within 150mm of the bottom of the borehole. The casing shall never be in advance of the bottom of borehole during undisturbed sampling or standard penetration tests.

(b) Borehole depth

All the boreholes shall be sunk to a depth of minimum 10m at field.

(3) Sampling

(a) Sequence of sampling

The general sequence of sampling adopted shall be such as to obtain alternatively undisturbed samples at every 1.5 meter intervals and at every significant change of stratum. Undisturbed sample wherever possible, shall be collected at every 3.0 meters interval and at every identifiable change of soil formation. Likewise disturbed samples, as obtained in the standard split spoon, shall be collected by conducting the standard penetration test at every 3.0 meters interval and at the significant change of soil stratum.

(b) Undisturbed sampling in boreholes

Samplers used for collecting undisturbed samples in soils shall meet BS and American Standards requirements and shall be appropriate to the type of soil to be sampled. Undisturbed soil samples collected shall be 90mm in diameter and 450mm in length so as to enable laboratory testing.

The area ratio of samplers shall be within the permissible limit and shall not exceed 25 percent for samples of 90mm diameter. The cutting edge of the cutting shoe of the sample shall be tapered at an angle not exceeding 20 degrees and inside clearance ratio shall generally be limited to 0.5 to 1.5 percent. Samples with lower clearance ratio shall be used in soft strata and these with higher clearance ratio shall be used in stiff strata. The cutting edge or shoe of sampler shall be free from rust, pitting, burring or any other defect. The sampler shall be fitted with ball check valve at the upper end.

For clays other than very soft clays open drive samplers are permissible whereas in very soft clays and in sandy soils piston samplers with core catcher device or other approved samplers shall only be used. The use of oil inside the samplers in operation shall be limited to minimum practicable.

Before sampling operation, the Contractor shall clean the bottom of borehole very carefully and every care shall be taken to avoid disturbance of material to be sampled. For sampling the sampler shall be lowered to the bottom of borehole without impact and pressed into the soil in a single continuous movement at a sufficiently slow rate to permit the check valve to pass the water in the tube with creating excess back pressure. In firm material, and whenever approved by the Employer the sampler may be driven into the soil; but the sampler shall never be pushed or driven to its full length. After penetration to the required depth, the sampler shall be free from the soil by being rotated by one full turn and then shall be withdrawn.

The sample shall not be removed from the tube but shall be trimmed back from the ends of the tube and the space filled with molten microcrystalline wax, the tube capped with metal or plastic cap and sealed with adhesive tape.

(c) Undisturbed soil samples from trial pits and other sources

The Contractor may be required to collect undisturbed soil samples from trial pits excavations or other sources. these samples may be core samples or block samples and may be obtained with a special orientation as indicated by the Employer core samples shall generally be obtained by jacking a thin walled open drive sampler of around 100mm diameter into the stratum. The sample tubes shall be driven if approved by the Employer or Employer's representative. The sample tubes shall be held steady during jacking/driving and a suitable frame shall be used for guiding inclined samplers.

(d) Disturbed soil samples

The material from the cutting shore of the thin walled sampler and from the split spoon sampler of the standard penetration test can be treated as disturbed sample, but will not be paid for separately. All disturbed samples collected shall be placed without delay in an air-tight jar of not less than 0.4kg nominal size and each sample shall fill the jar as far as possible.

Larger disturbed samples may be required to be collected from trial pits or excavations. Each of such samples should be at least 10 kg. Such samples shall be sealed into heavy duty polythene bags immediately on collection.

(e) Water samples

Contractor shall take water samples from boreholes, whenever directed by the Employer, before addition of water to the hole. If this is not possible prior to collection, the water level in the borehole shall be lowered by about 0.5m, water allowed to rise by seepage through walls of bore hole and then water sample collected.

No water sample shall be taken when bentonite slurry or mud has been circulated in the borehole. The method of sampling shall be such as to ensure that the sample is not contaminated by rain water, surface water etc. The quantity of sample to be collected is about 1 liter and shall be stored only in approved airtight, clean container. Water samples should be tested as soon as possible after collection.

(f) Numbering of samples

The Contractor shall assign a reference number to each soil and water sample taken from the borehole. This number shall be unique for that borehole and shall be in order of depth below ground level.

(g) Labelling of samples

All samples shall be clearly labeled indicating job number, borehole number sample number, date of sampling, brief description of samples, type of sample, elevation of sample etc. and in case of undisturbed samples, the top and bottom of samples shall also be clearly labelled. Each such label shall be pasted on the container and shall also be included in the container.

(h) Transporting and storing of samples

The Contractor shall store properly all the samples at the site till they are transported to his laboratory for testing. All rock cores and samplers with undisturbed soil samples shall be placed in order of their occurrence in strong wooden boxes suitably partitioned and provided with hinged wooden covers, so that the samples are not damaged during transit by impact or improper handling. To minis disturbance during shipment samplers containing undisturbed soil samples shall be packed with wood dust or similar other resilient material and as directed by the Employer or Employer's representative

The Contractor shall transport all samples to his testing laboratory as quickly as possible and test the samples. Samples shall be transported by air, if the stipulated completion period so warrants. All unused and excess samples after testing should be retained and safely stored by Contractor till three months after the end of submission of the report.

(4) Specific observations during boring

The observation to be made by the Contractor during boring shall include but not be limited to the following:

(a) Sequence and thickness of different strata

Visual description of each stratum shall be provided.

(b) Ground water table

The depth at which ground water is struck during boring shall be carefully noted and the depth of water table shall be ascertained subsequently in the complete borehole by daily observing the depth for the next six to seven days. Depth of ground water shall also be observed in wells, if wells exist in the vicinity.

(c) "Loss" or "Make" of drilling fluid

The "Loss" or "Make" of drilling fluid if observed during the boring shall be noted and brought to the attention of the Employer or Employer's representative. Attempts shall be made to detect joints, fissures, artisan conditions etc.

(d) Presence of lime, mica. Etc.

The soil and rock samples shall be examined for presence of lime, mica etc. and shall be recorded, if any. The Contractors rate for boring shall be deemed to include these and all other relevant observations.

(5) Submission of field logs

The Contractor shall submit or mail to the Employer as directed, two copies of the preliminary log of each borehole as soon as the borehole is completed.

(6) Field tests

(a) Standard penetration test (SPT)

Unless directed otherwise by the Employer or Employer's representative, the Contractor shall carry out standard penetration test at 1.0 meter intervals and at every noticeable change of soil formation and as per the procedure in BS or ANSI. The finest test shall generally begin at 1.0m depth unless an undisturbed sample is collected at that depth, and further test at 2.0m, 3.0m, 4.0 m, 5.0m and 6.0m depths shall be done.

For conducting the test, the bottom of borehole shall be cleaned properly and the spoon shall be properly and centrally seated in position in the borehole. The derive weight assembly shall consist of a driving head of 65kg weight with 75cm free fall. It shall be ensured that the energy of falling weight is not reduced by friction between the drive weight and guides or between rope and winch drum. Standard connecting rods shall be used.

The test shall be stopped (When the test is not conducted in weathered/Soft rock) when the total blow count including seating drive reaches 120. The corresponding penetration shall be noted. If the total penetration is more than the seating penetration of 15cm, a breakup of blow count for 15cm seating penetration and for the remaining portion of penetration shall also be given.

(7) Excavation of trial pits

The Contractor shall excavate trial pits to the depth of 3.0 meters. Relevant tests specified in these pits shall also be carried out. Whether specified or not, in every trial pit, including those excavated for loading tests, tests by "Pocket Penetrometer" and by "Picket " shall be generously carried out at different depths in different strata. Picket test shall be conducted in non-cohesive strata. In this test a wooden picket of dimensions 5cm x 5cm in cross section, with a sharp point and about 70cm long shall be pushed perpendicular to the surface of soil by a force of about 70kg and the penetration of the picket shall be recorded. The test by pocket penetrometer shall be done in soils with cohesive touch and in weathered rock.

(8) Backfilling of boreholes and pits

The Contractor shall backfill the boreholes and pits. The borehole shall be back filled by bentonite/mud-cement grout. The cement and bentonite/mud for the grout shall be in the ratio 1 to 1 cement and bentonite for the grout shall be in the ratio 1 to 1 by weight, and shall be made into slurry with no more water than is necessary for placing the slurry in the borehole. If there is standing water in the borehole, grout shall be placed by tremie. The pit shall be backfilled with proper ramming using the excavated material.

11.1.6 Laboratory tests

(1) General

All the laboratory testing shall be performed by qualified and experienced personnel, familiar with and having access to equipment and facilities for the accurate determination of data necessary for requirements under this specification.

(2) Independent laboratory

The Employer reserves the right to have the samples tested in an independent laboratory. If the Contractor is directed to get the samples tested in an independent laboratory, he shall be paid only the actual cost of such tests.

(3) Program for testing

The Employer or Employer's representative will direct Contractor on samples to be tested and on type of test to be conducted. The Employer or Employer's representative is not bound to furnish this information at the beginning of the investigation itself but shall instruct the Contractor at appropriate time during the course of the investigation. In case of clayed soil triaxial compression test on undisturbed soil samples shall be carried out.

(4) Standards for testing

The Contractor shall test the samples as per the relevant BS, ANSI or directed by the Employer.

(5) Access to the laboratory

The Employer shall have the right of access to Contractor's Laboratory or other Laboratory where tests have been arranged to be carried out during the progress of this investigation.

(6) Submission test data and results

The Contractor shall submit when demanded by the Employer preliminary copy of the data and the computed results tests he has conducted. However, the final report shall contain all the experimental data and the results as stated below in Article 11.2.7.

11.1.7 Formal report

(1) General

The Contractor shall submit his report in two separate volumes.

Volume I shall be the main body of the report containing geological history of the Site summarized test data, observations, conclusions and recommendations.

Volume II shall be in the form of appendix and shall contain actual field and laboratory observations, calculations of test results, supporting calculations for the recommendations made etc. Initially, the Contractor shall submit these volumes to the Employer in a draft form.

(2) Route plan

A route plan showing location of all boreholes, trail pits, etc. shall be presented in the report.

(3) Bore logs

A true cross-section of all boreholes, trial pits showing thickness, position and classification of each soil stratum found between top surface and bottom of the hole shall be submitted. The various tests conducted and recovered from every soil and rock stratum shall be clearly against that stratum.

A record in full of every trial pit or incomplete boring with appropriate explanations shall be reported in the same manner as the completed pits or boreholes.

(4) Ground water

All available data on ground water conditions shall be presented separately and shall be identified by borehole number and sampling dates and timing of observations, showing clearly the number of observation made in a particular safe.

(5) Test results

(a) The recommendations shall be based on observations and test results and shall encompass theoretical as well practical considerations for foundations for the types of structures envisaged. The Contractor shall acquaint himself with the type of structures proposed.

(b) Recommendations shall include but not be limited to the following:

- A brief geological description including that of faults, folds, etc. if any on the basis of published literature.
- Seismic history including a brief description of previous earthquakes, giving time, period, magnitude, ground acceleration, epicenter, damage done etc.
- Recommended type of foundations and safe/allowable bearing capacities.
- Possibility and extent of scour in river beds.
- Recommendation for class of concrete to be used for foundations vis-à-vis deleterious effect of ground water/soil chemicals concrete and steel.
- Earth pressure coefficients that may be adopted.
- Any other relevant information and data.
- Technical services as and when called by the employer.

11.1.8 Others

The results of simplified boring and soil test at the tower site in Pokhara is shown in Appendix-B3 as reference.

11.2 MEASUREMENT OF GROUND RESISTANCE

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

The measurement of ground resistance shall be performed at every meter depth from ground surface to the specified depth or to maximum depth of sub-soil tests except where ground resistance value of 10 ohms or less is obtained at any adjacent levels, no further measurement is required.

The Contractor may use drilling rod(s) of sub-soil test equipment during performing the sub-soil test as earth electrodes for measuring the ground resistance.

The Contractor shall recommend the type of earth electrodes in accordance with the results of ground resistance obtained. Selection of earth electrode type shall be suitable for each structure and its particular site conditions. The data obtained shall be prepared in an approved form and submitted to the Employer.

CHAPTER 12:

ERECTION, STRINGING AND MISCELLANEOUS WORKS

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CHAPTER 12: ERECTION, STRINGING AND MISCELLANEOUS WORKS

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12.1 ERECTION OF STEEL TOWERS

The branch tower shall be vertical under the stresses set up by the completed overhead line.

Precautions shall be taken to ensure that no parts of the structures are strained or damaged in any way during erection and drifting shall not be allowed.

Support members, which arrive on site with slight distortions due to handling in transit, shall be straightened by the Contractor using an approved means and offered to the Employer or Employer's representative for inspection and subsequent acceptance or rejection before erection commences.

Suitable ladders shall be used whenever necessary during erection but such ladders and removable step bolts shall be removed when erection is not in progress.

Spanners used during erection shall be well shaped and fit closely on the hexagon to avoid damaging nuts and bolt head.

Reaming or drilling for correction of mismatched holes will only not be allowed without the written approval of the Employer or Employer's representative.

The Contractor shall ensure that a rigid bolt-checking program is carried out on all supports. On completion of initial assembly of towers, an organized bolt checking team shall check all bolts for tightness from the structure top downwards.

Bolt checking shall be carried out within one week from the time the support is erected. The bolt tightening shall be as follows:

Size of Bolt	Tightening Torque (kg.cm.)
16	1000 – 1200
20	1400 - 1800

Throughout the course of support erection the Contractor shall ensure that unbraced members are adequately supported by stays or guys or temporary struts prior to being braced.

The bracing of all four sides of the support shall be completed before guys are removed and before any erection of a higher section of the tower is commenced.

In no case the tower structure shall be erected until seven days after completing the foundation concrete work, and until proper backfilling and compaction. Safety belts must use while erecting the towers.

The Contractor shall notify the Employer two weeks before the supports are ready for inspection. The inspection and correction of defects, if any, shall be completed before the start of the stringing operation.

Damaged galvanizing may be repaired on site by galvanizing paint and as specified in accordance with Sub-Clause 1.2.7.

All bolts and nuts below the anti-climbing device shall be properly punched such as to provide safety against opening of the nut-bolts even with the wrench set. The punched area shall immediately be coated with zinc paint.

12.1 STRINGING OF CONDUCTOR/OPTICAL FIBER GROUND WIRE

At least 6 months before conductor/OPGW stringing commences, the Contractor shall submit to the Employer a detailed account of his proposed stringing procedure (method statement) which should include details of temporary support stays and compensation for initial stretch and long term creep of the conductors.

The conductors, OPGW, joints and clamps shall be erected using the approved tools and in such a manner that no bird-caging, over tensioning of individual wires or layers or other deformation or damage to the conductors occurs. Clamps or other devices used in erection shall be of approved design and shall allow no relative movement of strands or layers of the conductors.

The Contractor shall keep a record of all conductor joints giving the location, the date of assembly and the name of the lineman responsible for the jointing. Where records of joints made by a particular lineman show a repeated performance below that required, the Contractor shall cease to employ the lineman on jointing operations and shall immediately replace him with other qualified personnel.

Phase conductors shall be erected with such sags that everyday temperature in still air and 25 degree C temperature with maximum wind pressure, the final tensions shall provide factors of safety on the ultimate tensile strength of the conductor. The Contractor shall submit erection and final sag and tension charts for each type of conductor. These charts shall plot inter-related curves of tensions against equivalent span lengths, and actual span lengths against sags, at temperatures of 0°C, 25°C, 40°C, and 80°C in still air conditions, and shall show details of conductor size, conductor breaking load, and conditions of loading.

In calculating the sags and tensions, allowance shall be made for the elasticity and coefficients of expansion of the conductor materials.

The term "final tension" shall mean the tension existing in a line conductor, for any given condition of loading after sufficient period in service to allow for "bedding down" stretch and creep to take place. For purposes of calculating creep allowance this shall be taken as ten years from erection.

At the end of the guarantee period the specified ground clearance plus the conductor creep age allowance shall not be infringed, in addition, the sag of any phase conductors in the same span.

Where required by the Employer, prior to the issue of the Operational Acceptance Certificate, the Contractor shall be responsible for checking that the relative sags of the conductors are within the specified tolerance. Such checks shall be carried out at selected point along the route as required by the Employer. Clearances between conductors and ground and between jumpers and structures shall be checked by the Contractor during erection and before handing over the line.

The Contractor shall provide dynamometers, sighting boards and levels suitably mounted for clamping to support steelworks and other approved apparatus necessary for the proper checking of the work. When required by the Employer, dynamometers shall be tested and if necessary recalibrate at the Contractor's expense.

During the progress of the work, the Contractor shall record on approved schedules the particulars of the sagging of conductors on each section of the route. These schedules shall show the support numbers of the section, individual span lengths, the equivalent span, the design and erection sags, together with the mean actual sag of the phase conductor as well as the temperature, and the dates of the stringing and checking. At the end of the Contract six sets of these schedules shall be handed to the Employer.

Blocks for running out conductors shall be of approved type and shall be robust and full running.

The wheel of the running out block shall have a diameter of not less than 20 times the outside diameter of the conductor and shall be fabricated from aluminum.

The Contractor shall provide as a minimum sufficient running blocks commensurate with stringing the longest section of the project.

Jumper loops shall be cut to length such that the loop arcs at the points of departure from tension clamp are naturally tangential to the tension clamp departure angle.

All conductor, connections and clamps shall be treated with approved jointing grease to prevent galvanic corrosion between dissimilar metals and to inhibit aluminum surface oxidization.

After the line conductors have been finally tensioned to their correct sags, the Contractor shall erect vibration dampers at the recommended distance from the conductor clamps.

As for OPGW, new OPGW will be supplied and installed for two spans between a new branch tower and the existing No. 158 tower and for the other span the existing OPGW will be used. Therefore, OPGW splicing terminal boxes shall be installed on the new branch tower.

Furthermore, optical fibers that are contained in OPGW shall be connected from new branch tower to communication system in new Birauta substation buried under ground via OPGW terminal box on the new tower.

Outline of OPGW re-stringing work is shown as shown in Drawing No. BIR-OH-E-0009.

12.2 PERIOD OF ERECTION AND STRINGING WORKS

Since the existing 132kV line between Lekhnath substation and Syangja substation is extremely important to supply power to Pokhara city and it is difficult to plan long term power shutdown, erection and stringing works shall be carried out within short-termed period of power shutdown for few weeks during dry season as shown in Drawing No. BIR-OH-E-0010.

The Contractor shall submit appropriate work procedures including safety measures to the Employer and shall start the work after getting the approval of the Employer.

12.2.1 Power Shutdown

For the erection and stinging work of the lines, the Contractor shall request the Employer for the shutdown of existing transmission line, where necessary, a least 3 months in advance. The request letter or form shall include the place of work and duration of shutdown needed. The period of shutdown shall be as minimum as possible. The Employer has right to decrease the justified period of shutdown, if requested period of shutdown by Contractor is excessive and to shift the date of shutdown.

The Contractor shall complete the work, during the shutdown period within the stipulated time period. If the Contractor fails to complete the work within the stipulated time limit, the Employer will claim the amount of money arising from the loss of energy not transmitted or distributed.

12.3 CIVIL WORKS AND INSTALLATION OF EQUIPMENT AT TOWER SITE

12.3.1 Civil Works

Land formation and gravel surfacing works shall be carried out at the tower site.

12.3.2 Installation of Equipment

The following equipment shall be installed as shown in Drawing No. BIR-OH-E-0001, Drawing No. BIR-OH-E-0002, Drawing No. BIR-OH-E-0007 and Drawing No. BIR-OH-E-0008.

(a) 132kV lightning arrestors and the trestles

(b) 132kV shielding ends and the trestles

(c) Down dropper conductors between phase conductors and lightning arrestors, supporting insulators and the anchors

(d) Mesh earthing system under the tower site

Mesh earthing system shall consist of a web of copper mesh and ground rods spread throughout the tower site and the resistance value shall be satisfied bellow 1.0 ohm.

(e) Wall and the gate around the tower site

12.3.3 Period of Civil Works and Equipment Installation at Tower Site

Since the existing 132kV line between Lekhnath substation and Syangja substation is extremely important to supply power to Pokhara city and it is difficult to plan long term power shutdown, equipment installation shall be carried out without power shutdown and then connection work of down droppers between tower and equipment shall be carried out by power shutdown within one week during dry season.

The Contractor shall submit appropriate work procedures including safety measures to the Employer and shall start the work after getting the approval of the Employer.

12.3.4 Request of Power Shutdown

For the connection work of vertical lines between tower and equipment, the Contractor shall request the Employer for the shutdown of existing transmission line, where necessary, a least 3 months in advance. The request letter or form shall include the place of work and duration of shutdown needed. The period of shutdown shall be as minimum as possible. The Employer has right to decrease the justified period of shutdown, if requested period of shutdown by Contractor is excessive and to shift the date of shutdown as shown in Drawing No. BIR-OH-E-0010.

CHAPTER 13:

TEST AND COMMISSIONING

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CHAPTER 13: TEST AND COMMISSIONING

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TESTS AND COMMISSIONING I
(Underground Transmission Line)

13.1 132KV CABLE, JOINTS AND SEALING ENDS

13.1.1 Type Tests

Cables and associated jointing and terminating accessories shall have satisfactorily passed type approval tests in accordance with IEC60840 in the following sequence.

(a) Bending test generally according clause 12.4.3 IEC60840 followed by installation of the accessories and a partial discharge test at ambient temperature (see 12.4.4 of IEC60840)

(b) Tan δ measurement according clause 12.4.5 IEC60840

(c) Heating cycle voltage test as per clause 12.4.6 IEC 60840

(d) Partial discharge test as per clause 12.4.4 IEC 60840.

(e) Impulse voltage test as per clause 12.4.7 IEC60840. The impulse voltage shall be 650 kVp.

(f) Power frequency voltage test, as per clause 12.4 7 of IEC60840.

(g) Tests of outer protection for buried joints (as per annex G of IEC60840)

(h) Examination of the cable system with cable and accessories on completion of the above tests as per clause 12.4.8 of IEC60840.

(i) Resistivity of cable semi-conducting screens as per clause 12.4.9 of IEC60840.

(j) Non electrical type tests on cable components and completed cable as per clause 12.5 of IEC60840.

13.1.2 Sample Test at Factory

(1) Sample test on cables

The tests specified in clause 10 of IEC60840 shall be carried out on samples which taken to represent batches.

(2) Sample test on accessories

The tests specified in clause 11 of IEC60840 shall be carried out on samples which taken to represent batches.

13.1.3 Routine Tests at Factory

All the routine tests specified in IEC60840 shall be carried out on each manufactured cable length which shall include the following test items.

(a) Partial discharge test in accordance with IEC60885-3 for cables, except that the minimum detectable discharge shall be 10 pc or less. Testing of accessories follows the same principles, but the sensitivity shall be 5 pc or less. (See clause 9.2 of IEC60840). The test voltage shall be raised to 1.75 Uo for ten seconds and then slowly reduced to 1.5 Uo. The magnitude of the discharge at 1.5 Uo shall be recorded and shall not exceed the above value.

(b) An A.C. voltage of 2.5 Uo shall be applied at ambient temperature between conductor and metallic screen/sheath for thirty minutes. (See clause 9.3 of IEC60840).

(c) Conductor resistance measurement to clause 10.5 IEC60840.

(d) Voltage test on outer-sheath as specified in Clause 3 of IEC60229.

(e) Dielectric loss angle measurement

(f) Conductor examination

The following Routine tests shall be carried out on each manufactured piece of Joint/Termination and Stress relief cones:

(a) AC High voltage withstand test at 2.5 Uo for 30 minutes

(b) PD measurement at 1.5 Uo (PD shall be less than 5 pc with 2pc noise level)

13.1.4 Tests on Completion

The test procedure and schedule of site tests for Transmission Line Work shall be in accordance with GC Sub-Clauses 7.4 and 9.1 and well coordinated with site tests and commissioning of Substation Wok by the Contractor. The Contractor shall submit the test procedure and test schedule to the Engineer for approval at least 30 days before commencement of the pre-commissioning tests.

The site test items shall include at least the following items before energizing the transmission lines of power cable.

(a) AC High voltage test as per clause 16.3 of IEC60840.

(b) Voltage test of 10kV maximum per one minute on outer sheath in accordance with IEC 60229. This test shall be carried out after the cable laying, but before jointing and backfilling above concrete slabs.

(c) After completion of the installation (including termination), all sheath insulation shall be tested in accordance with clause 5, IEC 60229.

(d) The Contractor shall measure and record the thermal resistivity of the back-filling material after reinstatement, the tests shall be made at approximately 300 m intervals and the recorded values included in the as-built records. Every effort shall be made to obtain uniform thermal resistivity along the routes.

(e) Insulation resistance values are to be checked before and after HV test.

(f) Conductor DC resistance is to be measured

(g) Earth Resistance measurements at all joint bays

(h) Cross Bonding Verification Check (In the case of cross bonding system is applied).

Correctness of special bonding: With the links in the link box in their correct positions, a three phase current of approximately 100 A shall be applied to the main conductors. The currents and voltages shall be measured and agreed with theoretical values supplied by the Bidder/Contractor.

13.2 OPTICAL FIBER CABLE

The electrical and functional tests of the optical fiber cable shall be carried out according to the relevant latest issues of ASTM-B 415 and 14, ITUT (CCITT) G651 and G652, IEC 60793-1 and 60794-1, IEC-60068-2-14 and the relevant Electra Publication, valid at time of awarding the Contract.

13.2.1 SAMPLE TESTS

To be done on minimum one drum from a batch) Sample tests shall be performed and comprise at least:

Test Item	Test passing Criteria
Dimension Tests	
- Diameter of core	To be checked against manufacturer proposal and approved documents
- Diameter of cladding	-do-
- Diameter of primary coating	-do-
- Diameter of buffer	-do-
- Non-circularity	As per Technical Data Sheets
- Concentricity errors	-do-
- Length of cable/fiber	To be checked against manufacturer proposal and approved documents
- Thickness of insulation	As per Technical Data Sheets
- Thickness of sheath	-do-
- Overall dimension	To be checked against manufacturer proposal and approved documents
Transmission and optical characteristics	
- Cable Cut-Off wave length	As per Technical Data Sheets

13.2.2 ROUTINE TESTS

To be done on each drum before delivery to NEA

Following factory (routine) tests shall be performed on each drum before delivery & shall comprise as a minimum:

Test Item	Test passing Criteria
Transmission and optical characteristics	
- Attenuation at wavelength (1270, 1310 and 1500 nm)	As per Technical Data Sheets (at 1310 and 1550 nm)
Electrical characteristics	
- Dielectric strength	No breakdown
- Insulation resistance of outer sheath	Refer to IEC standards for the given insulation thickness

- TDR Scan (Trace to be retained for future reference, inclusion in the final test report) Attenuation (Trace to be retained for future reference, inclusion in the final test report.)

13.2.3 Tests on Optical Fiber Cables - At Site (after installation)

Following tests are to be performed and dummy spool fiber of not less than 500m in length shall be used at both ends while conducting end to end tests.

(a) Splice Tests for every joint (Attenuation & Backscatter)

(b) Link Tests for every section (TDR scan, Dispersion)

(c) End to End test by OTDR @1310nm & 1550nm

(d) End to end test by power meter and power source @1310nm & 1550nm

13.2.4 Test Reports

The Bidder/Contractor shall provide the test equipment for the above tests and shall ensure that the test equipment is calibrated and suitable for these tests. Calibration certificates shall be valid for at least six months.

All of the test results shall be clearly annotated with date/time; item identification; test equipment type and serial number; switch settings; screen axis names and dimensions and the marking of all points of special interest with comments. Detailed analysis and summary sections shall be included and the whole complied into a single volume for presentation within one month of the overall link acceptance.

The test results shall comply in all respect with the requirement as set out in the specification and data stated in technical particulars and guaranteed data and with standards ASTM-B415 and B416, ITUT (CCITT) G651 and G654, IEC 793-1 and 794-1, IEC-68-2-14, IEC-2-52. Method and procedure of test shall be guided by the standard as above or such other standard as may be provided.

13.3 CIVIL WORKS

13.3.1 General

The tests shall be conducted in accordance with the relevant standards. Measuring instruments used in testing shall be regularly calibrated at the expenses of the Contractor/Laboratory and records shall be available for examination by the Employer/Engineer.

The tests to be conducted by the Contractor are mentioned in the subsequent sub-clauses but not be limited.

13.3.2 Concrete Testing

The contractor shall submit method statement of concrete works to the Engineer for approval not less than one month before commencement of concreting operation at the Site.

(a) trial design mix composition and achieved concrete strength

(b) site concrete testing procedures

(c) laboratory concrete testing procedures

(d) ready-mixed concrete testing procedures

Coating imperfection such as dull grey, rough surface, lumpiness and runs may be accepted whereas wet storage stain or bulky white deposits, dark spots or flux staining, bare or rust stains will generally not be accepted.

13.3.3 Steel Testing

The Contractor shall be responsible to provide documentation and/or undertake the following activities:

(a) tensile tests on profile/bar samples site concrete testing procedures

(b) brittleness tests on profile/bar samples

(c) mill test certificates of steel and bolt batches

(d) galvanizing tests on profile and bolt samples

(e) uniformity and thickness tests of zinc coating

Coating imperfection such as dull grey, rough surface, lumpiness and runs may be accepted whereas wet storage stain or bulky white deposits, dark spots or flux staining, bare or rust stains will generally not be accepted.

13.3.4 Shop Assembly

Bolted structures shall be tested for dimensional accuracy before dispatch to site by complete or part assembly of the girder/truss in the manufacturer’s work shop. If a horizontal part-assembly of a girder is adopted, blocking and adequate support simulating the actual support conditions shall be applied. Test working vertical loads shall be applied (e.g. sand bags) according to the loading design of the girder to verify the actual deflection and compare with the allowable displacement.

Any member distorted, twisted or bent due incorrectness of detailed drawing shall be corrected. Welding to compose individual tower members or fill of mismatched bolt holes will not be permitted. Reaming of mismatched holes will not be permitted. All matching holes for bolts shall pass freely through the assembled members in a direction at right angles to such members. A reasonable amount of drifting will be allowed in assembling. If any errors on the drawings or fabrication are discovered, all incorrect drawings shall be revised and submitted for approval by the Engineer and the corrected part shall be re-fabricated and re-assembled at the Contractor’s expenses.

TESTS AND COMMISSIONING II
(Overhead Transmission Line)

13.4 TESTS AT MANUFACTURERS WORKS

13.4.1 General

Where no specific test is specified then the various items of materials and equipment shall be tested in accordance with the relevant British, IEC, or American Standards. Where no appropriate standard is available, tests shall be carried out in accordance with the makers' standard practice which must meet with the approval of the Employer.

At least fourteen days notice in writing or by fax shall be given to the Employer of the readiness of plant for test or inspection and every facility shall be provided by the Contractor and sub-Contractor(s) to enable the Employer or their Representative to carry out the inspections and witness the tests. This includes progress, test rig and packing inspection.

Inspection of equipment will not be carried out unless copies of the relevant sub-orders, drawings and test procedures have been approved by the Employer.

No equipment shall be packed, prepared for shipment, or dismantled for the purpose of packing for shipment, unless it has been satisfactorily inspected, or inspection has been waived by the Employer.

Functional electrical and mechanical tests shall be carried out on the completed plant after assembly in the Works. The extent and method of recording the results shall be agreed by the Employer in sufficient time to enable the tests to be satisfactorily witnessed or to make any change to the proposed program of tests.

All instruments and apparatus used in the performance of the tests shall be to the approval of the Employer and, if required by the Employer, shall be calibrated to an agreed standard at a laboratory of National standing to be nominated by the Contractor and approved by the Employer.

The cost of carrying out such calibration shall be borne by the Contractor in all cases.

13.4.2 Material tests

Requirements for the testing of castings and forging are detailed elsewhere in the Specification. Representative samples of all plates, bars and pipes etc. which form components of the plant shall be tested as required by the relevant standard or code at the request of the Employer.

13.4.3 Test certificates

Within 15 days of the completion of any test, triplicate (3) sets of all principal test records, test certificates and performance curves shall be supplied to the Employer.

These test records, certificates and performance curves shall be supplied for all tests, whether or not they have been witnessed by the Employer or his Representative. The information given on such test certificates and curves shall be sufficient to identify the material or equipment to which the certificate refers and should also bear the contract reference title. Specified requirements shall be shown on each certificate for comparison with actual test results.

When all equipment has been tested, test certificates from all Works and Site tests shall be compiled by the Contractor into volumes and bound in an approved form complete with index. Two copies of each volume shall be supplied to the Engineer and four copies to the Employer.

13.5 TOWER

Test on each type of towers to be supplied, shall be made at the manufacturer's plant or at such location as may be mutually agreed. The number of tower test, if required, is given in price schedule.

The Contractor shall give Employer not less than 30 days advanced notice, in writing or by fax, of the date when towers will be ready for tests. Employer reserves the right to waive the requirement for performing any or all tests. Should Employer exercise this right, the applicable unit prices for performing the test will be deducted from the total contract sum. The Contractor will not be entitled to any additional compensation by reason of such waiving.

Each test shall be performed in accordance with the following requirements:

(a) Tower: The tower shall be fabricated from approved detail drawings in a manner as close to final production procedures as is practicable. The tower shall be complete in every detail.

(b) Erection: The tower shall be erected on rigid foundation using the specified tower and bolts and nuts shall be tightened to the specified torque. The vertical axis through the center of gravity of the erected tower shall not be out of gravity of the erected tower and shall not be out of plumb by more than 1 cm for every 500 cm height.

(c) Rigging: The Contractor shall submit for approval as to compliance with the specifications, diagrams showing the proposed methods of applying loads and measuring deflection.

(d) Loading: All test loads corresponding to conductor and overhead ground wire loading shall be applied directly to the regular attachment. Details shall be provided for these loads. Test wind loads equivalent to wind loads on the tower shall be applied where convenient and in such a manner that the summations of applied load and overturning moment are as close as possible to the actual behaviour as designed. Extra compressible member is not allowed for use of applying wind loads on tower. To ensure application of full-test loads to the tower, friction losses in rigging shall be added to the rigging loads.

(e) Load Programs: The contractor shall program the tests to most favorably demonstrate that the towers will carry all design loads and conditions specified in the loading diagrams. Test wind loads on tower shall be the same as applied in design calculation.

(f) Deflection Measurements: Deflections shall be recorded for the "before-load", "load-on" and "load-off" condition to provide longitudinal and transverse deflections at the tower top center, at the elevation of the middle cross arm (s) and at least one intermediate point of tower body.

(g) Design Load Tests: The initially applied loads and the increment of loading shall be 25 percent of the loads given in the loading diagrams. Each load increment shall be maintained for not less than two minutes for each assumption except under maximum (full) design loads the period of five minutes shall be maintained and during which 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 assumptions are applied.

(h) Destruction Tests: After the successful completion of the load tests, the tower shall be further tested to destruction by increasing the transverse loads under any condition specified by Employer in increments not to exceed five per cent of full design transverse loads. The vertical and/or longitudinal load (s) is kept constant at their full design values while deflections are being recorded.

(i) Modification of Tower Components: Any conspicuous yielding or any failure of any part of the tower under any of the tests specified in sub-article shall be considered a defect. If a defect develops, the Contractor shall modify his design of the tower and send to Employer for approval. The modified tower shall then be retested at the Contractor's expense (including the cost of witness, if any) until satisfactory results are obtained.

(j) Material Tests: Steel materials used for tested towers shall be subject to tension or bend test in accordance with ASTM A370. Tests shall be performed by the Contractor at no additional cost to Employer. The test specimens shall be selected as follows:

- Two sets selected from the destructed members of each tested tower.
- Two sets selected from the undisturbed members of each tested tower.

(k) Reports: The Contractor shall furnish four 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, details diagrams deflection records.

13.6 INSULATORS

13.6.1 Impulse voltage withstand and flashover test

The insulators for Impulse Voltage withstand tests shall be tested applying five standard 1.2/50 waves as specified in BS 137 and BS 923. If there is no flashover or puncture the insulator shall be deemed satisfactory. If there is more than one flashover the insulator shall be deemed not to comply with BS 137. In the event of one flashover occurring, a new series of ten impulses shall be applied. The insulator shall be considered to comply with BS 137 if during the second series of tests there is no flashover or puncture.

50% Flashover tests shall be carried out per BS 137.

Additional tests will be required to show that the specified impulse level is obtained when the insulator strings are mounted on the structure. Tenderers should note that the impulse test rig will therefore require earthen metalwork to simulate the proposed power configuration.

Flashover tests to determine the optimum lift shall be carried out in order to avoid cascade over as many line end insulators as possible.

13.6.2 Dry power frequency withstand test

The Dry power frequency withstand test shall be carried out as specified in BS 137. The test voltage shall be maintained for one minute and the insulator shall be considered satisfactory if no flashover or puncture occurs.

13.6.3 Wet power frequency voltage withstand test

The wet power frequency withstand test shall be carried out as specified in BS 137. The test voltage shall be maintained for one minute and the insulator shall be considered satisfactory if no flashover or puncture occurs.

13.6.4 Radio interference tests

Radio interference tests shall be carried out in accordance with IEC 437.

13.6.5 Insulator Fittings test

Tensile tests, resistance tests and galvanizing tests shall be carried out in accordance with the requirements of BS 3288 Part 1 and BS 729.

13.7 CONDUCTORS

The conductors shall be tested in accordance with the requirements of the appropriate IEC, ISO or ANSI.

13.8 OPGW

The OPGW shall be tested in accordance with the requirements of the appropriate IEC only in case of a basic new design, repetition in exceptional cases.

13.9 ROUTINE TEST

All equipment shall be subjected to routine tests at the manufacturer's work and shall include but not be limited to the following:

13.9.1 Operational tests

All equipment shall be tested after complete assembly to ensure the correct operation.

13.9.2 Clamps, joints and insulator fittings

Sample parts selected at random by the Employer shall be subjected to such tests as the Employer may direct in order to demonstrate compliance with Specifications and BS 3288 as applicable.

13.9.3 Insulators, fittings, conductor and OPGW overall tests

A complete mechanical test of insulator string, fittings and section of conductor for suspension and tension sets at each voltage level will be required. The complete units shall withstand load tests including the safety factors specified. Tests other than mechanical tests on the complete unit may be required at the discretion of the Employer.

13.10 SITE TESTS

13.10.1 Measurement of footing resistance

Before stringing the conductor, the footing resistance of each support shall be measured with an earth resistance measuring instrument to the approval of the Employer.

13.10.2 Measurement of earth electrode resistance

Where the footing resistance is found to exceed 10 ohms additional earth electrodes are to be installed and the combined earth electrode and footing resistance measured together and recorded using the same test instrument. Additional electrodes are to be installed to obtain a maximum resistance value of 10 ohms.

13.10.3 Measurement of line impedance (Not applicable)

Positive and zero sequence impedance measurement tests shall be carried out after final line inspection has been completed. The measurement tests shall be carried out on all new lines covered by this Contract, by the Contractor and at his cost.

13.10.4 Measurement of galvanizing thickness

The Contractor shall have available on Site for the Employer's use an instrument suitable for the accurate checking of galvanizing thickness. The gauge shall be available from the time of arrival of the first consignment of steel work until the issue of the Operational Acceptance Certificate. The cost of the gauge and other operating expenses are deemed to be included in the Contract Price and the gauge will remain the property of the Employer.

13.10.5 Tests on completion

Acceptance tests shall be carried out on Site by the Contractor on each section of the Works. These tests shall immediately follow the commissioning of each section of the Works.

The lines shall be energized at full working voltage before handing over and the arrangement for this, and such other tests as the Employer shall desire to make on the complete line, shall be assisted by the Contractor who shall provide such labor, transport and other assistance as is required without any extra charge. Apparatus for special tests shall be provided by the Contractor.

The Contractor shall submit to the Employer at least two months before the anticipated commencement of acceptance tests his detailed proposal for carrying out acceptance tests.

13.10.6 Test instrumentation

The method of measuring all quantities and qualities and the measurement tolerances shall be in accordance with the appropriate BS, ISO or ANSI.

The terminal conditions required for establishing whether the guarantees are met shall be measured by precision test equipment to be installed by the Contractor in addition to the permanent measuring equipment where supplied under the Contract.

The overall design of the Works shall provide for the installation and use of test equipment so as not to interfere with the plant loading or delay the guarantee completion dates.

All the precision test equipment to be used for carrying out tests shall be calibrated against standard instruments before and also after the tests, if required by the Employer. Calibration records shall be available for inspection by the Employer or his Representative.

During the design stage of the plant, the contractor shall give details of measurements to be made to substantiate that the performance of the plant meets the requirements of the specification and in particular shall submit for approval a schedule of performance test instrumentation necessary to demonstrate the guarantees.

13.10.7 Test reports

For each of the specified tests the contractor shall agree the test figures with the Employer and shall submit for approval triplicate copies of the test report containing a complete analysis of the test results within one month of the completion of the relevant test. Eight copies of the final approved report shall be submitted to the Employer.

13.11 COMMISSIONING TEST

The contractor shall be responsible for checking that total and relative sags of conductors are within the specified tolerances. Such checks shall be carried out at positions along the route selected by the Employer and the contractor shall provide the necessary surveying instruments to enable the checks to be carried out with the line in service without any extra charge.

The commissioning tests are as follows:

(a) Measurement of line parameters (not applicable)

The electrical parameters of the lines such as resistance, reactance, susceptance etc. shall be measured in a manner to be approved by the Employer, sufficiently accurately to enable the positive, negative and zero sequence impedance to be determined for the lines.

The lines shall then be energized at the proposed operating voltage from the Employer's system or generating station and the charging current measured and other such tests performed as the Employer may require making on the completed line.

The contractor shall carry out all these tests in the presence of the Employer, and shall provide all the necessary labor, transportation, apparatus, instruments and other assistance as required, without any extra charge.

(b) High voltage tests

The overhead lines shall be tested in accordance with Sub-Clause 13.1.4 “Tests on Completion”.

CHAPTER 14:

OPTICAL FIBER GROUND WIRE

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CHAPTER 14: OPTICAL FIBER GROUND WIRE

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14.1 GENERAL

The scope of work comprises of supply, and installation of Optical Fiber Ground wire (OPGW) for new 132kV special branch tower to cut existing 132 kV transmission line between Lekhnath substation and Syangja substation and branch to new double circuits underground cables.

The Contractor shall offer the OPGW and their accessories from the reputed manufacturer.

14.2 TECHNICAL REQUIREMENTS

The optical fiber ground wire (OPGW) shall be of nominal cross section 60 mm2. Aluminum clad steel or/and aluminum alloy wires shall form the stranding part of earth wire. The Optical Fiber Cable, containing single-mode optical fibers shall be embedded loosely inside the protective tube. The protective tube shall be of aluminum alloy or stainless steel. Both fiber optic and stranding part of OPGW shall comply with this Specification, and with the following standards:

Single mode fibers	ITU-T (former CCITT) G. 652
Optical fiber cables	IEC 60793-1 & 2
	IEC 1089/91, IEC 60889/87
Stranding part	IEC 60104/87; BS 3242

The earth wire shall be suitable for the climatic conditions and compatible with the stringing condition of the phase conductor. Under no condition shall the OPGW sag exceed the conductor sag.

The optical fiber shall be made of germanium doped silica glass or pure silica glass. It shall have a primary coating made of silicone or similar material with physical and mechanical properties at least those of silicone (acrylic or similar).

The tube shall be made of suitable material sufficiently strong to hold its shape and provide protection for the optical fibers against deformation and friction. The strength member of the fiber optic cable shall provide protection against buckling, kinking and strain. The material to be used shall be fiber reinforced plastic.

The direction of lay of the outer layer of strands shall be right hand. Lay ratio of any layer shall be not greater than the lay ratio of the layer immediately beneath it.

The make up of shield wire shall be such that the strand shall remain and shall not twist when the conductor is cut. The earth wire shall be manufactured so that no twisting occurs when subjected to axial loads, i.e. when unrolling and stringing.

All wires used in the manufacture of the earth wire shall be free from protrusion, sharp edges, abrasion and any other imperfections.

No jointing of the aluminum clad steel wires shall be permitted.

There shall be no joints or splices in any optical fiber in any reel length of the complete optical cable.

The creep characteristic of the finished earth wire shall be of virtually unvarying uniformity.

14.3 OPTICAL FIBERS

All fiber installed as a part of this Contract shall have a minimum life of 30 years from the date of final acceptance.

The OPGW shall include minimum 48 fibers. The main optical characteristics of the OPGW are shown in the Clause 15.11.

14.3.1 Attenuation

The attenuation coefficient for wavelengths between 1285 nm and 1330 nm shall not exceed the attenuation coefficient at 1310 nm by more than + 0.05 dB/km.

The attenuation coefficient for wavelengths between 1535 and 1565 shall not exceed the attenuation coefficient at 1550 mm by more than + 0.05 dB/km. The attenuation of the fiber shall be distributed uniformly throughout its length such that there are no point discontinuities in excess of 0.1 dB.

The cable shall consist of single mode dual-window color coded optical fibers. There shall be no factory splices within the cable structure.

14.3.2 Optical fiber identification

Color-coding is essential for identifying individual optical fibers and groups of optical fibers. Individual optical fibers within a fiber unit, and fiber units will be identifiable using a color-coding scheme. The color coding system shall be discernible throughout the design life of the cable.

Each cable shall be traceable of each fiber back to the original fiber manufacture's fiber number and parameters of the fiber.

If more than the specified numbers of fibers are included in any cable, the spare fibers shall be tested by the cable manufacturer and any defective fibers shall be suitably bundled, tagged and identified at the factory by the Vendor.

14.3.3 Buffer tube

Loose tube buffer construction shall be applied. The individually coated optical fiber(s) shall be surrounded by a buffer for protection from physical damage during fabrication, installation and performance of the cable. The fiber coating and buffer shall be strippable for splicing and termination. The inside diameter of the buffer tube shall be of appropriate size to allow free movement of the fibers during cable Contraction or elongation resulting from thermal, tensile or vibration loads.

Buffer tubes shall be sleeved over multiple fibers forming a fiber unit. A fiber unit may consist of up to 6 fibers, individually identifiable utilizing the color code in conformance with EIA 359 A.

14.3.4 Optical fiber termination and splicing

Suitable splice boxes (enclosures) shall be provided to encase the optical cable ends and fusion splices in protective, moisture and dust free environment. The splice boxes shall be designed for the storage and protections of a minimum of 12 fibers cables and provide access through locked doors.

Fiber-optic cable of adequate length shall be provided so that all tower splicing can be performed at ground level.

14.3.5 Outdoor splice boxes

Splice boxes provided by the Contractor for outdoor use shall be suitable for use with the cable type provided as part of this Contract. The splice boxes shall be appropriate for mounting on steel structures and accommodate pass-through splicing and fiber terminations.

The splice box, including organizer/ splice trays, shall be designed to seal and protect the fiber cable splices from the environment defined in this specification and it shall provide easy access for any maintenance function.

All splice boxes shall be of metal construction that are clean and smooth finished, treated to resist rust, accommodate the storage of a minimum of 3 meters of coiled fiber and allow easy access to the splice trays.

14.4 PARTICULAR REQUIREMENT FOR OPGW EARTH WIRE FITTINGS AND ACCESSORIES

The associated fittings and other accessories have to satisfy the specific function of OPGW and fiber optics requirements for a total integrity of their components. The best way to achieve these goals shall be in application of suitable performed products. A brief description of the accessories is as follows:

(a) Suspension Assembly: Suspension assembly shall consist of:

- Armor grip suspension clamp (aluminum alloy hyper formed armor rods and suspension clamp);
- Associated hardware for earth wire suspension:
- Flexible grounding loop connection.

(b) Tension Assembly: The tension assembly shall consists of:

- Hyper formed alum weld dead end grip;
- Associated hardware for earth wire attachment (shackle, link, clevis, clamps);
- Flexible grounding loop connection.

(c) Vibration Dampers

Dampers where necessary, shall be of Stockbridge type installed complete with the armor rods of the size suitable to the earth wire size.

(d) Fiber Optic Splice Closure-Joint Box

The fiber optic splice closure allows clamping of the cables to be spliced. It shall have the following characteristics:

- The splice capacity for minimum 48 single-mode fibers from metal free optical cable with loose tube construction;
- Waterproof housing of the closure aluminum or stainless steel construction with protection class IP 65 of IEC 60529;
- Box and cable glands tightened by sealing compound.

Installation height shall be 1.5 m above the anti-climbing devices of the towers.

(e) Fiber Optic Hood Closure-Terminal Box

The fiber optic splice closure allows termination of OPGW on the substation gantry and interface with the underground fiber optic cable leading into the control building. It shall have the following characteristics:

- The cable glands for accepting of one metal free optical cables with minimum 48 single-mode fibers and loose tube construction;
- Waterproof housing of the closure aluminum or stainless steel construction with protection class IP 65 of IEC 60529;
- Box and cable glands tightened by sealing compound.

It shall be installed on the terminal gantry 1.5 m above ground level.

APPENDIX

TECHNICAL PARTICULAR OF OPTICAL GROUND WIRE (OPGW)

1. STANDARD

Aluminum alloy wires	IEC 104 type A
Aluminum clad steel wire	IEC 1232
Cable construction	IEC 1089 (where applicable)
Optical Unit	ITU-T (former CCIT) G 652

2. PROPERTIES OF THE OPTICAL FIBRES

single mode fibers	
dimensions and geometry of fiber	according to ITU-T G.652
fiber attenuation at 1310 nm at 200C max.	0.4 dB/km
fiber attenuation at 1550 nm at 200 C max.	0.25 dB/km
attenuation deviation at 1310 nm and 1550 nm	0.1 dB/km within -450C to 800C
other properties of fire	according to ITU-T G.652

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CHAPTER 15:

TECHNICAL SCHEDULE

(ONLY FOR OVERHEAD LINE)

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CHAPTER 15: TECHNICAL SCHEDULE (Only for Overhead Line)

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15.1 SYSTEM AND LINE DATA

Item	Description	Unit	Data
1	System Data		
1.1	System nominal voltage	kV	132
1.2	System maximum voltage	kV	145
1.3	System nominal frequency	Hz	50
1.4	Line Data		
	Lekhnath S/S- Kaligandaki P/S	Km	66
	132kV Single Circuit Line		
	- Conductor		ACSR"DUCK"
	- OPGW		Equivalent to ASLH-D(S)bb1x12SMF (AA/ACS 77/43-10.3)

15.2 DESIGN DATA

Item	Description	Unit	Data
1	Temperature		
1.1	Maximum ambient temperature	°C	40
1.2	Minimum ambient temperature	°C	0
1.3	Maximum temperature of conductor	°C	80
1.4	Everyday temperature of conductor	°C	25
2	Wind Loads : Maximum wind velocity 31.0m/sec		
2.1	Wind pressure on the whole projected area	kg/m^2	60.9
2.2	Wind pressure on the whole projected area members	kg/m^2	98.5
2.3	Wind pressure on 1.71 times projected area of steel angle face of structure	kg/m^2	168.5

15.3 MINIMUM CLEARANCES

The followings are the minimum clearances between live conductors and other objects, which correspond to the maximum conductor sag conditions.

Item	Description	Minimum Clearances (in meter) in Normal Condition
1	Normal ground for pedestrians only	7
2	Residential areas	7
3	Roads and streets	8
4	Highways	8
5	To metal clad or roofed buildings or building or structures upon which a man may stand	5
6	Power lines (above or below)	3.5
7	Telecommunication lines	3.5

For other objects not listed in the Schedule the requirements for minimum clearances shall comply also with NESC (NATIONAL ELECTRIC SAFETY CODE).

Approximately 0.5m shall be added to the clearance values above to allow for survey and drawings errors.

Crossing of houses, huts and other objects with soft roofing is not allowed.

15.4 SUPPORT TYPES AND DESIGN SPANS

(1) Tower Type (Special Branch Tower)

Item	Tower Type	Position where used	Angle of deviation (degree)	Insulator Type
1.1	Special Branch Tower	Dead End	30	Tension

(2) Tower Type (Special Branch Tower)

Item	Tower Type Single Circuit	Ruling Span (m)	Wind Span (m)	Weight Span (m)
1.1	Special Branch Tower	350	350	350

15.5 TOWER CLEARANCE

Description	Data
Minimum clearance between live conductor to earth	1500mm
Minimum clearance between phases (Down dropper conductors)	3000mm
Ground clearance including 0.5m margin at 80oC conductor temperature	7.5m

Height of the lowest crossarm above ground level for the special branch tower shall be ensured more than 16.0m as follows, considering sufficient space to use heavy machines and materials/equipment transportation at tower site during foundation work and installation of equipment on tower site without power shutdown.

Conductor sag at 80 degree (Span=200m)	2.16m
Length of Tension Insulator string	0.0m
Ground clearance	7.5m
Space for works without shutdown	6.0m
Allowance	0.3m
Total	16.0m

15.6 FACTORS OF SAFETY

Item	Description	Minimum Factor of Safety
1	Towers and Foundations	
1.1	All types of towers under Normal working conditions	2.0
1.2	All types of towers under broken wire conditions	1.5
1.3	Foundations for all normal types of towers under all lateral uplift and overturning forces	1.5
1.4	Foundations for special types of tower under all lateral uplift and overturning forces (for river crossing)	2.0
2	Conductors and Insulators	
2.1	Conductors based on ultimate tensile strength	2.5
2.2	Conductors based on ultimate tensile strength at still air every-day temperatures	5.0
2.3	Complete insulator strings and fittings on	3.0

	minimum breaking load of insulator	
2.4	Dead end compression clamps and compression splices based on conductor ultimate tensile strength	0.95
3	Earth Wires	
3.1	Earth wire based on earth wire ultimate tensile strength	4.0
3.2	Earth wire at still air everyday temperature based on earth wire ultimate tensile strength	6.5
3.3	Complete tension assembly at earth wire maximum working tension	4.0
3.4	Complete suspension assembly at maximum vertical load	4.0

15.7 TOWER PARTICULARS

(1) Unit Stresses

The quality of steel used for support members and bolts.

Item	Description	Unit	Minimum Values
1.1	Structural Mild Steel		
1.1.1	Structural Members		
	Tension based on net Sectional area	kg/cm^2	2600
	Axial compression based on gross sectional area	kg/cm^2	2550
1.1.2	Connection bolts		
	Shear on gross area	kg/cm^2	2220
	Bearing (on mild steel)	kg/cm^2	4440
	Tension on net area of threaded portion	kg/cm^2	1980

(2) Slenderness Ratios (L/R)

The slenderness ratio of unsupported length of steel compression members to their least radius of gyration.

Item	Description	Maximum values
2.1	Main members	150
2.2	Braces	200
2.3	Redundant members	250
2.4	Members loaded in tension only	375

15.8 TOWER MEMBER PARTICULARS

The minimum thickness and diameter of material used in members and bolts shall be as follows:

Item	Description	Unit	Minimum Values
1	Calculated members	mm	45x45x4
2	Redundant members	mm	45x45x4
3	Thickness of legs, members in cross arms and in earth wire peaks	mm	6
4	Diameter of bolts for member carrying stress	mm	16
5	Diameter of bolts for redundant members without calculated stress	mm	16
6	Gusset plates	mm	6

7	Stub angles	mm	8

15.9 INSULATORS

Item	Description	Unit	Data
1	Insulator unit		
1.1	Type of insulator		Toughened glass or porcelain disc
1.2	Type of coupling		Ball & socket
1.3	Dimensions		
	Spacing of insulator	mm approx.	146
	Diameter of sheds	mm approx.	255
	Creepage distance	mm approx.	320
1.4	Minimum breaking load		
	Tension string/ Down dropper	kN	120
1.5	Power frequency withstand voltage		
	Dry one minute	kV	70
	Wet one minute	kV	40
1.6	Impulse withstand voltage	kV	110
1.7	Power frequency puncture voltage	kV	100
2	Insulator Strings		
2.1	Number of units: (minimum)		
	Single tension string/Down Dropper		10
2.2	Ratio of horn gap length for single tension string		More than 85%
2.3	Standards		ANSI/IEC

15.10 LINE CONDUCTOR

Item	Description	Unit	Data
1	ACSR "DUCK"		
1.1	Conductor size	mm^2	306.9
1.2	Conductor type	ACSR	Duck
1.3	Number and size of wires		
1.3.1	Aluminum	No.	54
		dia.mm	2.69
1.3.2	Steel	No.	7
		dia.mm	2.69
1.4	Cross section		
1.4.1	Aluminum	mm^2	264.4
1.4.2	Steel	mm^2	61.7
1.4.3	Total	mm^2	326.1
1.5	Conductor diameter	mm	24.21
1.6	Ultimate strength	kg	10,250
1.7	Modulus of elasticity final	kg/mm^2	8,200
1.8	Coefficient of linear expansion	per °C	17.8×10^{-6}
1.9	Standard mass of conductor	kg/km	1,161
1.10	Electrical D.C. resistance at 25 °C	ohm/km	0.09424
1.11	Standards		ASTM B232

15.11 OPGW

Item	Description	Unit	Data
1	OPGW		

1.1	No. of Fibers	No.	48
1.2	Nominal sectional area	mm^2	Provide by NEA
1.3	Number and diameter of component wire and steel and steel tube	No./dia.mm No./dia.mm	8/4.3 1/1.4
1.4	Standard mass of conductor	kg/km	560
1.5	Overall diameter	mm	12.8
1.6	Ultimate breaking strength	kN	84.7
1.7	Modulus of elasticity final	MPa	140
1.8	Coefficient of linear expansion	per °C	13.4×10^{-6}
1.9	Electrical D.C resistance at 20 °C	ohm/km	0.743
1.10	Short circuit current for 0.5 sec	kA(°C)	10 (200)
1.11	Attenuation coefficient at 1310nm	dB/km	<=0.4
1.12	Attenuation coefficient at 1550nm	dB/km	<=0.25
1.13	Attenuation deviation at 1310nm and 1550 nm	dB/km	<=0.1 within 45 to 80 °C
1.14	Standards		IEC 104 Type A, 1232, 1089 ITU-T G.652

15.12 MATERIAL FOR TOWER GROUNDINGS

Item	Description	Data
1	Ground rods	
1.1	Galvanized steel pipes/angle	60mm dia./50 x 50 x 5mm steel angles 2m long
2	Ground wire	
2.1	Galvanized steel wire/ strip	38mm2 / strip 7/2.6 dia. mm
3	Connection of ground electrode with stub angle	
3.1	For connection of steel angle	Steel wire as above
3.2	For connection of copper weld rods	Copper conductor as above

15.13 FOUNDATION APPLICATION SCHEDULE

FOUNDATION TYPE	APPLICATION	SOIL DESCRIPTION
I "Spread Footing with undercut"	For use with all 132kV lattice tower types	Soil capable of being undercut such that footing concrete is placed against undisturbed soil bearing capacity - 1.5 Kg/Sq. cm. Assume cone of earth - 30 degrees. Cohesive material – Very stiff clay requiring picking for removal. A fresh sample of which can not be molded by finger pressure and intended by thumb. Blow count over 10. Granular Material – Very dense cemented gravel. Difficult to excavate by shovel alone. Relative density over 75%. Blow count over 20.

II. "Spread Footing"	For use with all 132kV lattice tower types	Soil capable of being excavated with vertical wall bearing capacity - 1.0 kg/sq. cm. Assume cone of earth - 20 degrees. Cohesive Material – Stiff clay. Some silt and sand. Not readily excavated by shovel alone. Can not be molded by finger pressure and intended by thumb. Blow count 8 to 10. Granular Material- Compacted sand. Some silt and gravel. Difficult to excavate by shovel alone. Relative density over 60%. Blow count 10 to 20.
III "Spread Footing"	For use with all 132kV lattice steel tower	soil capable of being excavated without appreciable sloughing. Bearing Capacity- 0.5 kg/sq. cm. Assume cone of earth- 10 degrees. Cohesive Material – Soft to medium clay. Some silt and sand. Can be excavated by shovel alone and molded by medium finger pressure. Blow count 4 to 8. Granular Material – Loose to medium sand and silt. Easily excavated by shovel alone and molded by medium finger pressure. Blow count 4 to 10. *General note: Backfill must be compacted and must control ground water during the concreting time, select borrow may required for backfill material.*

15.14 TESTS AT MANUFACTURER'S PLANT

Item	Description	Standards
1	Rolled Steel Angles and Bolts	
1.1	Tensile strength test and chemical Steel mill analysis, zinc coating test	Steel mill certificates
	Full scale tower load test to destruction	IEC 652
2	Insulators	
2.1	Temperature cycle test, mechanical IEC 383 & failing load test	IEC 383 & IEC 575
2.2	Porosity test, continuity of zinc coating	BS 137
2.3	Electrical test on complete insulator strings	ANSI C-29.1
3	Insulator Fittings	
3.1	Routine and sample mechanical tests	BS 3288
3.2	Galvanizing tests	BS 729
4	Clamps and joints	
4.1	Mechanical and electrical type tests, galvanizing and mechanical routine tests	BS 3288, BS 729, ISO
5	Dampers	
5.1	Fatigue resistant tests	
5.2	Test of clamp slippage resistance	BS 729
5.3	Galvanizing tests	ISO
6	Line Conductor and OPGW	

6.1	Mechanical test, galvanizing test and resistivity test, ultimate tensile stress of complete conductor/OPGW	IEC 209 & BS 2627

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CHAPTER 16:

SAFETY SPECIFICATION

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CHAPTER 16: Safety Specification

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16.1 GENERAL REQUIREMENTS FOR SAFETY SPECIFICATION

The Contractor shall be responsible to fully comply with JICA Standard Safety Specification (JSSS), Ver.1.0 February 2021 issue (or latest version).

The Safety Specification shall consist of two (2) parts, namely:

(a) Part 1; JICA Standard Safety Specification (JSSS)

(b) Part 2: Particular Safety Specification

The Safety Specification shall be incorporated in part of the Employer's Requirements, and have priority over the other parts of the technical specifications in respect of health and safety matters.

16.2 JICA STANDARD SAFETY SPECIFICATION

The Contractor (Bidder) shall refer to JICA Standard Safety Specification, shown in the JICA homepage as follows:
https://www.jica.go.jp/Resource/english/our_work/types_of_assistance/c8h0vm00008zx0m8-att/jsss_01.pdf

16.3 PARTICULAR SAFETY SPECIFICATION

The Particular Safety Specification comprises a schedule containing the particular additions and modifications to JSSS, necessary to create a precise and relevant specification for the health and safety requirements for the Project.

Within the Safety Specification, the Particular Safety Specification have priority over JSSS.

The Particular Safety Specification for this project is in Annex.16-1 enclosed hereafter this Chapter.

16.4 SITE OFFICE MANAGEMENT

The Contractor shall establish and maintain throughout the period of the performance of the contract a site office to serve as a base for all the operations necessary to perform the works and shall maintain adequate store facilities for storing materials and equipment issued by the Engineer. In case the above-mentioned facilities and establishments are not found satisfactory during the site verification, the Engineer shall have right to instruct the Contractor for rectification of the same.

16.5 CONTRACTOR'S HEALTH AND SAFETY OBLIGATIONS

The Contractor shall be fully responsible for the health and safety on the Site, for the Works, his personnel, sub-contractors' personnel, the public domain and all persons directly or indirectly associated with the Works, on or in the vicinity of the Site in accordance with Clause 6 of General Conditions.

The Contractor shall submit the Safety Plan to the Engineer for review, which shall be incorporated in the Programme. The Contractor's health and safety activities shall be monitored and recorded on a daily basis.

The provisions in the Contract Documents regarding the health and safety shall apply to the Contractor and his sub-contractors of any level for any part of the Works.

The Employer reserves the right to order the immediate removal and replacement of any item of Contractors Equipment or Temporary Works, which in his opinion, is unsatisfactory for its purpose or is in an unsafe condition.

The safety requirements specified here shall be strictly followed as a minimum throughout the Project construction period. There is no restriction for the Contractor to follow his own additional safety measures.

16.6 CONTRACTOR'S SAFETY PLAN

The Safety Plan shall be submitted by Contractor (and Bidder) as per the requirements mentioned in the Safety Specification.

16.7 HEALTH AND SAFETY OFFICER

The Contractor shall appoint a Health and Safety Officer (HSO) as per the Safety Specification.

The appointment and designation of HSO shall be subject to the Engineer's approval. Unless specifically agreed in writing by the Engineer, the Contractor shall not undertake any work on the Site until the Health and Safety Officer has commenced duties on Site.

The Contractor shall provide an HSO with enough supporting staffs in accordance with the staffing levels set out in the Safety Specification.

Annex.16-1 Particular Safety Specification (PSS)

1. GENERAL

The Particular Safety Specification shall supplement corresponding clause of JSSS. Whenever there is a conflict, the provisions herein shall prevail over those in JSSS.

2. PARTICULAR SAFETY REQUIREMENT

CHAPTER 1: GENERAL REQUIREMENTS

1.7.7 (1) BASELINE SAFETY PLAN

1.7.7 (1) shall be replaced with the following.

The Baseline Safety Plan shall be submitted within 60 days from the Commencement Date or at least 45 days prior to the start of construction activities, whichever comes earlier.

1.7.9 PROCEDURES FOR SUBMISSION AND REVIEW

Clause 1.7.9 (2) (b) shall be replaced with the following sentence.

The Particular Safety Plans by the date forty five (45) days prior to the commencement of each particular part of the Works where sufficient detail has not been included in the Baseline Safety Plan and/or within twenty eight (28) days after the date of the Engineer's request.

Only in exceptional circumstances, submission up to fourteen (14) days prior to the commencement of work may be permitted.

1.12 HEALTH AND SAFETY OFFICER AT THE SITE (HSO)

Specific requirement shall be referred to Vol.1 EQC 1.1.1 Personnel.

In accordance with Clause 1.13.1 of JSSS, the HSO shall devote his full time and attention to maintaining health and safety upon the Works and protecting against accidents.

The HSO (Health and Safety Officer) shall be assigned exclusively and shall not concurrently perform any other duties or hold additional positions.

1.12.2 SUPPORTING PERSONNEL

The number of supporting personnel of HSO shall be one (1).

1.21 SKILL TRAINING

In accordance with Clause 1.21.4 of JSSS, the Contractor is not allowed to bring into the Country for use upon the Works any unqualified, unskilled or inexperienced foreign Contractor's Personnel.

1.22 DANGEROUS WORK

The following works are expected as dangerous works in the Works:

- Welding work, Hot cutting work, and Demolition work
- Construction of Trench and manhole on the heavy traffic road during day and night time
- Shuttering work for cable manhole construction
- Work in closed place (tank, cable manhole, etc)
- Foundation work of special branch tower (live line proximately work)
- Equipment Installation work of special branch tower (live line proximately work)
- High place work at Transmission Tower and Utility Poles
- Transmission line work and Distribution line work (Live line proximity work and de-energized work)
- Work near the energized electrical facilities such as high voltage cable, exposed power line, switchgear and transformer

The above list is just examples of dangerous works, the Contractor shall take responsibility for the dangerous works, shall suggest additional dangerous work in the safety plan.

It shall be the Contractor's responsibility to provide appropriate insurance, safety and health management, security measures, and welfare facilities for such hazardous work at the own cost.

1.22.11 HAZARDOUS SUBSTANCES

There is not expected to be likelihood of the existence of Hazardous Substances such as UXO at the construction site of Birauta substation and along the underground cable route.

1.23 PERMIT TO WORK SYSTEM – DANGEROUS WORK

(1) General Requirements

'Permit To Work' includes the following information as the minimum requirements.

The 'Permit to Work' shall be arranged through the Project and the same shall also be got cancelled through the project only.

Dangerous works shall not commence until the PTW is fully completed, reviewed, signed by all responsible parties (e.g., Work Supervisor, Health and Safety Officer, and Site Manager), and visibly displayed at the worksite.

All PTW records shall be maintained in the site safety file and organized in a manner that allows for audit and verification.

No.	Category	Detail
1.	Basic Information	Work title, location, date, scheduled start and end times, responsible person(s)
2.	Worker Information	Names of supervisors and workers, qualifications or certifications (license numbers, if applicable), number of workers involved
3.	Work Description	Brief explanation of the task (e.g., welding work inside substation, etc.)
4.	Equipment and Material Used	List of tools, flammable materials, hazardous substances, or

		electrical equipment to be used
5.	Key Work Procedures	Outline of essential safety procedures (detailed method statements may be attached separately)
6.	Identified Risk and Control Measures	Description of potential hazards (e.g., fire, electric shock, toxic gas, falls) and specific control measures such as LOTO, ventilation, or assignment of standby personnel
7.	Work Conditions and Limitations	Conditions for work approval or suspension (e.g., “work shall be suspended if wind speed exceeds XX m/s” or “delay work if heat stress index exceeds safe threshold”)
8.	Pre-work Safety Inspection Checklist	Confirmation of gas leakage tests, grounding measures, voltage absence, ventilation, etc.
9.	Approval Signatures	Signature fields for the Work Supervisor, Health and Safety Officer, and Site Manager
10.	Emergency Contact Information	Emergency contact numbers (fire department, ambulance, safety personnel), location of emergency stops and evacuation routes

(2) Substation Work (Electrical)

After partial or complete energization of substation equipment, the Work Supervisor to undertake involving work shall take the Permit to Work from the responsible person in charge of substation operation.

A minimum seven (7) day advance notice in writing for the de-energization of necessary part of the equipment shall be given to the Project.

Before the starting of the involving work, the Work Supervisor shall confirm de-energization of the equipment by earthing and voltage detector. Also, other living facilities shall be clearly indicated and isolated from involving facilities.

After involving work is completed, the Work Supervisor shall check the evacuation of personnel and tools from job site and the earthing is disconnected.

(3) Substation Work (Civil and Building)

Before starting demolition work, the Contractor shall ensure that all utilities such as electricity and water supply are properly disconnected.

(4) Transmission Line Work

For foundation work and equipment installation work (such as lightning arrestors and cable sealing ends) can be expected to involve live line proximity work.

Heavy machinery such as cranes must maintain a minimum distance of 3.05 meters (10 feet) from energized 132 kV transmission, the Contractor shall monitor the safety during the work.

For the erection and stringing work of the lines, the Contractor shall request the Employer for power shutdown of existing transmission line, where necessary, at least 6 months in advance. The request letter or form shall include the place of work and duration of shutdown needed. The period of shutdown shall be as minimum as possible. The Employer has right to decrease the justified period of shutdown, if requested period of shutdown by Contractor is excessive and to shift the date of shutdown.

The Contractor shall complete the work, during the shutdown period within the stipulated time period.

If the Contractor fails to complete the work within the stipulated time limit, the Employer will claim the amount of money arising from the loss of energy not transmitted or distributed.

The Contractor shall obtain a PTW prior to undertaking a work near the energized transmission line, work on the de-energized line (including installation of temporary protective earth before work), and high place work (including tower climbing).

(5) Distribution Line Work

The Contractor shall inform the Project Manager whenever he wants to avail the ‘Permit to Work’ from the local distribution centre for erecting the new 11 kV line or augmenting the existing 11 kV line.

A minimum seven (7) day advance notice in writing for availing the shutdown on any live 11 kV feeder/LT lines shall be given to the Project.

Even after taking the "Permit to Work", the Contractor must verify the absence of voltage with voltage detector before commencing the work.

The 11 kV/ LT line on which permit is taken shall be made clear from all the temporary protection earth, men and material before cancellation of the ‘Permit to Work’.

1.24 ACCIDENT RESPONSE PLAN

As there are several hospitals near the construction site in Pokhara that provide 24-hour medical services, the establishment of a dedicated medical facility within the site shall not be required. But AED and facilities capable of providing first aid treatment for injured or ill persons shall be equipped at the construction site.

Examples of hospitals with 24-hour availability in Pokhara are listed below.

1. Manipal Teaching Hospital

Operator	A private teaching hospital affiliated with Kathmandu University.
Departments	General Medicine, Surgery, Internal Medicine, Obstetrics and Gynecology, ICU, Orthopedics, among others.
Operating Hours	Outpatient Services: 9:00 AM – 3:00 PM (Sunday to Friday) Emergency Services: 24 hours

2. Gandaki Medical College Teaching Hospital

Operator	A private teaching hospital affiliated with Tribhuvan University
Departments	A wide range including Internal Medicine, Surgery, Neurology, Ophthalmology, ENT, Dentistry, etc.
Operating Hours	Outpatient Services: 8:30 AM – 2:30 PM (Sunday to Friday) Emergency Services: 24 hours

1.30 HEALTH AND SAFETY COORDINATION WITH OTHER CONTRACTORS

There are no other Contractors employed by Employer near the construction site.

1.36 HEALTH MATTERS

The Contractor shall collect wastes from and clean in accommodation facility, offices, workshops and work sites on a daily basis and transport it to an area approved by the Employer and Engineer. The Site shall be kept clean and free of refuse at all times. No waste shall be dumped in areas other than the locations designated by the Contractor and approved by the Employer and Engineer for waste disposal. No waste of any kind shall be deposited in any watercourses.

1.36.4(2) PROVISION OF ANTI-MOSQUITO MEASURE

Safety Measure for mosquito shall be required in the project area.

1.38 UNEXPLODED ORDNANCE (UXO)

There is not expected to be likelihood of the existence of Hazardous Substances at the Site.

ANNEX 1.2: CONTENT OF BID STAGE SAFETY PLAN

A1.2.2 (9) SAFETY PLAN FOR THE WORKS

The anticipated work activities and associated hazards in this project are listed in the table below. The Contractor must ensure that the safety measures for each work activities are fully implemented.

Work activities in the table are not comprehensive, the Contractor shall make safety plan for anticipated work in the Project.

Work Activity	Main Hazards	Notes
1. Substation Work (Electrical)		
Work near live equipment	Electric shock, arc flash	Live work generally prohibited unless under strict control
High-voltage withstand/insulation testing	Electric shock, equipment rupture	Requires controlled environment and trained personnel
Grounding installation	Electric shock due to potential difference	Especially hazardous during fault conditions
Cable termination (heat application)	Fire, burns, inhalation hazard	Ensure proper ventilation and flame control
2. Substation Work (Civil & Building)		
Demolition work	Collapse, dust	Safety barricade and water spraying
Excavation (foundation, pit, cable trench)	Collapse, buried utility strike	Use shoring and pre-surveys
Piling Work	Machine overturning, falling objects	License or training of operator required
Work near floor openings	Falls, dropping tools	Install covers and clear signage
Formwork, rebar work and scaffolding	Punctures, falls	Rebar caps and scaffolding checks required

	Concrete casting	Formwork failure	Supervised pouring and curing control, check formwork strength, emergency plan in place
	Work at heights	Falls, dropped objects	Use of full-body harness mandatory
	Falsework, temporary supports and scaffolding	Collapse of formwork, earth retaining, shoring and scaffolding	Design and inspection documentation required
	Painting/plastering (organic solvents)	Solvent inhalation, falls	Respiratory protection and ventilation required
3. Substation Work (Heavy Equipment & Machinery)			
	Equipment delivery using cranes	Crushing, suspended load drop, machine overturning, overloading, strong wind	Signalmen and exclusion zones required, license required
	Cable laying from drums	Reel tip-over, entanglement	Secure drum stands and use proper rollers
	Transformer/GIS installation	Crushing, overturning	Use level base and rigging plan
4. Overhead Transmission Line Work (Foundation & Ground)			
	Borehole drilling, soil testing	Machine entanglement, cave-in	Monitor ground conditions and machinery limits
	Foundation excavation	Collapse, buried objects	Shoring and excavation permits needed
	Earth retaining work	Structural failure	Pre-approved temporary work plans
	Anchor embedding and concrete work	Tripping, entrapment	Level monitoring and proper mix procedures
5. Overhead Transmission Line Work (Tower Assembly and Erection)			
	Component assembly (on ground)	Crushing, tool mishandling	Work zone isolation necessary
	Tower erection (crane or jacks)	Suspended load risk, collapse	Rigging plan and load chart compliance
	High-place work (tower top)	Fall, object drop	Full-body harness with fall arrest
	Brace and wire installation	Electric contact, whipping wires	Clearance from energized lines mandatory
	Adverse weather work (wind, lightning)	Gust-induced falls, lightning strike	Wind speed ≥ 15 m/s requires work suspension
6. Underground Transmission Line Work and Distribution Line Work			
	Trench excavation (manual or mechanical)	Cave-in, buried utility damage	Use shoring, perform utility checks
	Pavement cutting (asphalt/concrete)	Blade injury, flying debris, dust	Use water cooling, PPE, isolation barriers
	Earth retaining/shoring	Collapse, material fall	Install supports per plan, daily inspection
	Underground crossing (jacking/shield)	Oxygen deficiency, machinery damage	Forced ventilation and gas detectors mandatory
	Conduit installation	Snap-back, entrapment	Use proper tools and team coordination
	Manhole/joint pit construction	Fall into openings, toxic gas	Guard openings, monitor air quality
	Concrete work (underground)	Formwork collapse, slips	Adequate access and curing supervision
	Work inside pits and manholes	Confined space risks	Atmospheric testing, ventilation
	Cable delivery and pulling	Reel instability, tension break	Use of pulling winch with load monitoring
	Jointing/termination work	Electric shock, fire	Flame control and insulation check required
	Withstand & continuity testing	Shock, arc flash	Post warning signs and restrict

			access
	Backfilling & compaction	Equipment collision, burial hazard	Spotters and phased filling techniques
	Pavement restoration	Burns, vibration, traffic hazards	Control heat exposure and secure work zone
	Work on public road	Traffic accidents	Safety guards and safety barricade
7. Overhead Distribution Line Work			
	Pole removal or erection	Tip-over, entrapment	Pre-burial depth and utility check mandatory
	Excavation for poles	Striking buried objects	Visual and marked inspection zones required
	Stay wire (guy wire) installation	Snap-back injuries	Ensure tension control and anchor strength
	Conductor stringing & re-tensioning	Wire breakage, entanglement	Controlled tension monitoring and exclusion zone
	Heavy equipment lifting (e.g., pole-mounted transformers)	Suspended load, falling objects	Signal control and PPE enforcement
	Conductor removal and winding	Flying cable ends, rollback	Controlled winding and team communication
	High-voltage proximity work	Shock, arc fault	Insulated gloves/tools and exclusion distance
	Bucket truck work	Falls, tipping	Full harness and vehicle inspection required
	Roadside work	Traffic accidents	Traffic control plan and flaggers essential

A1.2.2 (22) ENVIRONMENTAL, TEMPORARY WORKS AND STRUCTURAL MONITORING PLANS

The Contractor shall ensure that the contents of the clause are consistent with those of Environmental Management Plan (EMP) and Construction Environment Management Plan (CEMP). The specific requirement for monitoring and record shall be referred to Vol.2A-2_Chaper 16, Vol.3B-2_Chapter 17, Vol.4C-2_Chapter 25.

CHAPTER 2: GENERAL SAFETY MEASURES

2.1.1 HAZARDOUS SUBSTANCES

There is not expected to be likelihood of the existence of Hazardous Substances at the Site.

2.1.2.(4) ASBESTOS

Existing buildings to be demolished don't contain any asbestos in the components.

2.1.3.(2) POOR VENTILATION

Clause 2.1.2 shall be supplemented with the following sentences:

Furthermore, if entering a location where ventilation is considered insufficient, the oxygen concentration should be measured using an oxygen meter each time to ensure safety. In addition, if the generation of hydrogen sulfide or other toxic gases is expected, adequate ventilation must be provided.

2.1.7 (6)-(13) MONITORING AND RECORDING

Requirement for monitoring and record shall be referred to Vol.2A-2_Chaper 16, Vol.3B-2_Chapter 17, Vol.4C-2_Chapter 25.

This requirement represents the minimum standard, and compliance with it does not exempt the Contractor from its contractual responsibility to carry out the Works without causing damage to other property.

2.2.2 WORKING AREA PERIMETER

The Contractor shall follow the following requirements for the Construction fence, and as a general, security personnel shall be arranged by Contractor at the own expense.

(1) Temporary Fence for Welding Works and Hot Cutting Works

Temporary Fence for welding works and hot cutting works shall be satisfied with the following requirement.

Parameter	Requirement
Fence Type	Temporary steel or plastic barricade with mesh or panel type design
Fence Height	Minimum 1.8 meters (for outdoor) Minimum 1.2 meters (for indoor)
Minimum Clearance Radius	More than 3 meters from welding point
Foundation	Weighted base or anchored posts (stable against wind)
Visibility Control	Opaque flame-retardant welding screen or curtain shall be attached to block arc light
Fire Protection	Flame-resistant tarpaulin or spark-resistant blanket shall be applied inside the fence area
Opening Access Gate	For Welder only, kept closed during operation

(2) Temporary Fence for Constructing Scaffolding Zone

Parameter	Requirement
Fence Type	Temporary steel or plastic barricade with mesh or panel type design
Fence Height	Minimum 1.8 meters
Marking	Display warning signs in English and local language – “Scaffolding Work in Progress” – “No Unauthorized Entry”

	– "Falling Objects Risk"
Reinforcement	Use additional braces or sandbags in windy conditions
Lighting	Provide LED lights along fence perimeter if working at night

(3) Barricade for Energized Area

When construction work is performed in an energized distribution substation, authorization shall be obtained from the Employer's designated, authorized person before work is started by the Contractor. When work is to be done in an energized distribution substation, the Contractor to fully understand the following;

- What facilities are energized, and
- What protective equipment and precautions are necessary for the safety of personnel.
- Barricades or barriers shall be installed to prevent accidental contact with energized equipment.
- Appropriate signs indicating the hazard shall be posted near the barricade or barrier.

(4) Temporary Fence for Underground Cable Construction Works

For underground cable construction and excavation works, pylons and safety barriers shall be placed around all excavation openings to alert and protect the public.

The traffic lanes shall be clearly marked by safety cones, barricades and guide signs to prevent accidents and to ensure quality control of constructing roads.

If an excavation is to remain open and unfilled for long time, the Contractor shall either assign security personnel to the location or cover the opening the trench with steel plates or other appropriate materials to ensure public safety.

(5) Temporary Fence for Overhead Line Works

During lifting or lowering of heavy materials in the vicinity of utility poles or transmission towers, appropriate safety controls such as pylons or safety bars shall be installed to ensure that no personnel enter the area directly beneath the suspended load.

2.2.6 COMMUNITY RELATIONS

Requirement for communication with local society shall be referred to Vol.2A-2_Chaper 16, Vol.3B-2_Chapter 17, Vol.4C-2_Chapter 25.

2.7.6 SAFETY MEASURES FOR EARTHQUAKE AND TSUNAMI

In the event of an earthquake, do not rush outside in panic, but instead, take shelter under a sturdy structure.

When the Contractor are engaged in outdoor work, protect your head and evacuate to an open area.

2.8 FIRE PREVENTION

As the following fire stations are located near the construction site, large-scale firefighting facilities within the site shall not be required.

Main Fire Station	Pokhara Fire Station

Location	Pokhara Metropolitan City
Phone Number	061-520222
Operating Authority	Pokhara Metropolitan City
Operating Hours	24 hours a day, 365 days a year
Travel Time to Site	Approximately 15 minutes

However, to ensure initial response in the event of a fire, the Contractor shall comply with the following requirements.

At least one fire evacuation route shall be provided at the construction site.

During the substation construction phase, portable fire extinguisher and fire blankets shall be equipped on each floor of the building.

All firefighting equipment shall be subject to regular inspections, typically once per month.

CHAPTER 3: EXISTING UNDERGROUND, CONCEALED AND OVERHEAD SERVICES

3.1.3 REQUIREMENTS AND PRECAUTIONS

There are some other utility facilities along the underground cable route, and on the utility pole. The Contractor shall take proper preventive measures by themselves.

- Water Supply : Nepal Water Supply Corporation
- Telephone : Nepal Telecom
- Internet : Many ISPs are there
- Public Road : Road Department and Local Authorities

Location of existing underground facilities such as water pipes and telecommunication lines shall be referred to Drawing No. BIR-XXXXXXXXXXXX.

3.1.3 (7) REQUIREMENTS AND PRECAUTIONS

If there is a possibility that underground installations, such as power cables, are energized with high voltage, work shall only be carried out after the Work Supervisor has confirmed that the cable is de-energized

3.1.3 (14) REQUIREMENTS AND PRECAUTIONS

The following sentence shall be added as Clause 3.1.3 (14).

When backfilling underground facilities, the Contractor shall restore the site to its original condition in accordance with the instructions of the road management authority or other relevant agencies.

3.2.3 (3) REQUIREMENTS AND PRECAUTIONS

Clause 3.2.3 (3) shall be replaced with the following:

As a general rule, when working near energized cables or wires, power must be shut off and the Person in Charge at the site must confirm that they are de-energized before work begins.

If, due to certain circumstances, power cannot be shut off, the target object must be insulated, or a safe distance must be maintained during the work.

In such cases, care must be taken to avoid the risk of electric shock, all contractor personnel must be kept safe, and the provision and use of protective equipment must be strictly enforced.

CHAPTER 5: HOISTING AND RIGGING

5.3.1 (6) PLANNING, INSTALLATION AND REMOVAL

The following sentence shall be added as Clause 5.3.1 (6).

Crane operations must be suspended when the 10-minute average wind speed exceeds 10 m/s.

CHAPTER 6: TEMPORARY WORKS

6.1.1 DESIGN AND PROVISION

The following temporary supporting structures (falsework) shall be eligible for the application of alternative requirements:

- No need for fabrication or design of custom-made structures
- Not subject to temporary support or retention of heavy loads (such as structural components)
- Do not require special considerations for ground conditions or working space
- Can be safely implemented using standard or commercially available components (e.g., steel props, formwork supports)

6.7.7 (4) SAFETY MEASURES

The following sentence shall be added after Clause 6.7.7 (4) (a).

The Contractor shall ensure that all metallic structures in areas where temporary facilities are installed are properly grounded.

CHAPTER 7: EXCAVATION WORKS

7.2 PARTICULAR SAFETY MEASURES

The Contractor may choose either manual or mechanical excavation; however, for excavation works on roads, where there is a high possibility of existing utility equipment such as water pipes, the excavation shall be carried out manually up to the depth at which such installations are likely to be present.

7.6.5 (2) PERSONNEL

The following sentence shall be added as Clause 7.6.5 (2) (c).

Blasting engineers and blasting technicians must hold a national license or an equivalent qualification in the relevant country or in a country approved by the Engineer.

CHAPTER 9: CONCRETE WORKS

9.2.3 (1) SAFETY MEASURES FOR PLACEMENT BY PUMPING

The following sentence shall be added as Clause 9.2.3 (1).

Personnel operating concrete pump trucks must have received training on safe operation.

CHAPTER 10: ELECTRICAL WORKS (ADDITIONAL CHAPTER)

The following clauses and sentences shall be added as safety requirement for electrical works

10.1 SCOPE

This Chapter applies to electrical work carried out during the construction of substations, overhead transmission lines, underground transmission lines, overhead distribution lines, and underground distribution lines. The scope includes equipment installation, wire and cable laying, connection work, testing and commissioning, and control panel wiring.

10.2 APPLICABLE STANDARD

The Contractor shall comply with the following standards for the electrical work.

- NFPA 70E (Electrical Safety in the Workplace)
- OSHA 29 CFR 1910 Subpart S and 1910.147 (LOTO requirements)
- IEC 60364 series (Low-voltage electrical installations)
- IEC 61936-1 (Power installations exceeding 1 kV AC – General requirements)

Compliance with these standards enables international-level management of hazards such as electric shock, arc flash, and equipment malfunction.

10.3 GENERAL SAFETY REQUIREMENTS

(1) Electrical work shall be carried out only by qualified personnel (holders of national licenses or those who have received formal training).
(2) The work area shall be clearly demarcated using signs and barricades, and entry by unauthorized persons shall be strictly prohibited.
(3) Appropriate Personal Protective Equipment (PPE), including insulated tools, insulated gloves, dielectric boots, and face shields, must be used during work.
(4) All electrical work must be carried out in accordance with a work procedure based on a pre-approved Risk Assessment (RA).

10.4 ENERGY ISOLATION MANAGEMENT (LOTO: LOCKOUT/TAGOUT)

10.4.1 PURPOSE AND APPLICABILITY

All electrical work shall implement LOTO procedures to protect workers from hazards such as accidental energization, residual voltage, or unintended operation of equipment.

If the equipment and facilities are entirely new, with no connection to other power sources or systems and no energized components, the application of LOTO shall not be applied.

However, if any part of the equipment is energized, LOTO shall be applied to that portion, and the Contractor shall ensure worksite safety accordingly.

10.4.2 IMPLEMENTATION PROCEDURE

(1) Identify the target equipment (circuit breakers, switches, DC sources, Ring Main Unit etc.)
(2) Completely de-energize the equipment using disconnecting devices
(3) Apply physical lockout using padlocks or equivalent devices
(4) Attach a tagout label (indicating worker name, work content, and contact information)
(5) Verify zero voltage using a voltage detector
(6) Upon work completion, after the Work Supervisor confirm the evacuation of all workers, testing engineers and their tools, the responsible person shall remove the lock and tag.

10.4.3 ADDITIONAL PROVISIONS

(1) Each piece of equipment subject to LOTO shall be clearly labelled with a unique identifier such as a number or name.
(2) When multiple contractors are involved in the same electrical system, a group lockout box capable of accommodating multiple locks shall be used.
(3) All LOTO records shall be maintained in the site safety file and organized in a manner that allows for audit and verification.

10.5 SAFETY MEASURES FOR SPECIFIC ELECTRICAL WORK

10.5.1 TERMINATION AND CONNECTION OF HIGH- AND EXTRA-HIGH VOLTAGE CABLES

These tasks require complete de-energization of the relevant circuits followed by disconnection, grounding, and application of LOTO procedures. Workers shall wear proper PPEs, and exposed conductors must be properly insulated. A Permit to Work (PTW) must be issued prior to work, and risks and countermeasures must be communicated to all workers.

10.5.2 INSTALLATION AND HIGH VOLTAGE TESTING OF SWTICH GEAR

Handling of switch gear including Gas-Insulated Switchgear (GIS) and Ring Main Unit (RMU) involves risks of gas leaks, electric shock, and arc flash; therefore, the work area must be designated as restricted entry. Clear signage shall be posted during testing, and all energizations shall be performed under the supervision of the responsible person. Especially in case of first energization and high voltage testing, all personnel shall be evacuated in switch gear area except minimum testing engineer. Then testing engineer shall keep a safety distance from tested equipment.

10.5.3 RELAY PROTECTION AND CONTROL PANEL WIRING

LOTO must be applied to DC control sources. To prevent incorrect wiring, a dual-check procedure shall be implemented. During testing, only authorized personnel may access the area, and results shall be documented in test records. The living adjacent facilities shall be clearly indicated and isolated by insulation sheets or similar material if possible.

10.5.4 LIVE LINE PROXIMITY WORKS (TRANSMISSION AND DISTRIBUTION LINE WORK)

Foundation work and equipment (such as lightning arrestors and cable sealing ends) installation work of special branch tower can be expected to involve live line proximity work.

Heavy machinery such as cranes must maintain a minimum distance of 3.05 meters (10 feet) from energized 132 kV transmission line and 11kV distribution line, the Contractor shall monitor the safety distance during the works.

The heavy machinery must be securely grounded to prevent electric shock, the earth installation must be confirmed by the Work Supervisor before commencing the related work.

For distribution lines operating at 11 kV, any work within 1.5 meters of the energized conductor is considered proximity work, the work must be done by specially trained personnel on high voltage.

10.5.5 DE-ENERGIZATION WORK (TRANSMISSION AND DISTRIBUTION LINE WORK)

Due to risks of electric shock, fall from height, induced voltage, and accidental re-energization, proper work permits (PTW) must be issued and confirmed before starting the work. Where the system has previously been energized, Lockout/Tagout (LOTO) procedures shall be applied, and conductors on both sides of the work zone must be visibly grounded (temporary protective grounds).

Before commencing any electrical work, the absence of voltage shall be verified using an appropriate voltage detector. Once de-energization is confirmed, temporary grounding and short-circuiting devices shall be applied to the conductors, following the principle of "first to apply, last to remove." Only after these safety measures are in place may the work proceed. Upon completion of the work and confirmation that all personnel have vacated the area, the grounding devices shall be safely removed.

10.5.6 LIVE WORK (DISTRIBUTION LINE WORK)

Live work on low-voltage electrical lines (typically up to 1000V AC) shall be permitted only when justified and carried out under strict safety protocols. The following conditions must be met:

Workers must wear Class 0 rubber insulating gloves (rated for up to 1000V AC), leather protector gloves over insulating gloves, Insulated footwear, Arc-rated face shields and flame-resistant clothing.

All work must be performed by qualified and trained electricians who have received specific instruction in live-line working procedures.

10.5.7 CABLE CONNECTION WORK IN UNDERGROUND CABLE MANHOLES

Due to risks of oxygen deficiency, electric shock, and limited evacuation, oxygen concentration must be measured, ventilation provided, and monitoring personnel assigned. LOTO and PTW procedures are mandatory, and emergency response readiness must be ensured.

GENERAL CONDITIONS

GC6.6 FACILITIES FOR STAFF AND LABOUR

The Contractor shall provide worker accommodation and welfare facilities that meet the following requirements:

(1) Worker Accommodation

Function	Requirements
Living Quarters	Adequate space, ventilation, natural lighting, furnished with beds, mattresses, and storage space
Bed Spacing	A minimum distance of 1 meter between beds is generally recommended (to reduce overcrowding and for infection control)
Sanitary Facilities	Toilets and shower facilities (with hot water) shall be provided in each accommodation block
Heating/Cooling	Fans, air conditioners, or heaters shall be provided as necessary
Drinking Water	Safe drinking water shall be supplied at all times in compliance with WHO standards
Security & Safety	Lockable entrances, designated evacuation routes, and fire-fighting equipment must be in place

(2) Welfare Facilities

Function	Requirements
Canteen & Kitchen	Clean dining space and kitchen capable of providing nutritious meals (self-cooking is acceptable)
Rest Area	Sheltered or indoor rest areas for use during work breaks
Medical Facilities	First-aid room equipped with basic medical supplies, medicines, and assigned first-aid personnel
Laundry Facilities	Washing machines or designated hand-washing areas
Hygiene Management	Waste collection points, drainage systems, pest control, and other hygiene-related measures
Communication	Mobile network coverage and Wi-Fi (desirable but not mandatory)

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CHAPTER17:

SOCIAL AND ENVIRONMENTAL REQUIREMENTS

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CHAPTER 17: Social and Environmental Requirements

The Contractor shall be responsible for the full compliance with the following laws, regulations and / or guidelines, including related by-laws, with respect to the execution of this Project. In addition to the ones listed below, the Contractor shall also comply with any new or amended laws, regulations and / or guidelines for social and environmental safeguards during the execution of this Project.

1. Environment Protection Act, 2076 B.S.
2. National Environmental Policy, 2076
3. Environment Protection Rule, 2077 BS
4. National Environmental Impact Assessment Guidelines, 2050 BS (1993 AD) (2009)
5. JICA Guidelines for Environmental and Social Considerations, 2022 A.D.
6. Land Use Act, 2076
7. Land use Policy of Nepal, 2075
8. Land Acquisition Act, 2034 (1977)
9. Land Acquisition, Rehabilitation and Resettlement Policy 2071
10. Contribution Based Social Security Act 2074
11. Contribution based social Security Regulations, 2075
12. Labour Act, 2074 (2017)
13. Labor Rule, 2075
14. Child Labour (Prohibition and Regulation) Act. 2056
15. Soil and Watershed Conservation Act, 2039 (1982)
16. Water Resources Act, 2049 (1992)
17. Water Resources Regulation, 2050 BS (1993)
18. Solid Waste Management Act, 2068 (2011)
19. Solid Waste Management Regulation, 2070
20. Electricity Act, 2049 (1992)
21. Local Government Operation Act, 2074
22. Electricity Regulation, 2050
23. National Wetlands Policy, 2059 (2003)

The Bidders shall take into consideration in the relevant costs that will be incurred, for the strict adherence to the environmental and social consideration measures, including both mitigation measures and monitoring activities, stipulated in the environmental approvals such as the Initial Environmental Examination Report for this Project, the relevant documents forming part of such approvals obtained under the above laws/regulations/guidelines with respect to this Project, and the Environmental Management Plan (EMP), which is attached as Annex 1 to this document. When there are discrepancies among the above documents, the EMP in Annex 1 shall prevail.

The Contractor shall submit the draft Construction Environmental Management Plan (CEMP) promptly after succeeding the Bid for review of the Employer and shall obtain approval on the final CEMP by the Employer before physical construction start. The Contractor shall submit the draft CEMP with schedule consideration of procedure until to obtain the approval of the Employer such as review, revise, finalise, etc.

The Contractor shall implement mitigation measures and monitoring based on the CEMP and submit a report to the Employer the progress of CEMP implementation once in a month during construction period. With the progress of work, the CEMP shall be reviewed and revised if required by the Employer.

Annex 1 Environment Management Plan for Transmission Line (TL) Construction

The Environment Management Plan (EMP) in this Annex is prepared based on the "IEE of Construction of 132/11 KV Birauta Substation and 600m underground cable line in Kaligandaki-Pokhara (Lekhanath) 132 kV Transmission Line Project, Kaski District, Gandaki Province, Nepal" (referred to as "the IEE report") The EMP of the IEE report includes all work items for Substation, Transmission Line, and Distribution line. Therefore, the item of Transmission Line (TL) part was quoted from the IEE report and some parts was modified in this Annex.

The EMP of the IEE report is composed with 2 parts as Augmentation measure for beneficial impact and Mitigation measures for adverse impact. These are prepared for construction and operation phase but the plans for design phase was not prepared but the Sub-project includes design phase. Therefore, the plans for design phase were prepared for the bidding document referring to the other IEE reports for the other projects in Nepal.

1. Purpose of the Environmental Management Plan (EMP)

The purpose of the EMP is to list minimum requirement of social and environment impact mitigation, management and monitoring activities to be implemented during the detailed design phase and the construction phase by the Contractor.

Based on this EMP, and the Mitigation and Monitoring Plan included in the EMP, the Contractor shall prepare the draft Construction Environment Management Plan (draft CEMP) to be included in the Tender document. The Contractor shall take overall responsibility of works on the implementation of mitigation measures stipulated in the CEMP, which will be finalized through review and check by the Employer.

The CEMP shall be reviewed during the Design and Construction Phase among stakeholders to verify that mitigation measure in the CEMP are duly targeted to minimize the negative impact in the project areas and then revised as appropriate. This iterative process shall continue throughout the construction period.

2. Implementation Structure of EMP

The key parties who are responsible for the implementation of EMP are indicated in Table 1.

The Employer is responsible for the implementation of the Project.

The Contractor prepares the CEMP, based on this EMP, and implement the plan.

The Consultant reviews the CEPM and supervise its implementation.

Table -1 Environmental Management Responsibilities

SN	Organization	Roles and Responsibility
1	Employer and its institutional line offices	• The Employer owes the top level responsibility for the implementation, management and supervision of the project including the EMP. • The Project Management Unit (PMU) of the Employer is in charge of the overall management of project design and construction, including internal monitoring of the EMP. The PMU is composed with the project Director (PD), the Project Magers (PMs) of Sub-projects, and the counterpart staff. • The Site Engineer is to be assigned in the PMU, whose responsibility is to act as the construction manager and to supervise the mitigation and monitoring activities of the Contractor at the construction site and

		Office/ Storage/ Camp sites. • Environment and Social Monitoring Unit (ESMU) under the Environmental Social Studies Department (ESSD) of NEA cooperates with PMU and assists any activities on the field, with the general public including local communities. • ESMU also will take independent monitoring of the implementation of EMP by the Contractor to keep transparency and submit the monthly monitoring report to the PMU.
2	The Contractor	• The Contractor is responsible for the implementation of the mitigation and monitoring plan, including opening the window for receiving opinions, complaints and grievances from the stakeholders. • The Contractor prepares the Final Project Design which satisfies the requirements of the EMP included in the Bidding Documents. • The Contractor prepares the Construction Plan including the Safety Management Plan and the updated CEMP with detailed mitigation measures and monitoring plan.
3	The Consultant	• The Consultant is responsible for management of the project implementation, including monitoring of the activities of Contractor. • The Consultant ensures that the EMP is fully implemented by the Contractor, and submits monthly progress reports and Quarterly Reports to PMU of the Employer.

The institutional coordination for the implementation of the EMP/CEMP is shown in Figure-1.

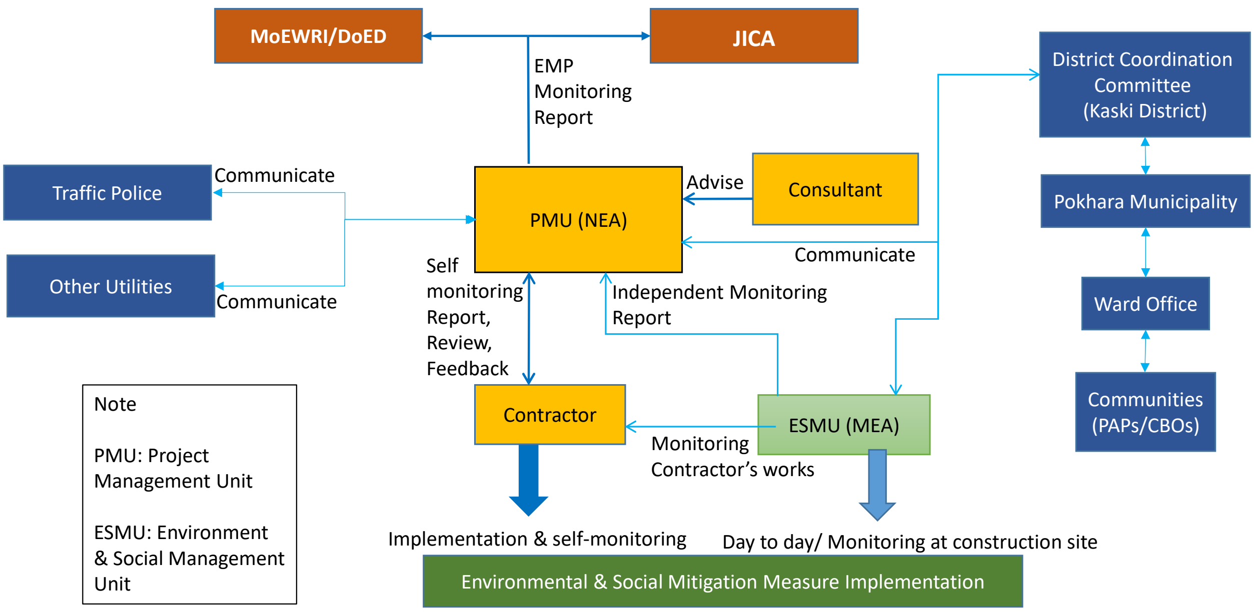

Figure 1 Implementation Structure of Environmental Management Plan

3. Contractor's Environmental Management Unit

During the construction phase, the Contractor shall establish a Contractor's Environmental Management Unit (C's-EMU) for the Sub-project including three parts of Substation, Transmission Line, Distribution Line. And the Contractor shall assign at least one chief officer and one support staff member to the unit. The chief officer will primarily oversee tasks related to the design and construction of the Sub-station, while the support staff member will focus on activities related to the design and construction of the Transmission and Distribution Lines. Both positions shall be full-time roles, with their primary responsibility being to ensure the proper implementation of the Contractor’s Environmental Management Plan (CEMP).

The roles and responsibilities of the C’s-EMU shall include, but are not limited to, the following:

- Document construction activities, mitigation measures and environmental incidents by field notes and photographs
- Prepare monthly Environmental Monitoring Report to submit to the Employer
- Arrange training sessions on environmental management, health and sanitation and safety addressed in the CEMP
- Participate in Construction Meetings when necessary
- Communicate with regulatory agencies and key stakeholders
- Provide technical assistance on environmental matters to construction personnel
- Provide recommendations for modifying and/or improving environmental mitigation measures when necessary
- Report spills of hazardous material, accidents, complaints, and other environmental and social incidents

4. Reporting

The Contractor shall provide environmental monitoring report throughout the Design approval stage and Construction Phase, which, at minimum, shall provide the following information:

- A description of ongoing construction activities
- All mitigation measures taken and all monitoring results during the reporting period
- Photos documenting construction activities, environmental issues and corresponding measures

5. Beneficial Enhancement Measures

The Beneficial Enhancement Measures is shown in the Table -2 below.

Table -2 Beneficial Enhancement Measures for Transmission Line (TL) part in Subproject-A (Construction stage)

Environmental domains	Enhancement measures of beneficial impact	What to do	Where to do	How to do	When to do	Who will do
1. Socio-economic and Cultural Environment	1.1 Increase in the Economic Activity within the Project Sites	A total of 80 human resources will be recruited for construction of the project. Support small enterprise development activities suitable to fulfil likely demands from the work force.	Near Project Location	Install the tea or small business at existing shops. Increase agricultural productivities, expansion of new market, business and increase in land value.	Construction Phase	PMU will enhance the activities. Local people will develop their business.
	1.2 Employment Opportunities to the Local People	Hiring both skilled and unskilled labour forces and give daily wages or monthly wages equal to the district official rates.	Project location	Priority of employment opportunities will be provided to project affected families. The project information will be disseminated through pamphlets and other printed materials time to time	Construction Phase	PMU will give guidance to the Contractor. Contractor will assure the prior employment and report to NEA the results.
	1.3 Development of New Skills on the TL Construction	Launch training programs in electro-mechanical works, electric wiring, metal work, tailoring and maintenance of transmission line, underground cable laying and substation to local people to generate semi-skilled manpower.	Project Location	First priority will be given for the project affected people, marginalized community, indigenous people, dalits and local people to the extent they are interested to get involved	Construction Phase	PMU will provide the training to the local people.

6. Environmental Mitigation Plan for adverse impact

6.1 Desing approval phase

The detailed design, which will be prepared by the Contractor must allow for the implementation of the mitigation measures outlined in Chapter 6.2 during the construction phase.

6.1.1 Inventory survey and land acquisition, resettlement

In accordance with the Basic Design which the Consultant prepared, there are no land acquisition and resettlement are expected. Therefore, the Contractor will prepare the detailed design within the given areas which shown in the Basic Design. If any requirements of land acquisition or resettlement, the Contractor shall report and discuss the necessities to the PMU at the very early stage of the design phase.

6.1.2 Coordination with utilities

The Stakeholders' Meeting (SHM) will be held at least once before finalization of the detailed design and once a year by the Employer (PMU). The Contractor shall attend in the SHM, arranged by the Employer (PMU), that invites all relevant utility authorities and any other stakeholders, local communities. The Contractor shall explain the design and the construction plan in the meeting, including the location, duration, and size of the construction works at SHM. Suggestions and inputs obtained in the meeting shall be incorporated in the final design and the construction plan.

The Contractor shall prepare an Emergency Plan that describes the necessary procedures and actions to minimize the negative impact of accidents with water and other utilities.

The Contractor shall set up a compliant desk to receive the opinions and grievances from the local residents and businesses. The desk shall disclose the information of personal names, contact number, address for meeting in person of the desk by publication of the information, i.e. sign boards, flyers, advertisement in newspapers, etc.

6.1.3 Impact on the public/ private trees

In accordance with the Basic Design which the Consultant prepared, tree cutting is not expected. The Contractor shall pay maximum effort to avoid felling public/ private trees in the project areas. If the Contractor will require any tree cutting of both public tree and private tree, the Contractor shall report and discuss the necessities to the PMU at the very early stage of the design phase. In case felling of public/private trees, the Contractor shall assist the Employer in the process of taking due process for permission and paying necessary compensation fee.

6.1.4 Office, storage and camp

The Contractor shall request for the approval of plan for arrangements of office, storage and camp if the Contractor considers these are necessary. However, land acquisition and involuntary resettlement even if temporary, are not permitted.

6.1.5 Informing the construction schedule

The Contractor Shall request the PMU to inform the residents of the construction schedule in writing, at least three weeks before the start of construction. The same applies in case of any changes to the construction schedule. The PMU will inform this to the Ward office(s) at least two weeks before the start of the construction. The Ward office(s) will inform this to the corresponding residents at least one week before the start of the construction. The informing system is shown in the Figrue-2.

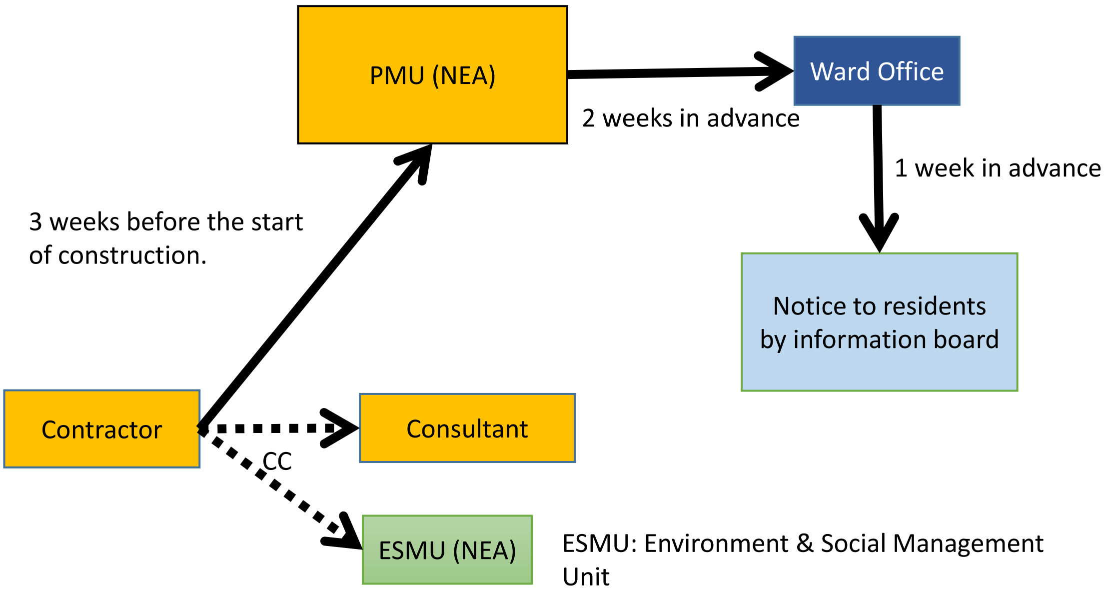

Figure 2 Construction Schedule Informing System

6.2 Construction phase

The Environmental Mitigation Plan is shown in Table-3 below.

Table -3 Environmental Mitigation Plan for TL part (Construction stage)

Environmental domains	Mitigation measures of adverse impact	What to do	Where to do	How to do	Who will do
1. Physical Environment	1.1 Soil/ Top soil cutting and filling	Proper levelling, compaction, conserve top soil and stability of land will be done after excavation during construction of tower, and laying underground cable.	Tower foundation, underground cable laying	Allowing a short time for the soil to begin drying and then using a bulldozer to smooth and fill in the soil ruts. Identifying site-specific soil characteristics and concerns from the landowner and farm operator before construction begins; Plastic sheets or tarpaulin will be covered on top soil generated during excavation. Soil generated during construction work will be backfilled and compacted. Keep soil heaps away from the edge equivalent to 1.5 m or depth of pit whichever is more. Provide barricade with warning signal with at least two entries/exits.	Contractor
	1.2 Land use change due to tower foundation, underground cable laying	Construction activities will be done with minimal impact on land use changes.	Tower foundation, underground cable laying	Avoid unstable land and examine carefully before excavations. Avoid unnecessary excavation and limit as mentioned in project design.	Contractor
	1.3 Solid and liquid waste disposal	Control haphazard disposal of solid and liquid wastes from camp sites and construction work sites	At active construction works site and camp sites	Provision of separate safe designated storage area for proper management of solid and liquid waste. Provision of timely transportation of solid and liquid waste in designated location specified by authority.	Contractor

				Hazardous materials will be handled carefully and safely as per the manufacturer guidelines and specifications. Hazardous materials shall be stored in secure and bunded areas, and in accordance with manufacturer specifications on structures built within campsite. Immediately contain and mop up will be done for accidental chemical spill.	
	1.4 Occupational health safety (Accident contact with electrical lines)	Provide safety gear to workers, ensure safe working environment.	Construction sites	The construction workforce will be instructed in regard to the occupational health risk of the construction workers on a regular basis. First-aid kits and safety gears will be made available at every working site with the instructions of use. The contractor must ensure proper safety management to minimize the risk of accidents with residents.	Contractor
	1.5 Temporary air pollution (Due to levelling work, operation of heavy machineries)	Avoid emission of fugitive dust particles due to construction of TL and tower foundation. Water will be sprinkled when there is an obvious dust problem on all exposed surfaces to suppress emission of dust.	Tower foundation and TL site, underground cable laying areas and access road	Frequency of sprinkling will be kept such that the dust remains under control in dry seasons. Vehicular movement will be restricted to a specific time for dumping of supplies and construction material. Material loads shall be suitably covered and secured during transportation to prevent the scattering of soil, sand, materials or dust. No burning of waste or construction materials.	Contractor
	1.6 Noise Pollution due to operation of heavy	Anthropogenic noise at the camp sites will be minimized through special instruction to the workforce	At active construction works site	Provide maintenance of construction machinery/vehicles will be done quarterly. Acoustic barriers/enclosures will be provided to high noise generating machinery where	Contractor

	machineries			applicable. All workers will be provided with earmuffs/plugs. Noise level monitoring will be conducted periodically. Controlling operation time (7a.m.-5p.m.) to reduce impact by noise as much as possible. In case of nighttime construction cannot be prevent, the Contractor shall explain the construction schedule in the SHM and inform the schedule to the residents in advance certainly.	
	1.7 Impacts on pedestrian and vehicular movement	Prior notification as shown in Figure-2. Proper restoration of soil and construction materials	Underground cable laying and Tower construction	Safety signs will be provided in order to reduce potential hazards to pedestrian and vehicular movements. Secure public, local people and entrance of construction site by placing plastic strips, barriers, phosphoric warning lights. In order to facilitate pedestrian, prior notification will be provided as shown in Figure-2, for upgrading road and provide support on covering open canal by appropriate measures.	Contractor Contractor, PMU and Ward office(s)
	1.8 Impact due to construction activities (Underground cable laying and tower foundation)	Provide safety equipment and trainings on work site during machinery operations. Proper storage and management of non-hazardous construction waste, toxic waste and liquid waste. Control air pollution with dust emission Control noise generation	Tower foundation, underground cable laying,	Provision of construction Workers with uniforms and PPE. Allowing only specially trained personnel of controlling machines and provision of labor safety training to all workers prior to machinery operations. Temporary storage of construction waste and toxic wastes in especially allocated bunded/lined areas and formally designed locations within the fenced area of SS and timely disposal of wastes to the formally	Contractor

				designed locations. Suppression of dust during machinery activities by ongoing water spraying and prohibit open burning of construction/waste material at the site.	
	1.9 Impact on utilities while laying underground cables	Careful planning and risk assessment will be done	Underground Cable laying	Soil generated during excavation will be backfilled, proper compaction and restoring as per previous soil conditions Regular, effective maintenance and restoration activities will be done for damaged water supply pipes and other public utilities (if damaged)	Contractor
	Major crossing	None.			
2. Biological Environment	2.1 Disturbance to wildlife habitat, movement, feeding and migratory route	No mitigation measures is required as project area is not considered as critical habitat and no significant impact is expected			
3. Socio-economic and Cultural Environment	3.1 Issues of Loss of Property and Land	The TL and Tower will be constructed under the public road and on the land has already been acquired for the site and no loss of property and land are expected. In case of unexpected loss of property and land, following measure shall be taken properly. Compensate all permanently acquired lands as per rate fixed by Compensation Determination Committee.	Tower Foundation	Private land owners will be compensated as per the Land Acquisition Act (1977). Compensation for permanently acquired lands has provided as per the land rate fixed by compensation determination committee. Compensation of a temporary structures has compensated as per rate fixed by compensation determination committee without deducting capital gain tax.	NEA
	3.2 Direct and indirect impacts on Gender,	Instruct the workers to respect and behave decently with women	Construction work sites	Priority in employment opportunities to indigenous, vulnerable people based on skills and capacity. Training program will be conducted for	NEA will give guidance to the

	Indigenous, Tribal and Vulnerable Groups			marginalized women, indigenous and vulnerable project affected families	Contractor. The Contractor will follow the guidance.
	3.3 Loss of Standing crops during construction of new tower	The TL and Tower will be constructed under the public road and on the land has already been acquired for the site and no loss of standing crops are expected. In case of unexpected loss of standing crops, following measure shall be taken properly. Compensate the land owners for the loss of crops due to permanent acquisition.	Tower Foundation	Proper compensation will be provided for the loss of crop in private land as per market price.	NEA
	3.4 Community Health and Hygiene	The Contractor shall keep the project area clean and hygienic to ensure the project activities will not cause the spread of communicable diseases. The contractor shall educate the communities around the sub-project site and construction workers in particular on infectious diseases, including HIV/AIDS.	Substation and camp site	The Contractor shall manage solid waste properly and construct adequate toilets to mitigate impact on community health. The Contractor shall provide good quality drinking water in camp site. The Contractor shall conduct regular health checkup during construction of project The Contractor will conduct education program for the communities around the sub-project site and construction workers at least one a year.	Contractor
	3.5 Issues on Law and Order situation (Local safety and security)	Local authorities will be regularly informed about the construction plans, construction sites and other related activities	Construction work sites	Construction workforce will be regularly instructed to respect local people, their traditions and cultures and not to indulge in any conflict with them. Strict code of conduct will be provided.	PMU (NEA) /Ward office(s)/ Contractor

				Construction will be stopped immediately if breached laws and order situations and until positive response was received.	
	3.5 Aesthetic Impacts due to Stockpiling of the Construction Materials	Proper storage of construction materials without aesthetic impact.	Construction sites	Construction materials will be stored in closed area without creating general visual/ aesthetics obstructions Excavation works will be limited only to the required level.	Contractor
	3.6 Impact on existing infrastructures and utilities	Construction activities will be carried out without affecting road and utilities to the extent possible. Early Restoration of the road and public utilities (Drinking water supply) to previous condition.	Construction sites	Underground cable laying will be carried in coordination with local stakeholder, Nepal Water Supply Corporation, Pokhara and Pokhara Metropolitan Office The Contractor will be responsible for repairing any properties damaged during construction of project.	Contractor
	3.7 Grievance Redress Mechanism (GRM)*1	GRM will be secured during the construction phase.	Construction area and surrounding area	NEA will establish the coordination committee*2 to resolve additional issues, queries, and grievances. The Contractor shall keep one compliant desk open of the sub-project area, where includes Substation, Transmission Line and Distribution Line, throughout the construction phase to receive the complains and grievances from local residents and businesses. The Contractor shall take prompt action to solve raised complaints or to improve accident prevention measures.	NEA Contractor

(Note *1) The GRM for any infrastructure project provides an effective approach for complaints and resolution of issues reliably made by the affected community. A grievance redress mechanism will be established to address the social issues associated with the project and look into complaints and concerns from local stakeholders etc. GRM will seek to resolve the issues quickly to expedite project activities.

(Note *2) A coordination committee will be formed comprising of seven members including a member each from Nepal Electricity Authority Substation Officer, Tole development committee, mother's group (Aama Samuha), youth club, and local representatives. Additionally, the project will coordinate with the coordination committee for any activities. In addition to the above, if there are any grievances related to environmental management issues in the project area, grievances and suggestions will be recorded and passed on to the relevant authorities for necessary action and follow-up.

7. Monitoring plan

7.1 Deign approval phase

The Contractor shall monitor the items of the Tables under Chapter 7.1. The contractor will carry out the items listed in the Tables as common monitoring for the three parts (Substation, Transmission Line and Distribution Line).

7.1.1 Inventory survey

Due to TL and Tower will be constructed under the public road and on the land that has already acquired for the site, no land acquisition is required. Therefore, inventory monitoring is not required. In case of unexpected land acquisition and resettlement will be occurred, the Contractor shall discuss the matters with PMU(NEA) in earlier stage and NEA shall take necessary actions.

7.1.2 Coordination with Utilities, other stakeholders and Local Communities

Table -4 Coordination with Utilities, Stakeholders and Local Communities

S.N	Item	Parameters to be Monitored	Location	Monitoring Frequency
1	Water usage and water right Disturbance to social infrastructures and services Living environment of residents	<u>Meeting with Utilities</u> Attend and record the meetings and discussion with utilities arranged by the Employer.	Sub-Project sites or as per the mutual understanding	At least once before finalization of the design, then once per year
		<u>Emergency Plan</u> Submission of the emergency plan for accidents to the Employer and record of approval.		At least once before finalization of the design, then once per year
		<u>Grievance Redness Mechanism</u> Record the information (Name of the person, contact number, address) of the complaint desk to receive the opinions and grievance from the stakeholders. Record of publication of above information about the compliant desk (i.e. photos of sign board, flyers, advertisement in newspapers)		At least once before finalization of the design, then quarterly throughout the Construction phase.
2	Land Acquisition, Resettlement	The TL and Tower will be constructed under the public road and the land has already been acquired for the site. In case of unexpected land acquisition and resettlement, the Contractor shall record the meetings with stakeholders.	Sub-Project sites or as per the mutual understanding	At least once before finalization of the design.

7.1.3 Coordination on the public/private trees

Table 5 Coordination on Public/Private Trees

S.N	Item	Parameters to be Monitored	Location	Monitoring Frequency
1	Impacts on public/private trees Destruction of landscape	Number of public/private trees planned to be felled Planning of compensatory plantation Permission of felling tree from authority and Record of meeting with relevant authority.	Sub-Project sites	At least once before finalization of the design, then monthly until the end of payment.

7.1.4 Coordination on office, storage and camp

Table 6 Coordination on Office, Storage and Camp

S.N	Item	Parameters to be Monitored	Location	Monitoring Frequency
1	Land Acquisition/ Land Leasing	Land Leasing agreement Observe and record the existence/absence of occupants on the land. In case the potential site had occupants, record	Potential sites for the Office/storage/camp	Until appropriate sites(s) is (are) decided.

7.1.5 Informing the construction schedule

Table 7 Informing the construction schedule

S.N	Item	Parameters to be Monitored	Location	Monitoring Frequency
1	Construction schedule	Official letter asking NEA to inform the construction schedule to the resident through Ward Office(s) Observe and record the public notice(s).	Sub-Project site and surrounding areas. Especially, if the TL will be constructed by section, the residents must be notified through the Ward office of the construction schedule for each section. For this purpose, the Contractor shall submit an official	At least once before physical construction starts, then monthly until the end of payment.

			letter to the PMU at least 3 weeks prior to the construction of the section.	

7.1.6 Baseline monitoring

The baseline monitoring will make a baseline data for comparison with the impact monitoring which will be taken during construction. The baseline monitoring shall be carried out after contract between NEA and the Contractor will be completed and before the physical construction such as civil works will start. The air pollution baseline monitoring will be conducted at one place and the noise pollution baseline monitoring will be done at two places in all construction sites including Substation, Transmission Line, and Distribution Line. The place of monitoring of air pollution will be set at one sensitive area i.e. hospital, temple and school. The places of noise pollution monitoring will be set at sensitive area and urban residential area.

Location and timing of monitoring of air and noise pollution shall be proposed by the Contractor and approved by the Employer.

(Air Pollution monitoring)
- ✧ [Parameters]: PM10, PM2.5, TSP, and CO
- ✧ [Sampling duration]: 24 hours
- ✧ [Reference values]: National ambient air quality standard

Methodology of air sampling for air pollution monitoring is shown below as a reference. The Contactor shall propose appropriate methodology in the tender document.

	Parameter			
Item	PM10	TSP	PM2.5	CO
Unit	(μg/m3)			
Sampling device	The Contractor shall follow the standard above.			Non-Dispersive InfraRed (NDIR) or electro-chemical sensor can be used.
Vacuum amount	1m3 air per minute will be vacuumed through filter paper.		1m3 air per hour will be vacuumed through filter paper.	None
After sampling	Sampling filter paper will be analysed at Labo. The amounts of parameters will be measured.			

(Noise Pollution monitoring)
- ✧ [Required value]: Leq (Equivalent Continuous Sound Level) for every hour and 12 hours of daytime and 12 hours of nighttime.
- ✧ [Sampling duration]: 12 hours of daytime (07:00-21:00), 12 hours of night time (21:00-07:00)
- ✧ [Measurement frequency]: once per 5 seconds
- ✧ [Conversion formula from sound level to Leq]: Energy Averaging formula for sound level

Methodology, device and equipment of noise sampling for noise pollution monitoring shall be proposed by the Contractor in the tender document. The Contractor shall include them in the CEMP after approval by the Employer.

Table 8 Baseline Monitoring

Environment	Types of Monitoring	Monitoring Indicator	Monitoring Methods	Schedule (Time)	Location	Financial commitment	Monitoring responsible
Physical and chemical environment	Land Use change	Cultivable land, barren land, Settlement	Direct observation and consultation with local people	Design approval phase	Tower foundation, Substation and underground cable laying	Included in civil cost	PUM (NEA)
	Air Pollution	CO, $PM_{2.5}$, PM_{10} and TSP	Sample collection and lab analysis Duration is 24 hours.	Design approval phase	One place in project affected areas		Contractor
	Noise pollution	Noise level (Leq) (dB)	Noise level meter Duration is 24 hours.	Design approval phase	Two places in project affected areas		Contractor
Biological Environment	Wild animal status	Status on wild animal accident	Consultation with local people	Design approval phase	Project affected areas		PMU (NEA)
Socio-economic and cultural environment	Loss of land/property	Area of Land/property loss	Records of land/ property acquisition	Design approval phase	Substation area		PMU (NEA)
	Cultural and Religious status	Number of cultural and religious sites	Public consultation with local people	Design approval phase	Project affected ward and Pokhara Metropolitan Office		PMU (NEA)
	Socioeconomic condition	Number of Labors and economic status	Direct observation, Consultation with local and relevant stakeholders	Design approval phase	Project affected ward and Pokhara Metropolitan Office		PMU (NEA)
	Community Health	Types of disease, Number of health center	Direct observation, Consultation with local and relevant stakeholders	Design approval phase	Project affected ward and Pokhara Metropolitan Office		PMU (NEA)

7.2 Impact monitoring

The Impact monitoring is the Contractor's own check on the implementation of the Environmental Mitigation Plan set out in Chapter 6 in this document. At the same time, the ESMU independently checks the work of the Contractor on site, prepares an independent monitoring report and submits it to the PMU. The impact monitoring plan is shown in Table 9.

7.3 Every hiring occasion

Table 10 Every Hiring Occasion

S.N	Item	Parameters to be Monitored	Location	Monitoring Frequency
1	Children's right	Check the age of every workers at hiring.	Sub-Project site and surrounding areas.	Daily check and monthly reporting.

Table 9 Impact Monitoring (Construction phase)

Environment	Types of Monitoring	Monitoring Indicator	Monitoring Methods	Schedule (Time)	Location	Monitoring responsible
1, Physical and chemical environment	1.1 Soil/ Top soil cutting and filling	Volume of soil excavated.	Direct observation	Daily observation and monthly reporting during construction	TL and Tower construction area	Contractor
	1.2 Land Use	Area of land acquired	Direct observation/ Record of land acquisition	Before physical construction starts	Along Tower foundation	PMU (NEA)
	1.3 Solid and Liquid Waste Disposal	Disposal pattern/ mechanism/ methods used for solid waste and liquid waste disposal	Direct observation	Daily observation and monthly reporting during construction	TL and Tower construction area	Contractor
	1.4 Occupational health safety (Accident contact with electrical lines)	No of Accidents Availability of Nos of First Aid Kits/ safety gear/ Health status of workers	Visual observation, Checking accidental records, Nos of First Aid kits/ Safety gears and records of health status	Daily observation and monthly reporting during construction	TL and Tower construction area	Contractor
	1.5 Temporary air pollution (Due to leveling work, operation of Heavy machineries, etc.)	Concentration of CO, $PM_{2.5}$, PM_{10} and TSP No. of Vehicle Movements	Air quality measuring Direct observation/ Vehicle Inspection records/	Once before monsoon (March to May), once after monsoon (October to November) during construction Daily observation and monthly reporting	Sub-Project construction area TL and Tower construction area	Contractor
	1.6 Noise Pollution due to operation of heavy machineries	Noise Level dB(A)	Noise monitoring	Once before monsoon (March to May), once after monsoon (October to November) during construction	Sub-Project construction area	Contractor

Environment	Types of Monitoring	Monitoring Indicator	Monitoring Methods	Schedule (Time)	Location	Monitoring responsible
			Vehicle Inspection records	Daily observation and monthly reporting	TL and Tower construction area	
	1.7 Pedestrian and vehicular movements due to underground cable laying.	Safety signage, status of covering open canal of fewa powerhouse.	Direct observation	Daily observation and monthly reporting during construction	TL and Tower construction area	Contractor
	1.8 Impact due to construction activities (Underground cable laying, tower foundation)	Volume of Storage and Handling of SF_6 gas and other hazardous toxic and liquid waste Nos of safety equipment, Spill kits	Direct observation and Inspection of safe storage and Handling, spill kits	Daily observation and monthly reporting during construction	TL and Tower construction area	Contractor
2.0 Biological Environment	2.1 Disturbance to wildlife habitat, movement, feeding and migratory route	Number of hunting, accident of the wildlife.	Community consultations and observation	Every six months	Surrounding TL and Tower area	Contractor
3.0 Socio-economic and cultural environment	3.1 Loss of land/property	Area of land and property loss Rate fixed by CDC meeting	Interviews, observation, and Land revenue office records observation	Before physical construction starts.	TL and Tower construction and surrounding area	PMU (NEA)
	3.2 Impacts on Gender, Indigenous, Tribal and Vulnerable Groups	Number of gender discrimination cases, Number of vulnerable groups, female workers involved in construction sites	Discussions with the affected communities, parties and records of complaint cases	Before finalization of detailed design, then, every two months during project construction	TL and Tower and surrounding area.	Contractor

Environment	Types of Monitoring	Monitoring Indicator	Monitoring Methods	Schedule (Time)	Location	Monitoring responsible
		Construction of separate toilets for male and female				
	3.3 Loss of Standing crops during construction of new tower	Loss of standing crops	Observation and Interview with land owners and records of CDC minute meetings	Before physical construction starts, then once loss will occurred during project construction	TL and Tower and surrounding area.	PMU (NEA)
	3.4 Community Health and Hygiene	Adequacy of Nos of toilets, first aid kits, drinking water supply and volume of solid wastes. Type of disease and number of community, people affected Education program for community and workers	Community consultations, and Checking grievance records Record of program	Daily check and monthly reporting during project construction Once per year at least	Project Affected Area of TL and Tower Project affected area (sub-project)	Contractor
	3.5 Impacts on Law and Order situation	Nos of conflicts and reasons for conflict. Nos of complaints Nos of incidents of law and order break down and reasons	Police records, consultation with the communities, Direct observation	Every six months during project construction Daily check and monthly reporting	Project Affected Area of TL and Tower	Contractor
	3.6 Aesthetic Impacts of Stockpiling of the Construction Materials	Construction materials stockpiling	Direct observation	Daily check and monthly reporting during project construction	Project Affected Area of TL and Tower	Contractor
	3.7 Impact on existing infrastructures and utilities	Nos of damaged infrastructure and utilities	Direct observation	Daily check and monthly reporting during project construction	Project Affected Area of TL and Tower	Contractor

8. Monitoring form

The Contractor shall implement the environmental management measures described in the CEMP and voluntarily monitor the results. The forms for recording the monitoring results are described below, and the Contractor should propose the monitoring forms for all monitoring items based on these. The following forms may have some shortcomings, but the Contractor should make up for them and submit a proposal with appropriate details.

8.1 Design Approval Phase

8.1.1 Inventory survey

Week	Reporting Date	Finished length a (km)	Finished% b = a (km)/ total length (km)	Remaining length c = total length (km) - a (km)
1				
2				
3				
4				
5				

8.1.2 Coordination with utilities, other stakeholders and local communities

Week	Dates			Record - Objectives - Attendants - Venue - Main points of discussions, decisions	Recorded by (Name)
	Meeting	Emergency Plan	GRM		
1					
2					
3					
4					
5					

8.1.3 Coordination on the public/ private trees

Week	Dates	Record	Recorded by (Name)
1			
2			
3			
4			
5			

8.1.4 Coordination on office, storage, and camp

Item	Parameters to be Monitored	Location	Timing/ Frequency

Land Acquisition, Resettlement/ Land leasing	1. Observe and record the existence/absence of occupants on the land. 2. In case the first potential site had occupants, record all the negotiation process with the Employer until suitable site is officially allocated.	Potential site for the Office/ Storage/ Camp sites	Until suitable site(s) is (are) decided
Date (DDMMYYY)	Location and existence/absence of occupants	If occupants exists, what is the next step?	Recorded by (Name)

8.1.5 Informing the construction schedule

Week	Dates	Record Construction place(s), target ward(s), Ref. No. of Letter to PMU	Recorded by (Name)
1			
2			
3			
4			
5			

8.1.6 Baseline monitoring (Contractor's responsibility parts only)

(Air pollution monitoring)

Monitoring form: Air pollution monitoring (Baseline monitoring)			
Season, Date/month/year: before/after monsoon, xx/xx/xx			
Time of monitoring:			
Recorded by (Name):			
Place (Nama and coordinate):			
Monitoring results			
Name and Address of Labo			
PM2.5 (μg/m3)	**PM10** (μg/m3)	**TSP** (μg/m3)	**CO** (μg/m3)

Note: Report by Labo shall be attached.

(Noise monitoring)

Monitoring form: Noise pollution monitoring (Baseline)-No.1
Season, Date/month/year: before/after monsoon, xx/xx/xx
Time of monitoring:

Recorded by (Name):			
Place (Nama and coordinate):			
Monitoring results			
Daytime		**Nighttime**	
Time	**Noise (Leq)**	**Time**	**Noise (Leq)**
07:00-08:00		**19:00-20:00**	
08:00-09:00		**20:00-21:00**	
09:00-10:00		**21:00-22:00**	
10:00-11:00		**22:00-23:00**	
11:00-12:00		**23:00-24:00**	
12:00-13:00		**24:00-01:00**	
13:00-14:00		**01:00-02:00**	
14:00-15:00		**02:00-03:00**	
15:00-16:00		**03:00-04:00**	
16:00-17:00		**04:00-05:00**	
17:00-18:00		**05:00-06:00**	
18:00-19:00		**06:00-07:00**	
07:00-21:00		**19:00-07:00**	

Note: Raw data (measurement of every 5second) and calculation results of Leq shall be attached.

Monitoring form: Noise pollution monitoring (Baseline)-No.2			
Season, Date/month/year: before/after monsoon, xx/xx/xx			
Time of monitoring:			
Recorded by (Name):			
Place (Nama and coordinate):			
Monitoring results			
Daytime		**Nighttime**	
Time	**Noise (Leq)**	**Time**	**Noise (Leq)**
07:00-08:00		**19:00-20:00**	
08:00-09:00		**20:00-21:00**	
09:00-10:00		**21:00-22:00**	
10:00-11:00		**22:00-23:00**	
11:00-12:00		**23:00-24:00**	
12:00-13:00		**24:00-01:00**	
13:00-14:00		**01:00-02:00**	
14:00-15:00		**02:00-03:00**	
15:00-16:00		**03:00-04:00**	
16:00-17:00		**04:00-05:00**	
17:00-18:00		**05:00-06:00**	
18:00-19:00		**06:00-07:00**	
07:00-19:00		**19:00-07:00**	

Note: Raw data (measurement of every 5second) and calculation results of Leq shall be attached.

8.2 Impact monitoring

8.2.1 Record of the machineries and vehicles

Record:	**(DDMMYYY)**	**At the start of the construction works**	**Quarterly**
Recorded by:	**Name**	**Position**	
Site:			

Serial Number	Types of Utilized Machinery, Vehicle	Number of same type			% of Low-emission Type
		Low-emission type	Ordinary type	Total	
		a	b	c=a+b	d= a/c*100
1					
2					
3					
4					

Add lines when necessary.

8.2.2 At the start of the construction works with follow-ups

Item ID	Item	Parameters to be Monitored	Location	Timing/ Frequency
2.1	Disturbance e of wildlife habitat, movement, feeding, and migratory route	Number of hunting, accident of the wildlife	Surrounding TL and Tower site	Every six months
3.2	Impacts on gender, indigenous, tribal and vulnerable groups	Number of gender discrimination cases. Number of vulnerable groups, female workers Number of separate toilets for male and female	Ditto	Before finalization of detailed design, then, every two months
3.4	Community health and hygiene	Record of education programs	Surrounding sub-project area	Once a year
3.5	Impacts on law and order situation	Police records shall be obtained and reported every six months. Once any incidents happen, daily record shall be reported.	Surrounding TL and Tower sites	Every six months
S.N.	Date (DDMMYYY)	Actions taken	Next date for action	Recorded by (Name)
1				
2				
3				
4				
5				
6				

8.2.3 Everyday patrol, observation, and recording during the Construction Works

Date:		Findings (Enter either 'Approved' or 'Need action')			Record of conditions	Actions taken	Recorded by (Name)
Item ID	Parameters	T/L construction sites	(Boeng Salang. Channel)	Office/ Storage/ Camp sites			
1.1	Volume of soil excavated Mud spill out of the site						
1.3	Disposal pattern/ mechanism/ methods used for solid waste and liquid waste disposal						
1.4	No. of accidents, Accidental record Nos of aid its/ safety gear/ health status of workers						
1.5	Visible dust, emission gas						
1.6	Noise condition						
1.7	Safety signage status of covering open canal						
1.8	Volume of storage and handling of SF6 gas and other hazardous toxic and liquid waste						
3.4	Adequacy of Nos of toilets, first aid kits, drinking water supply and volume of waste at community constructions. Record of grievance Record of types of disease and number of communities, people affected						
3.5	Nos of conflicts and reasons for conflict. Nos of complaints						

	Nos of incidents of law and order break down and reasons						
3.6	Construction materials stockpiling						
3.7	Nos of damaged infrastructure and utilities						
All items	Any accident or near- accident occurrences Received opinions and grievances						
All items	Sanitary condition						
All items	Stagnant water						
All items	Work accidents or spread of infectious diseases among workers						

Copy the table everyday.

8.2.4 Monitoring forms of Air and Noise pollution monitoring

Monitoring form: Air pollution monitoring (Impact monitoring)			
Season, Date/month/year: before/after monsoon, xx/xx/xx			
Time of monitoring:			
Recorded by (Name):			
Place (Nama and coordinate):			
Monitoring results			
Name and Address of Labo			
PM2.5 (µg/m3)	**PM10** (µg/m3)	**TSP** (µg/m3)	**CO** (µg/m3)

Note: Report by Labo shall be attached.

(Noise monitoring)

Monitoring form: Noise pollution monitoring (impact monitoring)-No.1			
Season, Date/month/year: before/after monsoon, xx/xx/xx			
Time of monitoring:			
Recorded by (Name):			
Place (Nama and coordinate):			
Monitoring results			
Daytime		**Nighttime**	
Time	**Noise (Leq)**	**Time**	**Noise (Leq)**
07:00-08:00		**19:00-20:00**	
08:00-09:00		**20:00-21:00**	
09:00-10:00		**21:00-22:00**	
10:00-11:00		**22:00-23:00**	
11:00-12:00		**23:00-24:00**	
12:00-13:00		**24:00-01:00**	
13:00-14:00		**01:00-02:00**	
14:00-15:00		**02:00-03:00**	
15:00-16:00		**03:00-04:00**	
16:00-17:00		**04:00-05:00**	
17:00-18:00		**05:00-06:00**	
18:00-19:00		**06:00-07:00**	
07:00-21:00		**19:00-07:00**	

Note: Raw data (measurement of every 5second) and calculation results of Leq shall be attached.

Monitoring form: Noise pollution monitoring (Impact monitoring)-No.2			
Season, Date/month/year: before/after monsoon, xx/xx/xx			
Time of monitoring:			
Recorded by (Name):			
Place (Nama and coordinate):			
Monitoring results			
Daytime		**Nighttime**	
Time	**Noise (Leq)**	**Time**	**Noise (Leq)**
07:00-08:00		**19:00-20:00**	
08:00-09:00		**20:00-21:00**	
09:00-10:00		**21:00-22:00**	
10:00-11:00		**22:00-23:00**	

11:00-12:00		**23:00-24:00**	
12:00-13:00		**24:00-01:00**	
13:00-14:00		**01:00-02:00**	
14:00-15:00		**02:00-03:00**	
15:00-16:00		**03:00-04:00**	
16:00-17:00		**04:00-05:00**	
17:00-18:00		**05:00-06:00**	
18:00-19:00		**06:00-07:00**	
07:00-19:00		**19:00-07:00**	

Note: Raw data (measurement of every 5second) and calculation results of Leq shall be attached.

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PART 2B

EMPLOYER'S REQUIREMENTS FOR

TRANSMISSION LINE WORK

APPENDIX - B1: TECHNICAL PARTICULARS

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APPENDIX - B1: TECHNICAL PARTICULARS

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The Bidder shall duly fill and complete the Technical Particulars. Non-completion and/or non-submission of the duly completed Technical Particulars may cause disqualification of the Bidder.

1. 132 KV TRIPLEX XLPE CABLE

No.	Item Description	Unit	Required	Proposed
1.	Applicable standards		IEC 60840	
2.	Type of Cable (Single core or Triplex type)		Triplex	
3.	Manufacturer/country			
4.	Year of first commercial operation of cable type offered			
5.	Nominal voltage (Uo/U)	kV	76/132	
6.	Frequency	Hz	50	
7.	Highest system voltage	kV	145	
8.	Number of cores		Three	
9.	Proposed cross-section	mm^2	800	
10.	Conductor:			
	a) Material		Copper	
	b) Shape		Milliken	
	c) Diameter of conductor	mm		
	d) Water stopper material in conductor		As per Specs	
	e) Thickness of binder layer	mm		
	f) Max. Continuous conductor temperature	°C	90	
	g) Max. Short time conductor temperature	°C	130	
	h) Applicable standard/clause		IEC60228	
10.	Extruded conductor screen			
	a) Material		As per Specs	
	b) Nominal thickness	mm		
	c) Minimum thickness	mm		
	d) Diameter above conductor screen	mm		
11.	Insulation:			
	a) Material		XLPE	
	b) Nominal thickness	mm	13.0	
	c) Minimum thickness at any point	mm		
	d) Diameter above insulation	mm		
	e) Details of vulcanization process		As per Specs	
	Extrusion method			
	Curing method		Dry	
	Cooling method			
12.	Insulation screen:			
	a) Material		As per Specs	
	b) Nominal thickness	mm		
	c) Minimum thickness	mm		
	d) Diameter above insulation screen	mm		
13.	Longitudinal sealing (Semi conductive swellable tape)			
	a) Material		As per Specs	
	b) Diameter above longitudinal sealing	mm		
14.	Metallic screen			
	a) Material		Copper wire	
	b) No. of strands	Nos.	80	
	c) Nominal diameter of each wire	mm	2.0	

No.	Item Description	Unit	Required	Proposed
	d) Minimum diameter of each wire	mm		
	e) Maximum diameter of each wire	mm.		
	f) Diameter above metallic screen	mm		
	g) Longitudinal sealing details		As per Specs	
15.	Radial water protection layer		As per Specs	
	a) Nominal thickness	mm		
	b) Diameter above water protection layer	mm		
16.	Outer sheath			
	a) Material		High density PE	
	b) Colour		Black	
	c) Nominal thickness	mm	5.0	
	d) Minimum thickness at any point	mm		
	e) Termite resistant	Yes/No	As per Specs	
	f) Conductor coating	Yes/No	As per Specs	
17.	Overall diameter of completed cable	mm		
18	Nominal weight of completed cable	kg/m		
19	Allowable minimum radius of bend round which cable can be laid:			
	a) Laid direct or in air	m		
	b) In ducts	m		
	c) For sealing ends	m		
20.	Maximum d.c. resistance of conductor at 20°C	μΩ/km	0.0221	
21.	Maximum a.c. resistance of conductor at 90°C	μΩ/km		
22.	Equivalent star reactance of three phase circuit at 50 Hz	μΩ/km		
23.	Maximum electrostatic capacitance per core	μF/km		
24.	Maximum charging current per conductor at nominal voltage	A/km		
25.	Maximum dielectric loss of three-phase circuit when operating at normal voltage and frequency at maximum conductor temperature of 90°C	W/km		
26.	Maximum continuous current carrying capacity per conductor when laid in the ground to a depth of 1200mm with ground temperature of 30°C and soil thermal resistivity 1.2°C m/W, conductor temperature of 90°C, load factor 1.0.			
	a) One three-phase circuit per trench	A		
	b) Two three-phase circuits at 400mm spacing	A		
27.	Maximum continuous current carrying capacity per conductor when drawn into ducts at a ground temperature of 30^0C and soil thermal resistivity 1.2^0Cm/W, conductor temperature of 90°C, load factor 1.0.			
	a) One three-phase circuit in duct	A		
	b) Two three-phase circuits at 680mm spacing	A		
28.	Maximum continuous current carrying capacity per conductor when installed in air at an ambient temperature of 45^0C and conductor temperature of 90°C			
	a) One three-phase circuit	A		
	b) Two three phase circuits at 1.0 m spacing	A		

No.	Item Description	Unit	Required	Proposed
29.	Metallic core screen losses in a cable of three-phase circuit at nominal voltage, 50 Hz frequency and at current ratings as given in item 27-a, b.	W/m		
30.	Total power losses (three phase system)	W/m		
31	Conductor short-circuit permissible current when short-circuit occurs at conductor temperature of 90°C			
	Symmetrical three phase short circuit withstand current for:			
	a) 0.1 sec	kA		
	b) 0.2 sec	kA		
	c) 0.5 sec	kA		
	d) 1.0 sec	kA	40	
32.	Earth fault short-circuit current carrying capacity for 1 second, cable loaded as in Item 27(a) before short-circuit and final limiting temperature of outer sheath	kA	40	
33.	Maximum dielectric loss angle of charging VA of cable at normal voltage and frequency at a conductor temperature of:-			
	a) 20 ºC			
	b) 90 ºC			
34.	AC high voltage withstand voltage (30 min/ambient temperature)	kV	190	
35.	Impulse withstand voltage (90ºC)			
	a) Positive 1/50 wave	kV_p	650	
	b) Negative 1/50 wave	kV_p	650	
36.	Positive / Negative sequence impedance:-			
	a) Resistance	μΩ/m		
	b) Reactance	μΩ/m		
37.	Zero sequence impedance:-			
	a) Resistance	μΩ/m		
	b) Reactance	μΩ/m		
38.	Other Performance Data			
	a) Maximum permissible pulling force of complete cable for nose pulling.	kN	164	
	b) Maximum permissible sidewall pressure to cable at bending point	kN/m	4.9	
	c) Nominal Delivery length per drum	m		
	d) Gross weight of a delivery drum	kg		
	e) Drum dimensions	mm		
	Shaft hole diameter	mm		
	Flange diameter	mm		
	Core diameter	mm		
	Width	mm		
	f) Material of drum		Steel	
39.	Pipes/Ducts			
	a) Nominal internal diameter of pipes/ducts	mm	230	
	b) Material		HDPE	
	c) Class/ Type			

2. 132KV CABLE ACCESSORIES

No.	Item Description	Unit	Required	Proposed
2.1	**JOINTS**			
1.	Manufacturer/country			
2.	Type and designation			
3.	Rated system voltage	kV	76/132	
4.	Highest system voltage	kV	145	
5.	Impulse withstand voltage	kV	650	
6.	Rated frequency	Hz	50	
7.	Rated current	A	700	
8.	Rated short time withstand current (1sec)	kA	40	
9.	Conductor connecting method			
10.	Material of stress relief corn			
11.	Dimensions (Length, Diameter)	mm		
12.	Weight	kg		
13.	Provisions for cross bonding available	Yes/No		
14.	Provisions for Sheath integrity tests available	Yes/No		
15.	Applicable standards			
2.2	**SF6 TYPE TERMINATIONS**			
1.	Manufacturer/Country			
2.	Type and designation			
3.	Rated system voltage	kV	76/132	
4.	Highest system voltage	kV	145	
5.	Impulse withstand voltage	kV	650	
6.	Rated frequency	Hz	50	
7.	Rated current	A	700	
8.	Rated short time withstand current (1sec)	kA	40	
9.	Insulator material			
10.	Dimensions (Height, Diameter)	mm		
11.	Weight	kg		
12.	Suitable for XLPE Cu Cable of Size	mm²		
13.	Provisions for periodic Sheath test available	Yes/No		
14.	Applicable Standards			
2.3	**OUTDOOR TYPE TERMINATION**			
1.	Manufacturer/country			
2.	Type and designation			
3.	Rated system voltage	kV	76/132	
4.	Highest system voltage	kV	145	
5.	Impulse withstand voltage	kV	650	
6.	Rated frequency	Hz	50	
7.	Rated current	A	700	
8.	Rated short time withstand current (1sec)	kA	40	
9.	Insulator material			
10.	Creepage distance (minimum)	mm/kV	As per Specs	
11.	Pollution severity levels			
12.	Dimensions (height, diameter)	mm		
13	Weight	kg		
14	Suitable for XLPE Cu cable of size	mm2		

No.	Item Description	Unit	Required	Proposed
15	Applicable Standards			

3. DISTRIBUTED TEMPERATURE SENSING (DTS) SYSTEM

No.	Item Description	Unit	Required	Proposed
1.	Applicable Standard			
2.	Manufacture/country			
3.	Fiber Mode (Single mode/Multimode)			
4.	Temperature accuracy	Degree C		
5.	Spatial resolution	m		
6.	Measurable temperature range	Degree C		
7.	Temperature resolution	Degree C		

4. OPTICAL FIBER CABLES

No.	Item Description	Unit	Required	Proposed
1.	Applicable standards			
2.	Manufacturer/country			
3.	Type and designation			
4.	Number of fibers		48	
5.	Central strength member		FRP	
6.	Loose tube			
	a) Material			
	b) Diameter		Nom. 2.5mm	
7.	Filling compound in tube		Jelly	
8.	Inner sheath			
	a) Material		HDPE	
	b) Diameter			
9.	Strength element		Aramid yarn	
10.	Armoring			
	a) Material			
	b) Thickness			
11.	Outer sheath			
	a) Material		HDPE	
	b) Thickness			
	c) Termite resistant	Yes/No		
12.	Cable diameter	mm		
13.	Weight of cable	kg/m		
14.	Mode field diameter at 1310nm		9.0um+-0.5um	
15.	Mode field concentricity error		Max.0.8um	
16.	Cladding diameter		125.0+-1.0um	
17.	Cladding non-circularity	%	Max1%	
18.	Attenuation			
	a) at 1310nm	dB/km		
	b) at 1550nm	dB/km		
19.	Dispersion at range 1285-1300nm	ps.nm.km		
20.	at 1550nm	ps/nm.km		
21.	Zero dispersion wavelength		<1310nm	
22.	Zero dispersion slope	ps/nm.km		

No.	Item Description	Unit	Required	Proposed
23.	Cable cut-off wavelength		<1270nm	

5. TOWER

No.	Item Description	Unit	Required	Proposed
1.	Applicable Standard			
2.	Manufacture/country			
	a) Steel			
	b) Bolts, nuts and washers			
	c) Tower accessories			
3.	Line voltage	kV	132	
4.	Number of circuits	No.	1	
5.	Tower Type	-	Dead-end	
6.	Angle of deviation	Deg.	30-60	
7.	Designed span			
	a) Standard span	m	350	
	b) Wind span	m	350	
	c) Weight span	m	350	
8.	Designed wind load			
	a) Conductor	kg/m^2	60.9	
	b) Steel angle members	kg/m^2	98.5	
	c) Steel angle front and back of structure	kg/m^2	168.5	
9.	Safety factors for tower/foundation/conductor/OPGW	-	As per specs	
10.	Tower members and bolts			
10.1	Structural members			
	a) Tension based on net sectional area	kg/cm^2	2600	
	b) Axial compression based on gross sectional area	kg/cm^2	2550	
10.2	Connection bolts			
	a) Shear on gross area	kg/cm^2	2220	
	b) Bearing (on mild steel)	kg/cm^2	4440	
	c) Tension on net area of threaded portion	kg/cm^2	1980	
10.3	Slenderness Ratios (L/R)			
	a) Main members	-	Bellow 150	
	b) Braces	-	Bellow 200	
	c) Redundant members	-	Bellow 250	
	d) Members loaded in tension only	-	Bellow 375	
10.4	Member particulars			
	a) Calculated members	mm	45x45x4	
	b) Redundant members	mm	45x45x4	
	c) Thickness of legs, members in cross arms and in earth wire peaks	mm	6	
	d) Diameter of bolts for member carrying stress	mm	16	
	e) Diameter of bolts for redundant members without calculated stress	mm	16	
	f) Gusset plates	mm	6	
	g) Stub angles	mm	8	
10.5	Dips and Tensions			
	a) Nil wind at everyday temperature	m kN		
	b) Full design wind pressure on conductor/OPGW	m		

No.	Item Description	Unit	Required	Proposed
	at everyday temperature	kN		
	c) 36% full design wind pressure on conductor/OPGW at everyday minimum temperature.	m kN		
	d) 75% full design wind pressure on conductor/OPGW at everyday temperature under broken wire condition	m kN		
	e) Nil Wind at Minimum Temperature	m kN		
10.6	Clearances			
	a) Minimum ground clearance under maximum temperature and nil wind	m	7.5	
	b) Min. clearance between conductor and tower	mm	1500	
	c) Min. clearance between phases	mm	3000	
	d) Height of lowest cross-arm above ground level	m	16.0	
10.7	Shielding angle of OPGW	Deg.	30	
11.	Weight of special branch tower	kg		

6. TOWER GROUNDING

No.	Item Description	Unit	Required	Proposed
1.	Applicable Standard			
2.	Manufacture/country			
3.	Materials			
3.1	Grounding rods			
	a) Galvanized steel angle	mm	50x50x5x2000	
3.2	Ground wire			
	a) Galvanized steel wire	mm^2	38	
	b) Galvanized steel strip	No./dia. mm	7/2.6	
4.	Required resistance value of tower	Ohm	Below 10	

7. CONDUCTORS

No.	Item Description	Unit	Required	Proposed
1.	Conductor			
1.1	Applicable Standard			
1.2	Manufacture/country			
1.3	Conductor Code	-	DUCK	
1.4	Particulars			
	a) Conductor size	mm^2	308.9	
	b) Number and size of wires			
	- Aluminum - Steel	No./dia. mm No./dia. mm	54/2,69 7/2.69	
	c) Cross section			
	- Aluminum - Steel - Total	mm^2 mm^2 mm^2	264.4 61.7 326.1	
	d) Conductor diameter	mm	24.21	
	e) Ultimate strength	kg	10,250	
	f) Modulus of elasticity final	N/mm^2	8,200	

No.	Item Description	Unit	Required	Proposed
	g) Coefficient of linear expansion	1/°C	17.6×10^{-6}	
	h) Standard mass of conductor	kg/km	1,161	
	i) DC resistance at 25 °C	ohm/km	0.09424	
2.	Vibration dumper			
2.1	Applicable Standard			
2.2	Manufacture/country			
2.3	Type		Stockbridge	
2.3	Particulars			
	a) Suitable for conductor size		For DUCK	
	b) Total weight of each damper	kg		
	c) The number of dumpers required per span	Nos.		
	d) Position of fixing damper on the conductor from the clamp e) mouth			
	- First damper	m		
	- Second damper	m		
	- Third damper	m		
	- Clamping torque	kg-m		
3.	Tension clamp			
3.1	Applicable Standard			
3.2	Manufacture/country			
3.3	Particulars			
	a) Suitable for conductor size		For DUCK	
	b) Slip strength	kN		
	c) Minimum failing load (No deformation)	kN		
	d) Shape of cross section			
	e) Before compression	mm^2		
	f) After compression	mm^2		
	g) Dimensions of sleeve			
	h) Before compression	mm		
	- After compression	mm		
	- Length of sleeve			
	i) Before compression	mm		
	- After compression	mm		
	- Electrical resistance of tension clamp as % of equivalent length of conductor	%		

8. OPGW

No.	Item Description	Unit	Required	Proposed
1.	OPGW			
1.1	Applicable standards			
	a) Aluminum alloy wires	-	IEC 104 type A	
	b) Aluminum clad steel wire	-	IEC 1232	
	c) Cable construction	-	IEC 1089	
1.2	Particulars			
	a) No. of Fibers	No.	48	
	b) Cross Section Area	mm^2	87.13	
	c) Overall Diameter	mm	12.8	
	d) Min Breaking Load	kN	84.7	
	e) Unit Mass	kg/km	560	
	f) DC Resistance at 200C	ohm/km	0.743	
	g) Short Circuit Current for 0.5 sec	kA (^{0}C)	10 (200)	

No.	Item Description	Unit	Required	Proposed
	h) Modulus Elasticity	MPa	140	
	i) Coefficient of Linear Expansion	1/°C	$13.4X10^{-6}$	
	j) Aluminum-clad steel wire Steel Tube	No./dia. mm No./dia. mm	6/4.3 1/1.4	
2.	Optical fibers			
2.1	Applicable standards	-	ITU-T G.652	
2.2	Particulars			
	a) Type of optical fiber	-	Dual window, single-Mode	
	b) Dimensions and geometry of fiber	-	According to ITU-T G.652	
	c) Attenuation Coefficient at 1310 nm at 200C	dB/km	≤0.4	
	d) Attenuation Coefficient at 1550 nm at 200C	dB/km	≤0.25	
	e) Attenuation deviation at 1310nm and 1550nm	dB/km	≤0.1 within -45^{0}C to 80^{0}C	
	f) Other properties of fiber	-	According to ITU-T G.652	
3.	Tension assembly			
3.1	Applicable standards			
3.2	Manufacture/country			
3.3	Particulars			
	a) Structure; consists of - Hyper formed alum weld dead end grip - Associated hardware for earth wire attachment (shackle, link, clevis, clamps) - Flexible grounding loop connection			
	b) Minimum slip strength	kN		
	c) Minimum ultimate breaking strength	kN		
	d) Total weight of complete assembly	kg		
	e) Breaking strength of tension clamp as % of breaking load of OPGW	%		
	f) Resistivity as % of equivalent length of OPGW	%		
4.	Vibration dumper			
4.1	Applicable Standard			
4.2	Manufacture/country			
4.3	Type		Stockbridge	
4.4	Particulars			
	a) Suitable for OPGW size		For “1. OPGW”	
	b) Total weight of each damper	kg		
	c) The number of dumpers required per span	Nos.		
	d) Position of fixing damper on the OPGW from the clamp mouth			
	- First damper	m		
	- Second damper	m		
	- Third damper	m		
	e) Clamping torque	kg-m		
5.	Fiber Optic Splicing Box			
5.1	Applicable Standard		IP 65 of IEC 60529	
5.2	Manufacture/country			

No.	Item Description	Unit	Required	Proposed
5.3	Particulars			
	a) Splice capacity for minimum number of fibers	Nos.	96	
	b) Installation height on tower	m	1.5	

9. INSULATORS

No.	Item Description	Unit	Required	Proposed
1.	Insulator unit			
1.1	Applicable Standard		IEC 60383 IEC 61109	
1.2	Manufacture/country			
1.3	Particulars			
	a) Type of insulator		Toughened glass or porcelain disc	
	b) Type of coupling	-	Ball & socket	
	c) IEC designation	-	U120B	
	d) Dimensions			
	- Spacing of insulator	mm appr.	146	
	- Diameter of sheds	mm appr.	255	
	- Creepage distance	mm appr.	320	
	e) Minimum breaking load	kN	120	
	f) Power frequency one minute withstand voltage			
	- Dry	kV(rms)	70	
	- Wet	kV(rms)	40	
	g) Impulse withstand voltage	kV(peak)	110	
	h) Power frequency puncture voltage	kV(rms)	100	
2.	Insulator string set			
2.1	Applicable standards	-	IEC60437	
2.2	Manufacture/country			
2.3	Particulars			
	a) Number of units			
	- Single tension string	Nos.	Min. 10	
	- Down dropper	Nos.	Min. 10	
	b) Ratio of horn gap length for tension string sets	-	More than 85%	
	c) Power frequency one minute withstand voltage for tension string sets			
	- Dry	kV (rms)		
	- Wet	kV (rms)		
	d) Power frequency flashover voltage for tension string sets	kV (rms)		
	e) Impulse withstand voltage for tension string sets	kV(peak)		
	f) Impulse flashover voltage for tension string sets	kV(peak)		
	g) Corona extinction voltage for tension string sets	kV (rms)		
	h) Maximum RIV for complete tension string set	dB(peak)		

No.	Item Description	Unit	Required	Proposed
	including arcing horns, clamps, etc. at 145 KV (rms)			
	i) Weight			
	- Single tension string	kg		
	- Down dropper	kg		

10. FOUNDATION

No.	Item Description	Unit	Required	Proposed
1.	Foundation			
1.1	Foundation Type I: Spread footing with undercut			
	a) Ultimate bearing capacity of soil	kg/mm^2	1.5	
	b) Assumed cone of earth	degree	30	
	c) Cohesive materials	-	Very stiff clay requiring picking for removal. A fresh sample of which can not be molded by finger pressure and intended by thumb. Blow count over 10.	
	d) Granular material	-	Very dense cemented gravel. Difficult to excavate by shovel alone. Relative density over 75%. Blow count over 20.	
	e) Length of stab	m		
	f) Base size (square) and depth	m		
	g) Volume of concrete per tower	m^3		
	h) Mass of reinforcing steel per tower	kg		
1.2	Foundation Type II: Spread Footing			
	a) Ultimate bearing capacity of soil	kg/mm^2	1.0	
	b) Assumed cone of earth	degree	20	
	c) Cohesive materials		Stiff clay. Some silt and sand. Not readily excavated by shovel alone. Can not be molded by finger pressure and intended by thumb. Blow count 8 to 10.	
	d) Granular material		Compacted sand. Some silt and gravel. Difficult to excavate by shovel alone. Relative density over 60%. Blow count 10 to 20.	
	e) Length of stab			
	f) Base size (square) and depth	m		

No.	Item Description	Unit	Required	Proposed
	g) Volume of concrete per tower	m^3		
	h) Mass of reinforcing steel per tower	kg		
1.3	Foundation Type III: Spread Footing			
	a) Ultimate bearing capacity of soil	kg/mm^2	0.5	
	b) Assumed cone of earth	degree	10	
	c) Cohesive materials		Soft to medium clay. Some silt and sand. Can be excavated by shovel alone and molded by medium finger pressure. Blow count 4 to 8.	
	d) Granular material		Loose to medium sand and silt. Easily excavated by shovel alone and molded by medium finger pressure. Blow count 4 to 10.	
	e) Length of stab	m		
	f) Base size (square) and depth	m		
	g) Volume of concrete per tower	m^3		
	h) Mass of reinforcing steel per tower	kg		

PART 2B

EMPLOYER'S REQUIREMENTS FOR

TRANSMISSION LINE WORK

APPENDIX – B2:

DRAWINGS FORMING PART OF SPECIFICATIONS

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APPENDIX – B2: DRAWINGS FORMING PART OF SPECIFICATIONS

Refer to ANNEX-2 in Volume of Annex

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PART 2B

EMPLOYER’S REQUIREMENTS FOR

TRANSMISSION LINE WORK

APPENDIX – B3:

TOPOGRAPHICAL AND GEOTECHNICAL

INVESTIGATION REPORT

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NEPAL ELETRICITY AUTHORITY

Transmission Grid Development Department

Project Title: Urban Transmission & Distribution System Improvement Project in Nepal

Report on: Topographic Survey Report on Birauta Substation (Pokhara)

Submitted To: Nippon Koei Co. Ltd

Submitted By: Total Management Services Pvt.Ltd

(May 2024)

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PROJECT AREA LOCATION

The location of the proposed Project site Birauta 132/11 kV GIS Substation, lies in Birauta, Ward 17 of Pokhara Metropolitan City in Kaski District of Gandaki Province, Nepal. Kathmandu, the capital city of the country is 201.1 km away from the Project site. The Project lies close to longitude 83° 58' 14.1132" to 83° 58' 19.0164" and Latitude 28° 10' 57.8856" to 28° 11' 3.534". The area of the Topographical survey for Birauta 132/11 kV GIS Substation includes within Boundary line of the Site, west side public road and existing canal. The project location is shown in ***Figure 1*** below.

Figure 1: Birauta 132/11 Kv GIS Substation location map.

SCOPE OF WORKS

The topographical survey works were carried out with the objective of preparing maps of substation area at appropriate scales to enable structure layouts to be prepared. The following works were performed during this phase of the survey:

- Collection of Data, Literature review and Purchase of necessary data form Department of Survey.
- Monumentation and Establishment Ground control point total two Nos.
- Horizontal and vertical control survey.
- Conducting detailed topographic survey, processing and analysis of survey data and preparation of drawings and report.

AVAILABLE INFORMATION AND DATA

The digital survey GIS dataset of the project site were also collected from Department of Survey. The project boundary coordinate, survey area boundary and overall project layout plan was provided by the client.

SURVEY EQUIPMENTS

The detail survey was conducted using advanced total station, which measures the angle and distance precisely. Total station instruments measure angles by means of electro-optical scanning of extremely precise digital bar-codes attached on rotating glass cylinders or discs within the instrument and measurement of distance is accomplished with the help of Electronic Distance Measurement (EDM) devices fitted inside the telescope to measure the distance accurately. The following instruments were used to complete the detail survey of the project:

Table 1: List of Survey Instruments.

S.N	Survey Equipment and Model	Nos.	Angle Accuracy	Distance Accuracy
1	Topcon ES	1	± 0.2”	± (2mm + 2ppm x D)
2	L1/L2/GLONASS GPS	2		Horizontal: 2.5mm +0.1 ppm RMS Vertical: 3.5mm+0.4 ppm RMS

METHODOLOGY

❖ General

This Chapter/Report describes in detail the Approach and Methodology; we follow in order to perform the Consulting Services related to the detailed Topographic Survey.

❖ Field Mobilization and Team Composition

The following survey field team was mobilized on 13th May 2024 for the purpose of detailed topographic survey works of Birauta 132/11 Kv GIS Substation. The list of team members performed the survey activities is shown in the table below.

Table 1: List of Team Members.

S.N	Name of Surveyors	Designation
1	Netra KC	Surveyor
2	Top Prakash Jaisi	Surveyor

❖ Identification of Control Points or Trigonometric Points

The data and information on the National Geodetic Network present in the vicinity of the project area have been obtained from the Survey Department Government of Nepal. Two trig points as shown in the ***Table 2*** and one level points were collected from Department of Survey Geodetic Branch GoN. In the location where 93-135 trig point was located, park was constructed so we were unable to find the control points. We carried out our static DGPS survey from geodetic control point 93-134 established by GoN placing the base station. The leveling points collected from Department of Survey no. 101-186.1, which was near the VIP, guesthouse was also could not be found may be removed due to structure construction activities. Another level point in the vicinity of project area was in the Seti Bridge, which was also destructed due to bridge construction. The photographs are shown below.

Structure found at the location of level point collected from DoS 101-186.1 in domestic Pokhara Airport

Park constructed at the location of trig point collected from DoS 93-135

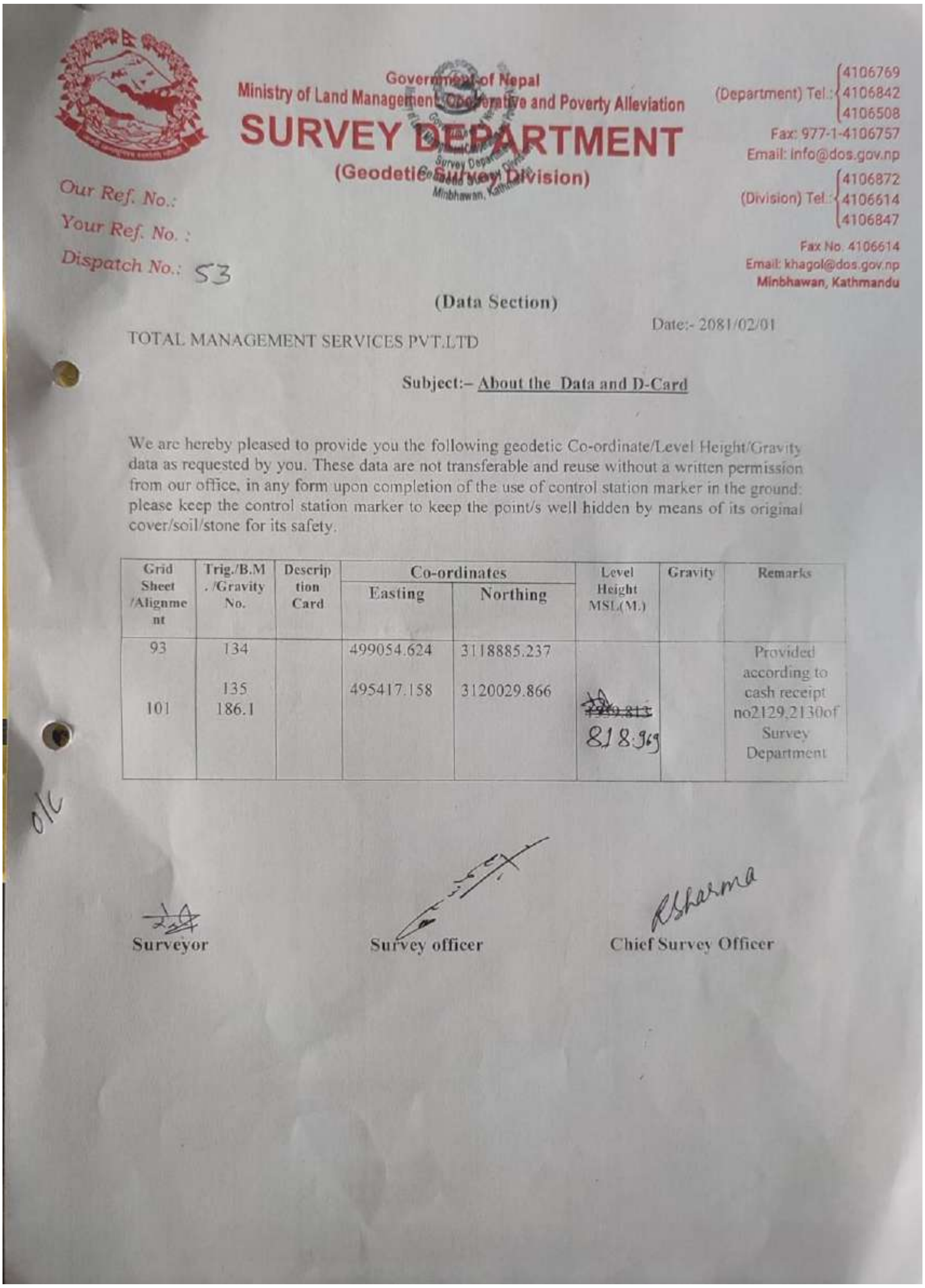
Bridge construction at Seti River where DoS level point was located.

Department of survey GoN, only provides coordinate of the point Trigonometric points but they do not provide the elevation along with coordinate. These trigonometric control points elevations were measured with the DGPS observations and checked with the control points established by the Pokhara International Airport. The details of trigonometric control point from survey department and Pokhara International Airport is shown in ***Table 2.*** The letter issued by Department of Survey with trigonometric station information and the letter of benchmark with only the elevation information is shown in ***Figure 2***.

Table 2: Control Points Obtained from Survey Department and Pokhara Airport.

Reference No.	In MUTM System (Central Meridian 84)		Reduced Level	Location	Remark
	Easting	Northing			
093-134	499054.624	3118885.237	-		3rd order point (Found point)
093-135	495417.158	3120029.866	-		3rd order point

Reference No.	In MUTM System (Central Meridian 84)		Reduced Level	Location	Remark
	Easting	Northing			
101-186.1			818.969		
BM1	501463.801	3119595.577	818.625		Pokhara Airport Control Station (Reference Level)



Government of Nepal
Ministry of Land Management, Cooperative and Poverty Alleviation
SURVEY DEPARTMENT
(Geodetic Survey Division)

(Department) Tel.: 4106769, 4106842, 4106508
Fax: 977-1-4106757
Email: info@dos.gov.np
(Division) Tel.: 4106872, 4106614, 4106847
Fax No. 4106614
Email: khagol@dos.gov.np
Minbhawan, Kathmandu

Our Ref. No.:
Your Ref. No.:
Dispatch No.: 53

(Data Section)

Date:- 2081/02/01

TOTAL MANAGEMENT SERVICES PVT.LTD

Subject:– About the Data and D-Card

We are hereby pleased to provide you the following geodetic Co-ordinate/Level Height/Gravity data as requested by you. These data are not transferable and reuse without a written permission from our office, in any form upon completion of the use of control station marker in the ground; please keep the control station marker to keep the point/s well hidden by means of its original cover/soil/stone for its safety.

Grid Sheet /Alignment	Trig./B.M./Gravity No.	Description Card	Co-ordinates		Level Height MSL(M.)	Gravity	Remarks
			Easting	Northing			
93	134		499054.624	3118885.237			Provided according to cash receipt no2129,2130of Survey Department
	135		495417.158	3120029.866			
101	186.1				~~[illegible].813~~ 818.969		

o/c

Surveyor

Survey officer

RSharma
Chief Survey Officer

Figure 2: Letter obtained from Department of Survey with trig coordinate information.

❖ Reconnaissance and Monumentation

An experienced surveyor together with the project officials has executed a quick preliminary reconnaissance survey. We visited and rapidly examined the whole survey area and identified the suitable locations for the establishment of the control stations and benchmarks.

During the site visit, the condition and usefulness of the identified ground control stations have been established. Issues such as accessibility to the proposed survey stations, visibility, lengths of lines of sight, ground cover, need for cutting and clearing of vegetation, etc. have been studied during the visit to confirm the proposed survey plans.

The monuments of the concrete pillars have been fixed on the strategic locations from where the detailed survey, longitudinal sectioning and cross sectioning can be carried out and the setting out of the construction can be carried out. The benchmarks have been established on a stable boulder or on manmade permanent structures that were available in and in the vicinity of the project area. The landmarks thus fixed have been referenced with some prominent witness marks so that they will be identified easily for the future use.

Figure 3: Monumentation of horizontal control points

A clear and well descriptive Description Cards (D-Cards) of each station have been prepared and photographs of all established control points and benchmarks have been taken, showing their designations clearly marked on the top of the permanent pillar monuments. The design of the monuments has been engraved by chisel on top of the rock or permanent Boulder. Altogether two nos. of benchmarks have been fixed on stable pillars for permanent use.

❖ Control Traversing

For control survey, the permanent benchmarks were established by Static DGPS traverse survey at the project area. All the permanent control points or Benchmarks at project area were monumented on stable ground and the description cards of all control points has been prepared and provided in **Annex-B**. The traversing for horizontal and vertical control has been performed by the DGPS traverse survey. After the DGPS, survey data collection raw data has been download and processed by using Leica Geo-Office tool software. The DGPS report describes the adopted methodology for DGPS data processing, used parameter, equipment accuracy and DGPS result.

▪ DGPS Approach Methodology

General practice of the DGPS processing involves a known coordinate of a reference point and other control points are established based on these reference points by differentially correcting the systematic GPS errors.

The Geographic coordinates of all Benchmark Points (GCPs) collected by "Static Mode" survey, will be post processed using Leica Geo-Office Software.

Before processing the data, we define

- Reference Ellipsoid: WGS84
- Projection system: UTM44N
- EGM 2008 Geoid separation model to apply for correction height between Ellipsoid height and sea level height.

The data process provides to compare all DGPS satellite observation of each benchmark according to the timeline of the collected raw data and convert in to finally UTM44 plane coordinates.

In this project following approaches are adopted;

a) A base station (93-134) was selected as the known points collected from Department of Survey Nepal.

b) A set of GPS instrument was set on the base station (93-134) shown in ***Figure 4*** and continuous GPS observation was made. At the same time, rover GPS sets were set on the unknown points and observation were made for at least 1 hour.

c) Determination of precise WGS84 coordinates of main points (BASE 93-134) in projects area.

d) Processing of the other Ground Control Points (GCPs) with respect to BASE with double differences and network adjustment

e) Transformation of Ground Control Points (GCPs) from WGS 84 to Department of Survey (DoS) coordinate system using three parameters transformation. The three parameters are given in **Table 3.**

Figure 4: Static DGPS observation at BASE trig Station 93-134

The detailed approaches with data analysis and illustrations are given in **Annex-C**.

- **Transformation of WGS84 coordinates System to MUTM 84**

The coordinates calculated above are transformed to Nepalese Coordinate system using the three parameters transformation. The values of three parameters transformation Nepal Nagarkot 84 to WGS84 used are as follows:

Table 3: Transformation Parameters from MUTM 84 to WGS84

S.N	Parameters	Estimate Value
1	Translation in X axis (m)	296.207
2	Translation in Y axis (m)	731.545
	Translation in Z axis (m)	273.001

❖ Horizontal and Vertical Control Points

The coordinates and levels of the control points are presented below which are established by DGPS survey. The coordinates area presented both in MUTM 84 and UTM 44N projection system.

Table 4: List of Coordinates and Elevations of Permanent Benchmarks.

Point ID	MUTM 84		Elevation	Latitude	Longitude	Remark
	Easting	Northing				
BM1	497415.052	3118199.289	786.104	28.183790797	83.971451174	
BM1AP	501460.984	3119610.894	**818.625**	28.196532034	84.012660205	**Pokhara Airport Reference RL**
BM2	497393.306	3118144.603	785.618	28.183297243	83.971229823	
Trig-134	**499054.624**	**3118885.237**	**856.385**	**28.189983511**	**83.988149438**	**Base**

❖ Detailed Topographical Surveys

For detailed topographic survey, tachometric method of survey has been introduced. The Total Stations instrument in the site recorded the X, Y and Z co-ordinates of every detail. The procedure for detail surveying is as follows:

After setting the instrument over a known survey station, the back sight was fixed on the prism reflector placed over a known point and then started taking details on the ground. The details include roads, footpath, houses, physical and man-made features, hydrographic features such as drains, taps etc. All information mentioned in the scope has been depicted from the ground. A rough sketch of surveyed points has been maintained so that it might be useful while plotting the maps.

The X, Y and Z Co-ordinates of every detail have been recorded and saved in the Total Stations and downloaded in the computer later. The further processing of all topographic data has been done in the computer and they have been prepared the plot file in AutoCAD format.

The topographic survey has in sufficient detail as to produce detail design of the project component.

PLOTTING AND PREPARATION OF MAPS

After the completion of fieldwork, all the survey data has been downloaded to computer at Kathmandu office & processed with appropriate survey processing software like MS-Excel, Word, AutoCAD, Arc.Map, SW-DTM, Autocad Civil-3D, Topconlink etc. After the processing that, steps have been followed as given below.

- Managing of data in proper location of the computer
- Plotting of maps
- Contour generation at an interval of 0.25m.
- Editing of contours and other topographic details
- Symbolization of details
- Preparation of layouts and adding of marginal information

Digital maps have been prepared in AutoCAD format at appropriate scales as mentioned above in the ToR Showing the location of control points, BMs, topographical features, project road, Houses, foot track, fence area, canal, Kholsi and shrub land. The contour is annotated and the symbol / database of the features are as prescribed in the Legend. Contours are shown at intervals of 0.25m. Every 1 m contour is plotted in a thickened line. Spot elevation at 5m x 5m grid interval is shown on the map.

FINAL REPORTING

The main report of the work is managed in Volume-I, which is prepared by incorporating the general approach and methodology and other general matters relating to the objectives of the work. The secondary data, which would be useful later, are annexed with the report as follows.

Annex-A: Field Photographs

Annex-B: Description cards of Benchmarks

Annex-C: DGPS processing report

ABBREVIATIONS USED IN SURVEY AND MAPPING

There are many abbreviations used when collecting the field data and preparing the report, maps and profiles. The abbreviations used are tabulated below.

Table 5: Abbreviations.

S.N.	Description	Abbreviations
1	Project Boundary Line	BL
2	Benchmark	BM
3	Boundary Wall	BW
4	Concrete Electric Pole	CEP
5	Differential Global Positioning System	DGPS
6	Department Of Survey	DoS
7	Drain Bottom	DRN-B
8	Drain Top	DRN-T
9	Electronic Distance Measurement	EDM
10	Earth Gravitational Model	EGM
11	Electric Pole	EP

S.N.	Description	Abbreviations
12	Fly Station	FS
13	Foot Track	FT
14	Foot Track Slab	FT-BRIGE
15	Fence Wall	FW
16	Ground Control Point	GCP
17	Gate Edge	GET
18	Gas Insulated Substation	GIS
19	Global Navigation Satellite System	GLONASS
20	Global Navigation Satellite System	GNSS
21	Government Of Nepal	GoN
22	Global Positioning System	GPS
23	House Edge	HC
24	Hume Pipe	HP-B
25	Road Junction	JRE
26	Microsoft	MS
27	Modified Universal Transverse Mercator	MUTM
28	Natural Surface	NS
29	Pitch Edge	PRE
30	Pitch Road Junction	PRE-J
31	Road Edge	RE
32	Real Time Kinematic	RTK
33	Serial Number	S.N.
34	Spot Height	SH
35	Temporary House	THC
36	Terms Of Reference	ToR
37	Total Station	TS
38	Universal Transverse Mercator	UTM
39	Very Important Person	VIP
40	World Geodetic System	WGS
41	X-Value (Easting)	X
42	Y-Value (Northing)	Y
43	Z-Value (Elevation)	Z

Annex-A Field Photographs

Static DGPS observation at control point established in Substation Area

Static DGPS observation at control point established by Pokhara International Airport

Instrument orientation for Static DGPS observation at control point established by Pokhara International Airport

Back sight target orientation for Total Station Survey

Detailed Topographical survey at Substation area with Total Station

Topographical survey site inspection at Substation area.

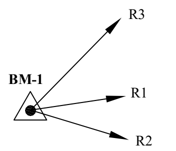
Annex-B Description cards of Benchmarks

Urban Transmission and Distribution System Inprovement Project in Nepal

Kaski,Nepal

Description Card of Permanent Benchmark

Coordinate:	Monumentedation Type:	Location Details:
E:497415.052 N:3118199.289 Z:786.104	BM is estabilshed on concrete Pillar with iron nail and marked with blue enemal paint.	District:Kaski VDC/Municipality:Pokhara Ward No.:17 Location Area:Birauta Powerhouse

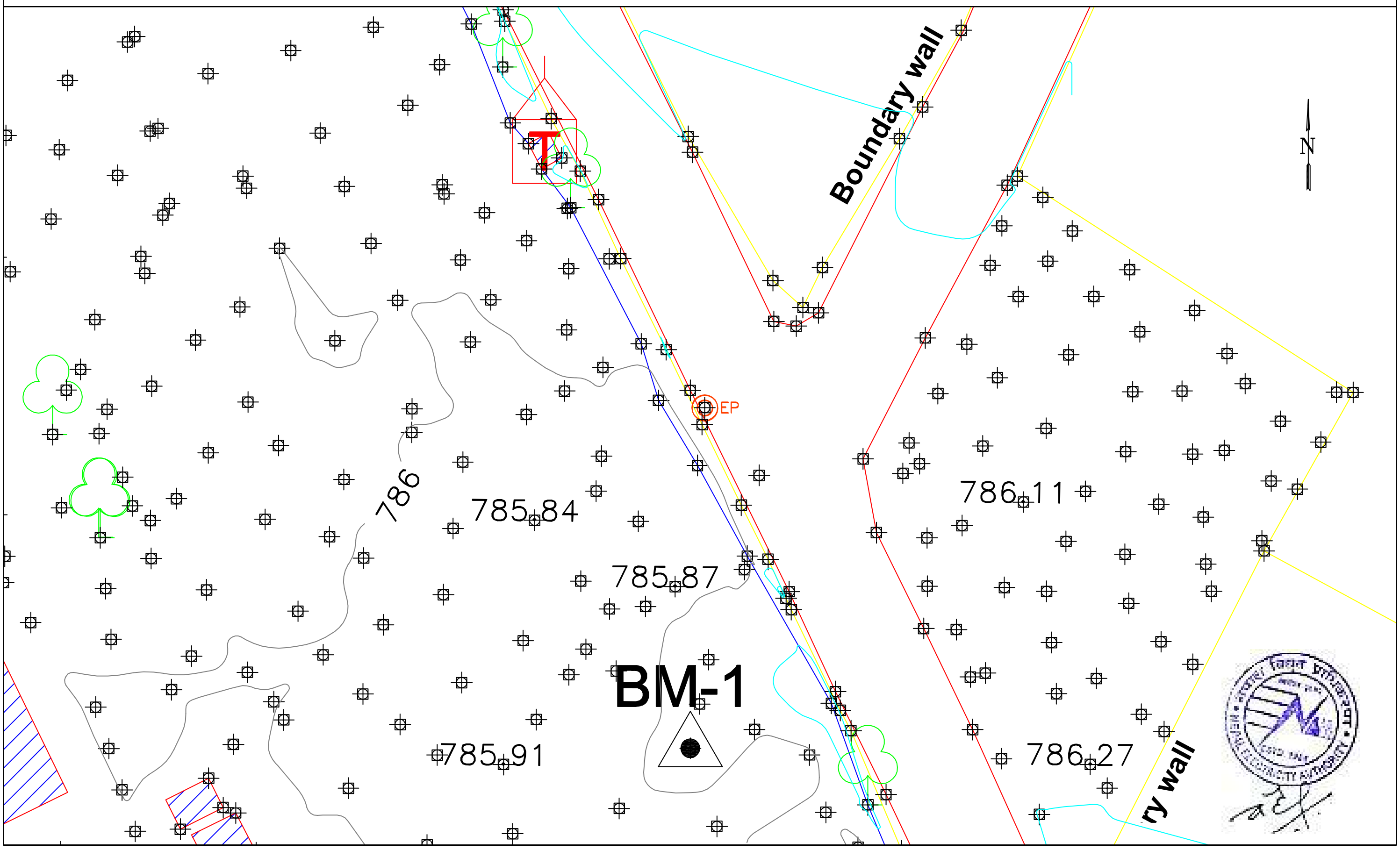
Benchmark No:	References Sketch:
BM-1	

Photograph

References Data:

No:	Distance:	Type:
R-1	7.08m.	Wall
R-2	8.91m.	Tree
R-3	16.28m.	Electric pole

Location Map



Urban Transmission and Distribution System Inprovement Project in Nepal

Kaski,Nepal

Description Card of Permanent Benchmark

Coordinate:

E:497393.306

N:3118144.603

Z:785.618

Monumentedation Type:

BM is estabilshed on concrete Pillar with iron nail and marked with blue enemal paint.

Location Details:

District:Kaski

VDC/Municipality:Pokhara

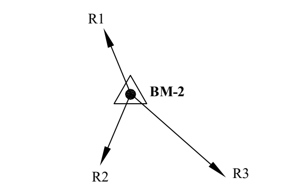
Ward No.:17

Location Area:Birauta Powerhouse

Benchmark No:

BM-2

References Sketch:

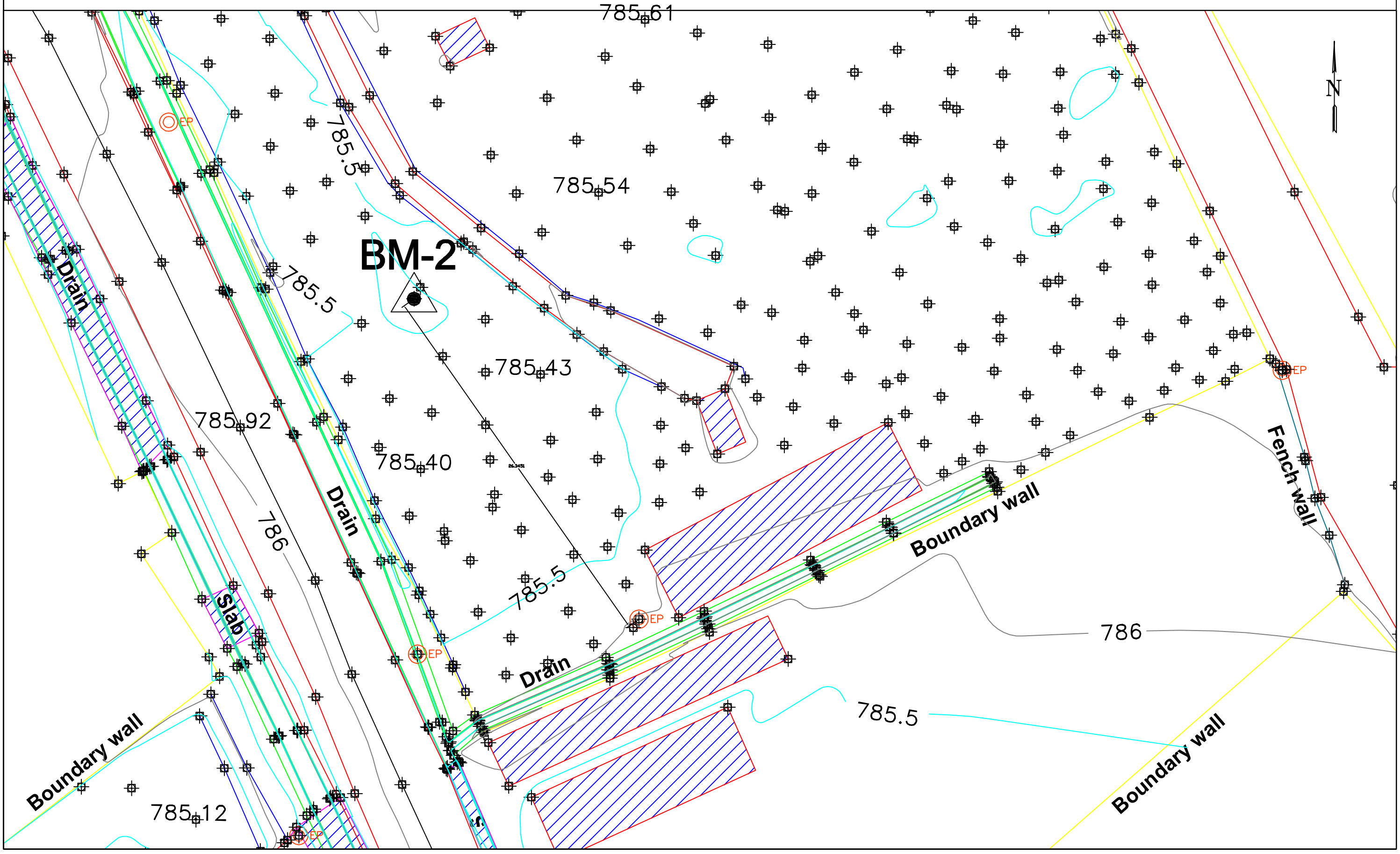


References Data:

No:	Distance:	Type:
R-1	20.37m.	Electric pole
R-2	23.91m.	Electric pole
R-3	26.34m.	Electric pole

Photograph

Location Map



Annex-C DGPS processing report

Coordinate System	
Name:	Nepal_MUTM
Datum:	Dat_Everest_1937
Zone:	Nepal_MUTM_84
Geoid:	EGM 2008 India
Vertical datum:	

Baseline Processing Report

Processing Summary

Observation	From	To	Solution Type	H. Prec. (Meter)	V. Prec. (Meter)	Geodetic Az.	Ellipsoid Dist. (Meter)	ΔHeight (Meter)
Trig-134 --- BM1AP (B2)	Trig-134	BM1AP	Fixed	0.039	0.089	73°12'52"	2513.644	-37.455
Trig-134 --- BM1 (B3)	Trig-134	BM1	Fixed	0.012	0.075	247°17'33"	1777.449	-70.524
Trig-134 --- BM2 (B1)	Trig-134	BM2	Fixed	0.010	0.056	245°58'03"	1819.107	-71.026

Acceptance Summary

Processed	Passed	Flag	Fail
3	3	0	0

Trig-134 - BM1AP (3:48:46 PM-4:59:52 PM) (S2)

Baseline observation:	Trig-134 --- BM1AP (B2)
Processed:	5/21/2024 11:15:25 PM
Solution type:	Fixed
Frequency used:	Dual Frequency (L1, L2)
Horizontal precision:	0.039 m
Vertical precision:	0.089 m
RMS:	0.038 m
Maximum PDOP:	2.197
Ephemeris used:	Broadcast
Antenna model:	NGS Absolute
Processing start time:	5/18/2024 3:49:12 PM (Local: UTC+5hr)
Processing stop time:	5/18/2024 4:59:42 PM (Local: UTC+5hr)
Processing duration:	01:10:30
Processing interval:	30 seconds

Vector Components (Mark to Mark)

From:	Trig-134				
Grid		Local		Global	
Easting	499054.624 m	**Latitude**	N28°11'22.803432601"	**Latitude**	N28°11'23.940634226"
Northing	3118885.237 m	**Longitude**	E83°59'25.330422159"	**Longitude**	E83°59'17.338012852"
Elevation	884.900 m	**Height**	860.678 m	**Height**	838.446 m

To:	BM1AP				
Grid		Local		Global	
Easting	501460.984 m	**Latitude**	N28°11'46.378879776"	**Latitude**	N28°11'47.515315578"
Northing	3119610.894 m	**Longitude**	E84°00'53.581617105"	**Longitude**	E84°00'45.576774580"
Elevation	847.139 m	**Height**	823.222 m	**Height**	800.913 m

Vector					
ΔEasting	2406.360 m	**NS Fwd Azimuth**	73°12'52"	**ΔX**	-2433.034 m
ΔNorthing	725.657 m	**Ellipsoid Dist.**	2513.644 m	**ΔY**	-122.357 m
ΔElevation	-37.760 m	**ΔHeight**	-37.455 m	**ΔZ**	621.973 m

Standard Errors

Vector errors:					
σ ΔEasting	0.016 m	σ NS fwd Azimuth	0°00'01"	σ ΔX	0.016 m
σ ΔNorthing	0.013 m	σ Ellipsoid Dist.	0.016 m	σ ΔY	0.039 m
σ ΔElevation	0.046 m	σ ΔHeight	0.046 m	σ ΔZ	0.027 m

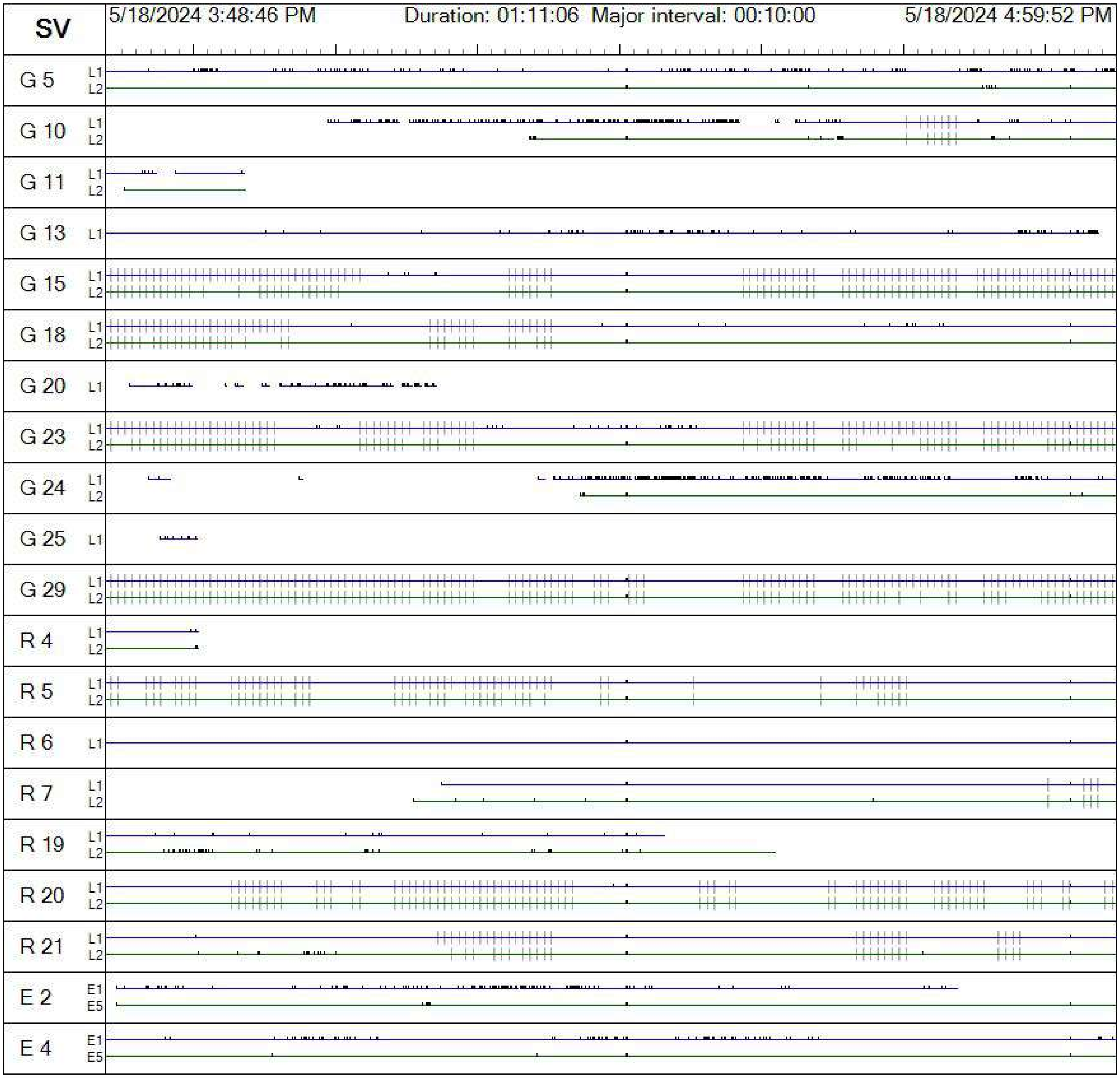
Aposteriori Covariance Matrix (Meter²)

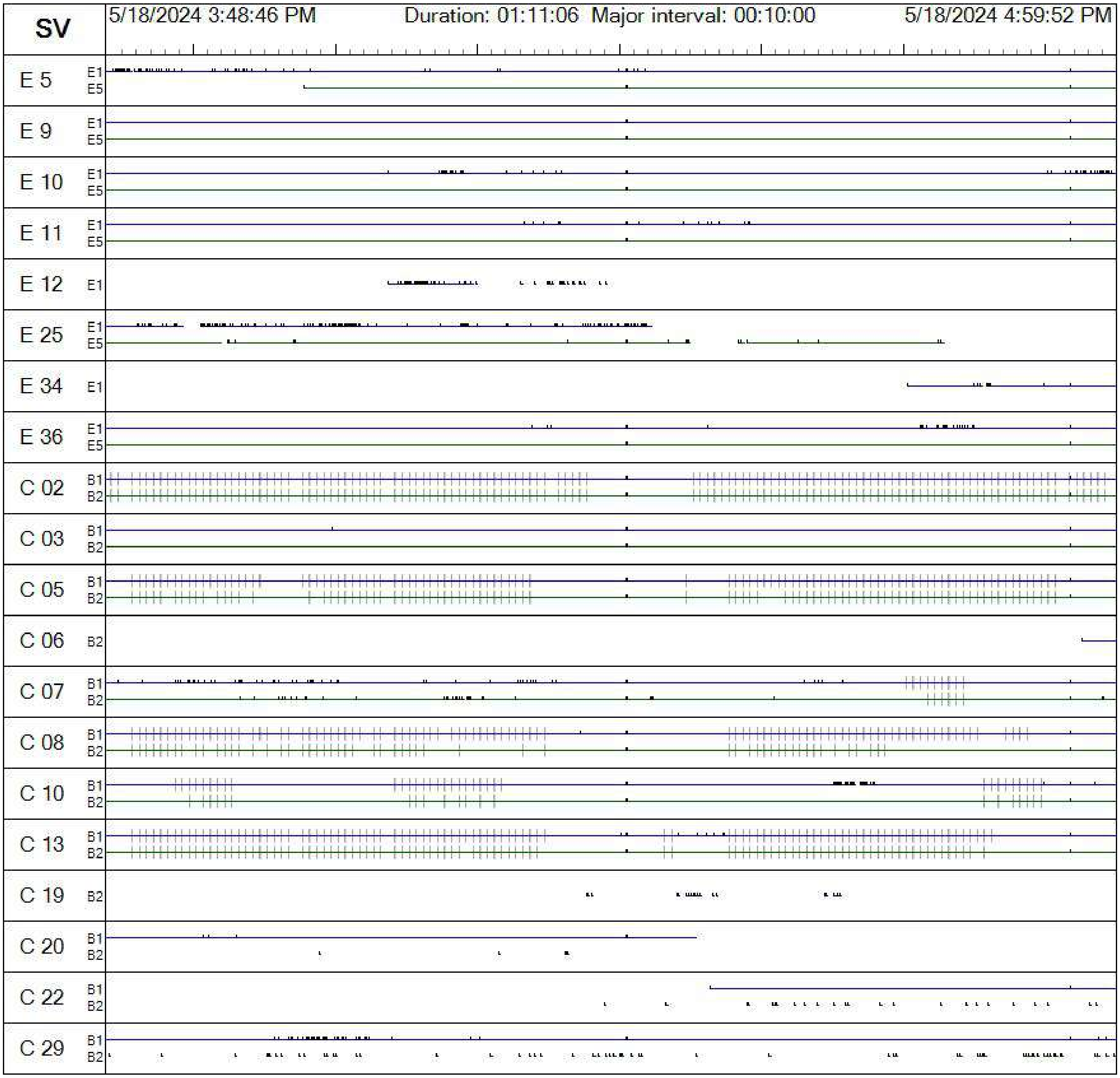
	X	Y	Z
X	0.0002571342		
Y	0.0000613616	0.0015052306	
Z	0.0000684394	0.0008890274	0.0007397755

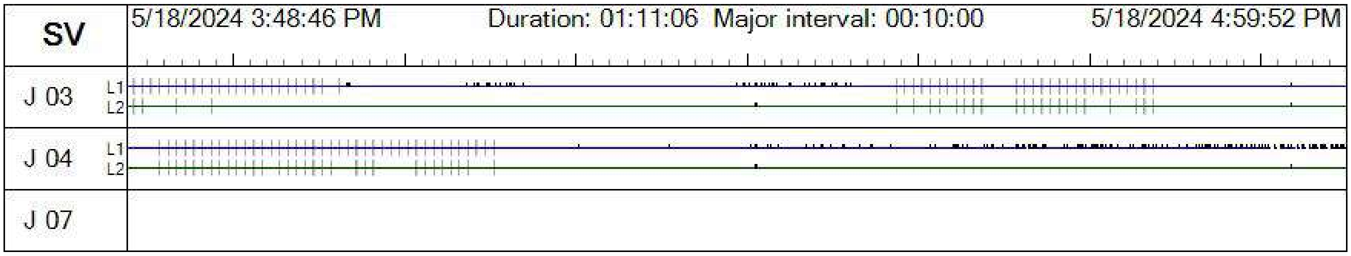
Occupations

	From	To
Point ID:	Trig-134	BM1AP
Receiver type:	Unknown	Unknown
Receiver serial number:		
Antenna type:	Unknown External	Unknown External
Antenna serial number:	AS-ANT2BCAL	AS-ANT2BCAL
Antenna height (measured):	1.460 m	1.455 m
Antenna method:	Antenna Phase Center	Antenna Phase Center

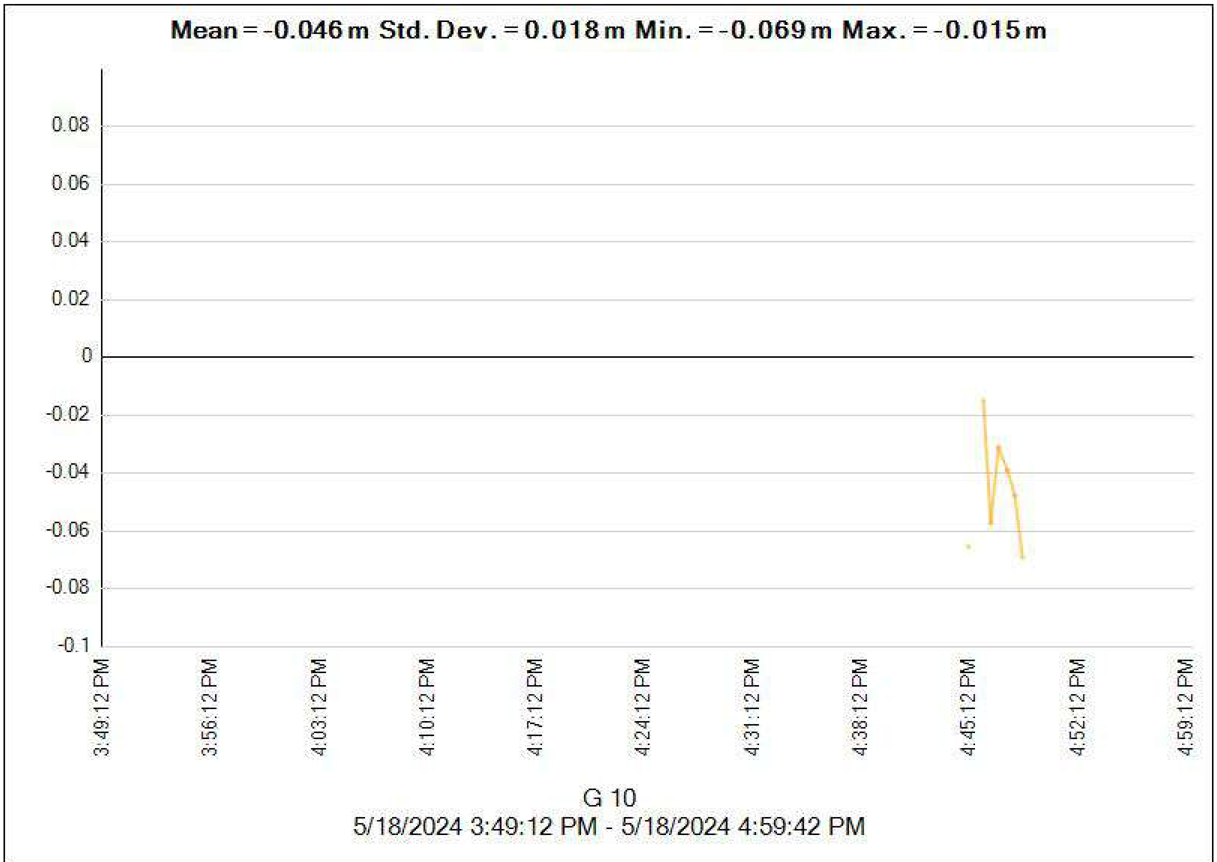
Tracking Summary

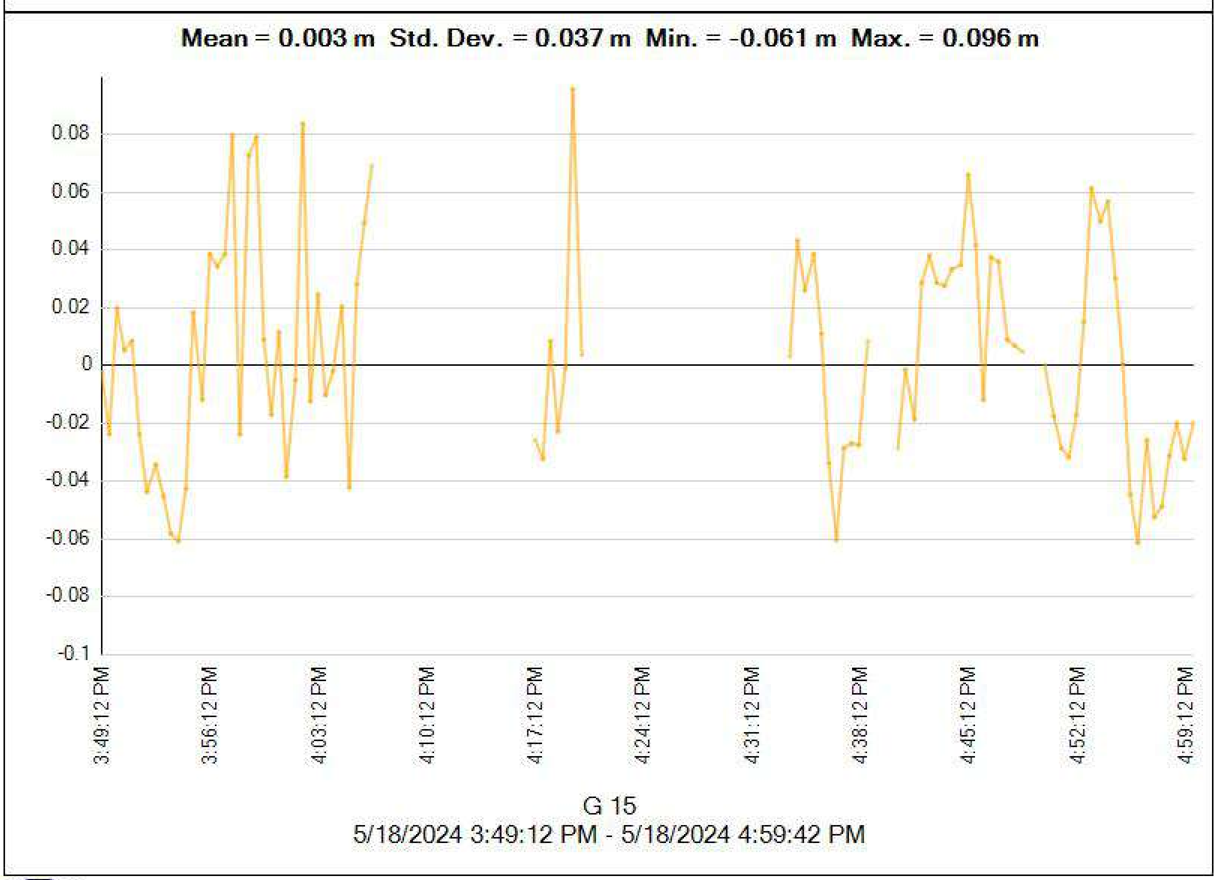



SV
5/18/2024 3:48:46 PM
Duration: 01:11:06 Major interval: 00:10:00
5/18/2024 4:59:52 PM
E 5 E1 E5
E 9 E1 E5
E 10 E1 E5
E 11 E1 E5
E 12 E1
E 25 E1 E5
E 34 E1
E 36 E1 E5
C 02 B1 B2
C 03 B1 B2
C 05 B1 B2
C 06 B2
C 07 B1 B2
C 08 B1 B2
C 10 B1 B2
C 13 B1 B2
C 19 B2
C 20 B1 B2
C 22 B1 B2
C 29 B1 B2

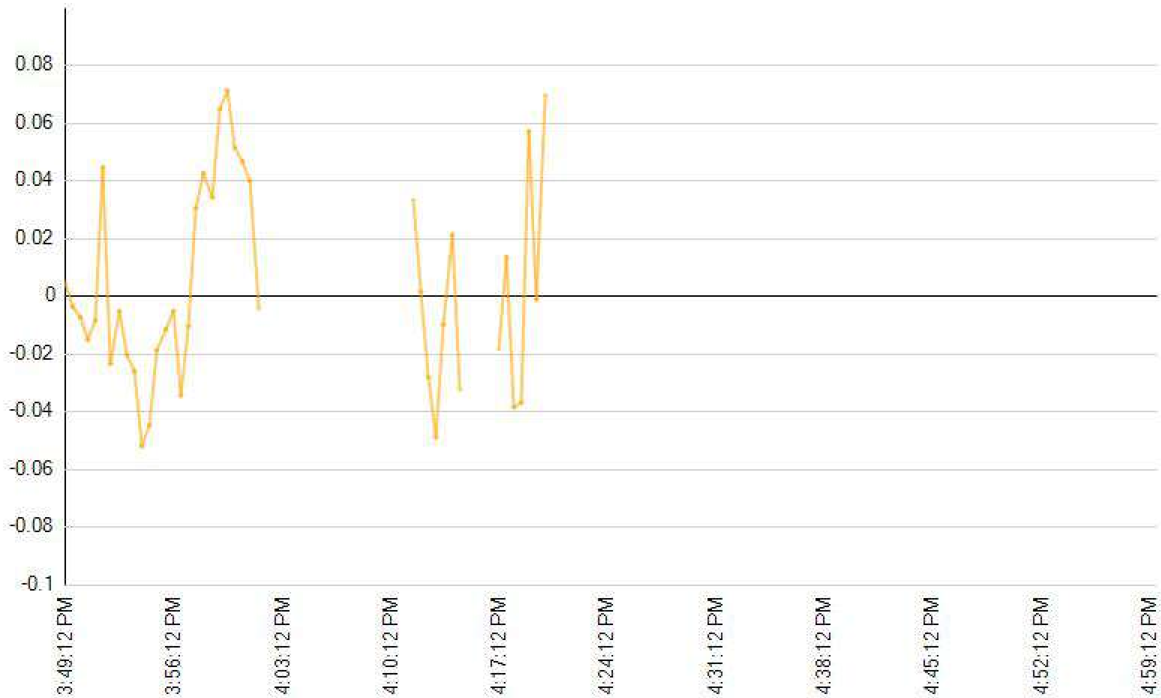

SV
5/18/2024 3:48:46 PM
Duration: 01:11:06 Major interval: 00:10:00
5/18/2024 4:59:52 PM
J 03
L1
L2
J 04
L1
L2
J 07

Residuals


Mean = -0.046 m Std. Dev. = 0.018 m Min. = -0.069 m Max. = -0.015 m
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
3:49:12 PM
3:56:12 PM
4:03:12 PM
4:10:12 PM
4:17:12 PM
4:24:12 PM
4:31:12 PM
4:38:12 PM
4:45:12 PM
4:52:12 PM
4:59:12 PM
G 10
5/18/2024 3:49:12 PM - 5/18/2024 4:59:42 PM

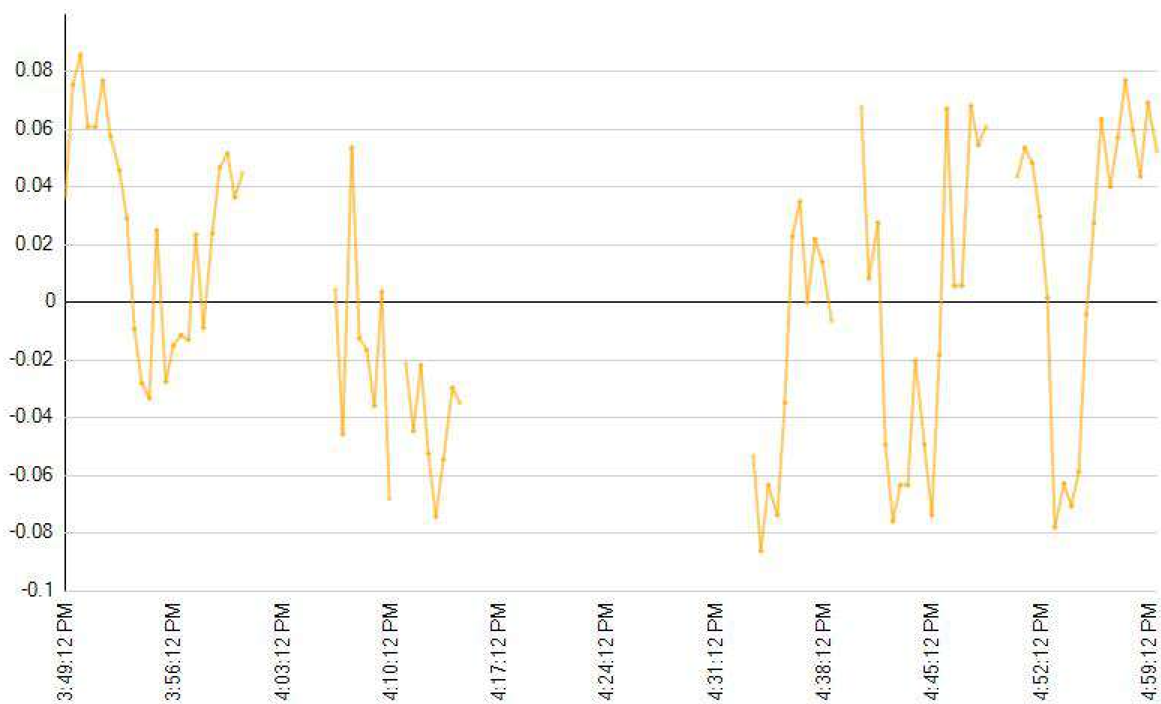

Mean = 0.003 m Std. Dev. = 0.037 m Min. = -0.061 m Max. = 0.096 m
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
3:49:12 PM
3:56:12 PM
4:03:12 PM
4:10:12 PM
4:17:12 PM
4:24:12 PM
4:31:12 PM
4:38:12 PM
4:45:12 PM
4:52:12 PM
4:59:12 PM
G 15
5/18/2024 3:49:12 PM - 5/18/2024 4:59:42 PM

Mean = 0.003 m Std. Dev. = 0.034 m Min. = -0.052 m Max. = 0.071 m



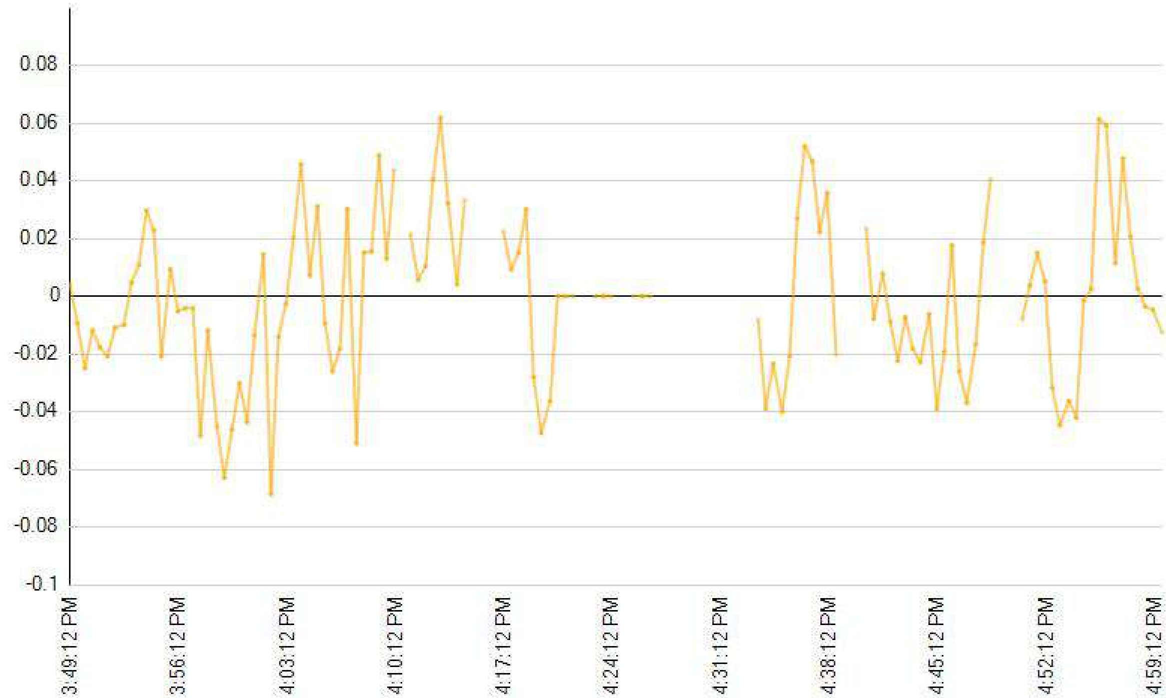
G 18
5/18/2024 3:49:12 PM - 5/18/2024 4:59:42 PM

Mean = 0.003 m Std. Dev. = 0.048 m Min. = -0.086 m Max. = 0.086 m



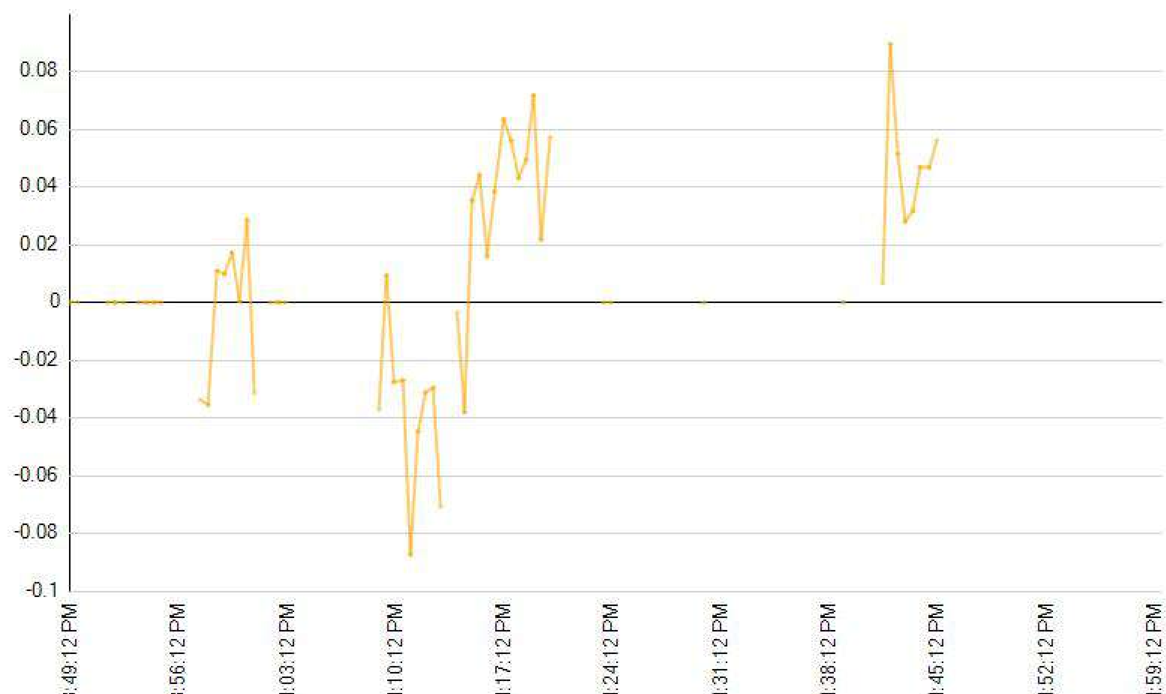
G 23
5/18/2024 3:49:12 PM - 5/18/2024 4:59:42 PM

Mean = -0.001 m Std. Dev. = 0.028 m Min. = -0.069 m Max. = 0.062 m

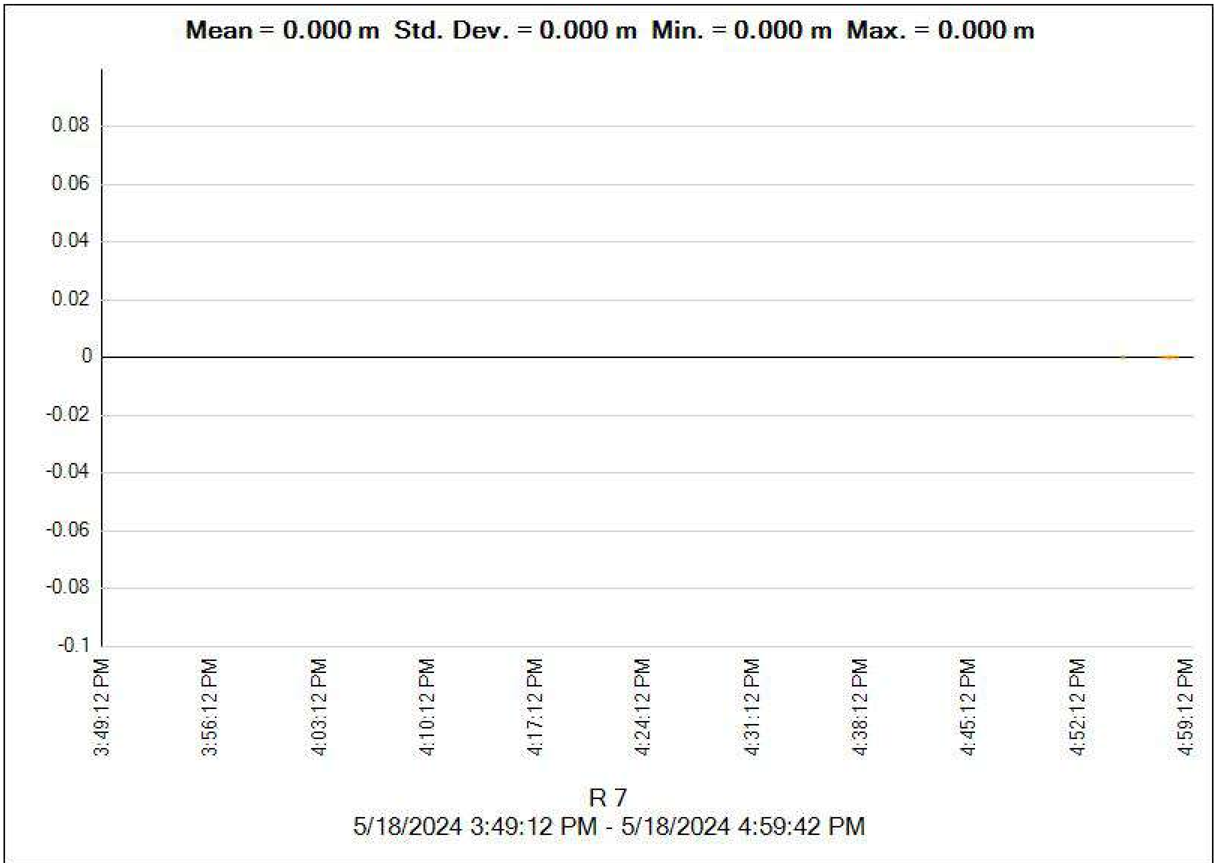


G 29
5/18/2024 3:49:12 PM - 5/18/2024 4:59:42 PM

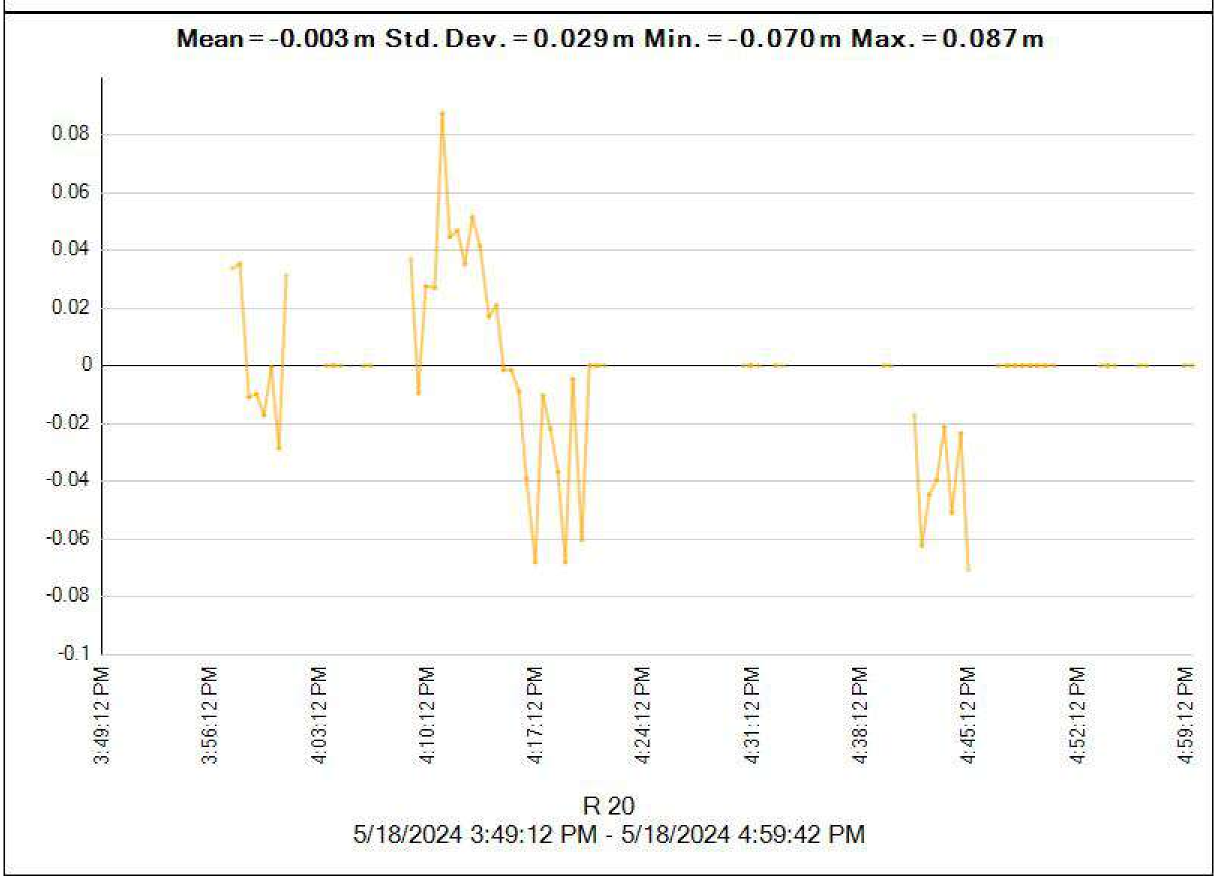
Mean = 0.008 m Std. Dev. = 0.035 m Min. = -0.087 m Max. = 0.089 m



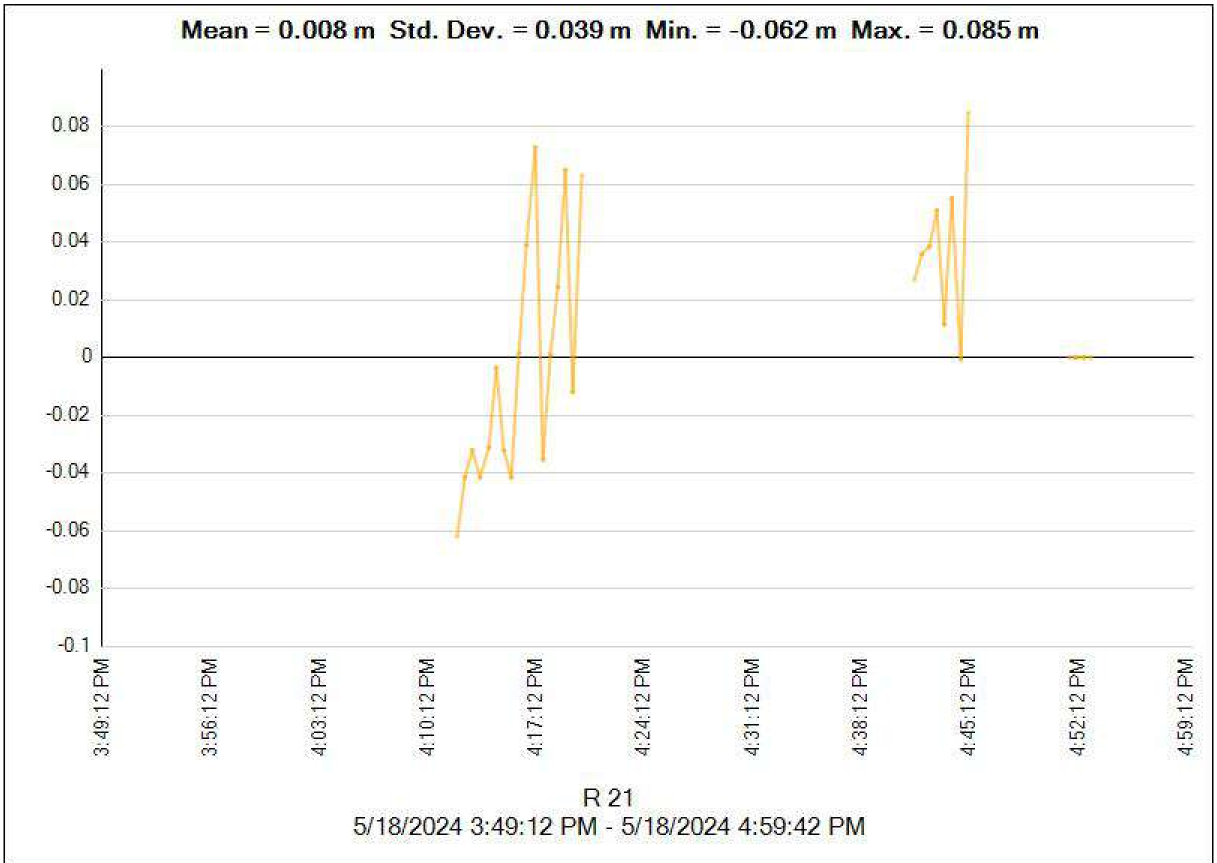
R 5
5/18/2024 3:49:12 PM - 5/18/2024 4:59:42 PM



Mean = 0.000 m Std. Dev. = 0.000 m Min. = 0.000 m Max. = 0.000 m
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
3:49:12 PM
3:56:12 PM
4:03:12 PM
4:10:12 PM
4:17:12 PM
4:24:12 PM
4:31:12 PM
4:38:12 PM
4:45:12 PM
4:52:12 PM
4:59:12 PM
R 7
5/18/2024 3:49:12 PM - 5/18/2024 4:59:42 PM



Mean = -0.003 m Std. Dev. = 0.029 m Min. = -0.070 m Max. = 0.087 m
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
3:49:12 PM
3:56:12 PM
4:03:12 PM
4:10:12 PM
4:17:12 PM
4:24:12 PM
4:31:12 PM
4:38:12 PM
4:45:12 PM
4:52:12 PM
4:59:12 PM
R 20
5/18/2024 3:49:12 PM - 5/18/2024 4:59:42 PM


Mean = 0.008 m Std. Dev. = 0.039 m Min. = -0.062 m Max. = 0.085 m
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
3:49:12 PM
3:56:12 PM
4:03:12 PM
4:10:12 PM
4:17:12 PM
4:24:12 PM
4:31:12 PM
4:38:12 PM
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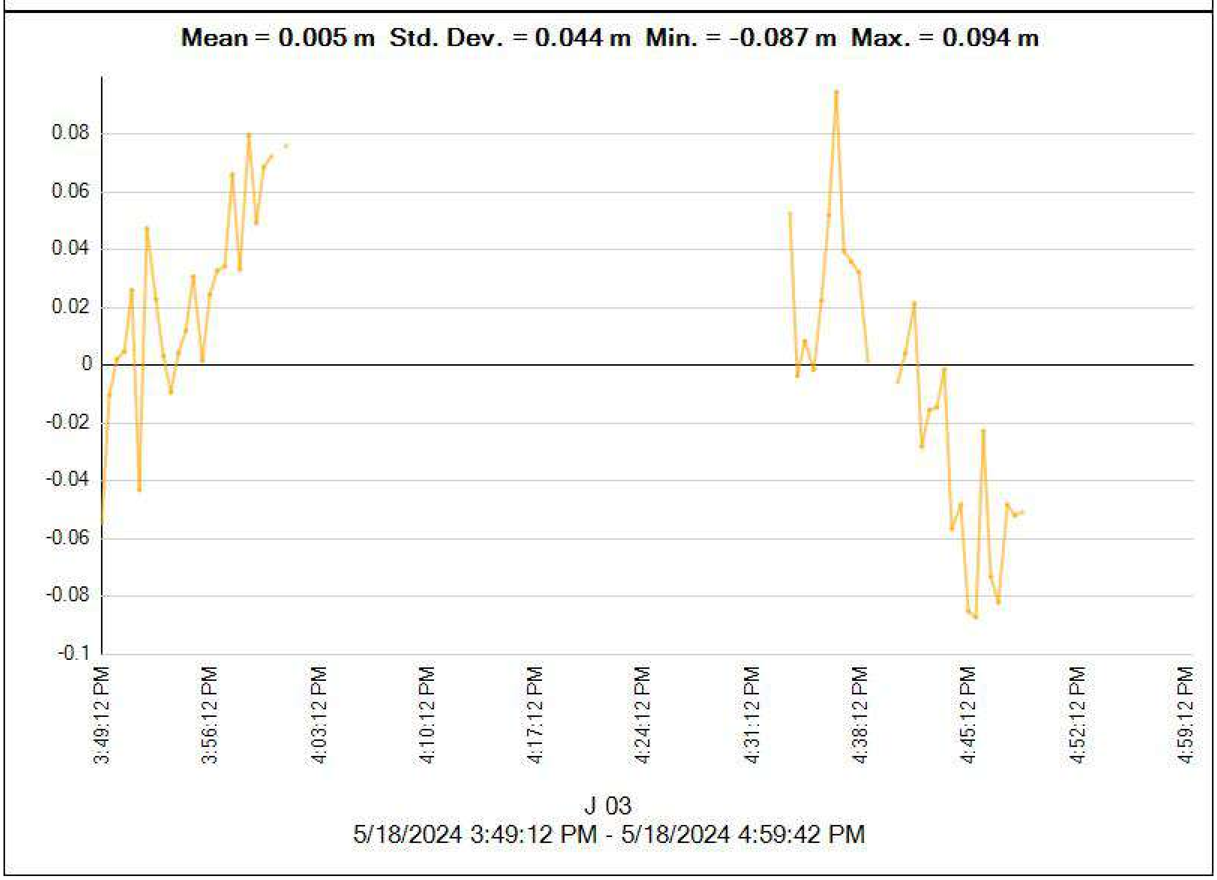
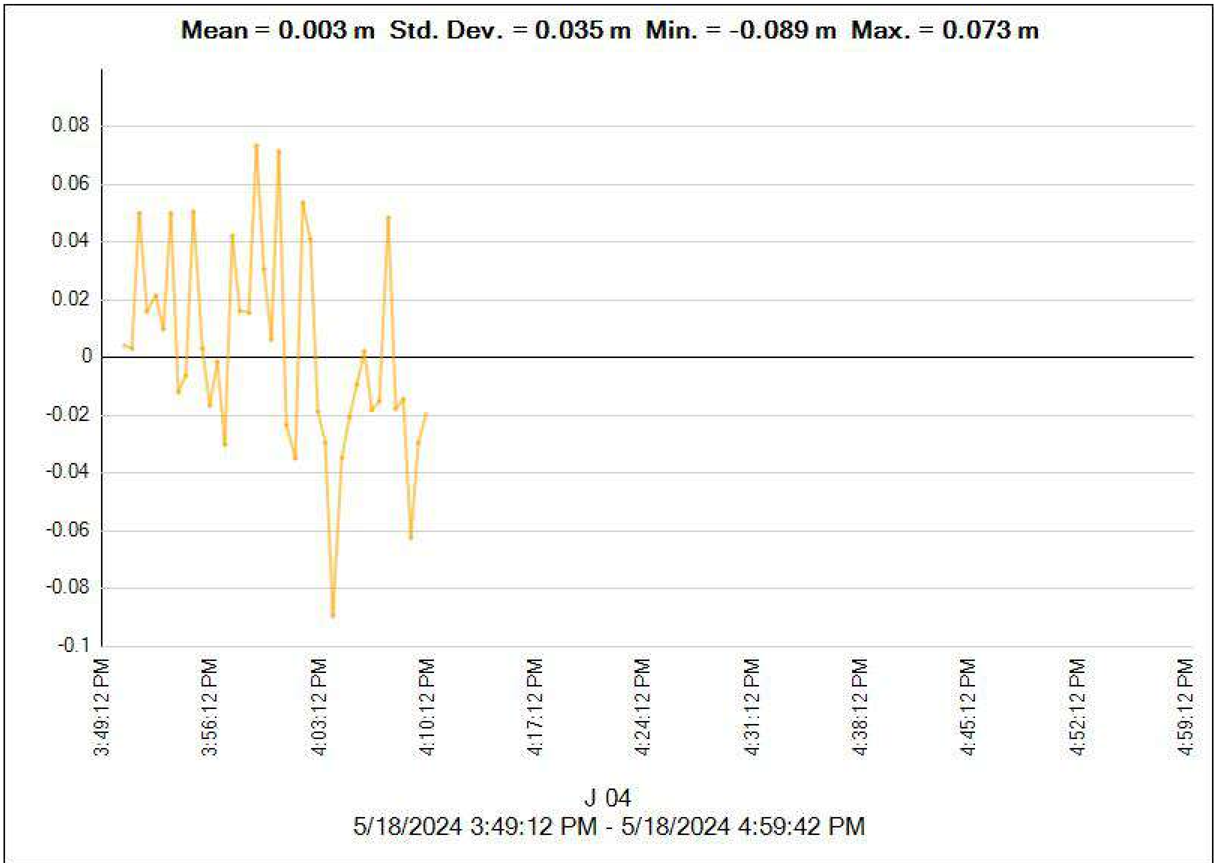
4:52:12 PM
4:59:12 PM
R 21
5/18/2024 3:49:12 PM - 5/18/2024 4:59:42 PM


Mean = 0.005 m Std. Dev. = 0.044 m Min. = -0.087 m Max. = 0.094 m
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
3:49:12 PM
3:56:12 PM
4:03:12 PM
4:10:12 PM
4:17:12 PM
4:24:12 PM
4:31:12 PM
4:38:12 PM
4:45:12 PM
4:52:12 PM
4:59:12 PM
J 03
5/18/2024 3:49:12 PM - 5/18/2024 4:59:42 PM


Mean = 0.003 m Std. Dev. = 0.035 m Min. = -0.089 m Max. = 0.073 m
0.08
0.06
0.04
0.02
0
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-0.06
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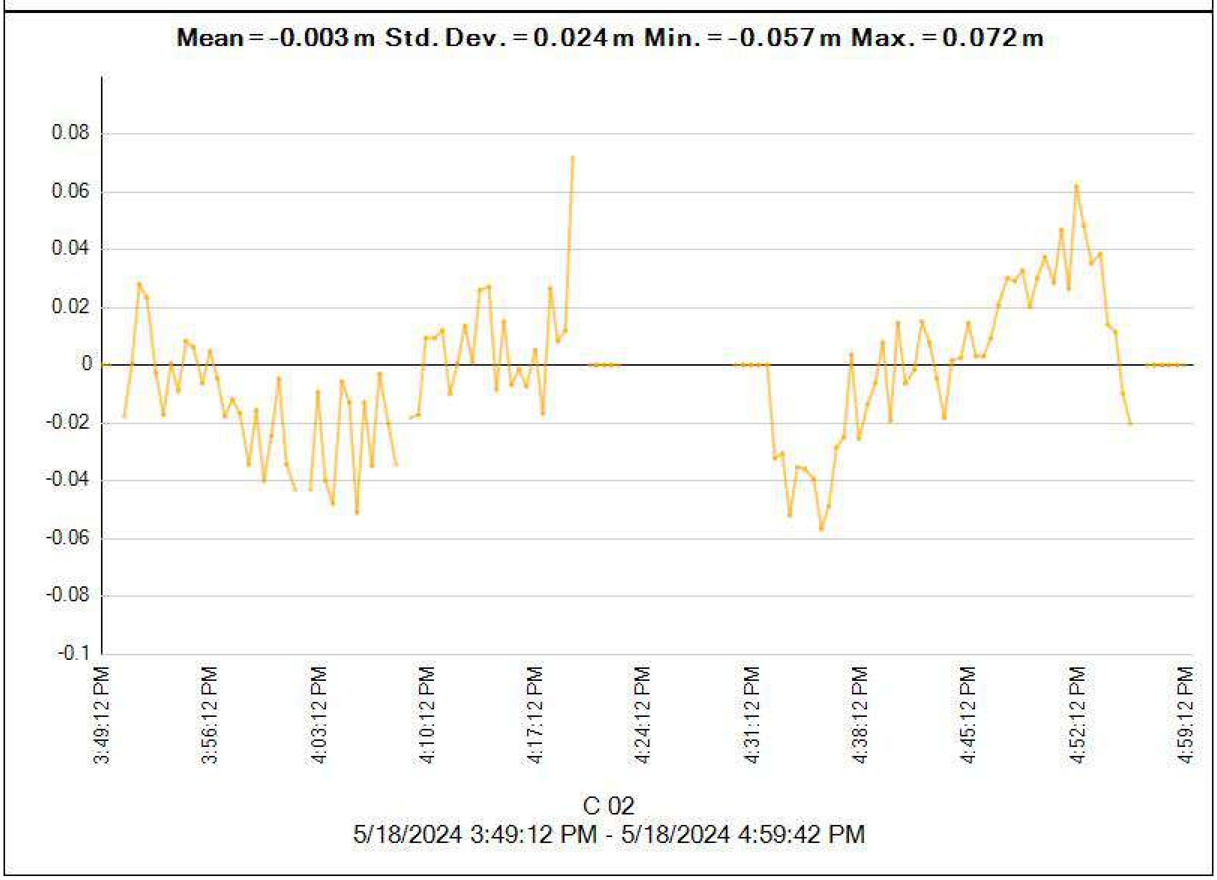
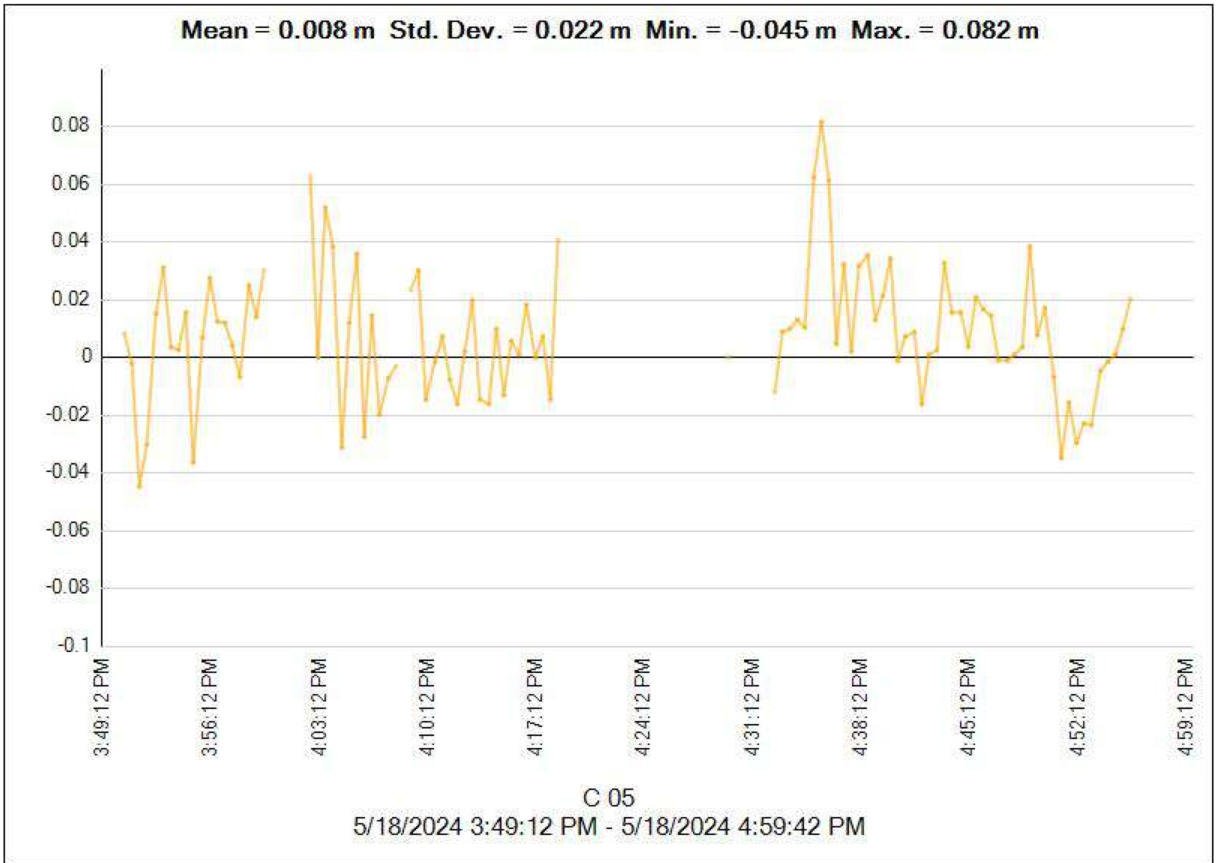
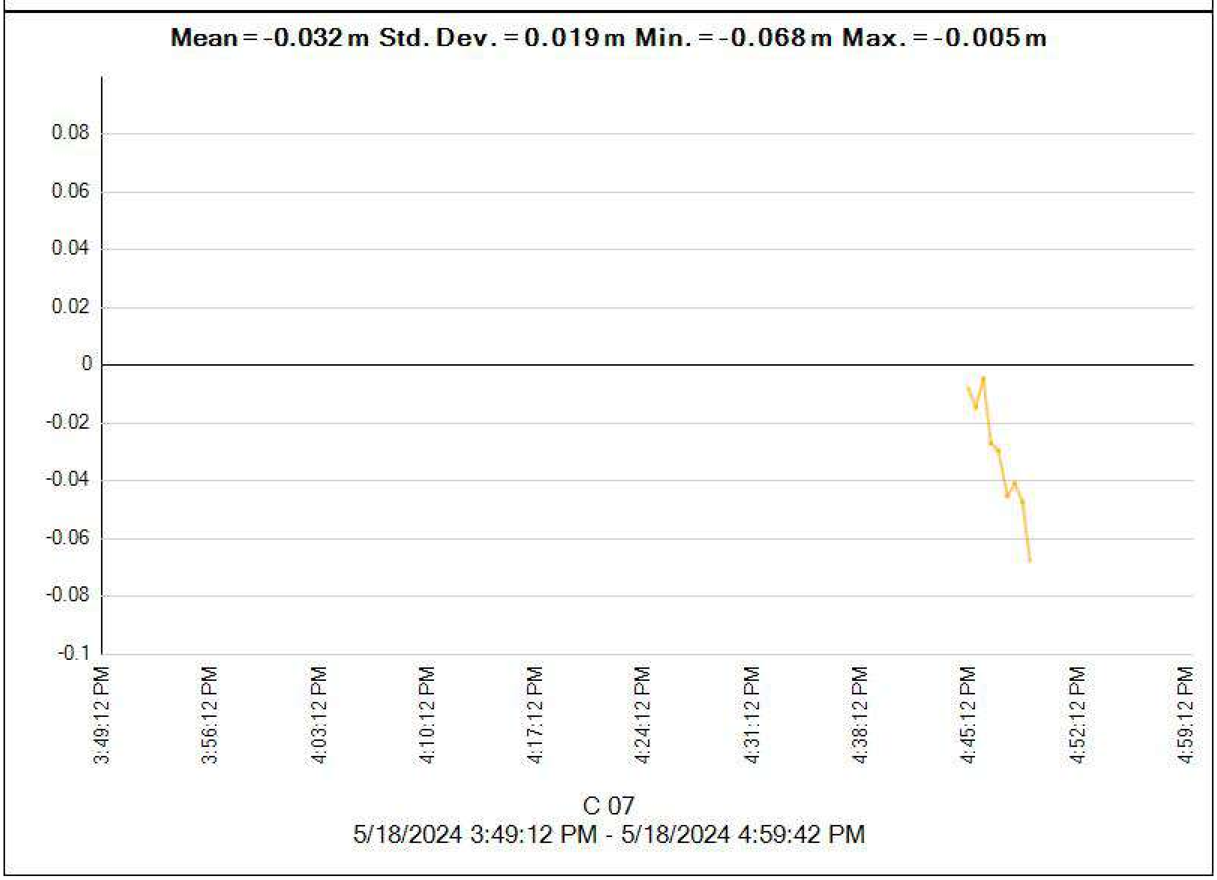
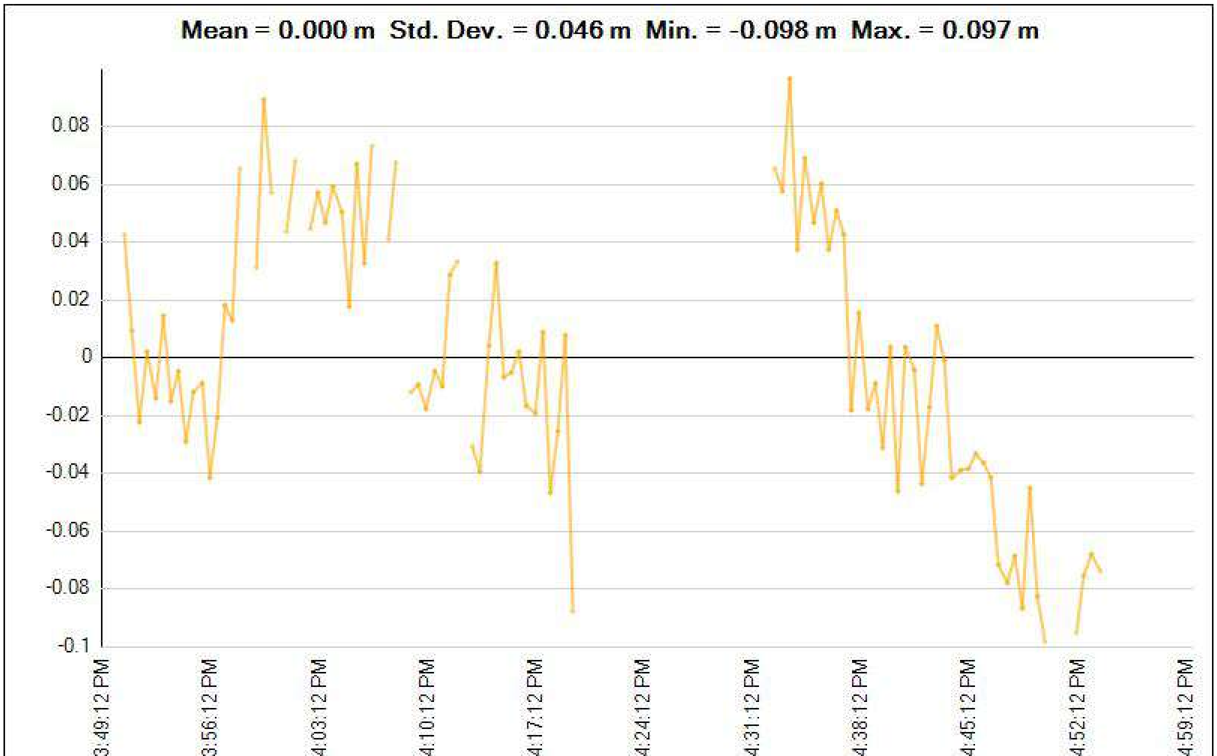
-0.1
3:49:12 PM
3:56:12 PM
4:03:12 PM
4:10:12 PM
4:17:12 PM
4:24:12 PM
4:31:12 PM
4:38:12 PM
4:45:12 PM
4:52:12 PM
4:59:12 PM
J 04
5/18/2024 3:49:12 PM - 5/18/2024 4:59:42 PM

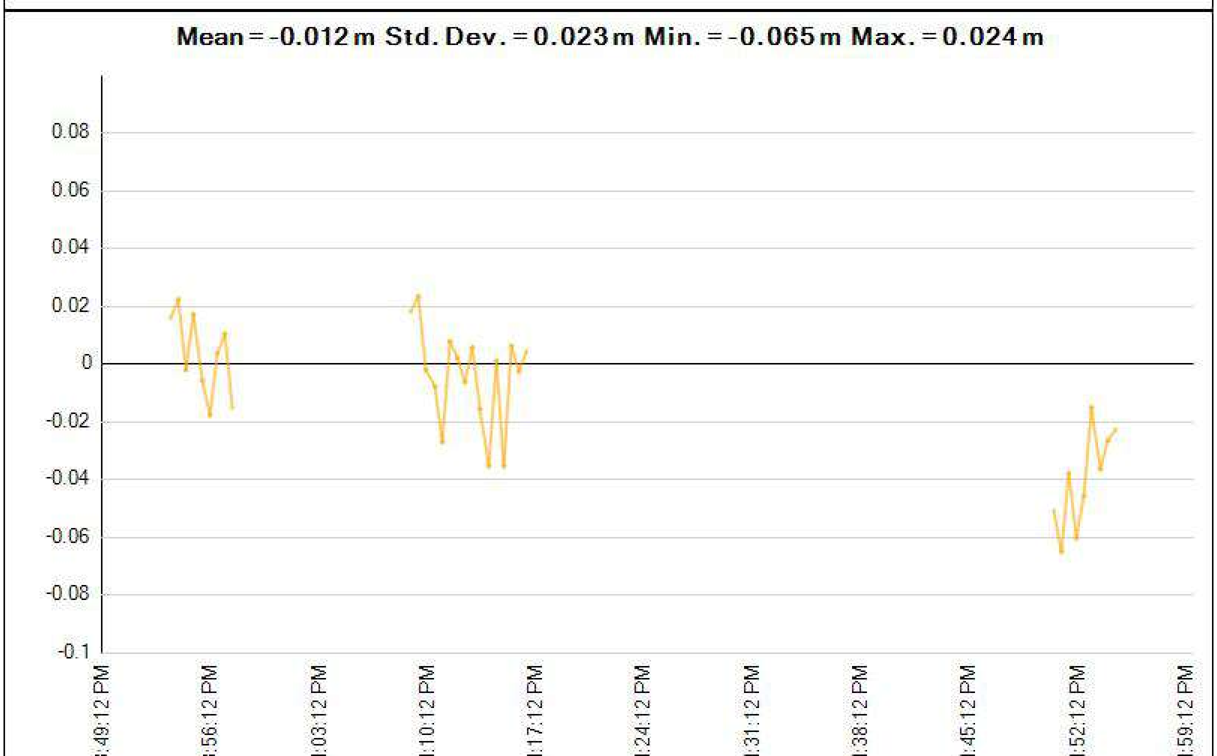

Mean = -0.003 m Std. Dev. = 0.024 m Min. = -0.057 m Max. = 0.072 m
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
3:49:12 PM
3:56:12 PM
4:03:12 PM
4:10:12 PM
4:17:12 PM
4:24:12 PM
4:31:12 PM
4:38:12 PM
4:45:12 PM
4:52:12 PM
4:59:12 PM
C 02
5/18/2024 3:49:12 PM - 5/18/2024 4:59:42 PM


Mean = 0.008 m Std. Dev. = 0.022 m Min. = -0.045 m Max. = 0.082 m
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
3:49:12 PM
3:56:12 PM
4:03:12 PM
4:10:12 PM
4:17:12 PM
4:24:12 PM
4:31:12 PM
4:38:12 PM
4:45:12 PM
4:52:12 PM
4:59:12 PM
C 05
5/18/2024 3:49:12 PM - 5/18/2024 4:59:42 PM

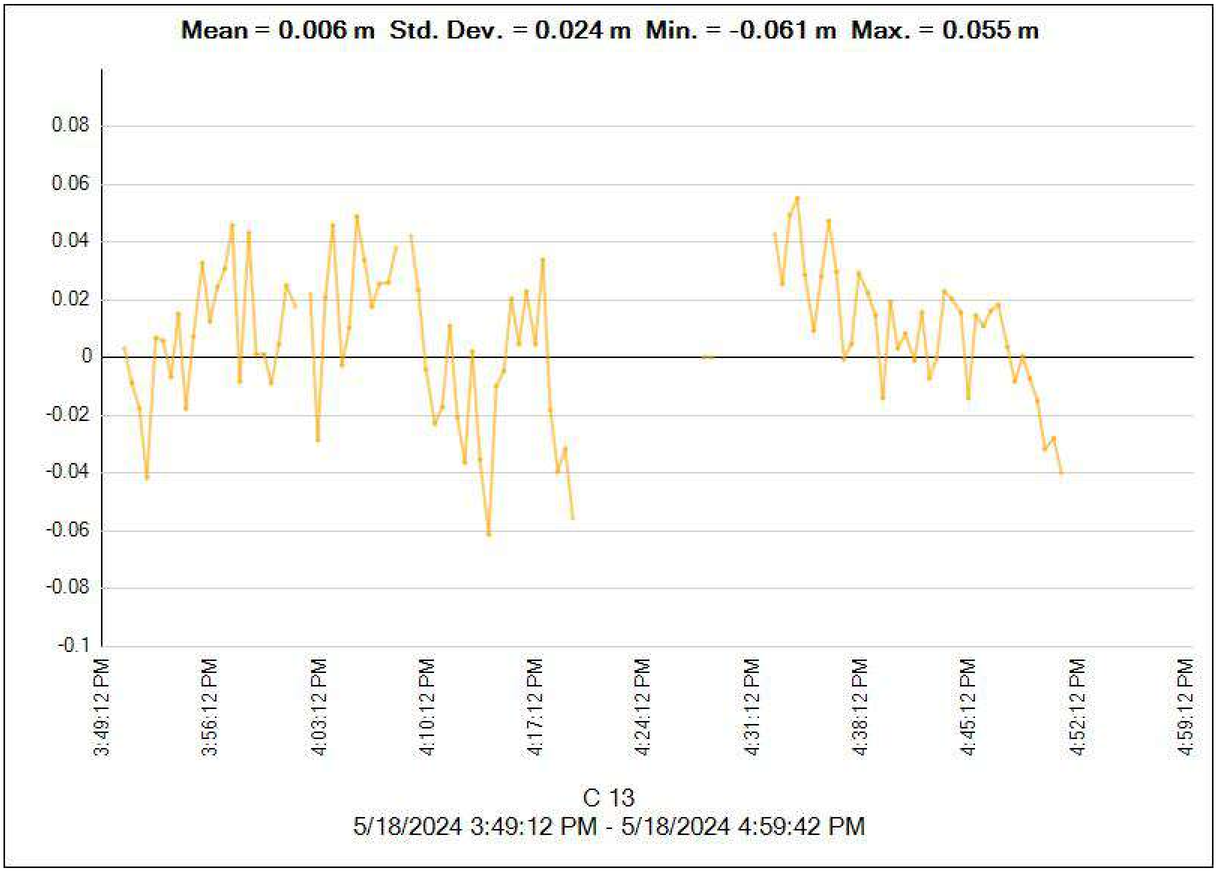

Mean = -0.032 m Std. Dev. = 0.019 m Min. = -0.068 m Max. = -0.005 m
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
3:49:12 PM
3:56:12 PM
4:03:12 PM
4:10:12 PM
4:17:12 PM
4:24:12 PM
4:31:12 PM
4:38:12 PM
4:45:12 PM
4:52:12 PM
4:59:12 PM
C 07
5/18/2024 3:49:12 PM - 5/18/2024 4:59:42 PM



C 08
5/18/2024 3:49:12 PM - 5/18/2024 4:59:42 PM



C 10
5/18/2024 3:49:12 PM - 5/18/2024 4:59:42 PM



Processing style

Elevation mask:	15°00'00.0"
Auto start processing:	Yes
Start automatic ID numbering:	AUTO0001
Continuous vectors:	No
Generate residuals:	Yes
Antenna model:	Automatic
Ephemeris type:	Automatic
Frequency:	Multiple Frequencies
Processing Interval:	Automatic
Force float:	No
GIS processing type:	Automatic Carrier and Code Processing

Acceptance Criteria

Vector Component	Flag	Fail
Horizontal Precision >	0.050 m + 1.000 ppm	0.100 m + 1.000 ppm
Vertical Precision >	0.100 m + 1.000 ppm	0.200 m + 1.000 ppm

Trig-134 - BM1 (10:44:26 AM-12:16:52 PM) (S3)

Baseline observation:	Trig-134 --- BM1 (B3)
Processed:	5/21/2024 11:15:16 PM
Solution type:	Fixed
Frequency used:	Dual Frequency (L1, L2)
Horizontal precision:	0.012 m
Vertical precision:	0.075 m
RMS:	0.023 m
Maximum PDOP:	1.499
Ephemeris used:	Broadcast
Antenna model:	NGS Absolute
Processing start time:	5/18/2024 10:44:42 AM (Local: UTC+5hr)
Processing stop time:	5/18/2024 12:16:42 PM (Local: UTC+5hr)
Processing duration:	01:32:00
Processing interval:	30 seconds

Vector Components (Mark to Mark)

From:	Trig-134				
Grid		Local		Global	
Easting	499054.624 m	Latitude	N28°11'22.803432601"	Latitude	N28°11'23.940634226"
Northing	3118885.237 m	Longitude	E83°59'25.330422159"	Longitude	E83°59'17.338012852"
Elevation	884.900 m	Height	860.678 m	Height	838.446 m

To:	BM1				
Grid		Local		Global	
Easting	497415.059 m	Latitude	N28°11'00.508638269"	Latitude	N28°11'01.646963323"
Northing	3118199.292 m	Longitude	E83°58'25.208462867"	Longitude	E83°58'17.224532132"
Elevation	814.619 m	Height	790.153 m	Height	767.974 m

Vector					
ΔEasting	-1639.565 m	NS Fwd Azimuth	247°17'33"	ΔX	1658.273 m
ΔNorthing	-685.945 m	Ellipsoid Dist.	1777.449 m	ΔY	88.665 m
ΔElevation	-70.281 m	ΔHeight	-70.524 m	ΔZ	-638.267 m

Standard Errors

Vector errors:					
σ ΔEasting	0.005 m	σ NS fwd Azimuth	0°00'01"	σ ΔX	0.005 m
σ ΔNorthing	0.005 m	σ Ellipsoid Dist.	0.004 m	σ ΔY	0.033 m
σ ΔElevation	0.038 m	σ ΔHeight	0.038 m	σ ΔZ	0.019 m

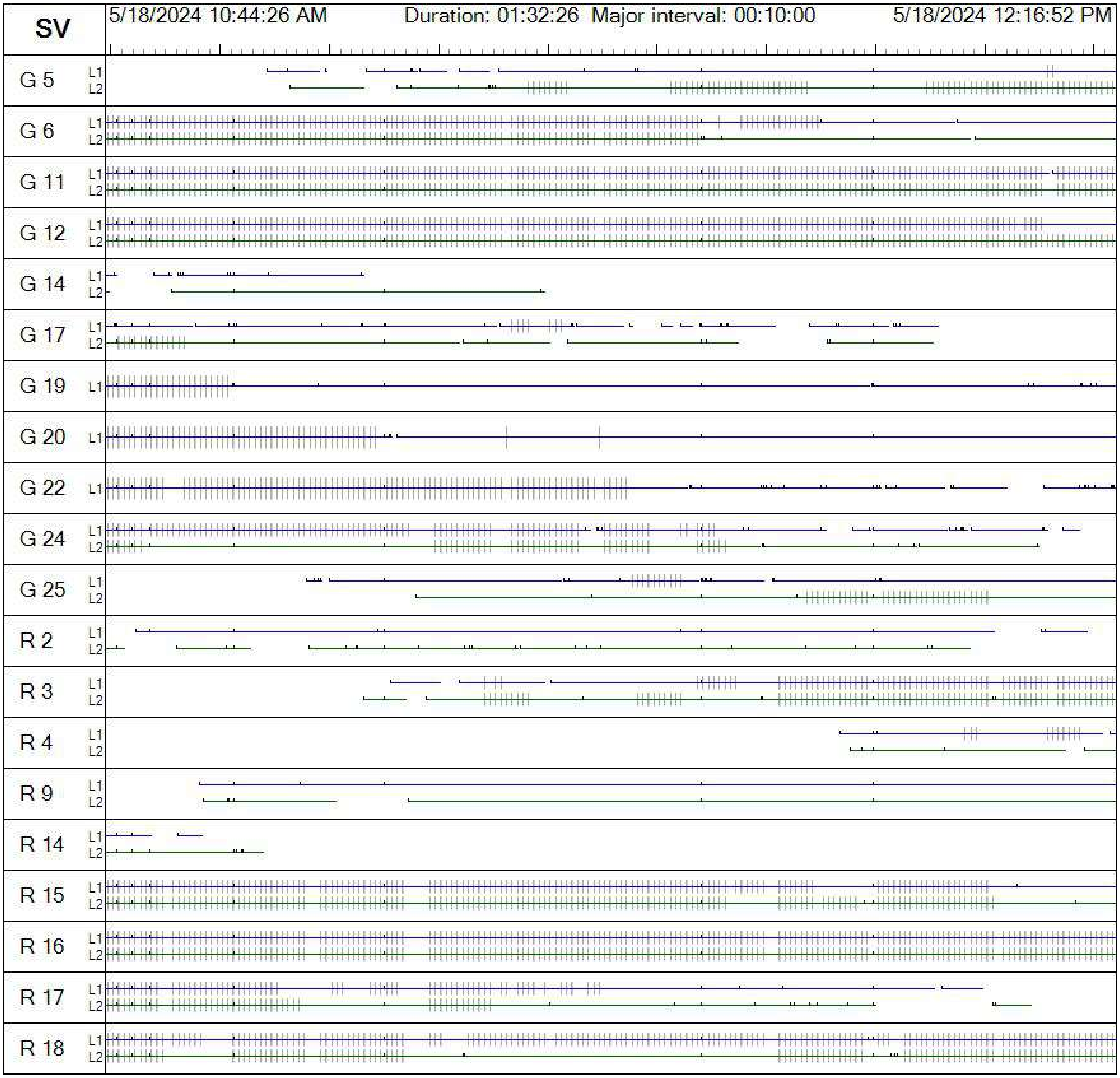
Aposteriori Covariance Matrix (Meter²)

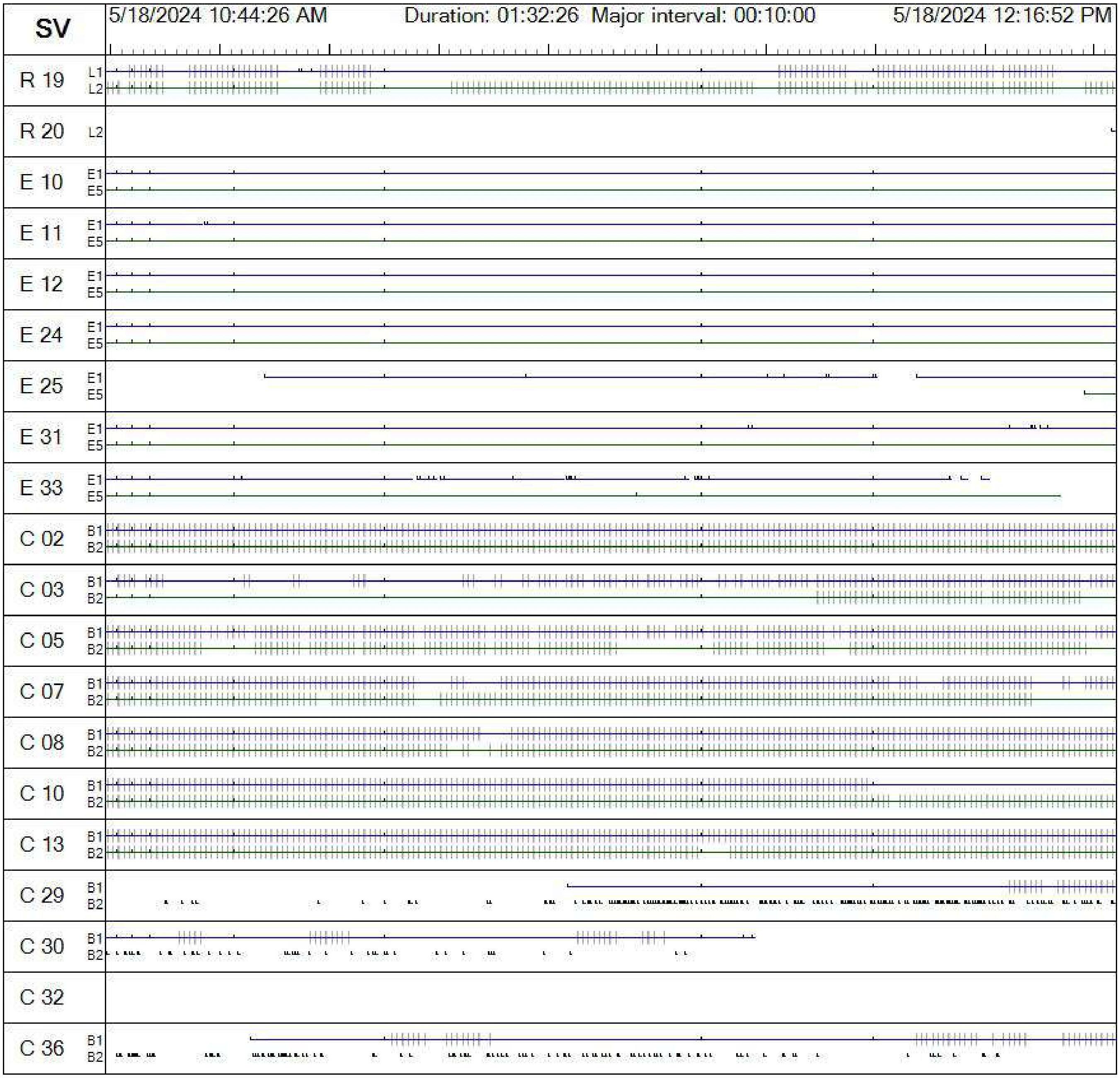
	X	Y	Z
X	0.0000282597		
Y	0.0000866284	0.0011133507	
Z	0.0000520935	0.0006079188	0.0003616999

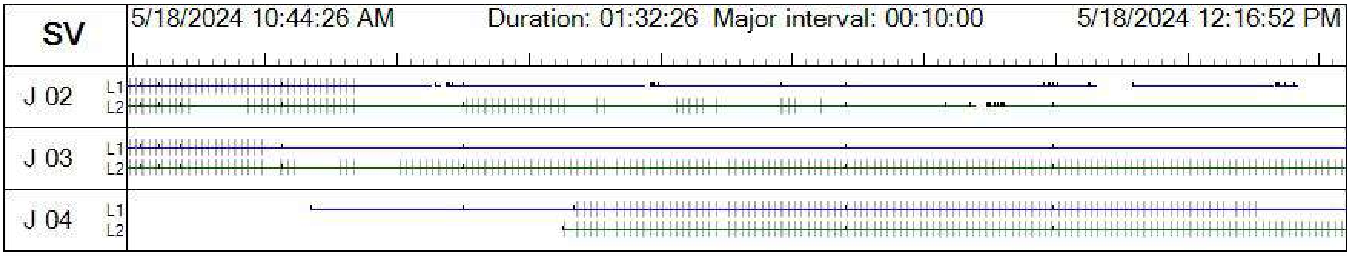
Occupations

	From	To
Point ID:	Trig-134	BM1
Receiver type:	Unknown	Unknown
Receiver serial number:		
Antenna type:	Unknown External	Unknown External
Antenna serial number:	AS-ANT2BCAL	AS-ANT2BCAL
Antenna height (measured):	1.460 m	1.340 m
Antenna method:	Antenna Phase Center	Antenna Phase Center

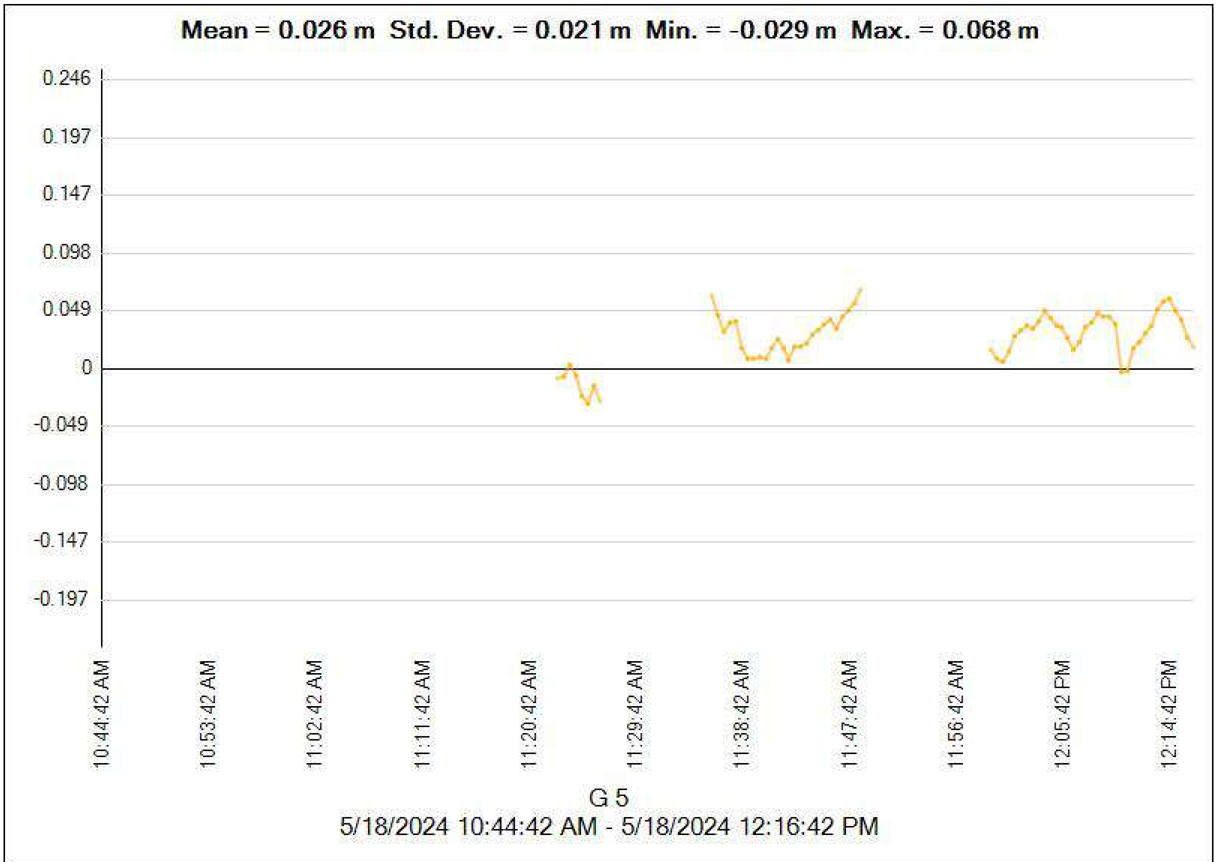
Tracking Summary

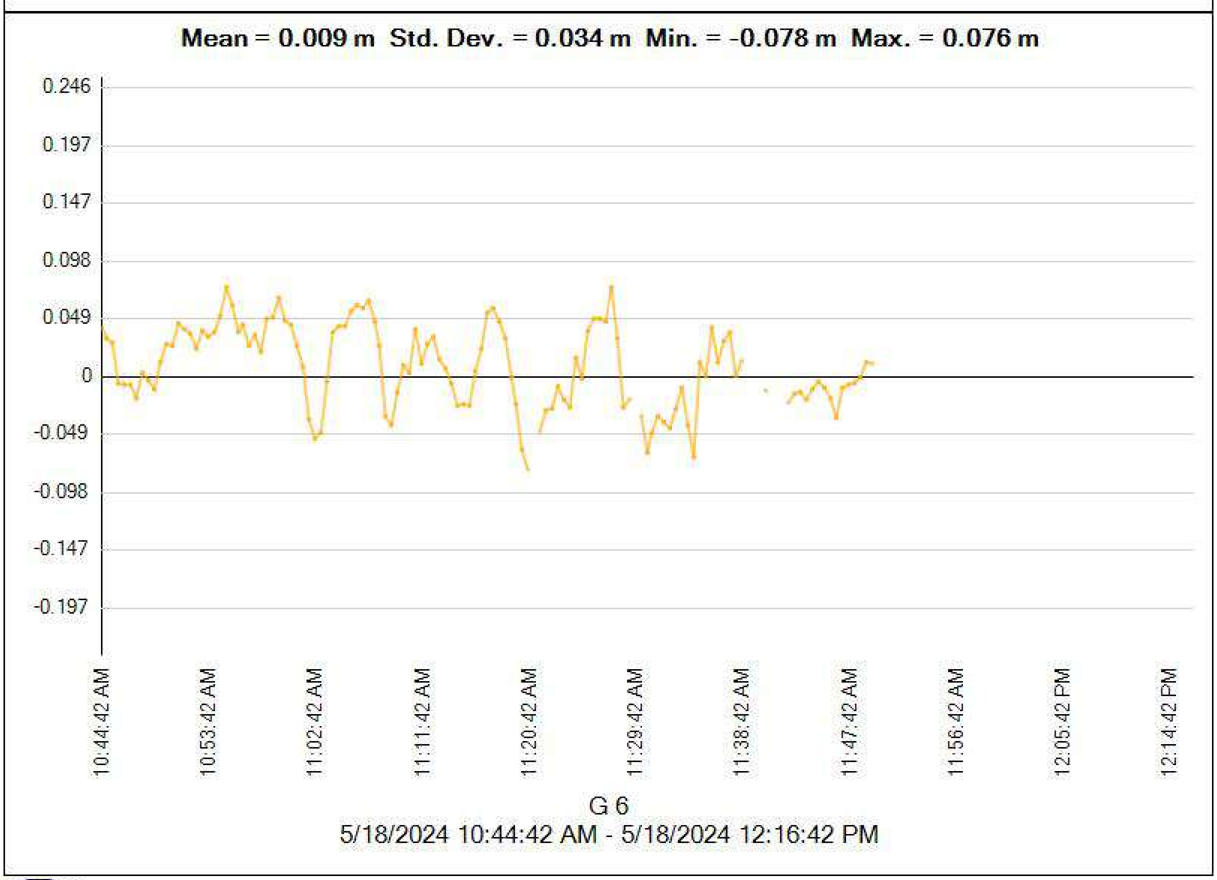


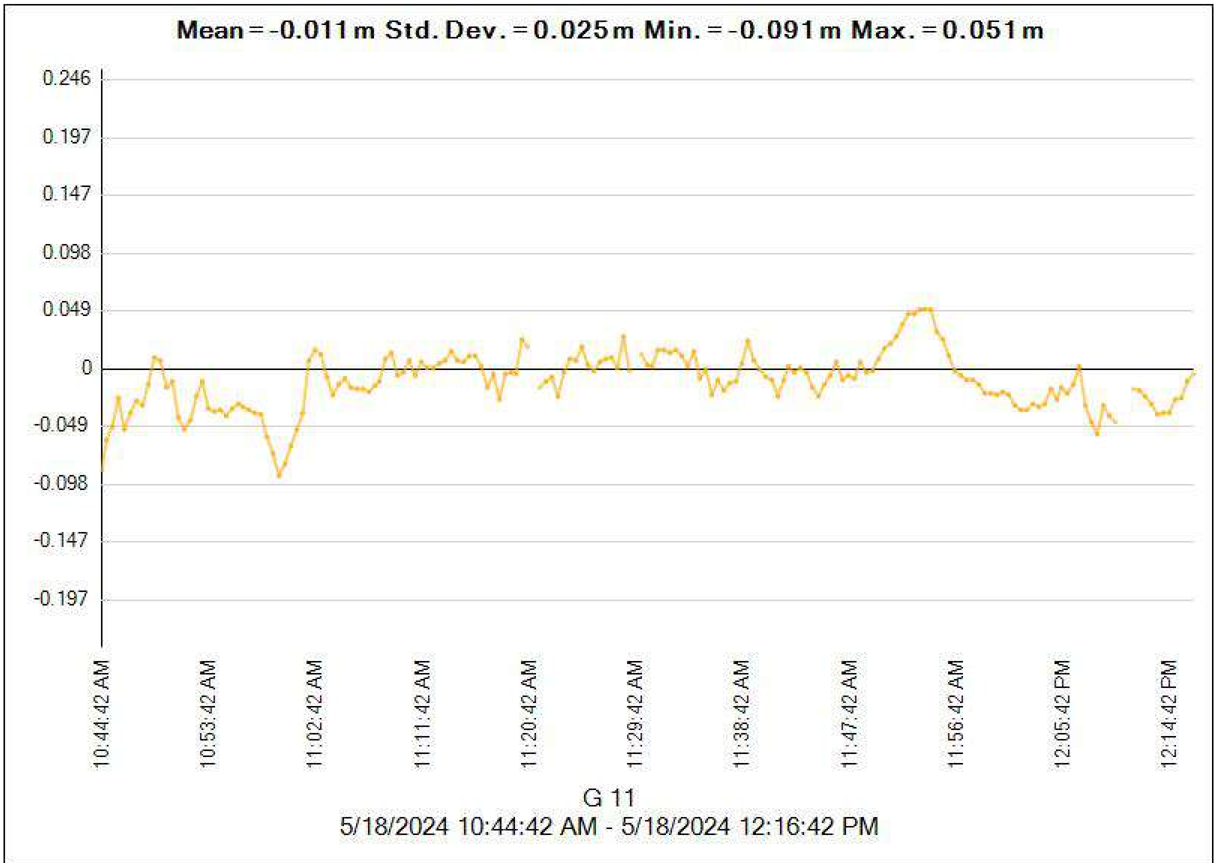

SV
5/18/2024 10:44:26 AM
Duration: 01:32:26 Major interval: 00:10:00
5/18/2024 12:16:52 PM
R 19 L1 L2
R 20 L2
E 10 E1 E5
E 11 E1 E5
E 12 E1 E5
E 24 E1 E5
E 25 E1 E5
E 31 E1 E5
E 33 E1 E5
C 02 B1 B2
C 03 B1 B2
C 05 B1 B2
C 07 B1 B2
C 08 B1 B2
C 10 B1 B2
C 13 B1 B2
C 29 B1 B2
C 30 B1 B2
C 32
C 36 B1 B2

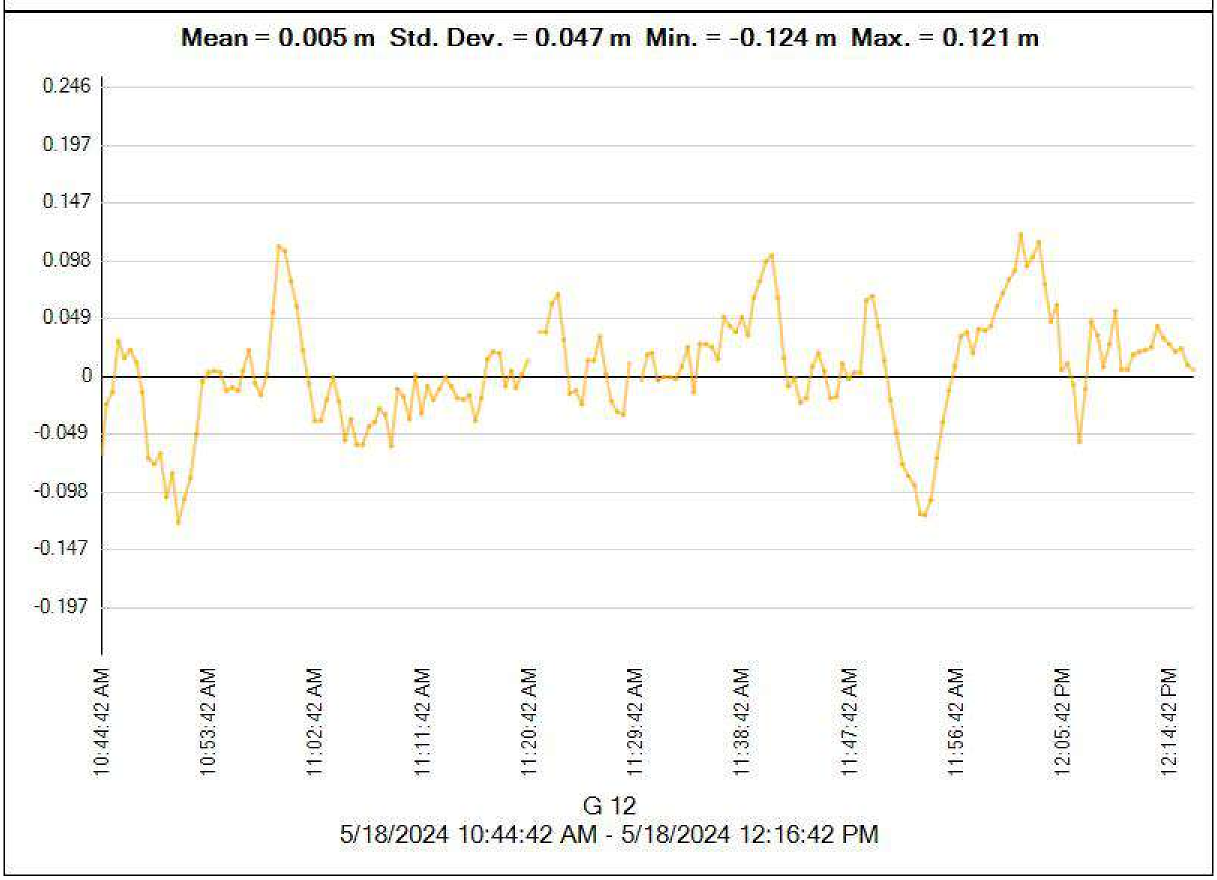

SV
5/18/2024 10:44:26 AM
Duration: 01:32:26 Major interval: 00:10:00
5/18/2024 12:16:52 PM
J 02
L1
L2
J 03
L1
L2
J 04
L1
L2

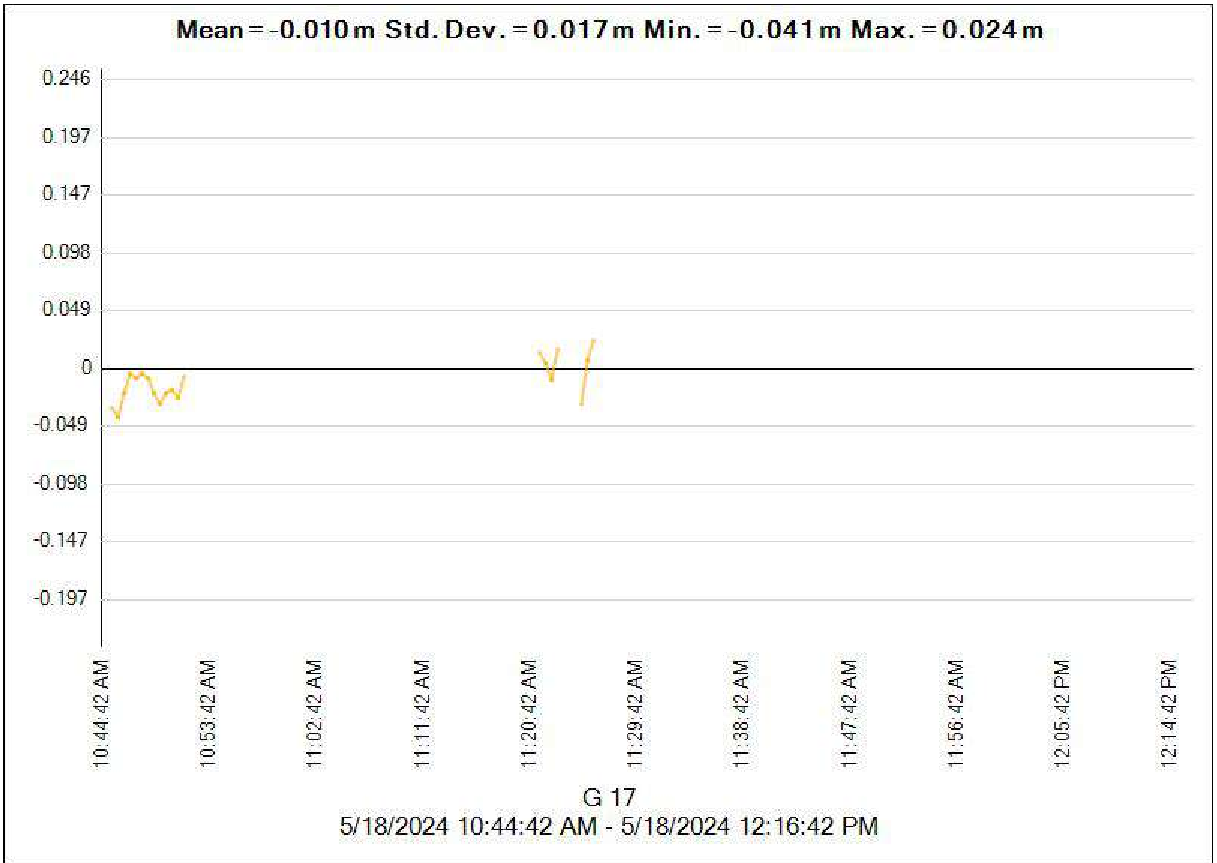
Residuals


Mean = 0.026 m Std. Dev. = 0.021 m Min. = -0.029 m Max. = 0.068 m
0.246
0.197
0.147
0.098
0.049
0
-0.049
-0.098
-0.147
-0.197
10:44:42 AM
10:53:42 AM
11:02:42 AM
11:11:42 AM
11:20:42 AM
11:29:42 AM
11:38:42 AM
11:47:42 AM
11:56:42 AM
12:05:42 PM
12:14:42 PM
G 5
5/18/2024 10:44:42 AM - 5/18/2024 12:16:42 PM


Mean = 0.009 m Std. Dev. = 0.034 m Min. = -0.078 m Max. = 0.076 m
0.246
0.197
0.147
0.098
0.049
0
-0.049
-0.098
-0.147
-0.197
10:44:42 AM
10:53:42 AM
11:02:42 AM
11:11:42 AM
11:20:42 AM
11:29:42 AM
11:38:42 AM
11:47:42 AM
11:56:42 AM
12:05:42 PM
12:14:42 PM
G 6
5/18/2024 10:44:42 AM - 5/18/2024 12:16:42 PM


Mean = -0.011 m Std. Dev. = 0.025 m Min. = -0.091 m Max. = 0.051 m
0.246
0.197
0.147
0.098
0.049
0
-0.049
-0.098
-0.147
-0.197
10:44:42 AM
10:53:42 AM
11:02:42 AM
11:11:42 AM
11:20:42 AM
11:29:42 AM
11:38:42 AM
11:47:42 AM
11:56:42 AM
12:05:42 PM
12:14:42 PM
G 11
5/18/2024 10:44:42 AM - 5/18/2024 12:16:42 PM


Mean = 0.005 m Std. Dev. = 0.047 m Min. = -0.124 m Max. = 0.121 m
0.246
0.197
0.147
0.098
0.049
0
-0.049
-0.098
-0.147
-0.197
10:44:42 AM
10:53:42 AM
11:02:42 AM
11:11:42 AM
11:20:42 AM
11:29:42 AM
11:38:42 AM
11:47:42 AM
11:56:42 AM
12:05:42 PM
12:14:42 PM
G 12
5/18/2024 10:44:42 AM - 5/18/2024 12:16:42 PM


Mean = -0.010 m Std. Dev. = 0.017 m Min. = -0.041 m Max. = 0.024 m
0.246
0.197
0.147
0.098
0.049
0
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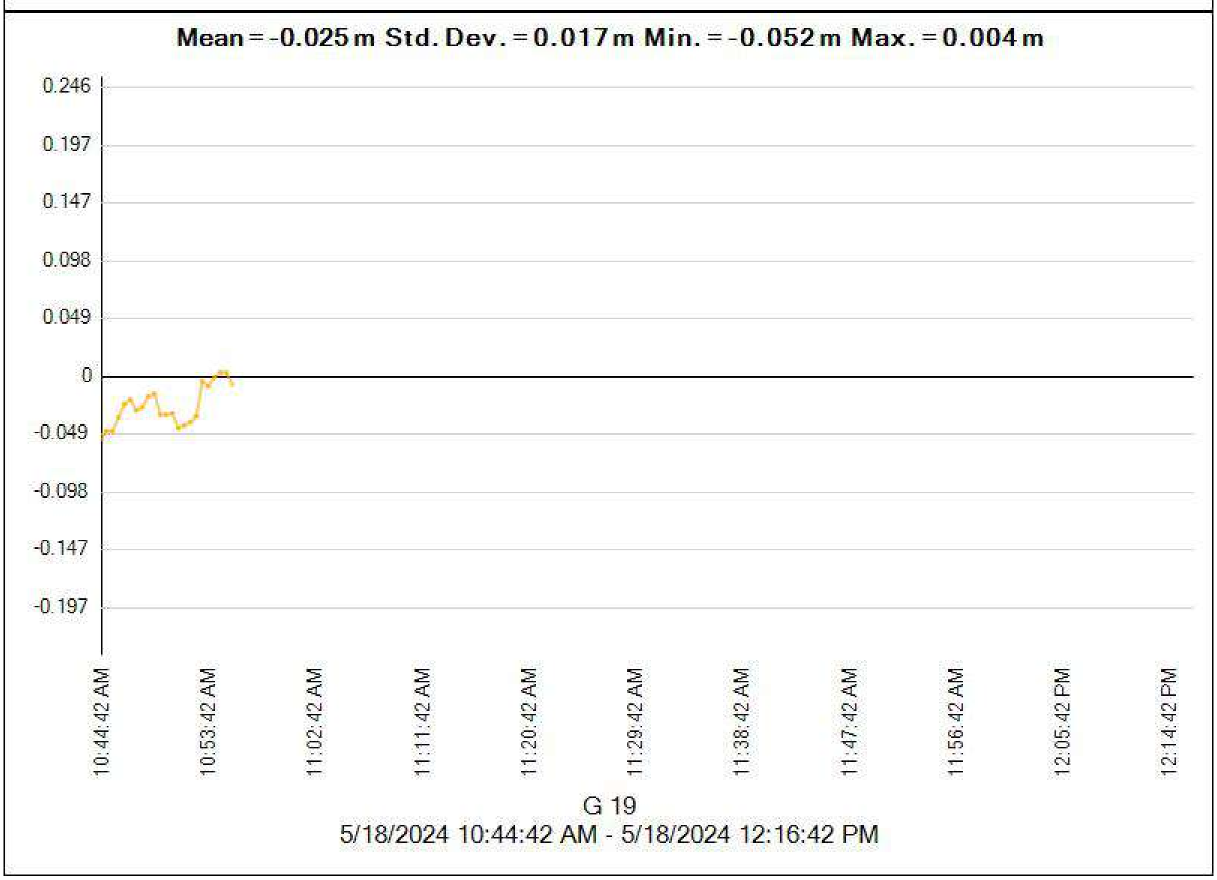
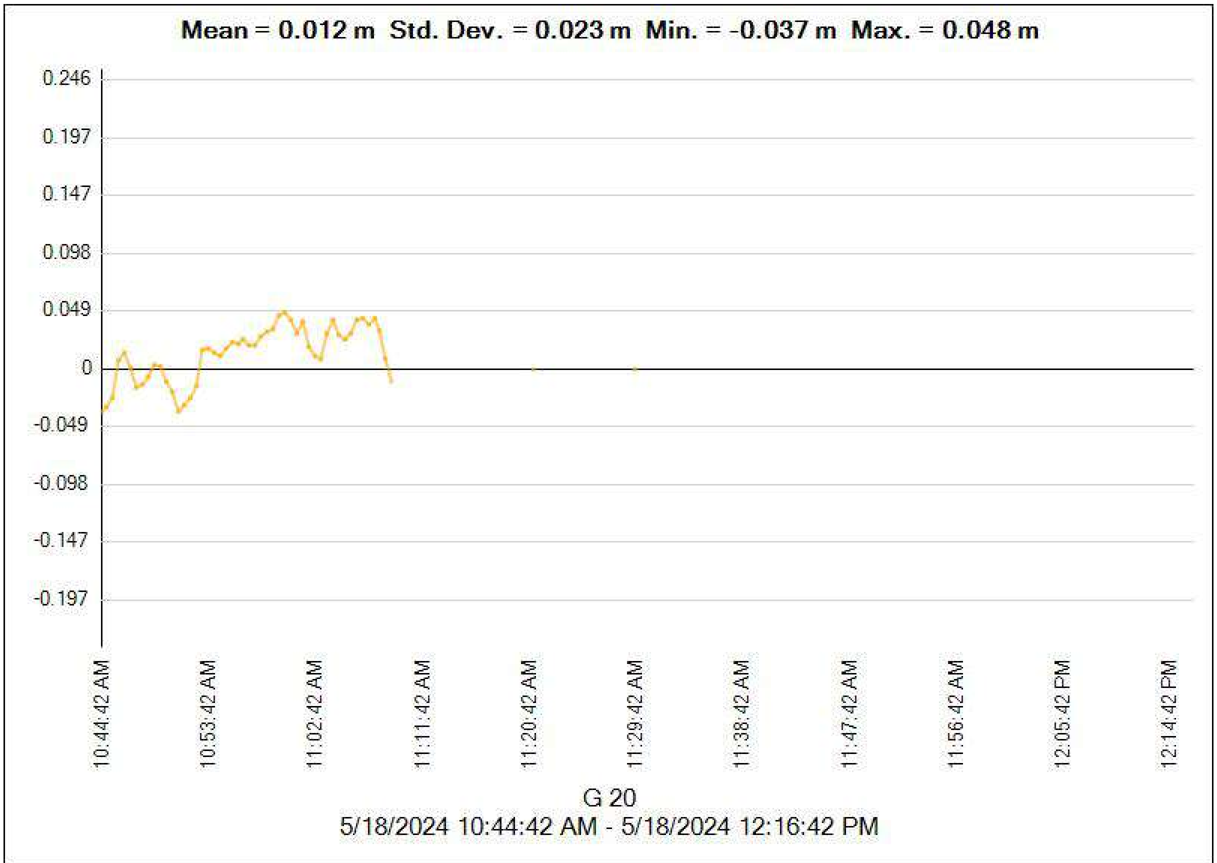
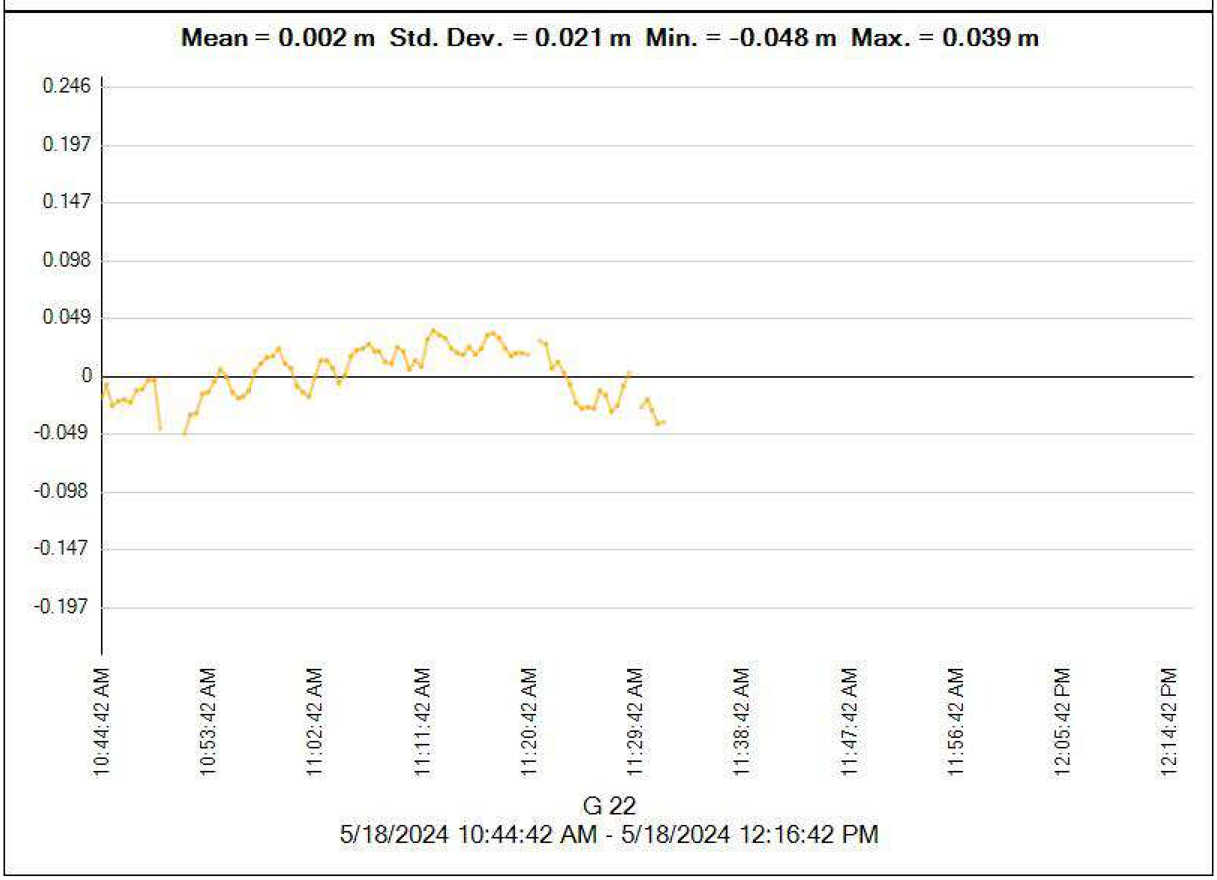
-0.098
-0.147
-0.197
10:44:42 AM
10:53:42 AM
11:02:42 AM
11:11:42 AM
11:20:42 AM
11:29:42 AM
11:38:42 AM
11:47:42 AM
11:56:42 AM
12:05:42 PM
12:14:42 PM
G 17
5/18/2024 10:44:42 AM - 5/18/2024 12:16:42 PM

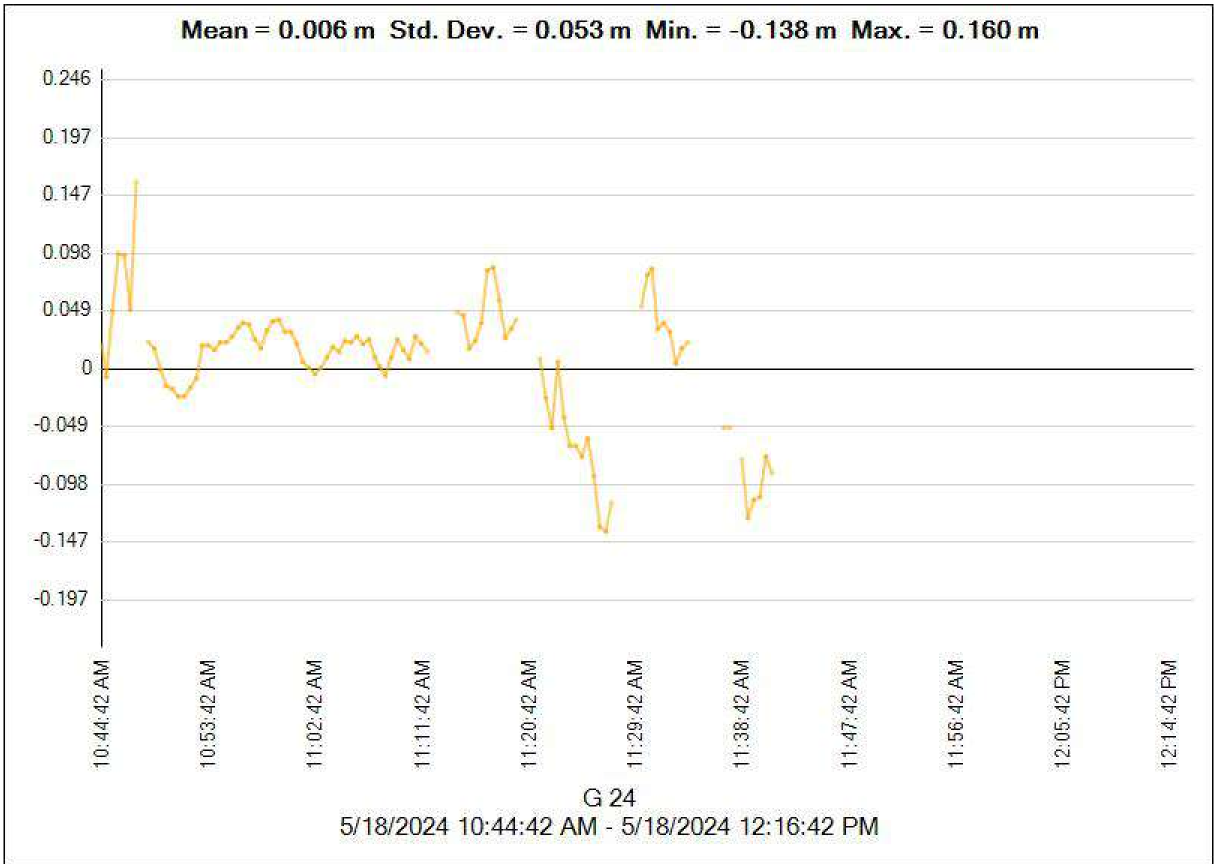

Mean = -0.025 m Std. Dev. = 0.017 m Min. = -0.052 m Max. = 0.004 m
0.246
0.197
0.147
0.098
0.049
0
-0.049
-0.098
-0.147
-0.197
10:44:42 AM
10:53:42 AM
11:02:42 AM
11:11:42 AM
11:20:42 AM
11:29:42 AM
11:38:42 AM
11:47:42 AM
11:56:42 AM
12:05:42 PM
12:14:42 PM
G 19
5/18/2024 10:44:42 AM - 5/18/2024 12:16:42 PM

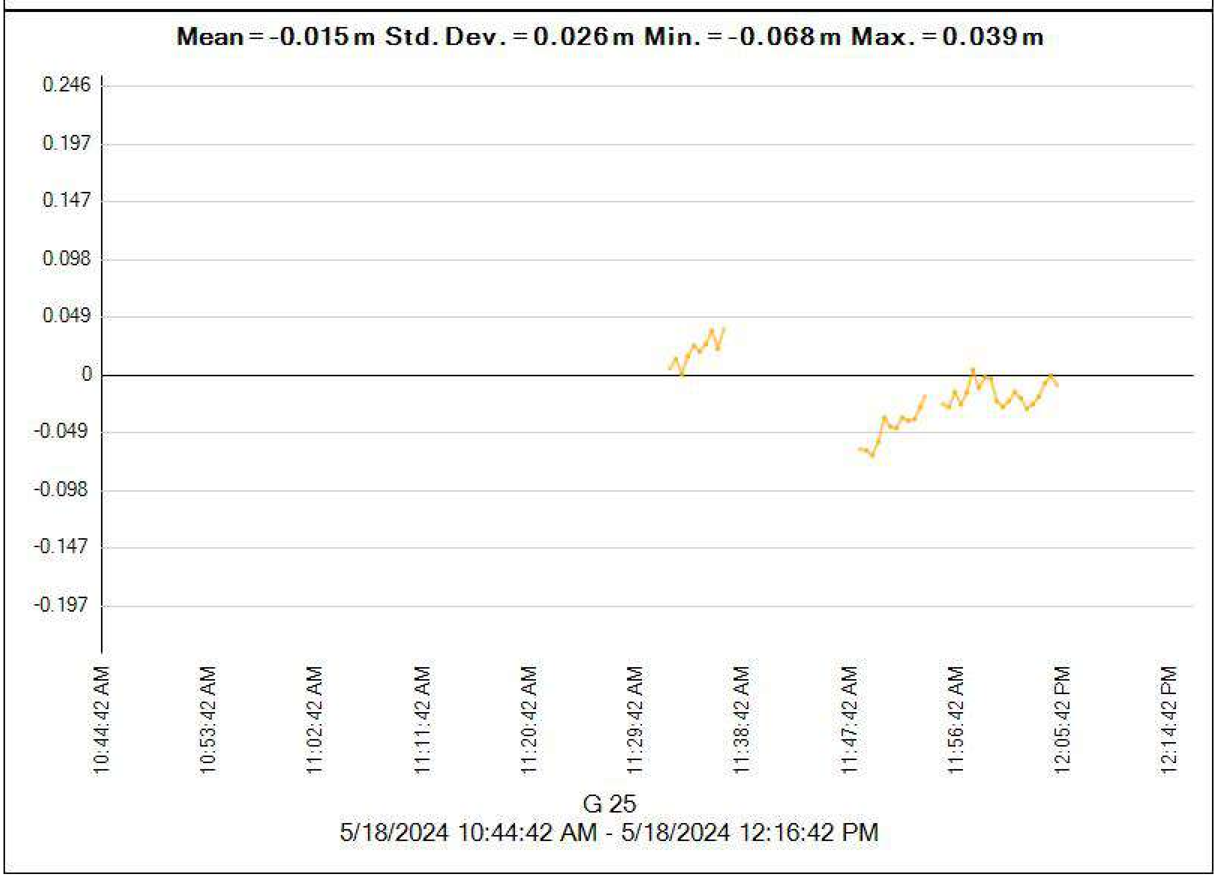


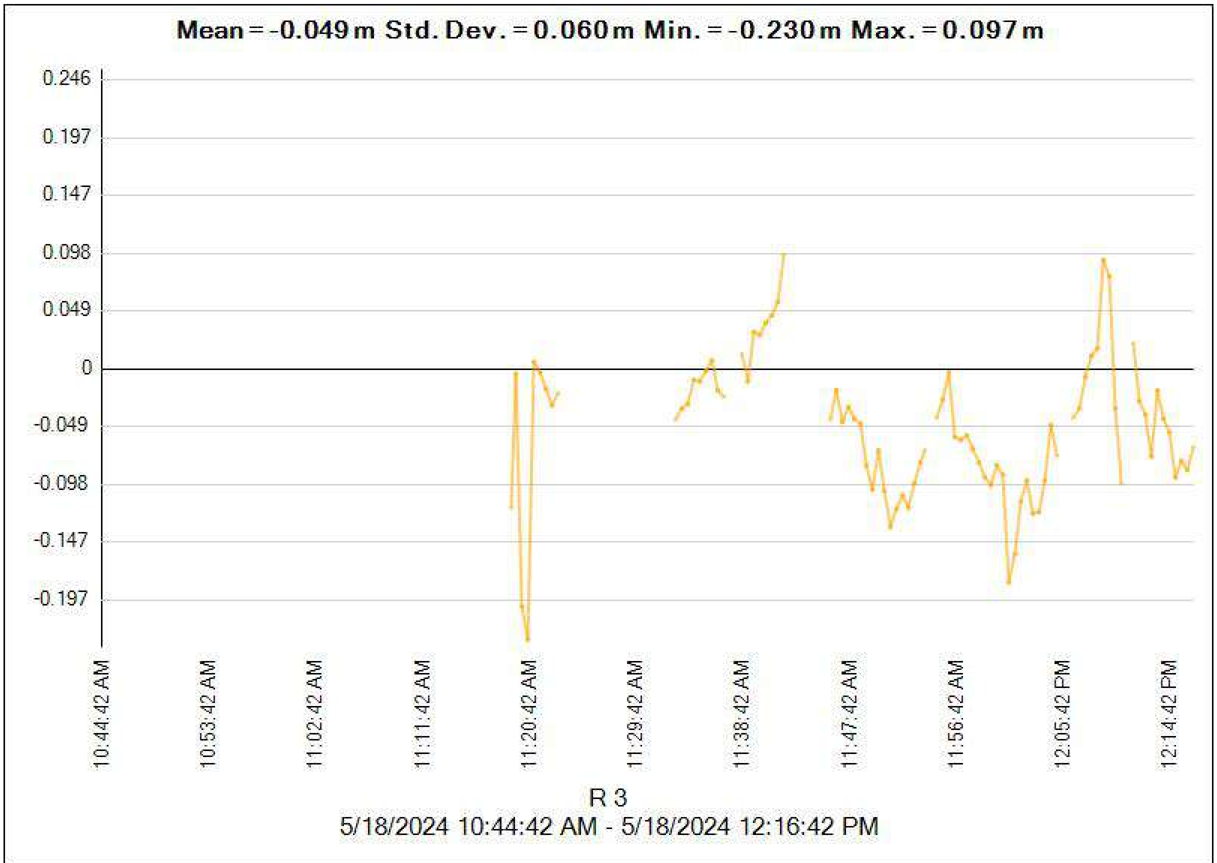
Mean = 0.012 m Std. Dev. = 0.023 m Min. = -0.037 m Max. = 0.048 m
0.246
0.197
0.147
0.098
0.049
0
-0.049
-0.098
-0.147
-0.197
10:44:42 AM
10:53:42 AM
11:02:42 AM
11:11:42 AM
11:20:42 AM
11:29:42 AM
11:38:42 AM
11:47:42 AM
11:56:42 AM
12:05:42 PM
12:14:42 PM
G 20
5/18/2024 10:44:42 AM - 5/18/2024 12:16:42 PM

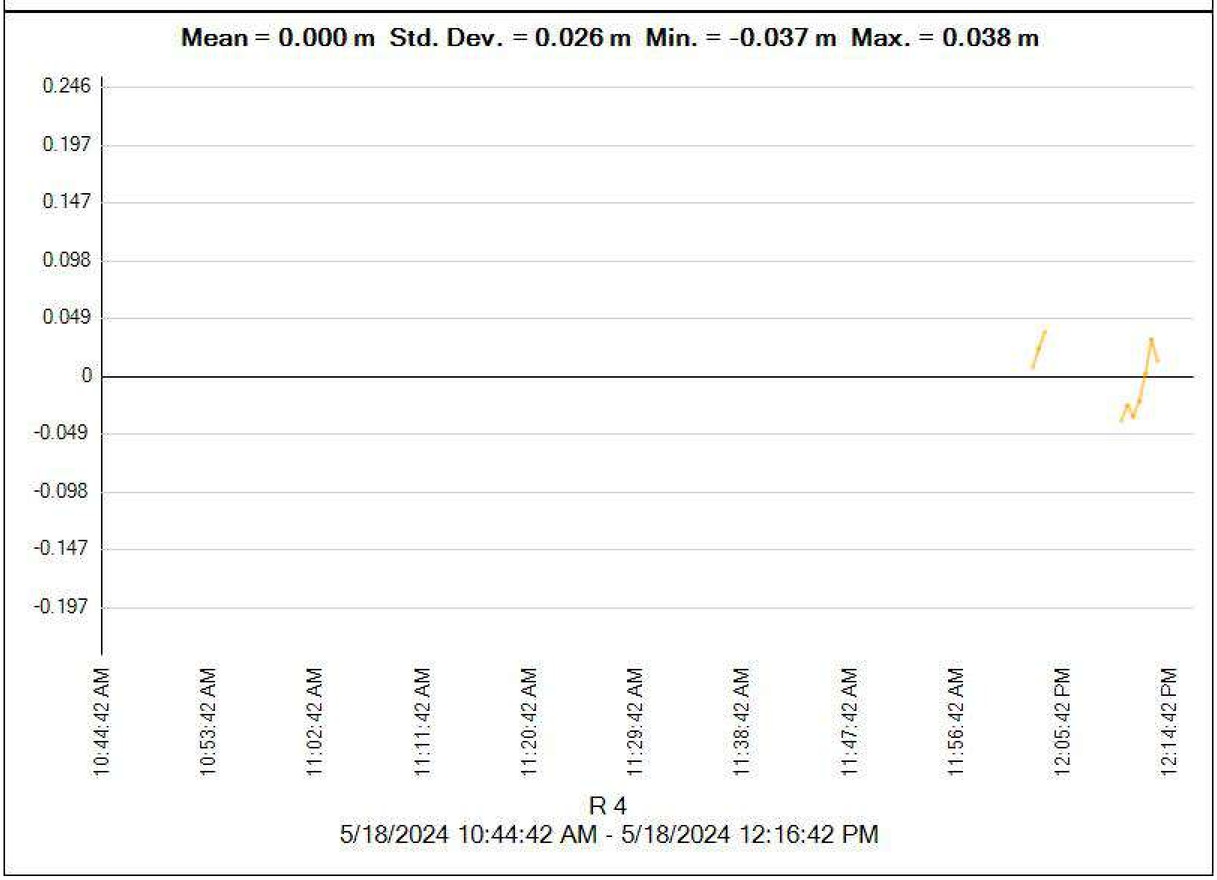


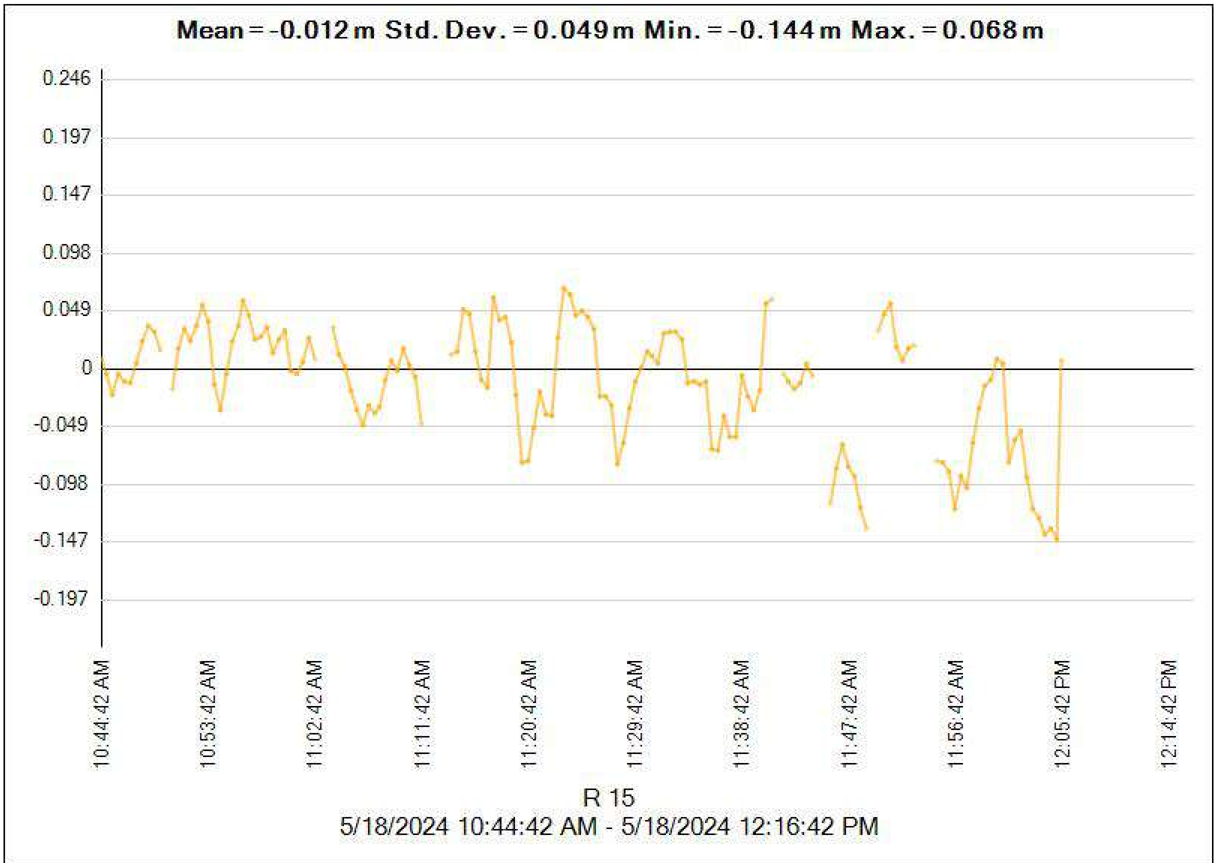
Mean = 0.002 m Std. Dev. = 0.021 m Min. = -0.048 m Max. = 0.039 m
0.246
0.197
0.147
0.098
0.049
0
-0.049
-0.098
-0.147
-0.197
10:44:42 AM
10:53:42 AM
11:02:42 AM
11:11:42 AM
11:20:42 AM
11:29:42 AM
11:38:42 AM
11:47:42 AM
11:56:42 AM
12:05:42 PM
12:14:42 PM
G 22
5/18/2024 10:44:42 AM - 5/18/2024 12:16:42 PM

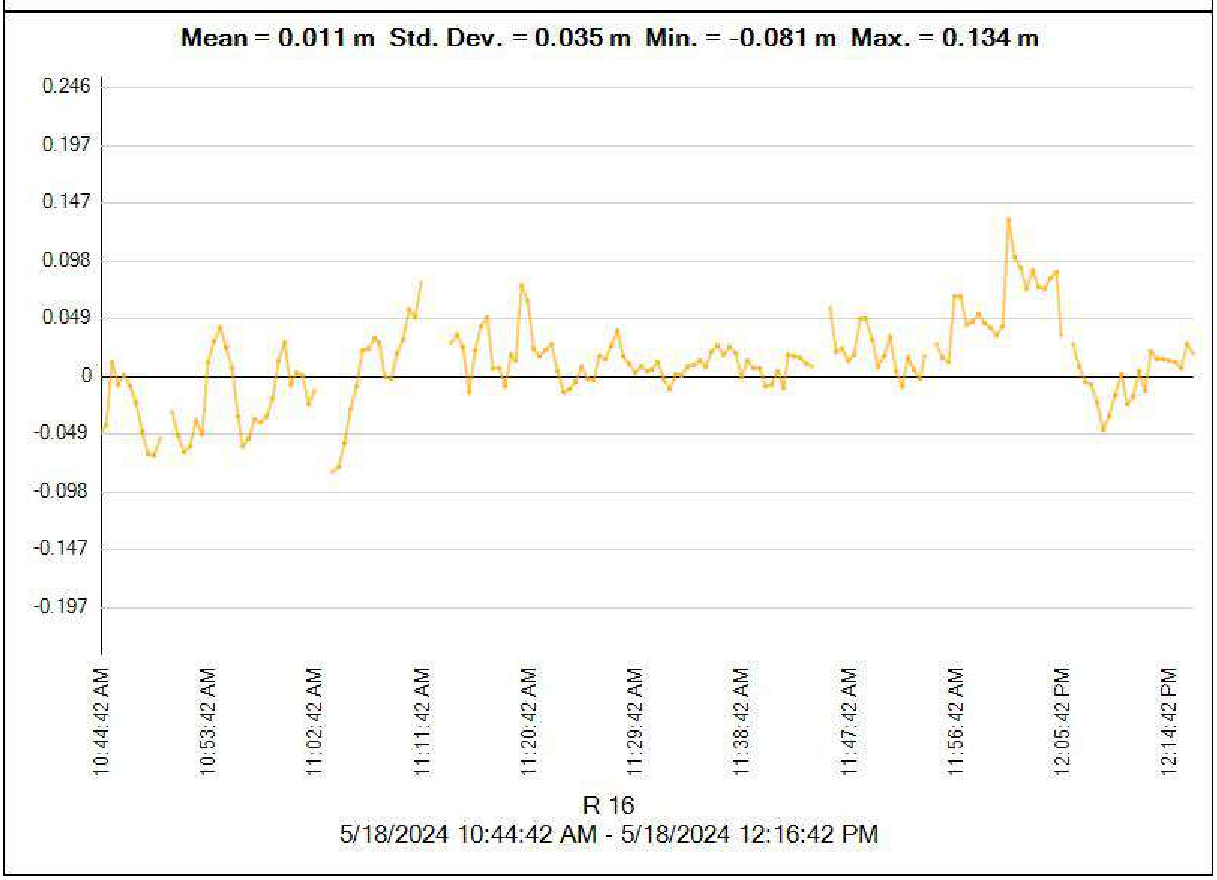

Mean = 0.006 m Std. Dev. = 0.053 m Min. = -0.138 m Max. = 0.160 m
0.246
0.197
0.147
0.098
0.049
0
-0.049
-0.098
-0.147
-0.197
10:44:42 AM
10:53:42 AM
11:02:42 AM
11:11:42 AM
11:20:42 AM
11:29:42 AM
11:38:42 AM
11:47:42 AM
11:56:42 AM
12:05:42 PM
12:14:42 PM
G 24
5/18/2024 10:44:42 AM - 5/18/2024 12:16:42 PM

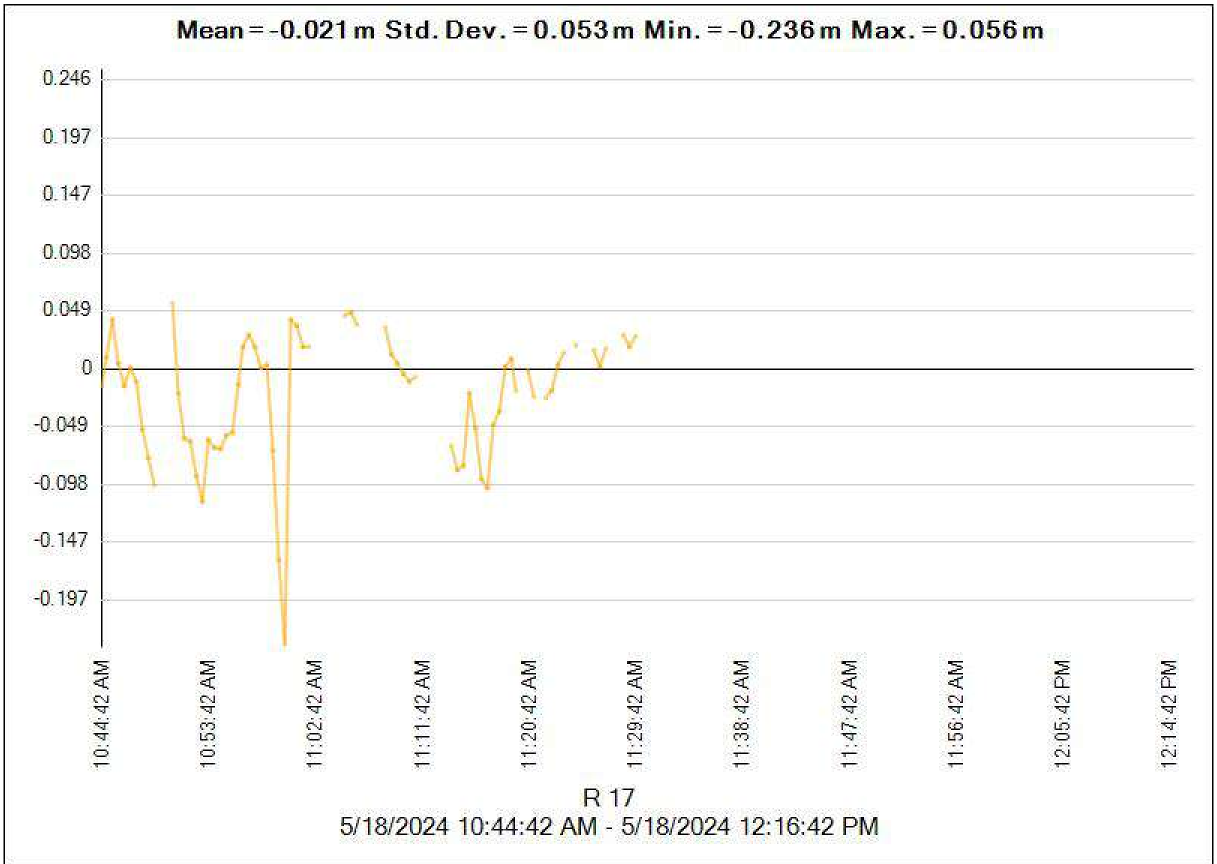

Mean = -0.015 m Std. Dev. = 0.026 m Min. = -0.068 m Max. = 0.039 m
0.246
0.197
0.147
0.098
0.049
0
-0.049
-0.098
-0.147
-0.197
10:44:42 AM
10:53:42 AM
11:02:42 AM
11:11:42 AM
11:20:42 AM
11:29:42 AM
11:38:42 AM
11:47:42 AM
11:56:42 AM
12:05:42 PM
12:14:42 PM
G 25
5/18/2024 10:44:42 AM - 5/18/2024 12:16:42 PM

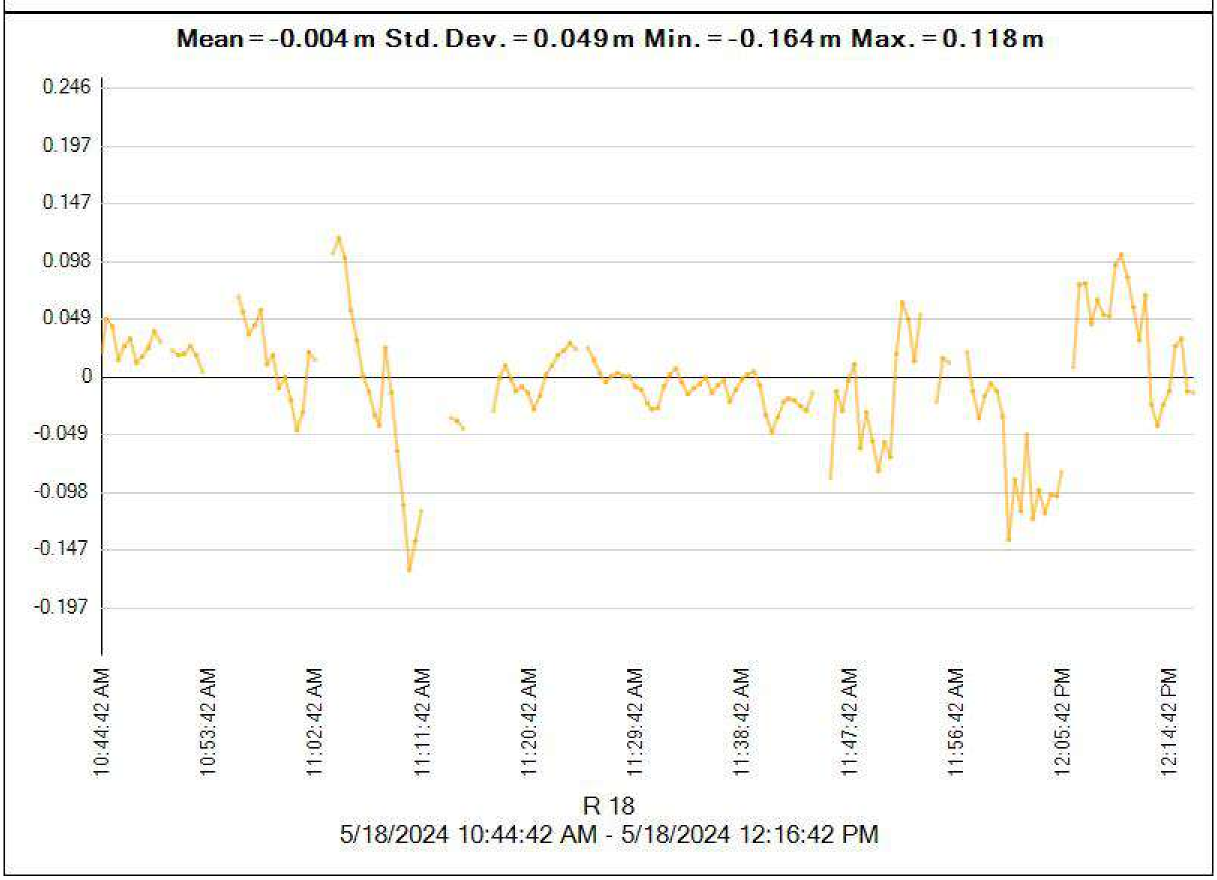

Mean = -0.049 m Std. Dev. = 0.060 m Min. = -0.230 m Max. = 0.097 m
0.246
0.197
0.147
0.098
0.049
0
-0.049
-0.098
-0.147
-0.197
10:44:42 AM
10:53:42 AM
11:02:42 AM
11:11:42 AM
11:20:42 AM
11:29:42 AM
11:38:42 AM
11:47:42 AM
11:56:42 AM
12:05:42 PM
12:14:42 PM
R 3
5/18/2024 10:44:42 AM - 5/18/2024 12:16:42 PM

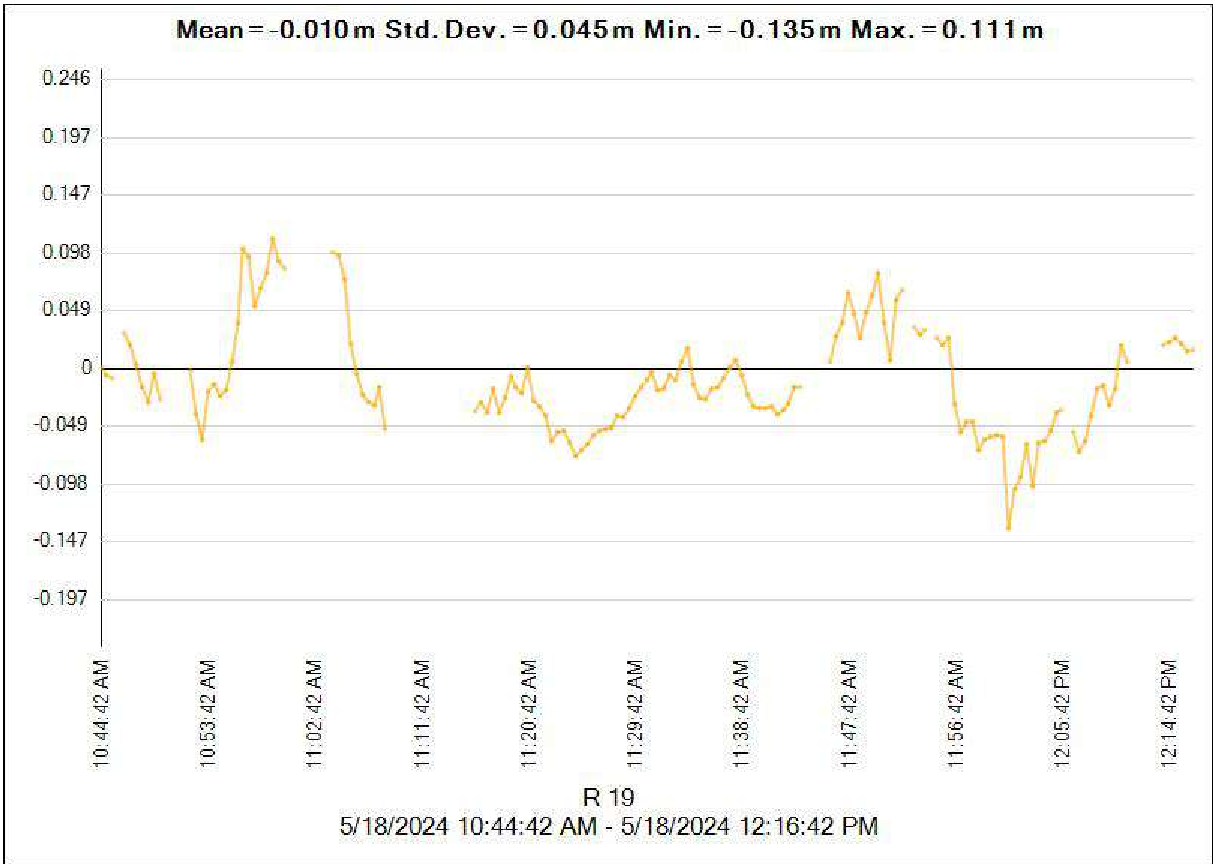

Mean = 0.000 m Std. Dev. = 0.026 m Min. = -0.037 m Max. = 0.038 m
0.246
0.197
0.147
0.098
0.049
0
-0.049
-0.098
-0.147
-0.197
10:44:42 AM
10:53:42 AM
11:02:42 AM
11:11:42 AM
11:20:42 AM
11:29:42 AM
11:38:42 AM
11:47:42 AM
11:56:42 AM
12:05:42 PM
12:14:42 PM
R 4
5/18/2024 10:44:42 AM - 5/18/2024 12:16:42 PM


Mean = -0.012 m Std. Dev. = 0.049 m Min. = -0.144 m Max. = 0.068 m
0.246
0.197
0.147
0.098
0.049
0
-0.049
-0.098
-0.147
-0.197
10:44:42 AM
10:53:42 AM
11:02:42 AM
11:11:42 AM
11:20:42 AM
11:29:42 AM
11:38:42 AM
11:47:42 AM
11:56:42 AM
12:05:42 PM
12:14:42 PM
R 15
5/18/2024 10:44:42 AM - 5/18/2024 12:16:42 PM

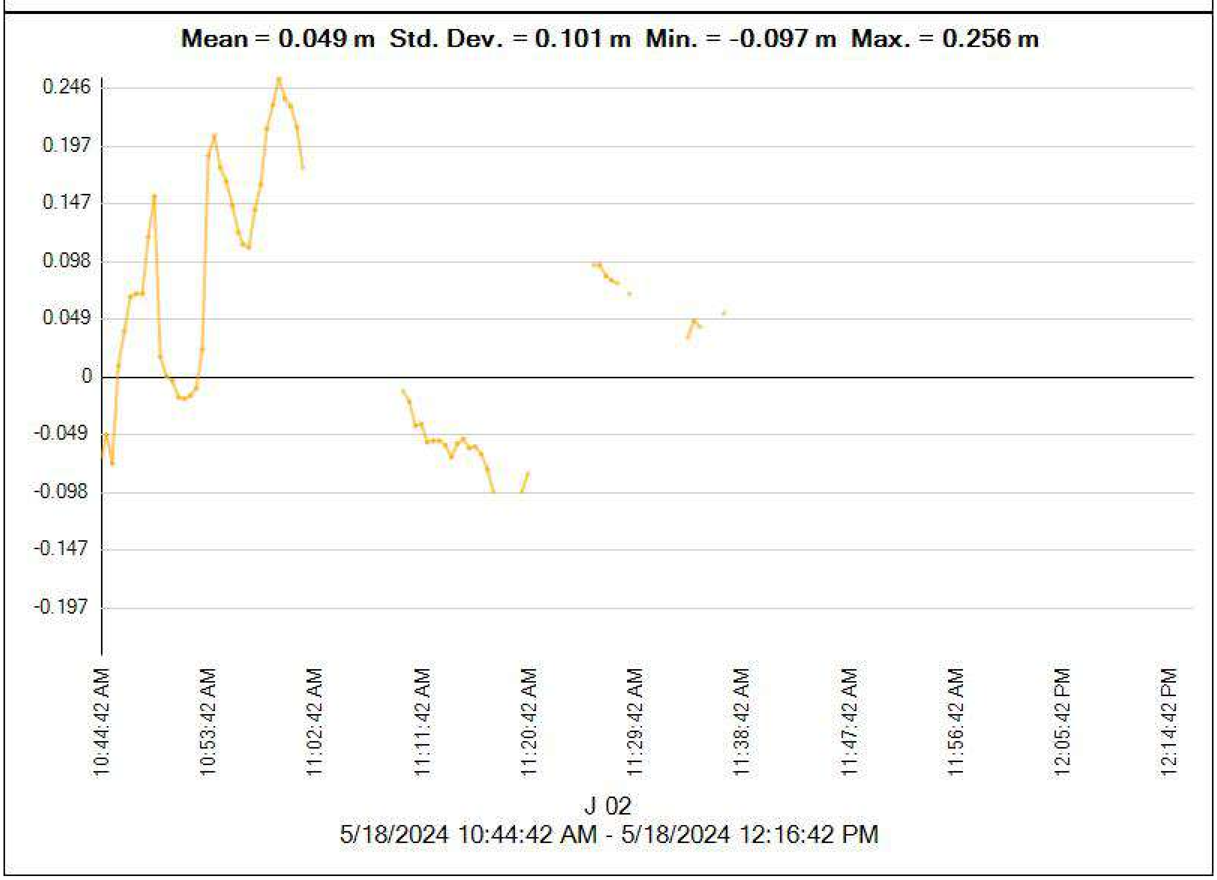

Mean = 0.011 m Std. Dev. = 0.035 m Min. = -0.081 m Max. = 0.134 m
0.246
0.197
0.147
0.098
0.049
0
-0.049
-0.098
-0.147
-0.197
10:44:42 AM
10:53:42 AM
11:02:42 AM
11:11:42 AM
11:20:42 AM
11:29:42 AM
11:38:42 AM
11:47:42 AM
11:56:42 AM
12:05:42 PM
12:14:42 PM
R 16
5/18/2024 10:44:42 AM - 5/18/2024 12:16:42 PM


Mean = -0.021 m Std. Dev. = 0.053 m Min. = -0.236 m Max. = 0.056 m
0.246
0.197
0.147
0.098
0.049
0
-0.049
-0.098
-0.147
-0.197
10:44:42 AM
10:53:42 AM
11:02:42 AM
11:11:42 AM
11:20:42 AM
11:29:42 AM
11:38:42 AM
11:47:42 AM
11:56:42 AM
12:05:42 PM
12:14:42 PM
R 17
5/18/2024 10:44:42 AM - 5/18/2024 12:16:42 PM

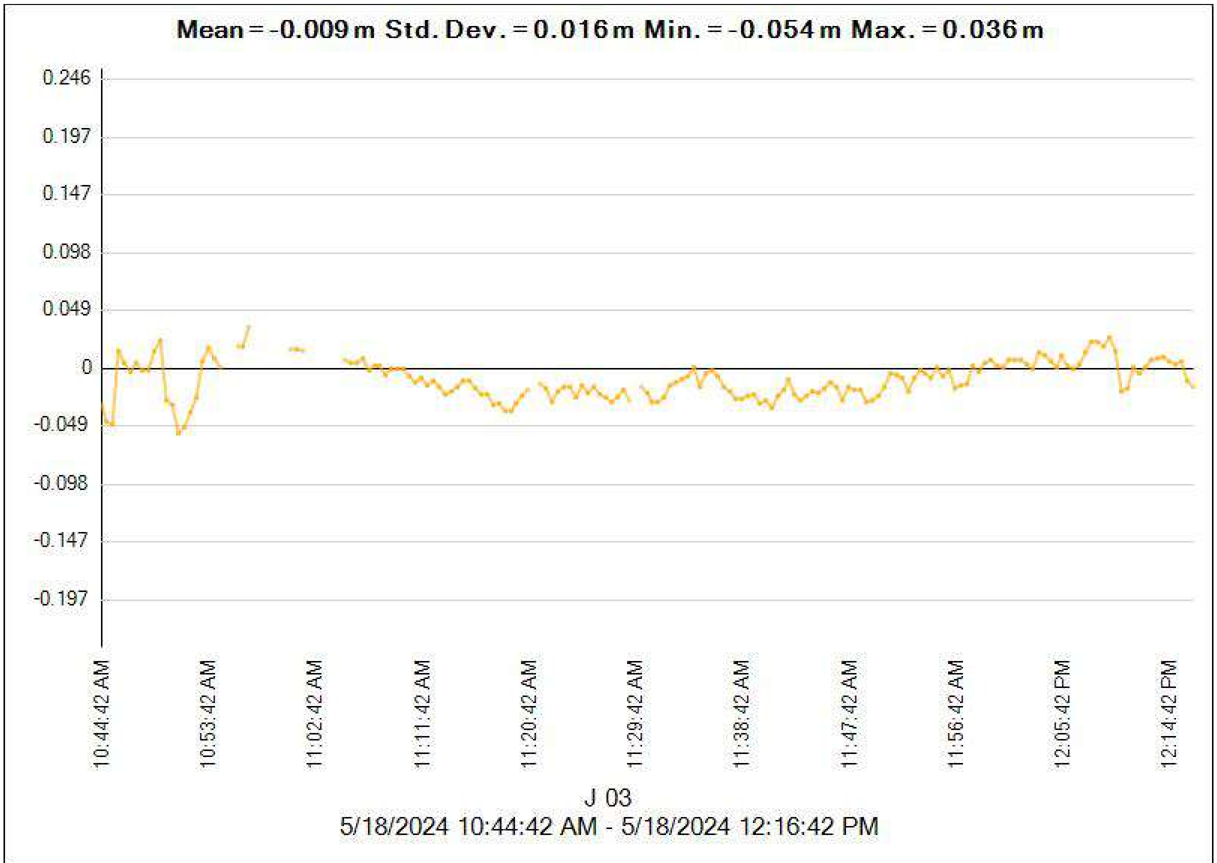

Mean = -0.004 m Std. Dev. = 0.049 m Min. = -0.164 m Max. = 0.118 m
0.246
0.197
0.147
0.098
0.049
0
-0.049
-0.098
-0.147
-0.197
10:44:42 AM
10:53:42 AM
11:02:42 AM
11:11:42 AM
11:20:42 AM
11:29:42 AM
11:38:42 AM
11:47:42 AM
11:56:42 AM
12:05:42 PM
12:14:42 PM
R 18
5/18/2024 10:44:42 AM - 5/18/2024 12:16:42 PM

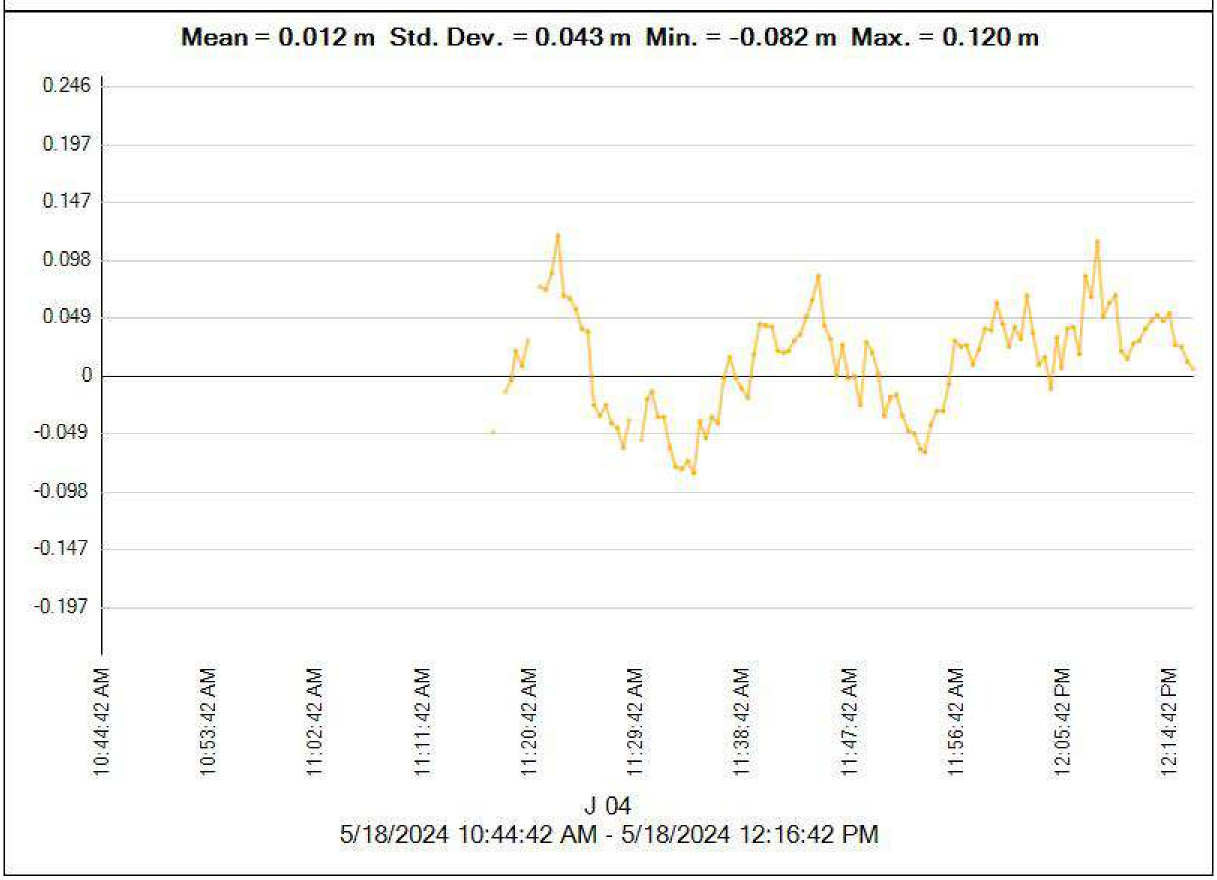


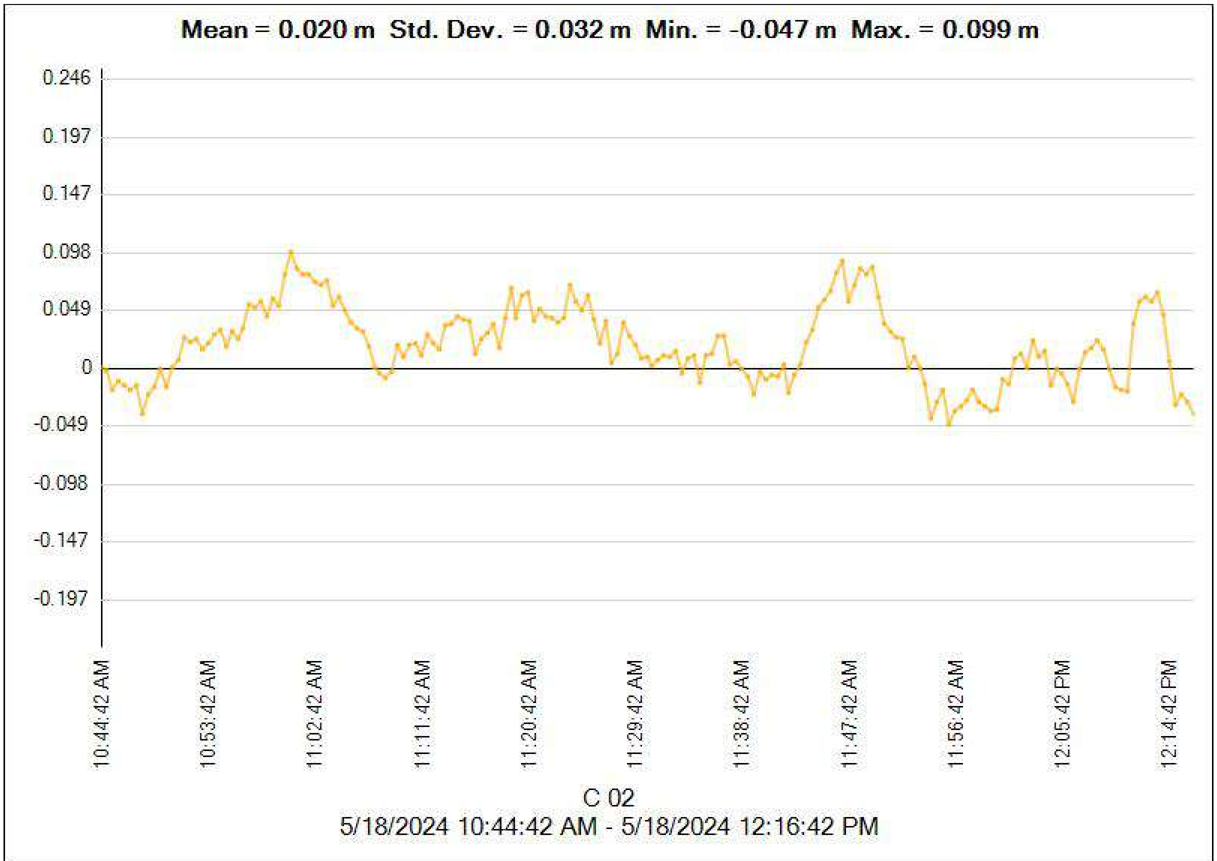
Mean = -0.010 m Std. Dev. = 0.045 m Min. = -0.135 m Max. = 0.111 m
0.246
0.197
0.147
0.098
0.049
0
-0.049
-0.098
-0.147
-0.197
10:44:42 AM
10:53:42 AM
11:02:42 AM
11:11:42 AM
11:20:42 AM
11:29:42 AM
11:38:42 AM
11:47:42 AM
11:56:42 AM
12:05:42 PM
12:14:42 PM
R 19
5/18/2024 10:44:42 AM - 5/18/2024 12:16:42 PM

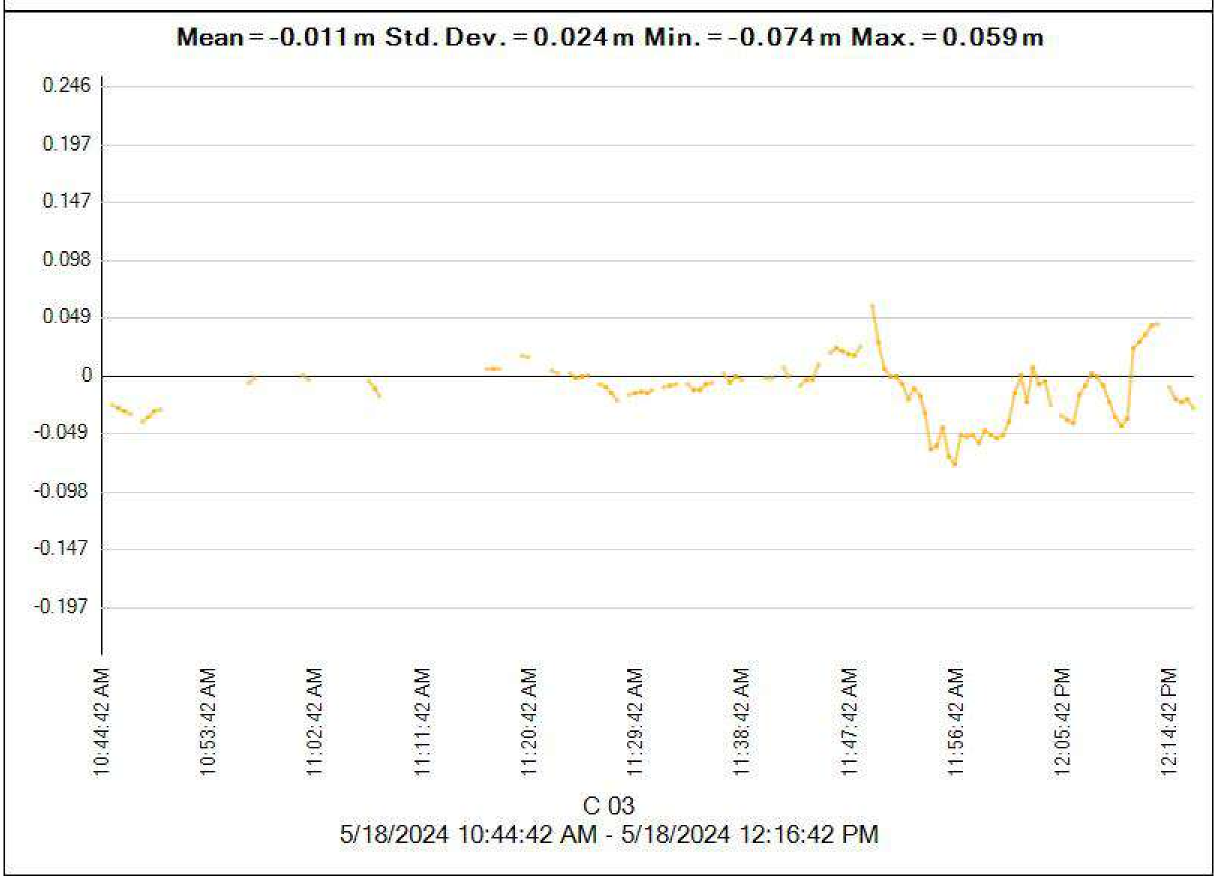


Mean = 0.049 m Std. Dev. = 0.101 m Min. = -0.097 m Max. = 0.256 m
0.246
0.197
0.147
0.098
0.049
0
-0.049
-0.098
-0.147
-0.197
10:44:42 AM
10:53:42 AM
11:02:42 AM
11:11:42 AM
11:20:42 AM
11:29:42 AM
11:38:42 AM
11:47:42 AM
11:56:42 AM
12:05:42 PM
12:14:42 PM
J 02
5/18/2024 10:44:42 AM - 5/18/2024 12:16:42 PM


Mean = -0.009 m Std. Dev. = 0.016 m Min. = -0.054 m Max. = 0.036 m
0.246
0.197
0.147
0.098
0.049
0
-0.049
-0.098
-0.147
-0.197
10:44:42 AM
10:53:42 AM
11:02:42 AM
11:11:42 AM
11:20:42 AM
11:29:42 AM
11:38:42 AM
11:47:42 AM
11:56:42 AM
12:05:42 PM
12:14:42 PM
J 03
5/18/2024 10:44:42 AM - 5/18/2024 12:16:42 PM


Mean = 0.012 m Std. Dev. = 0.043 m Min. = -0.082 m Max. = 0.120 m
0.246
0.197
0.147
0.098
0.049
0
-0.049
-0.098
-0.147
-0.197
10:44:42 AM
10:53:42 AM
11:02:42 AM
11:11:42 AM
11:20:42 AM
11:29:42 AM
11:38:42 AM
11:47:42 AM
11:56:42 AM
12:05:42 PM
12:14:42 PM
J 04
5/18/2024 10:44:42 AM - 5/18/2024 12:16:42 PM


Mean = 0.020 m Std. Dev. = 0.032 m Min. = -0.047 m Max. = 0.099 m
0.246
0.197
0.147
0.098
0.049
0
-0.049
-0.098
-0.147
-0.197
10:44:42 AM
10:53:42 AM
11:02:42 AM
11:11:42 AM
11:20:42 AM
11:29:42 AM
11:38:42 AM
11:47:42 AM
11:56:42 AM
12:05:42 PM
12:14:42 PM
C 02
5/18/2024 10:44:42 AM - 5/18/2024 12:16:42 PM

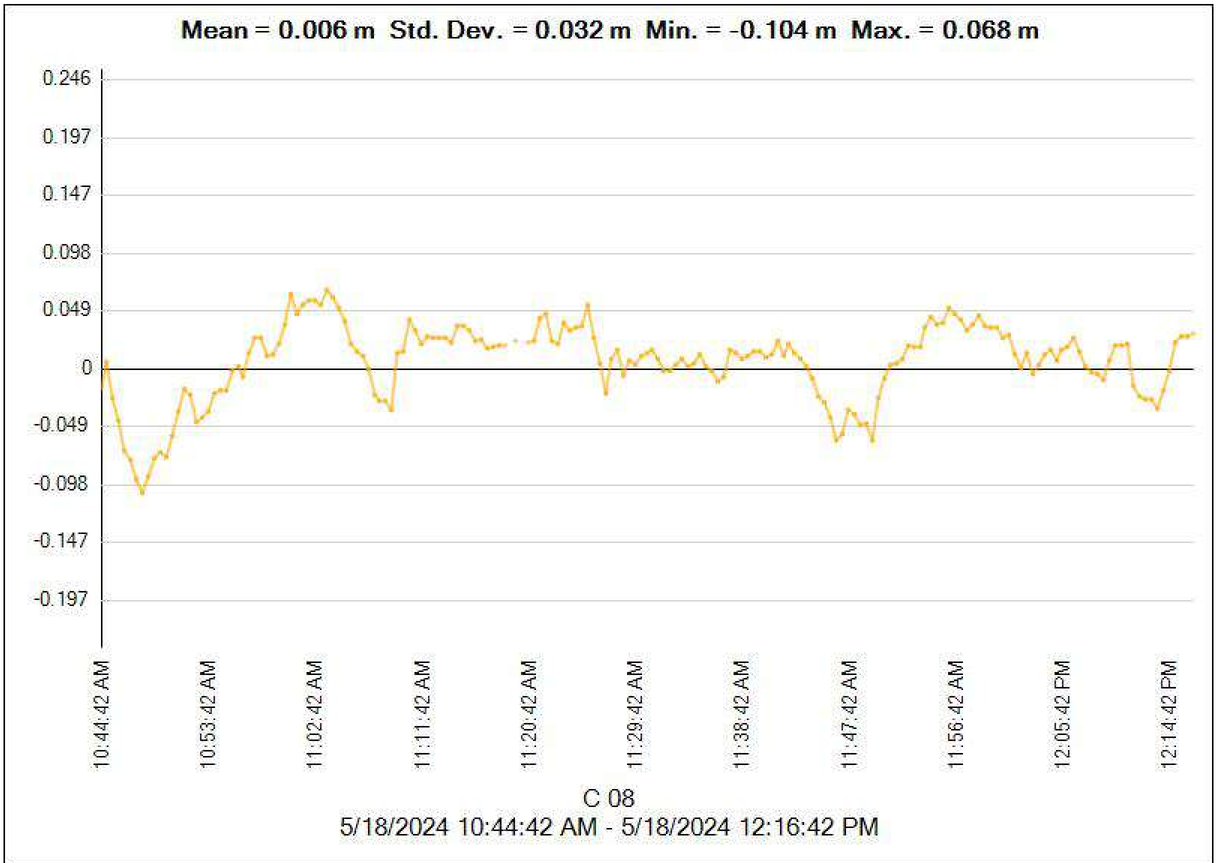

Mean = -0.011 m Std. Dev. = 0.024 m Min. = -0.074 m Max. = 0.059 m
0.246
0.197
0.147
0.098
0.049
0
-0.049
-0.098
-0.147
-0.197
10:44:42 AM
10:53:42 AM
11:02:42 AM
11:11:42 AM
11:20:42 AM
11:29:42 AM
11:38:42 AM
11:47:42 AM
11:56:42 AM
12:05:42 PM
12:14:42 PM
C 03
5/18/2024 10:44:42 AM - 5/18/2024 12:16:42 PM

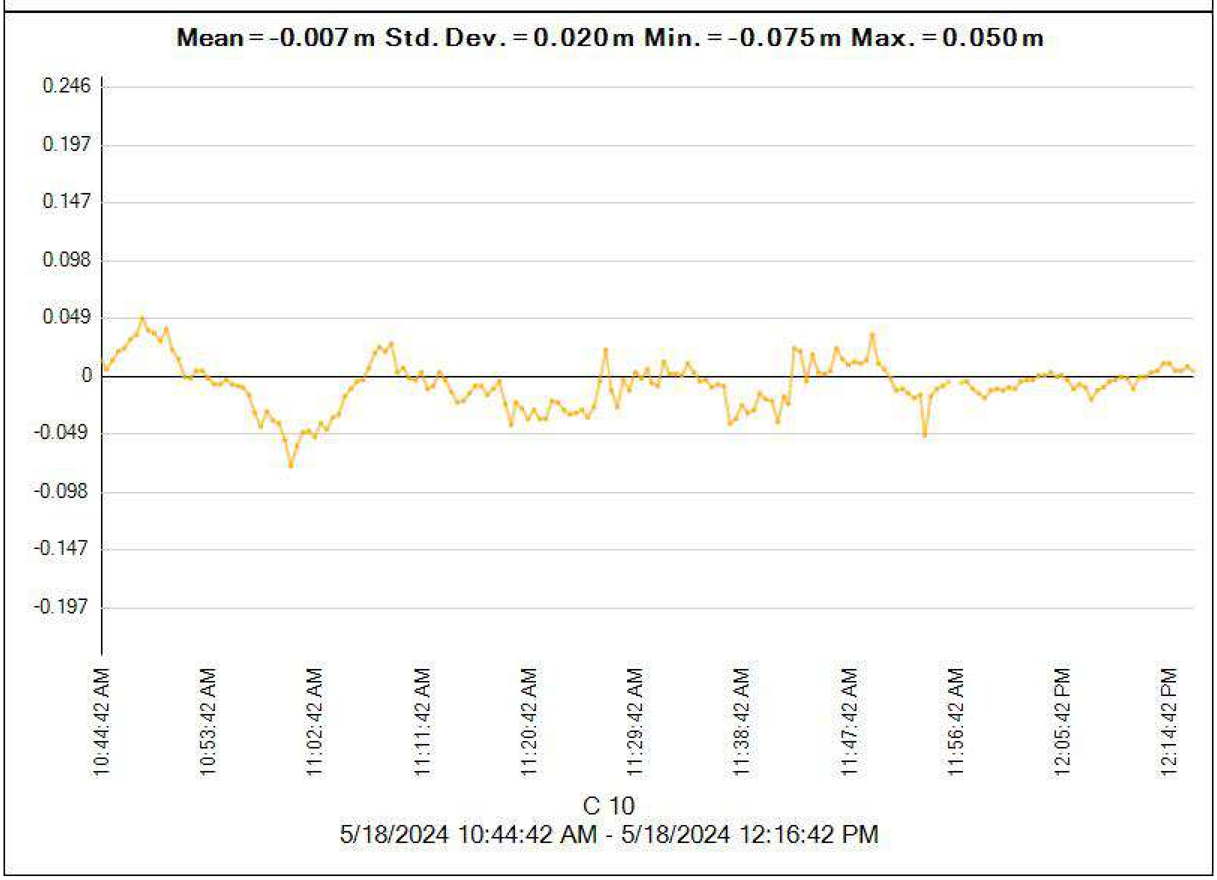
Mean = -0.002 m Std. Dev. = 0.033 m Min. = -0.082 m Max. = 0.073 m

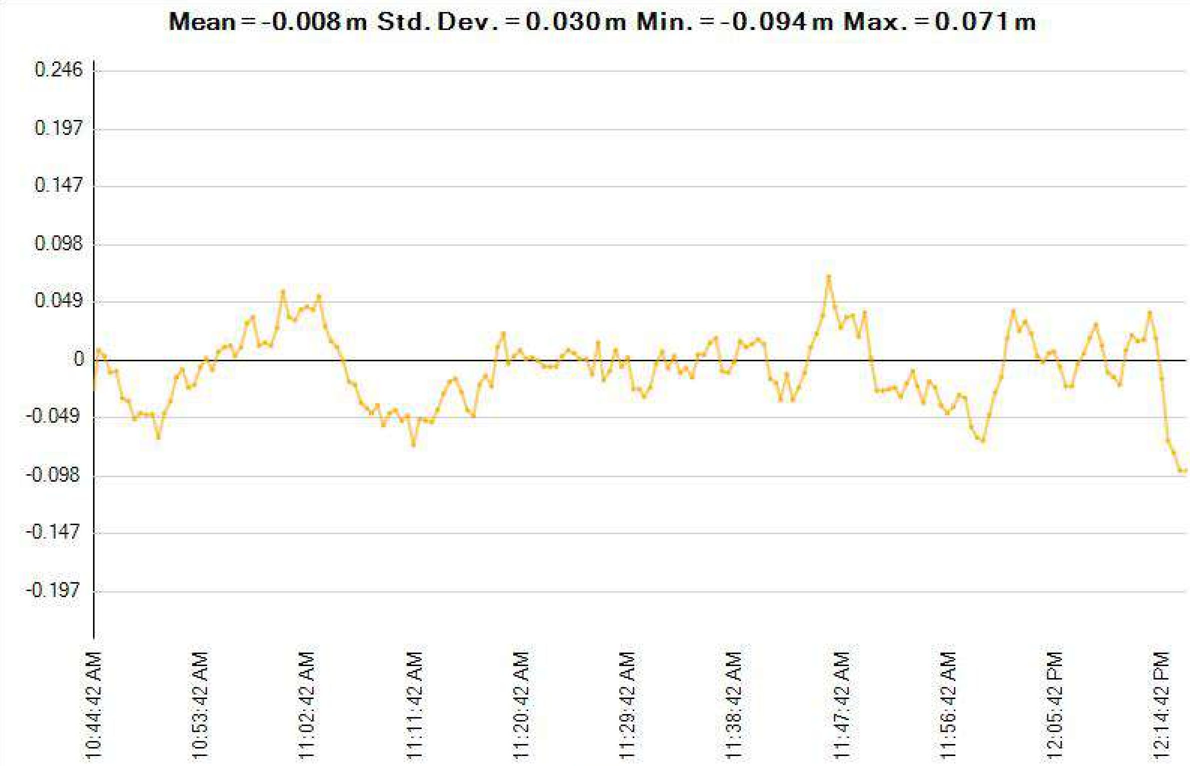
C 05
5/18/2024 10:44:42 AM - 5/18/2024 12:16:42 PM

Mean = 0.005 m Std. Dev. = 0.037 m Min. = -0.081 m Max. = 0.094 m

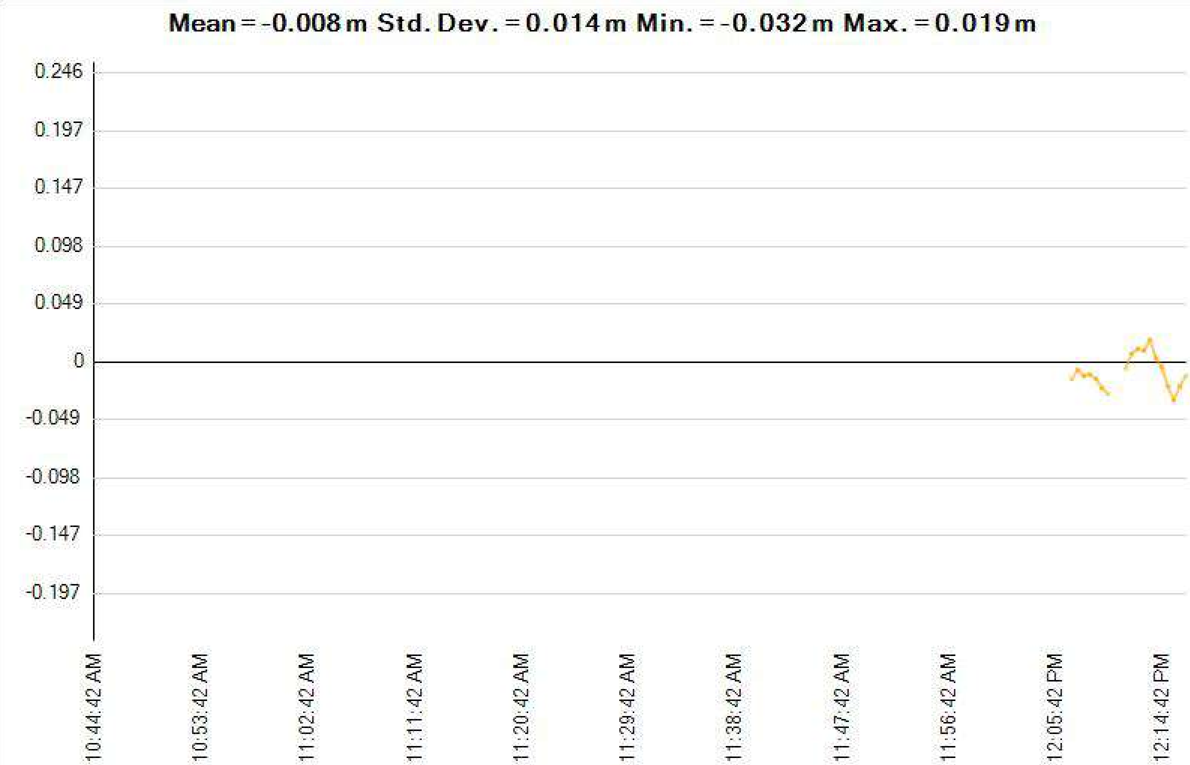
C 07
5/18/2024 10:44:42 AM - 5/18/2024 12:16:42 PM


Mean = 0.006 m Std. Dev. = 0.032 m Min. = -0.104 m Max. = 0.068 m
0.246
0.197
0.147
0.098
0.049
0
-0.049
-0.098
-0.147
-0.197
10:44:42 AM
10:53:42 AM
11:02:42 AM
11:11:42 AM
11:20:42 AM
11:29:42 AM
11:38:42 AM
11:47:42 AM
11:56:42 AM
12:05:42 PM
12:14:42 PM
C 08
5/18/2024 10:44:42 AM - 5/18/2024 12:16:42 PM

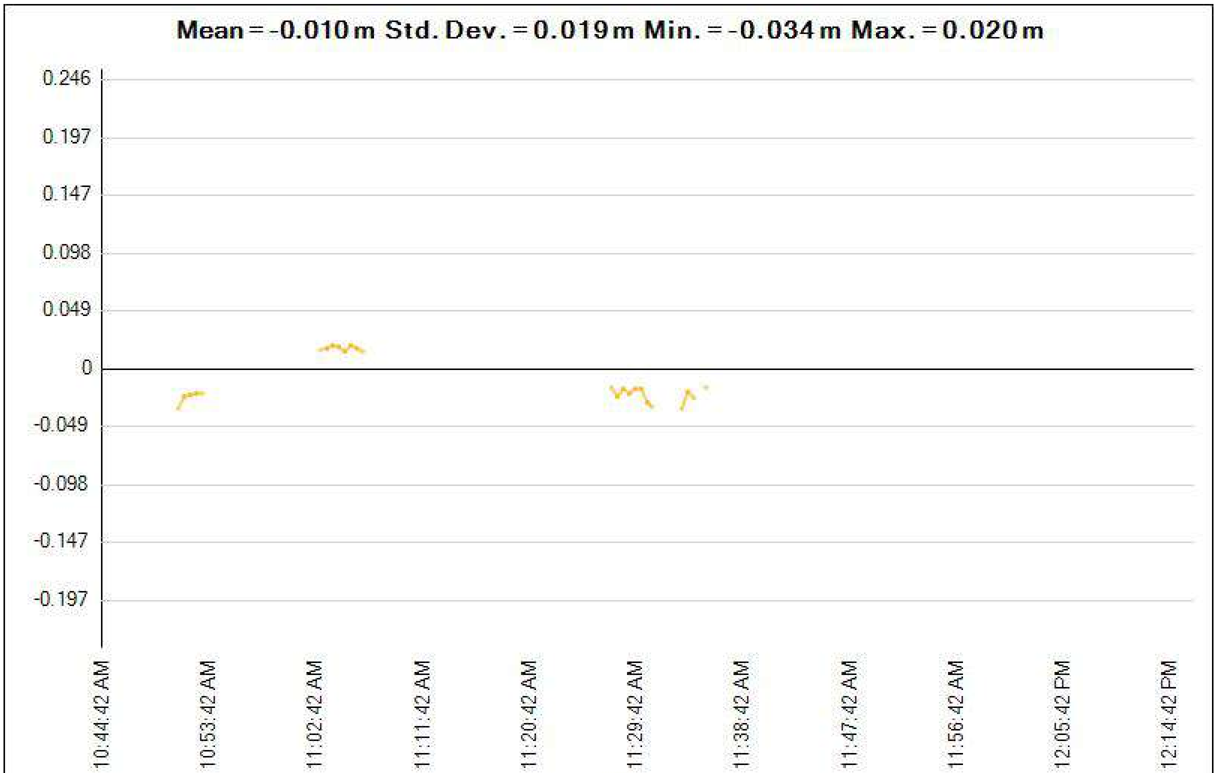

Mean = -0.007 m Std. Dev. = 0.020 m Min. = -0.075 m Max. = 0.050 m
0.246
0.197
0.147
0.098
0.049
0
-0.049
-0.098
-0.147
-0.197
10:44:42 AM
10:53:42 AM
11:02:42 AM
11:11:42 AM
11:20:42 AM
11:29:42 AM
11:38:42 AM
11:47:42 AM
11:56:42 AM
12:05:42 PM
12:14:42 PM
C 10
5/18/2024 10:44:42 AM - 5/18/2024 12:16:42 PM



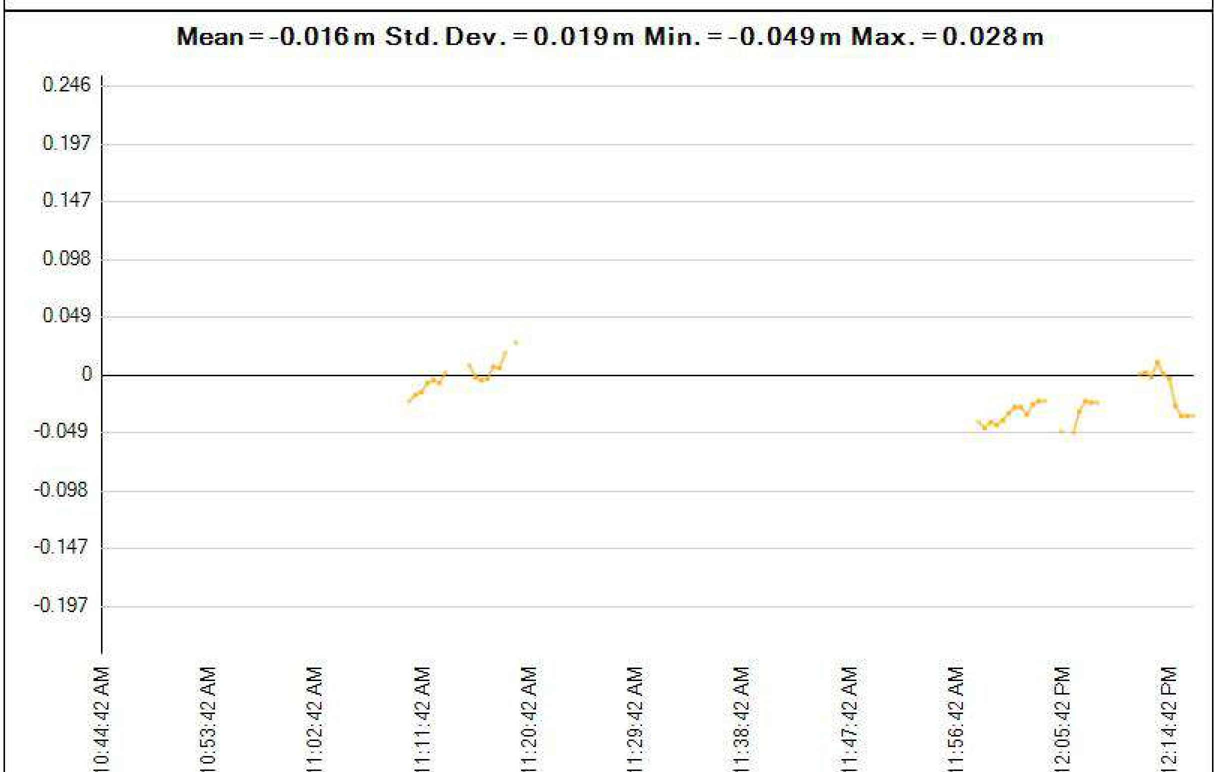
C 13
5/18/2024 10:44:42 AM - 5/18/2024 12:16:42 PM



C 29
5/18/2024 10:44:42 AM - 5/18/2024 12:16:42 PM



C 30
5/18/2024 10:44:42 AM - 5/18/2024 12:16:42 PM



C 36
5/18/2024 10:44:42 AM - 5/18/2024 12:16:42 PM

Processing style

Elevation mask: 15°00'00.0"

Auto start processing: Yes

Start automatic ID numbering: AUTO0001

Continuous vectors: No

Generate residuals: Yes

Antenna model: Automatic

Ephemeris type: Automatic

Frequency: Multiple Frequencies

Processing Interval: Automatic

Force float: No

GIS processing type: Automatic Carrier and Code Processing

Acceptance Criteria

Vector Component	Flag	Fail
Horizontal Precision >	0.050 m + 1.000 ppm	0.100 m + 1.000 ppm
Vertical Precision >	0.100 m + 1.000 ppm	0.200 m + 1.000 ppm

Trig-134 - BM2 (9:09:42 AM-10:39:25 AM) (S1)

Baseline observation:	Trig-134 --- BM2 (B1)
Processed:	5/21/2024 11:15:13 PM
Solution type:	Fixed
Frequency used:	Dual Frequency (L1, L2)
Horizontal precision:	0.010 m
Vertical precision:	0.056 m
RMS:	0.019 m
Maximum PDOP:	1.634
Ephemeris used:	Broadcast
Antenna model:	NGS Absolute
Processing start time:	5/18/2024 9:09:42 AM (Local: UTC+5hr)
Processing stop time:	5/18/2024 10:39:12 AM (Local: UTC+5hr)
Processing duration:	01:29:30
Processing interval:	30 seconds

Vector Components (Mark to Mark)

From:	Trig-134				
Grid		Local		Global	
Easting	499054.624 m	Latitude	N28°11'22.803432601"	Latitude	N28°11'23.940634226"
Northing	3118885.237 m	Longitude	E83°59'25.330422159"	Longitude	E83°59'17.338012852"
Elevation	884.900 m	Height	860.678 m	Height	838.446 m

To:	BM2				
Grid		Local		Global	
Easting	497393.313 m	Latitude	N28°10'58.731698828"	Latitude	N28°10'59.870177259"
Northing	3118144.606 m	Longitude	E83°58'24.411458392"	Longitude	E83°58'16.427671159"
Elevation	814.133 m	Height	789.652 m	Height	767.473 m

Vector					
ΔEasting	-1661.311 m	NS Fwd Azimuth	245°58'03"	ΔX	1682.558 m
ΔNorthing	-740.631 m	Ellipsoid Dist.	1819.107 m	ΔY	111.636 m
ΔElevation	-70.767 m	ΔHeight	-71.026 m	ΔZ	-686.721 m

Standard Errors

Vector errors:					
σ ΔEasting	0.004 m	σ NS fwd Azimuth	0°00'00"	σ ΔX	0.004 m
σ ΔNorthing	0.004 m	σ Ellipsoid Dist.	0.003 m	σ ΔY	0.025 m
σ ΔElevation	0.029 m	σ ΔHeight	0.029 m	σ ΔZ	0.014 m

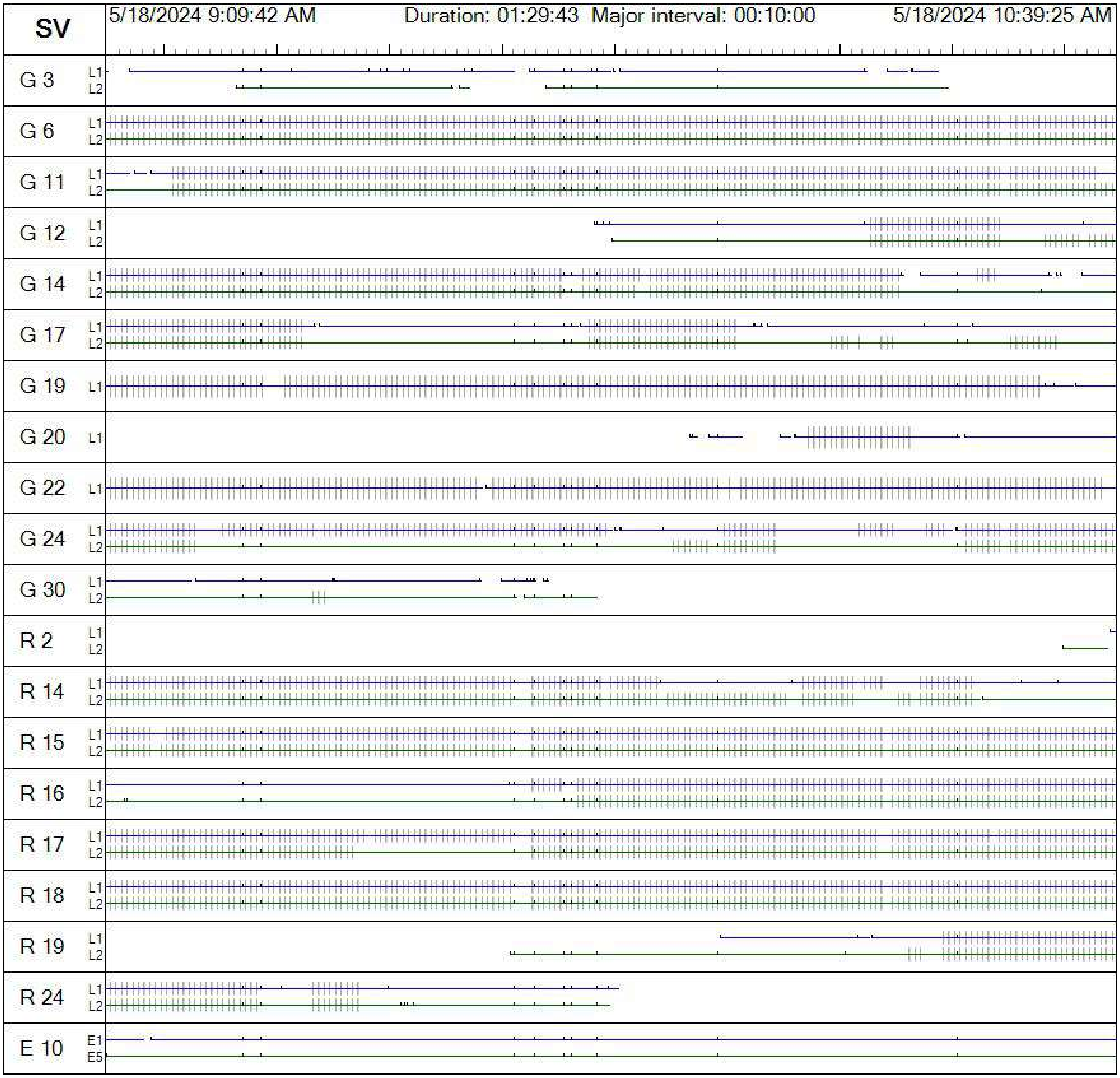
Aposteriori Covariance Matrix (Meter²)

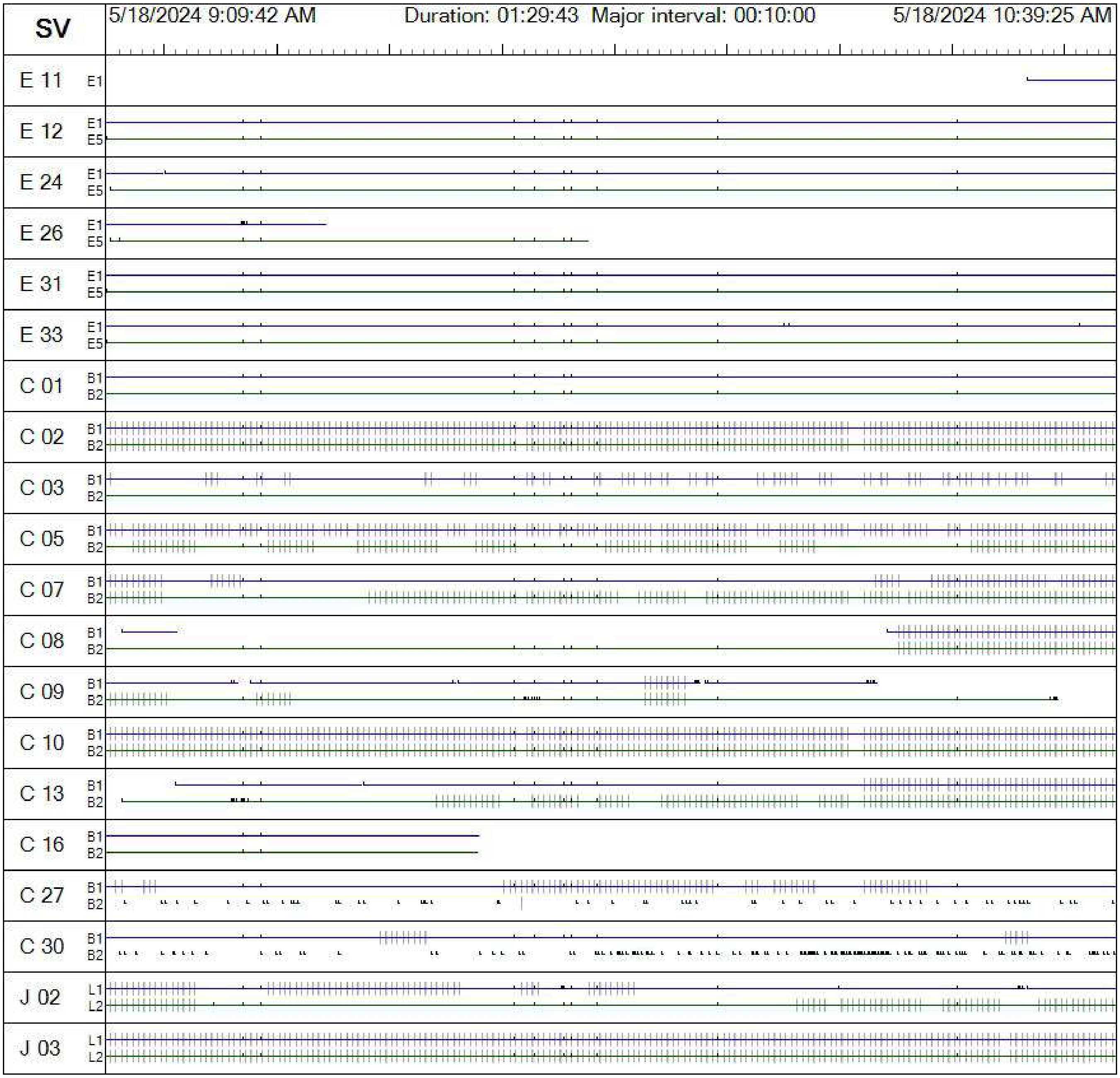
	X	Y	Z
X	0.0000156859		
Y	0.0000388502	0.0006389609	
Z	0.0000234776	0.0003289367	0.0001860201

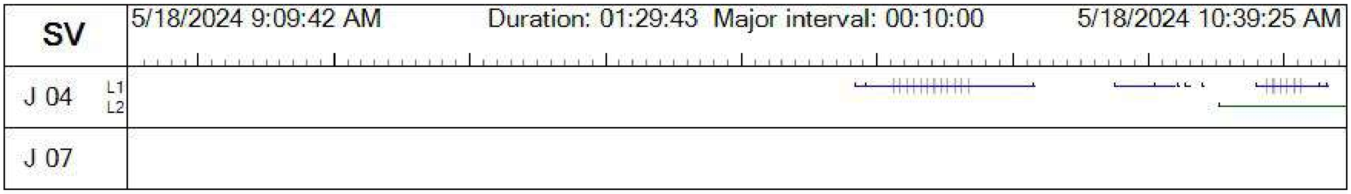
Occupations

	From	To
Point ID:	Trig-134	BM2
Receiver type:	Unknown	Unknown
Receiver serial number:		
Antenna type:	Unknown External	Unknown External
Antenna serial number:	AS-ANT2BCAL	AS-ANT2BCAL
Antenna height (measured):	1.460 m	1.276 m
Antenna method:	Antenna Phase Center	Antenna Phase Center

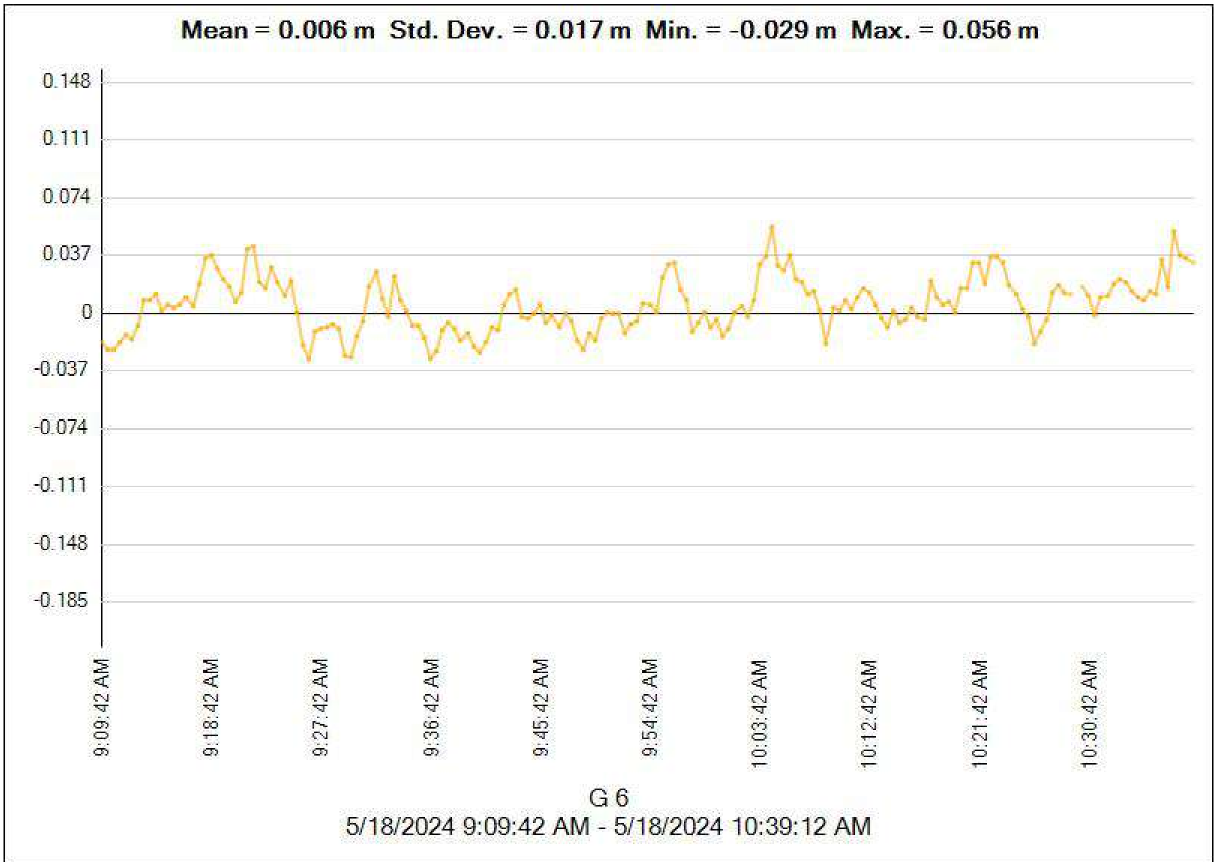
Tracking Summary



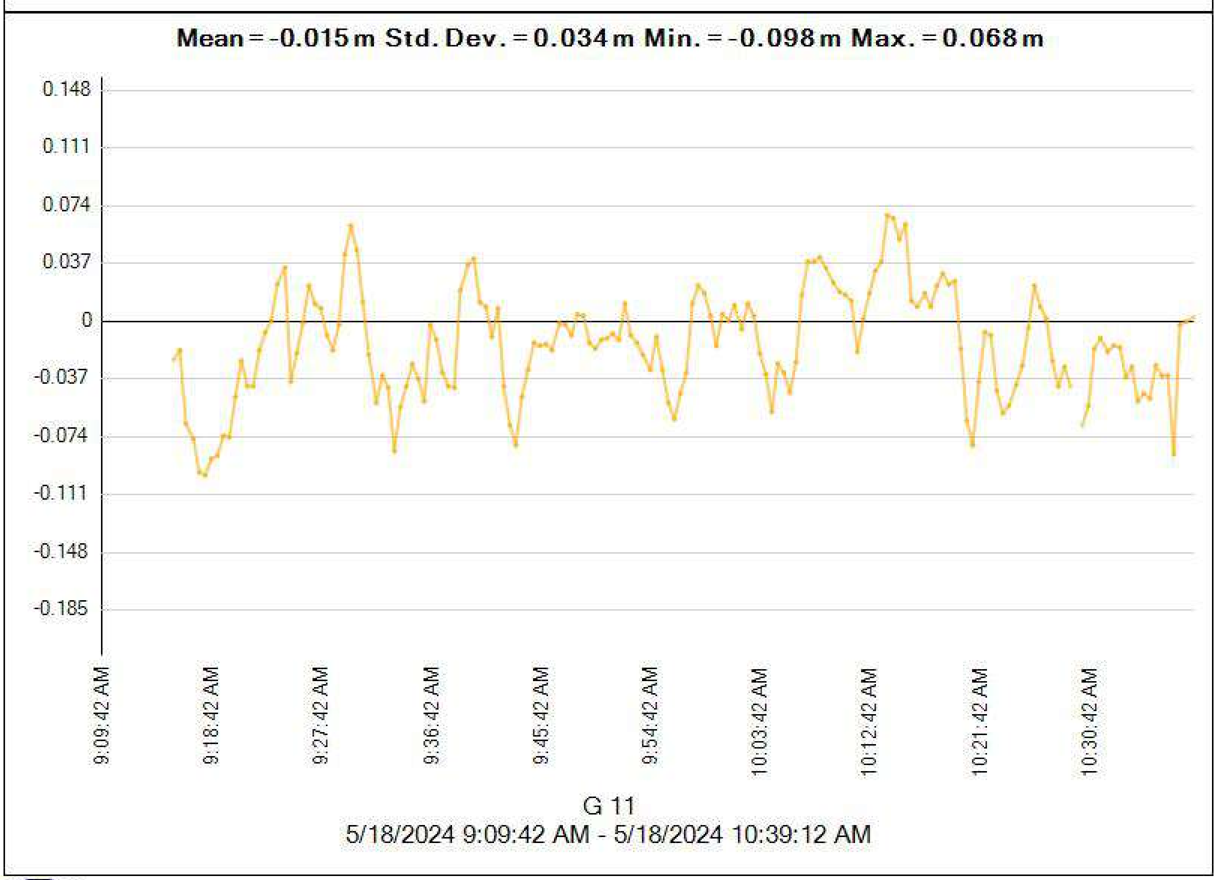

SV
5/18/2024 9:09:42 AM
Duration: 01:29:43 Major interval: 00:10:00
5/18/2024 10:39:25 AM
E 11 E1
E 12 E1 E5
E 24 E1 E5
E 26 E1 E5
E 31 E1 E5
E 33 E1 E5
C 01 B1 B2
C 02 B1 B2
C 03 B1 B2
C 05 B1 B2
C 07 B1 B2
C 08 B1 B2
C 09 B1 B2
C 10 B1 B2
C 13 B1 B2
C 16 B1 B2
C 27 B1 B2
C 30 B1 B2
J 02 L1 L2
J 03 L1 L2


SV
5/18/2024 9:09:42 AM
Duration: 01:29:43 Major interval: 00:10:00
5/18/2024 10:39:25 AM
J 04
L1
L2
J 07

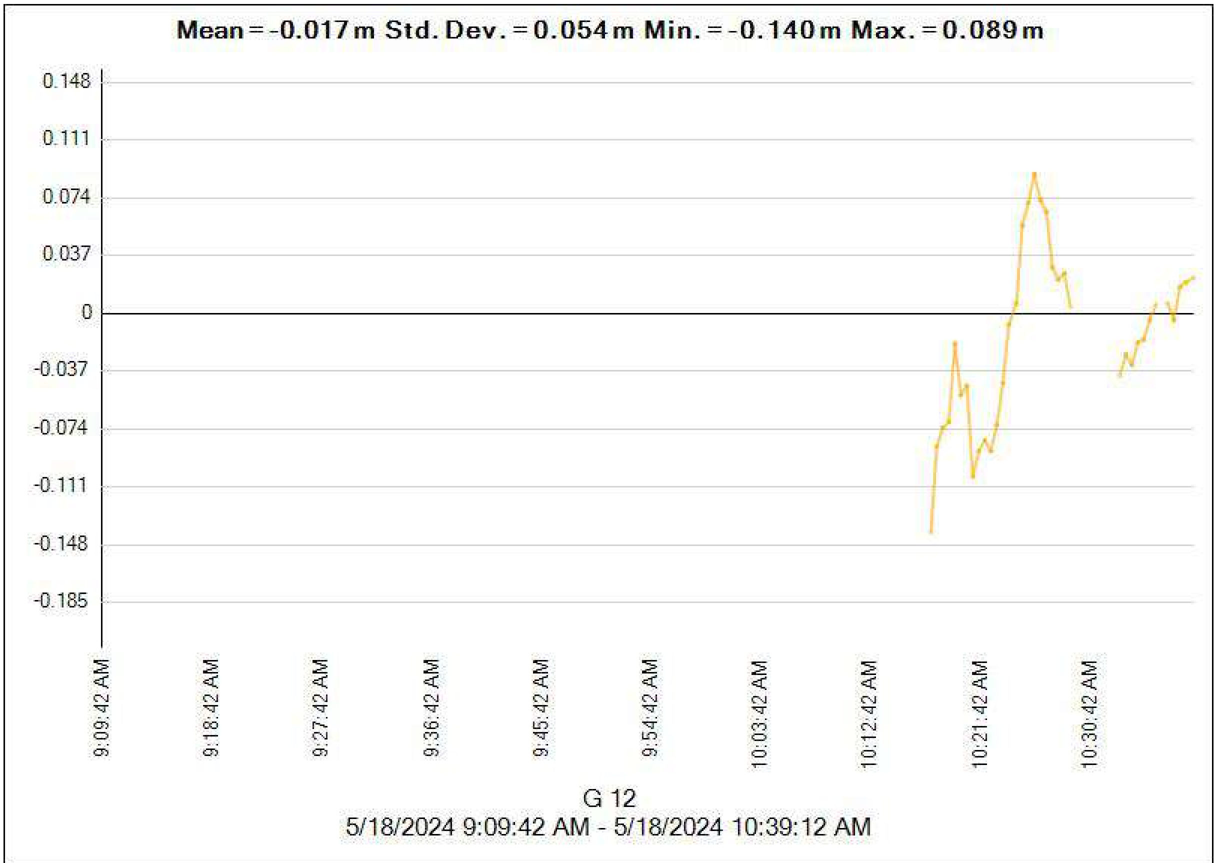
Residuals

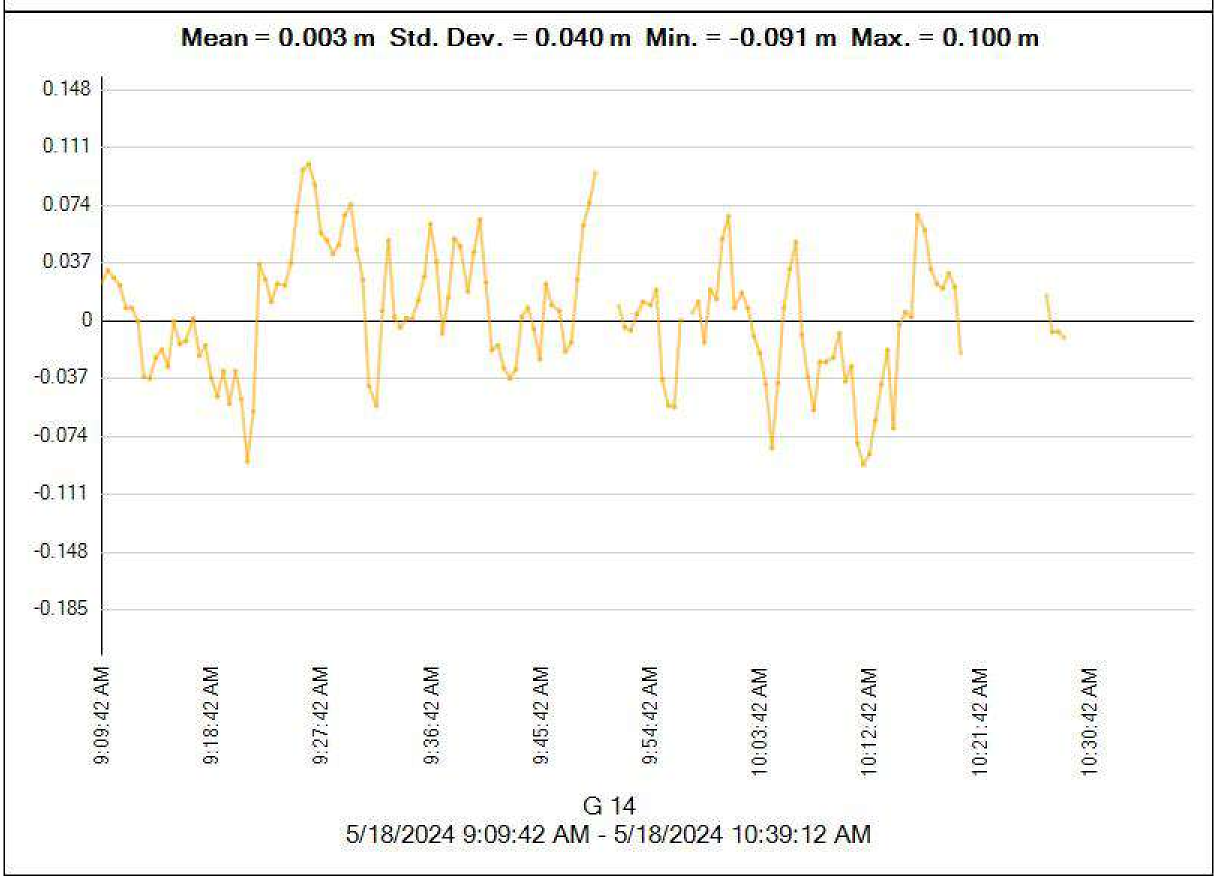


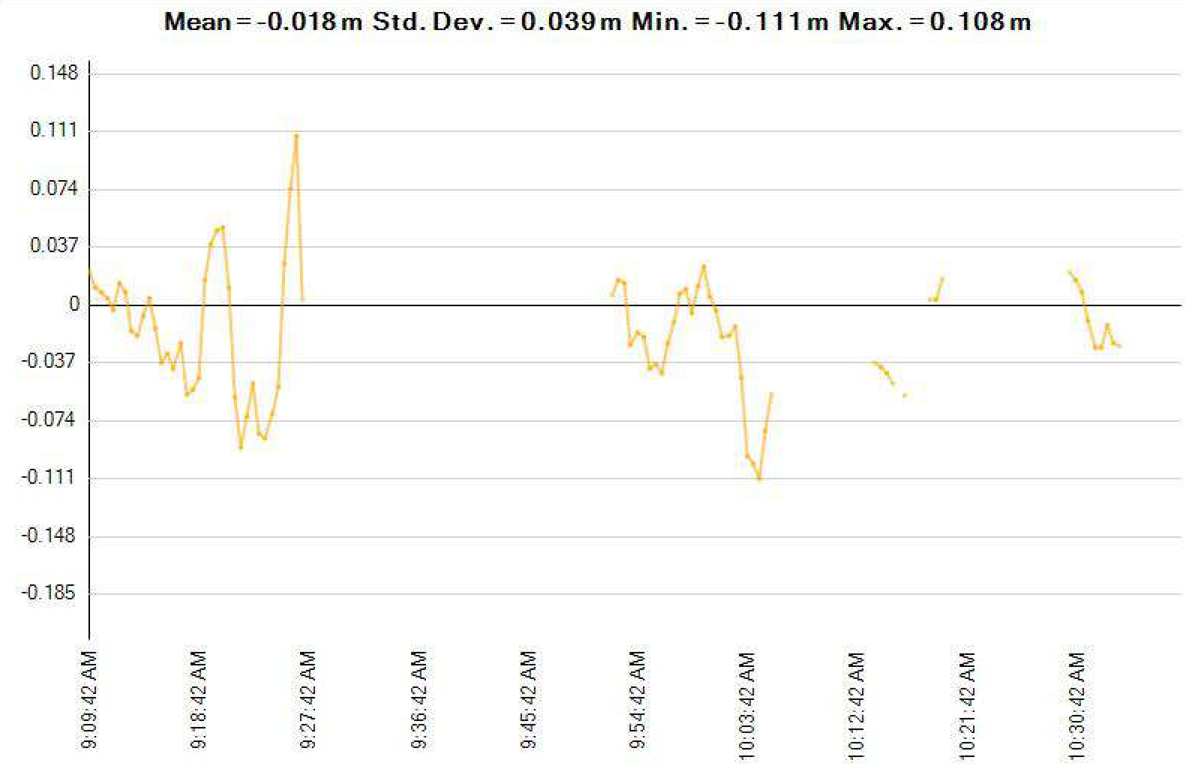
Mean = 0.006 m Std. Dev. = 0.017 m Min. = -0.029 m Max. = 0.056 m
0.148
0.111
0.074
0.037
0
-0.037
-0.074
-0.111
-0.148
-0.185
9:09:42 AM
9:18:42 AM
9:27:42 AM
9:36:42 AM
9:45:42 AM
9:54:42 AM
10:03:42 AM
10:12:42 AM
10:21:42 AM
10:30:42 AM
G 6
5/18/2024 9:09:42 AM - 5/18/2024 10:39:12 AM



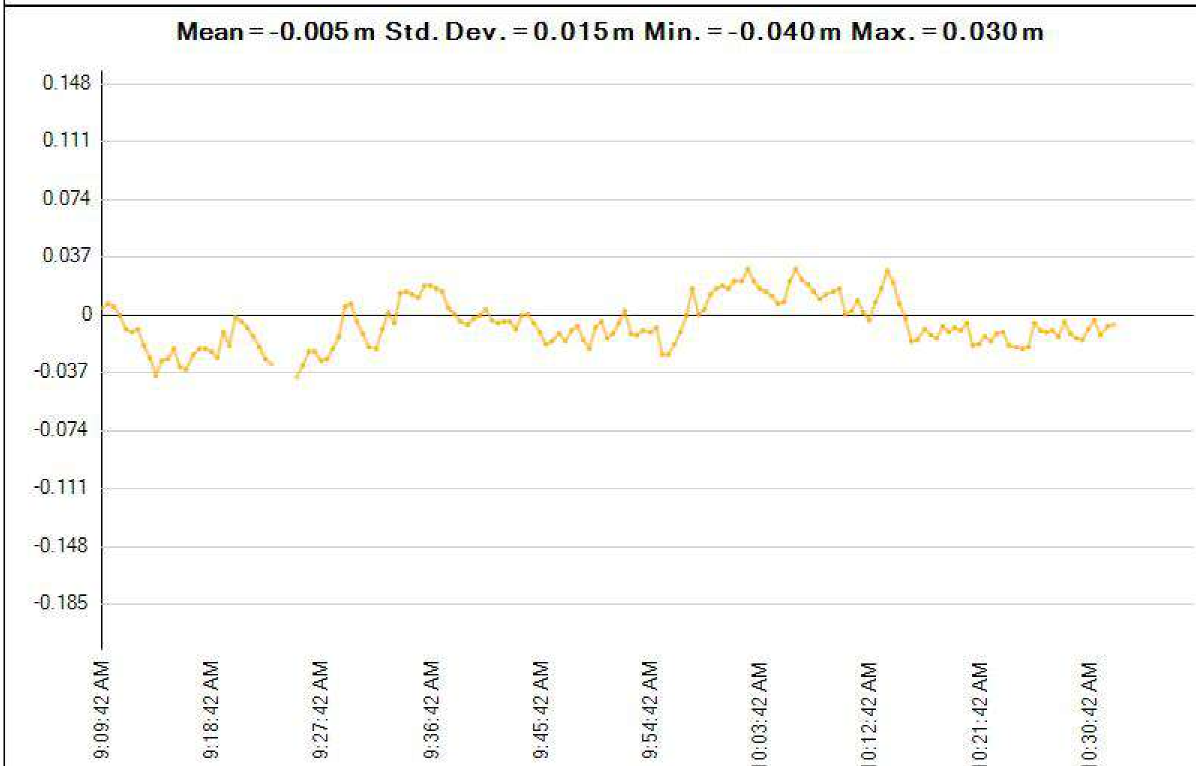
Mean = -0.015 m Std. Dev. = 0.034 m Min. = -0.098 m Max. = 0.068 m
0.148
0.111
0.074
0.037
0
-0.037
-0.074
-0.111
-0.148
-0.185
9:09:42 AM
9:18:42 AM
9:27:42 AM
9:36:42 AM
9:45:42 AM
9:54:42 AM
10:03:42 AM
10:12:42 AM
10:21:42 AM
10:30:42 AM
G 11
5/18/2024 9:09:42 AM - 5/18/2024 10:39:12 AM


Mean = -0.017 m Std. Dev. = 0.054 m Min. = -0.140 m Max. = 0.089 m
0.148
0.111
0.074
0.037
0
-0.037
-0.074
-0.111
-0.148
-0.185
9:09:42 AM
9:18:42 AM
9:27:42 AM
9:36:42 AM
9:45:42 AM
9:54:42 AM
10:03:42 AM
10:12:42 AM
10:21:42 AM
10:30:42 AM
G 12
5/18/2024 9:09:42 AM - 5/18/2024 10:39:12 AM

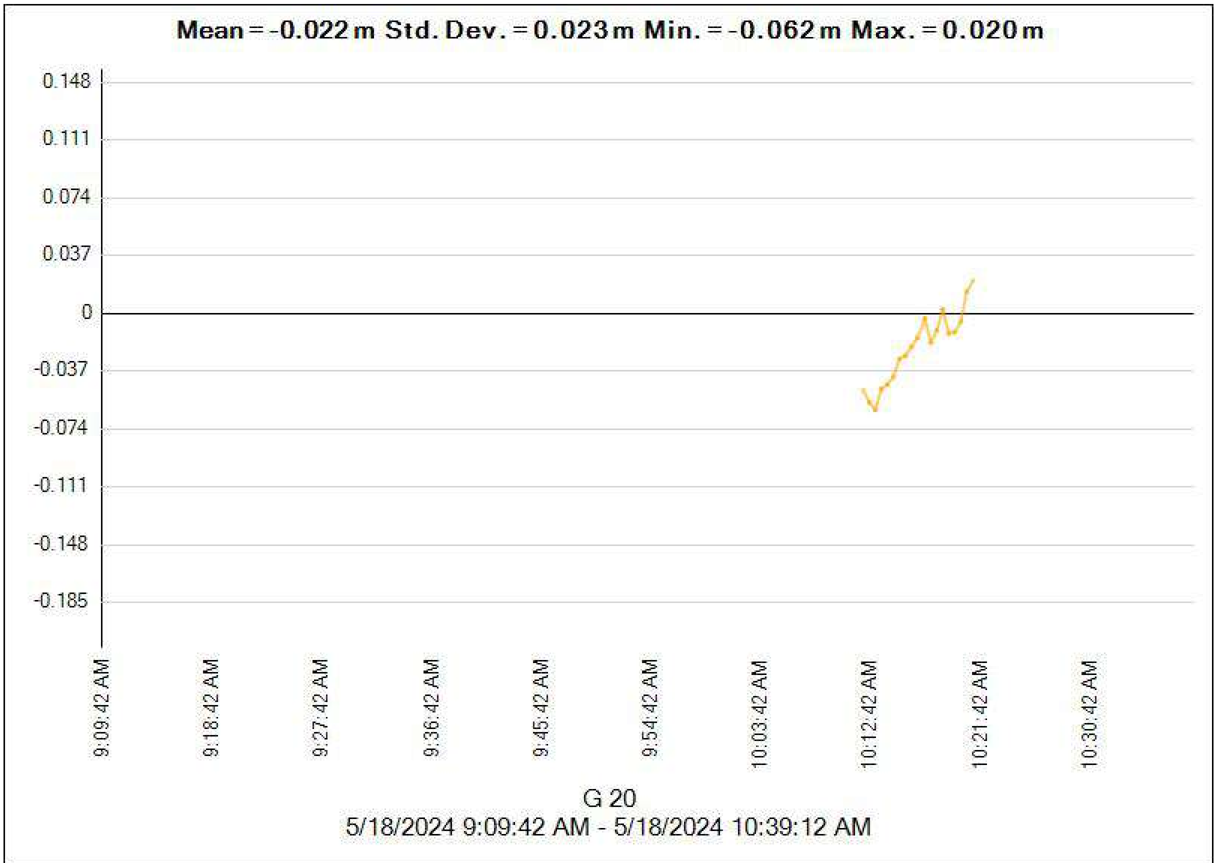

Mean = 0.003 m Std. Dev. = 0.040 m Min. = -0.091 m Max. = 0.100 m
0.148
0.111
0.074
0.037
0
-0.037
-0.074
-0.111
-0.148
-0.185
9:09:42 AM
9:18:42 AM
9:27:42 AM
9:36:42 AM
9:45:42 AM
9:54:42 AM
10:03:42 AM
10:12:42 AM
10:21:42 AM
10:30:42 AM
G 14
5/18/2024 9:09:42 AM - 5/18/2024 10:39:12 AM

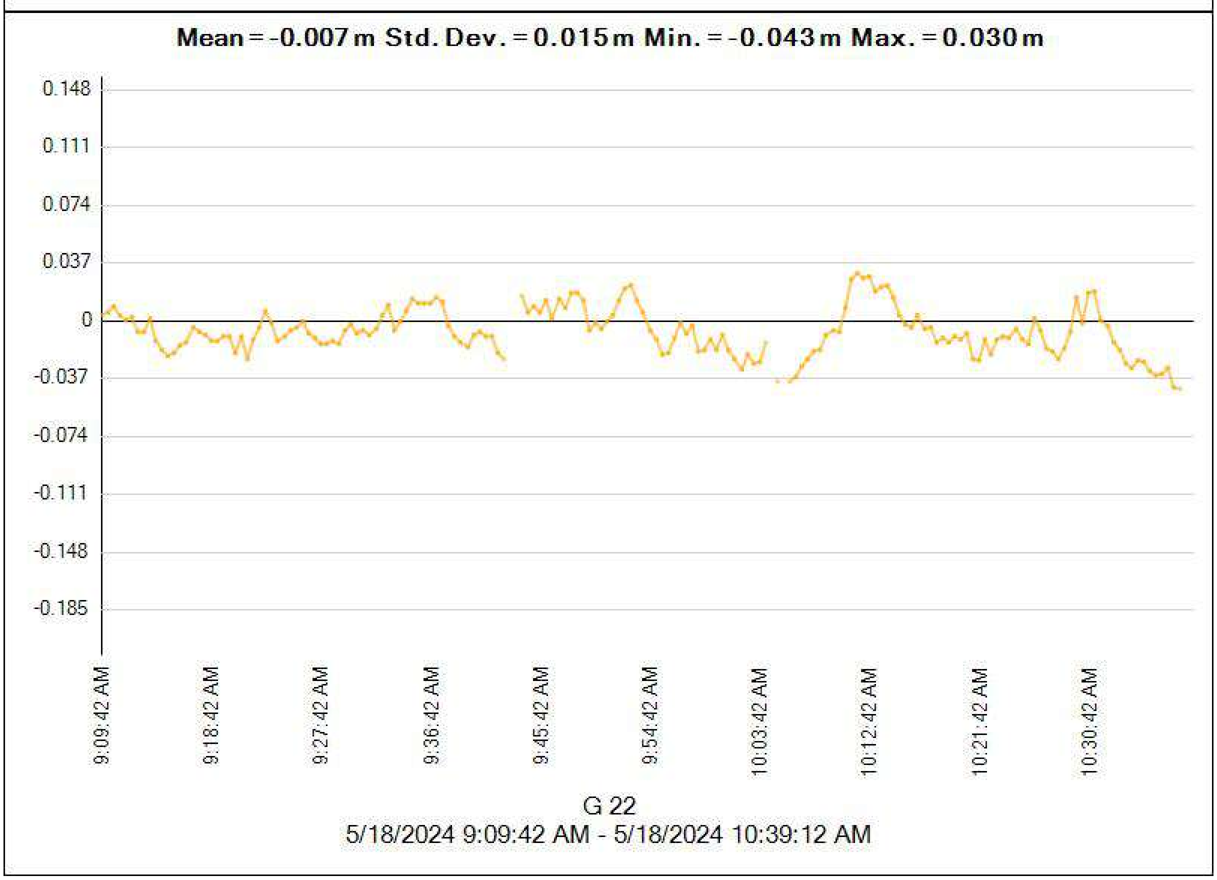


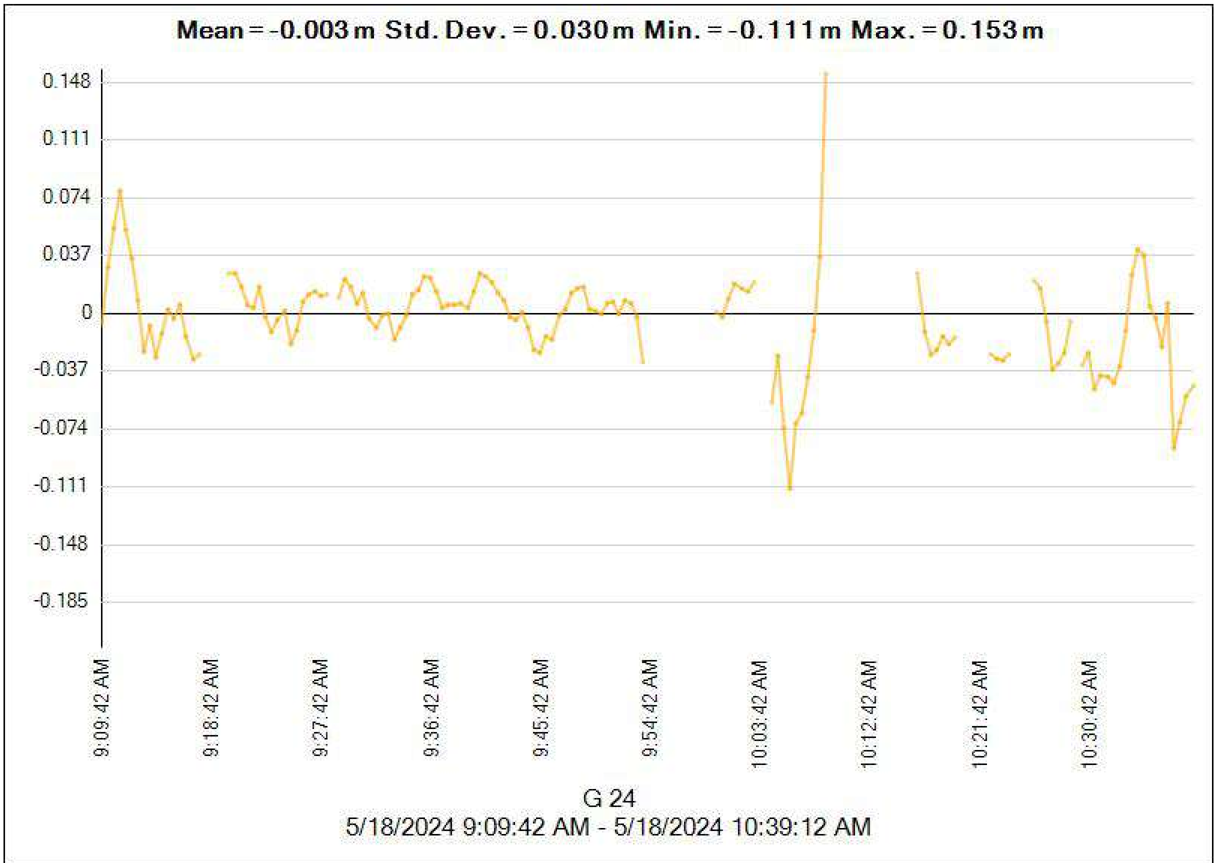
G 17
5/18/2024 9:09:42 AM - 5/18/2024 10:39:12 AM

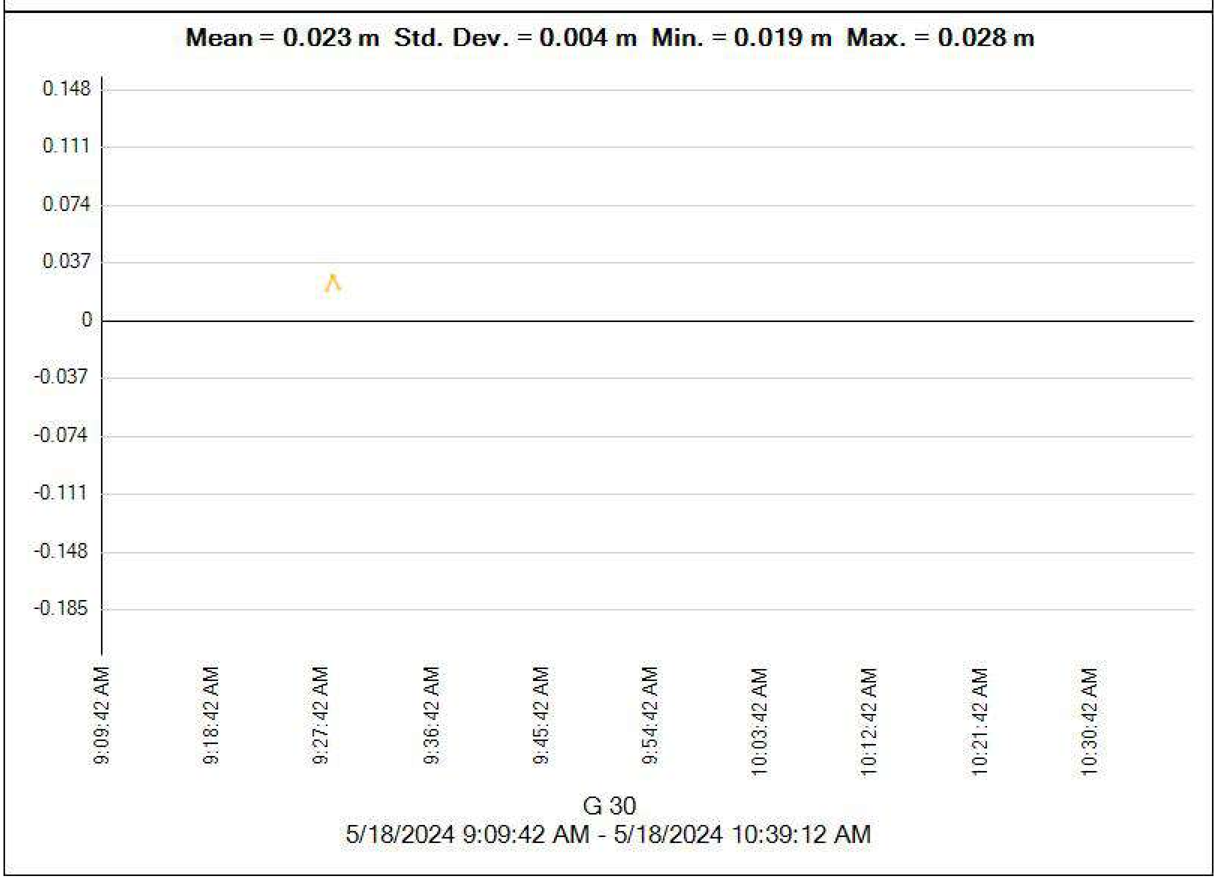


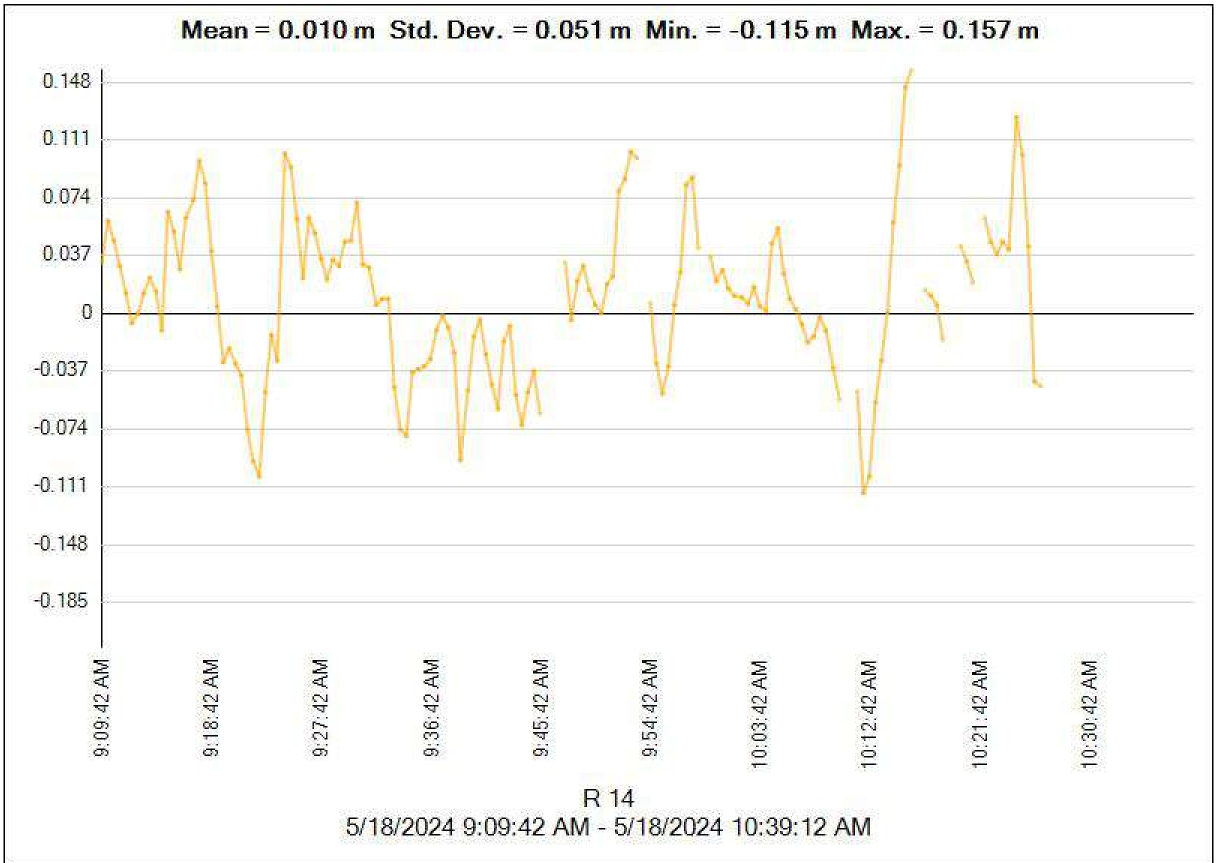
G 19
5/18/2024 9:09:42 AM - 5/18/2024 10:39:12 AM

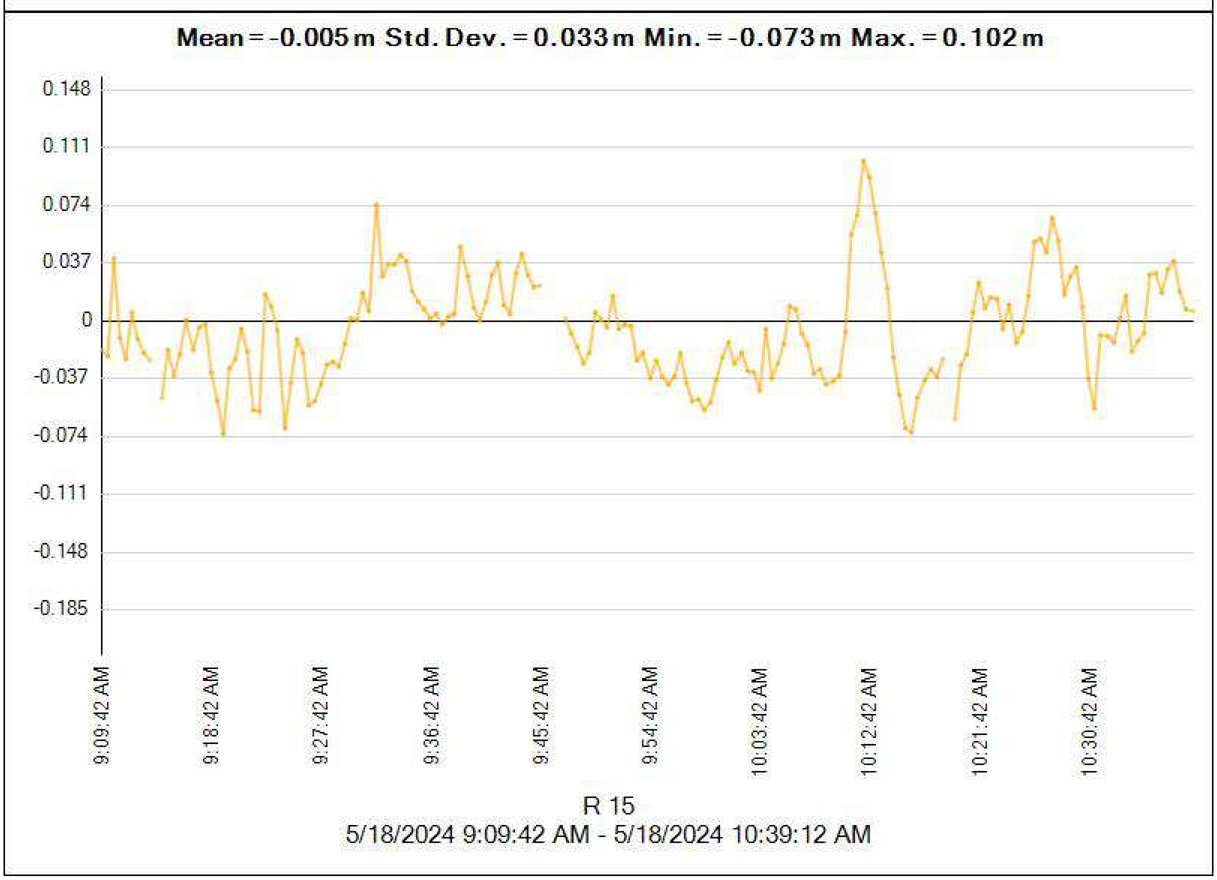

Mean = -0.022 m Std. Dev. = 0.023 m Min. = -0.062 m Max. = 0.020 m
0.148
0.111
0.074
0.037
0
-0.037
-0.074
-0.111
-0.148
-0.185
9:09:42 AM
9:18:42 AM
9:27:42 AM
9:36:42 AM
9:45:42 AM
9:54:42 AM
10:03:42 AM
10:12:42 AM
10:21:42 AM
10:30:42 AM
G 20
5/18/2024 9:09:42 AM - 5/18/2024 10:39:12 AM


Mean = -0.007 m Std. Dev. = 0.015 m Min. = -0.043 m Max. = 0.030 m
0.148
0.111
0.074
0.037
0
-0.037
-0.074
-0.111
-0.148
-0.185
9:09:42 AM
9:18:42 AM
9:27:42 AM
9:36:42 AM
9:45:42 AM
9:54:42 AM
10:03:42 AM
10:12:42 AM
10:21:42 AM
10:30:42 AM
G 22
5/18/2024 9:09:42 AM - 5/18/2024 10:39:12 AM

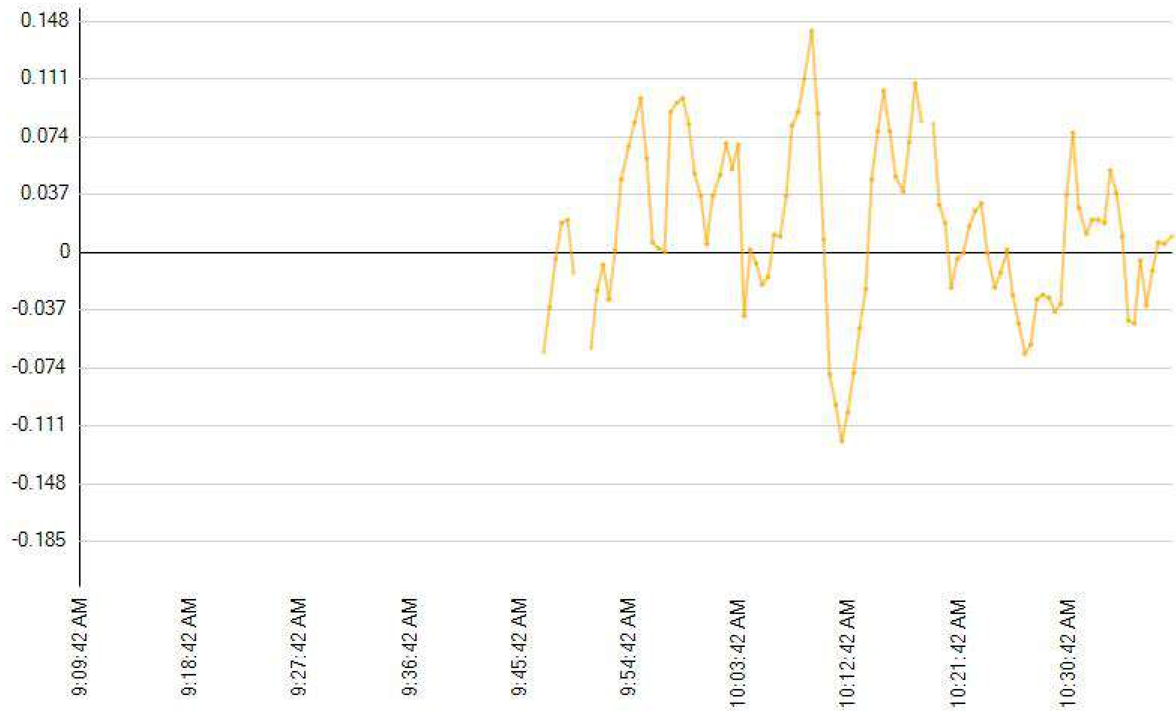

Mean = -0.003 m Std. Dev. = 0.030 m Min. = -0.111 m Max. = 0.153 m
0.148
0.111
0.074
0.037
0
-0.037
-0.074
-0.111
-0.148
-0.185
9:09:42 AM
9:18:42 AM
9:27:42 AM
9:36:42 AM
9:45:42 AM
9:54:42 AM
10:03:42 AM
10:12:42 AM
10:21:42 AM
10:30:42 AM
G 24
5/18/2024 9:09:42 AM - 5/18/2024 10:39:12 AM


Mean = 0.023 m Std. Dev. = 0.004 m Min. = 0.019 m Max. = 0.028 m
0.148
0.111
0.074
0.037
0
-0.037
-0.074
-0.111
-0.148
-0.185
9:09:42 AM
9:18:42 AM
9:27:42 AM
9:36:42 AM
9:45:42 AM
9:54:42 AM
10:03:42 AM
10:12:42 AM
10:21:42 AM
10:30:42 AM
G 30
5/18/2024 9:09:42 AM - 5/18/2024 10:39:12 AM


Mean = 0.010 m Std. Dev. = 0.051 m Min. = -0.115 m Max. = 0.157 m
0.148
0.111
0.074
0.037
0
-0.037
-0.074
-0.111
-0.148
-0.185
9:09:42 AM
9:18:42 AM
9:27:42 AM
9:36:42 AM
9:45:42 AM
9:54:42 AM
10:03:42 AM
10:12:42 AM
10:21:42 AM
10:30:42 AM
R 14
5/18/2024 9:09:42 AM - 5/18/2024 10:39:12 AM

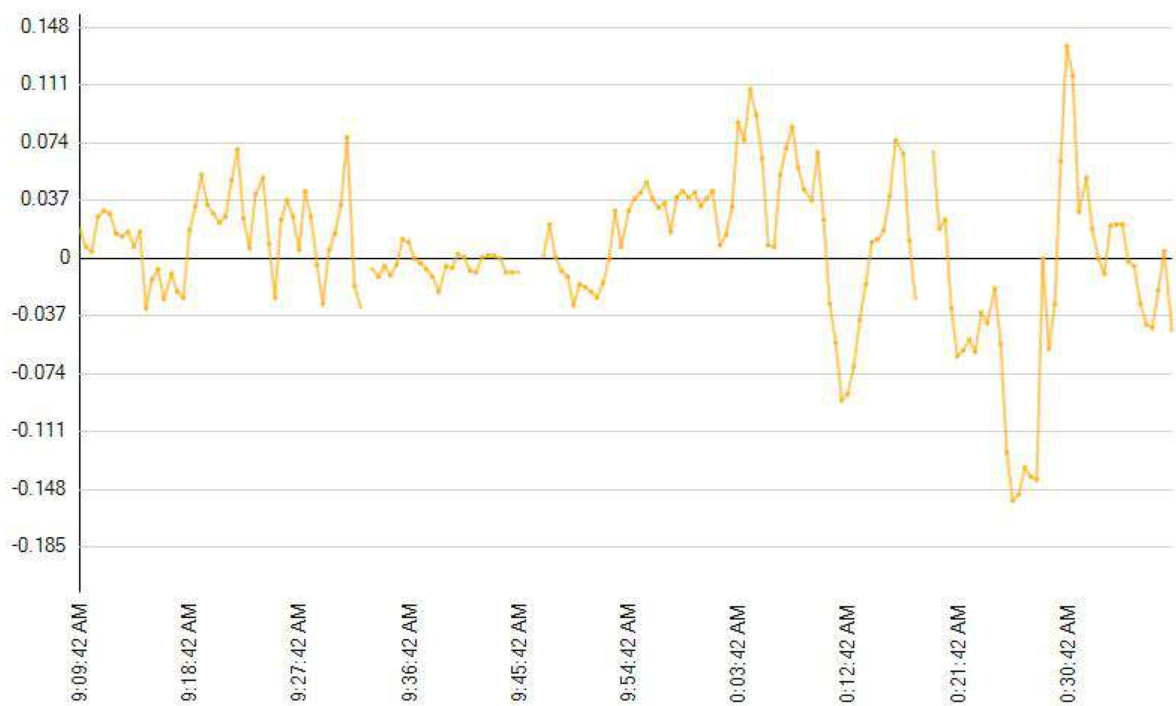

Mean = -0.005 m Std. Dev. = 0.033 m Min. = -0.073 m Max. = 0.102 m
0.148
0.111
0.074
0.037
0
-0.037
-0.074
-0.111
-0.148
-0.185
9:09:42 AM
9:18:42 AM
9:27:42 AM
9:36:42 AM
9:45:42 AM
9:54:42 AM
10:03:42 AM
10:12:42 AM
10:21:42 AM
10:30:42 AM
R 15
5/18/2024 9:09:42 AM - 5/18/2024 10:39:12 AM

Mean = 0.015 m Std. Dev. = 0.052 m Min. = -0.120 m Max. = 0.142 m

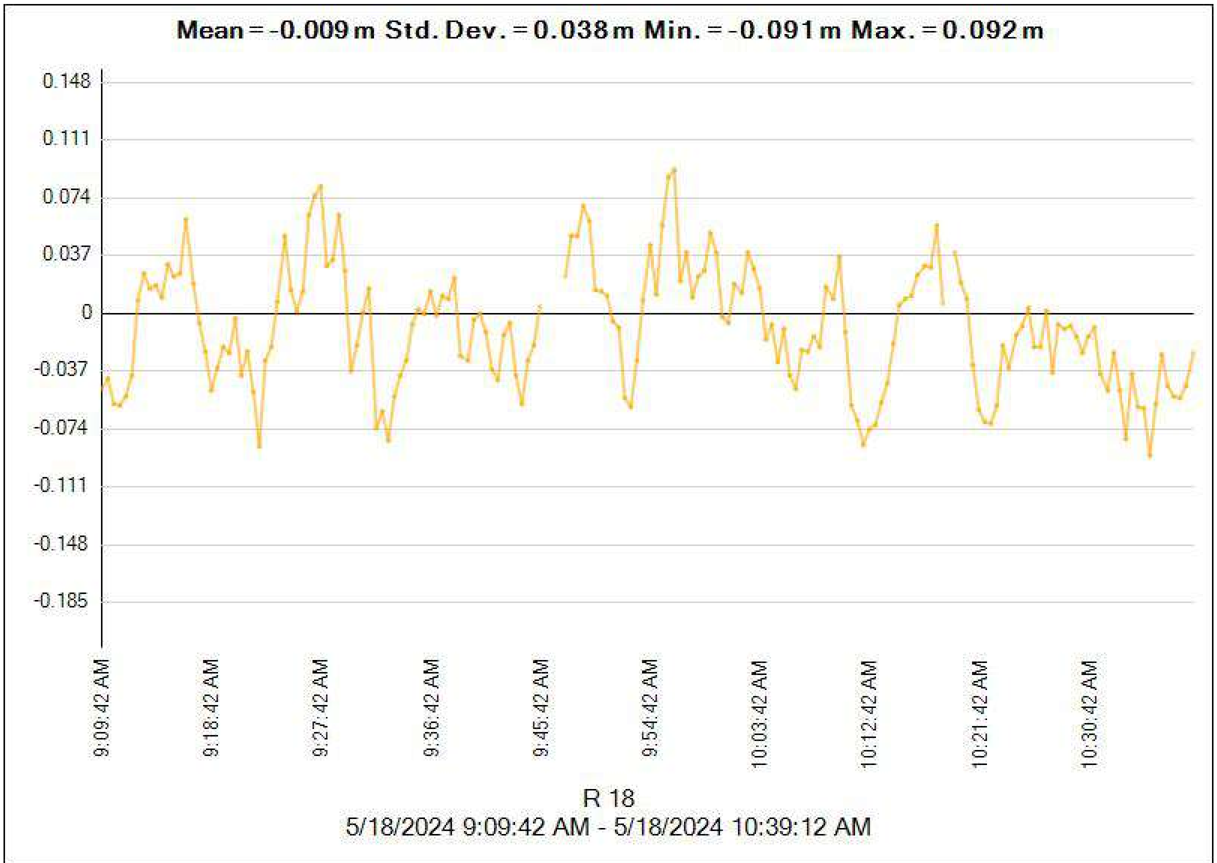


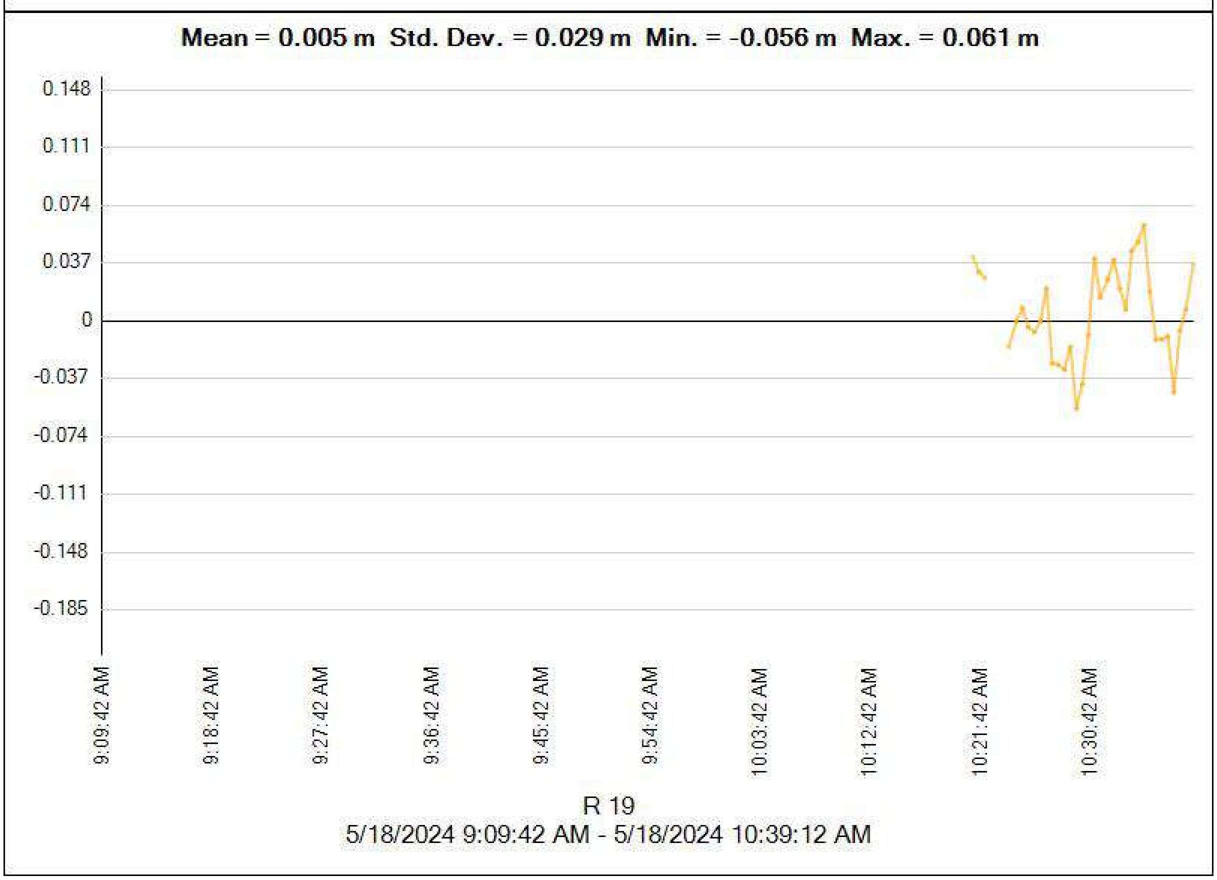
R 16
5/18/2024 9:09:42 AM - 5/18/2024 10:39:12 AM

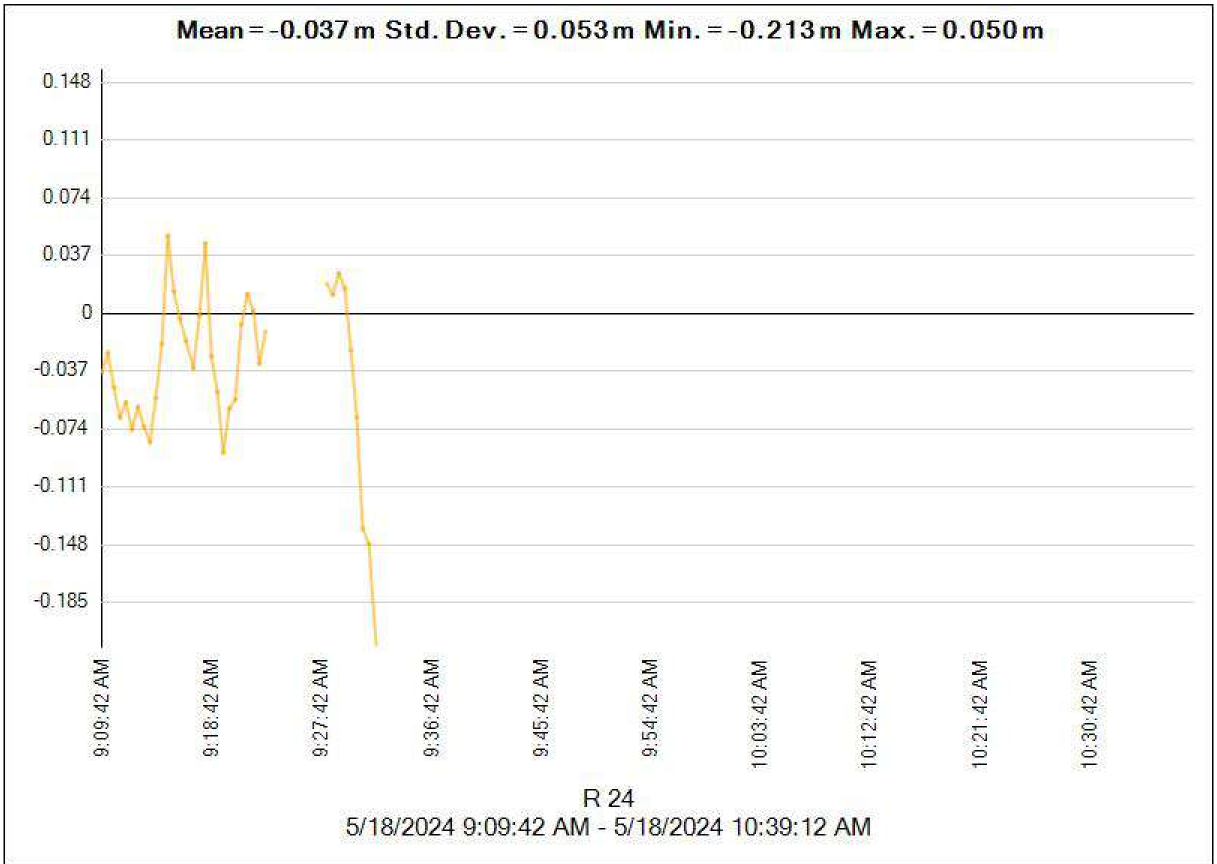
Mean = 0.005 m Std. Dev. = 0.046 m Min. = -0.155 m Max. = 0.136 m

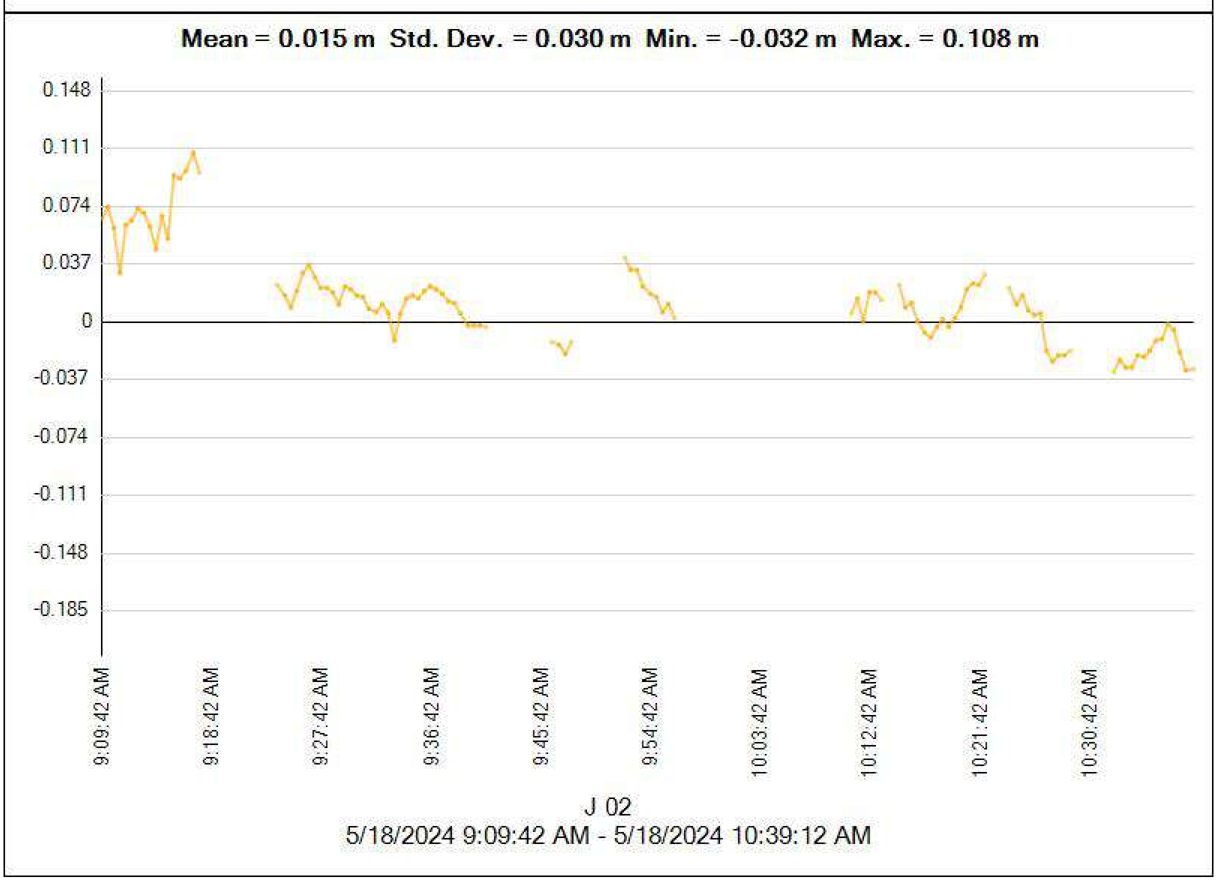


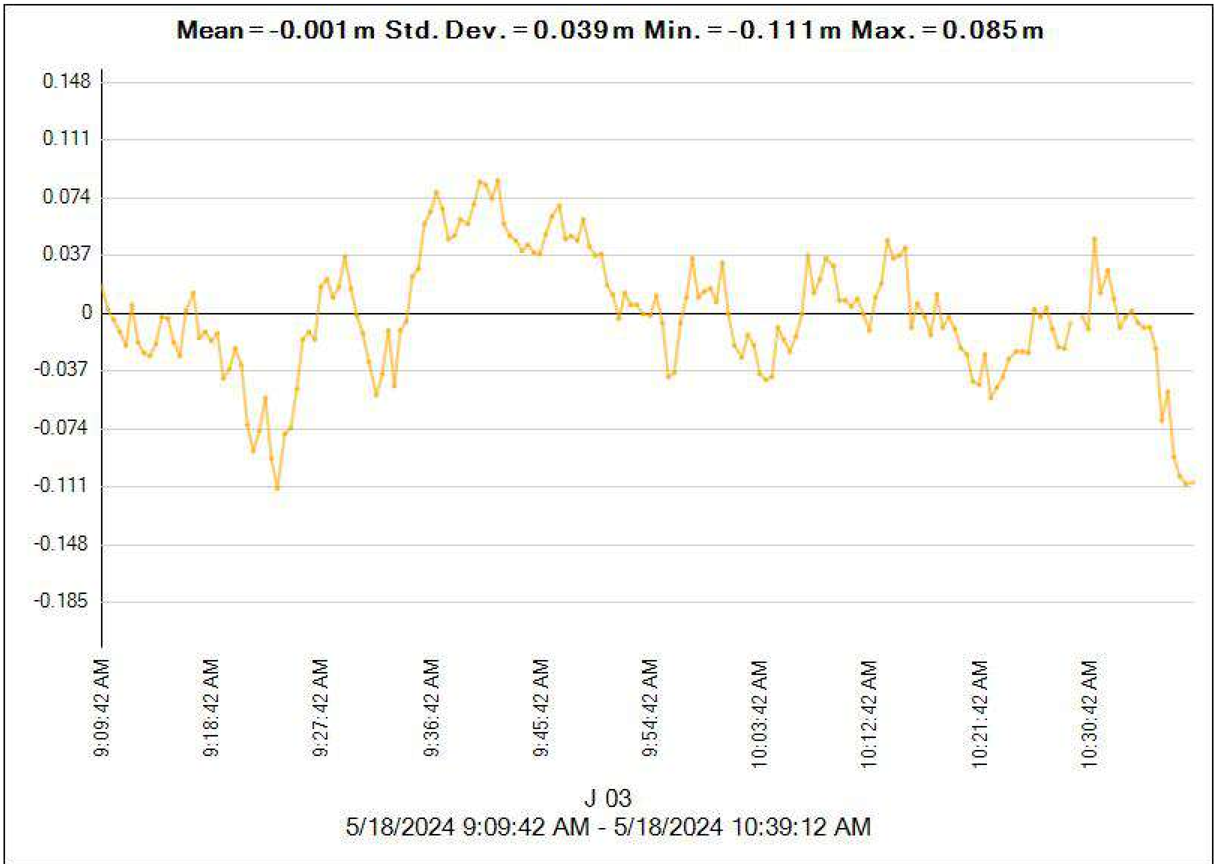
R 17
5/18/2024 9:09:42 AM - 5/18/2024 10:39:12 AM

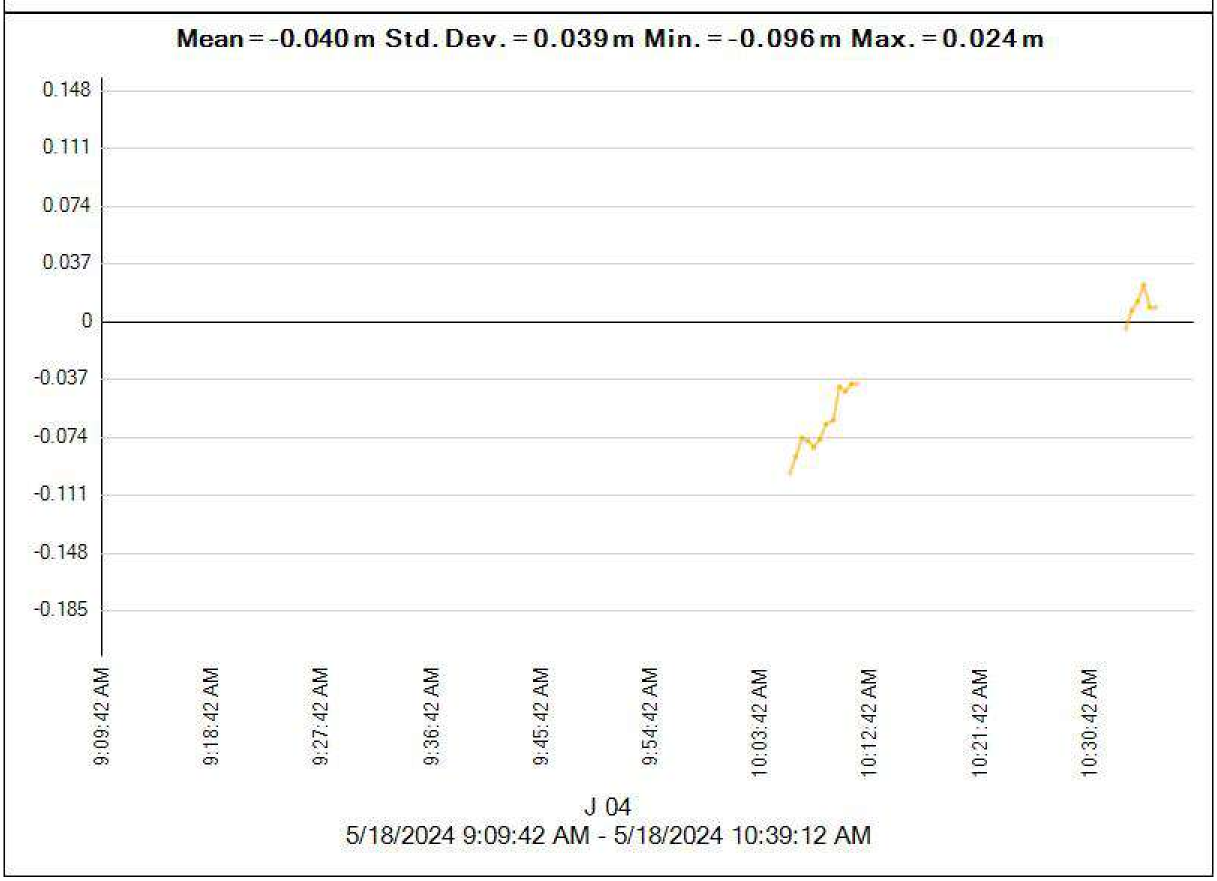

Mean = -0.009 m Std. Dev. = 0.038 m Min. = -0.091 m Max. = 0.092 m
0.148
0.111
0.074
0.037
0
-0.037
-0.074
-0.111
-0.148
-0.185
9:09:42 AM
9:18:42 AM
9:27:42 AM
9:36:42 AM
9:45:42 AM
9:54:42 AM
10:03:42 AM
10:12:42 AM
10:21:42 AM
10:30:42 AM
R 18
5/18/2024 9:09:42 AM - 5/18/2024 10:39:12 AM

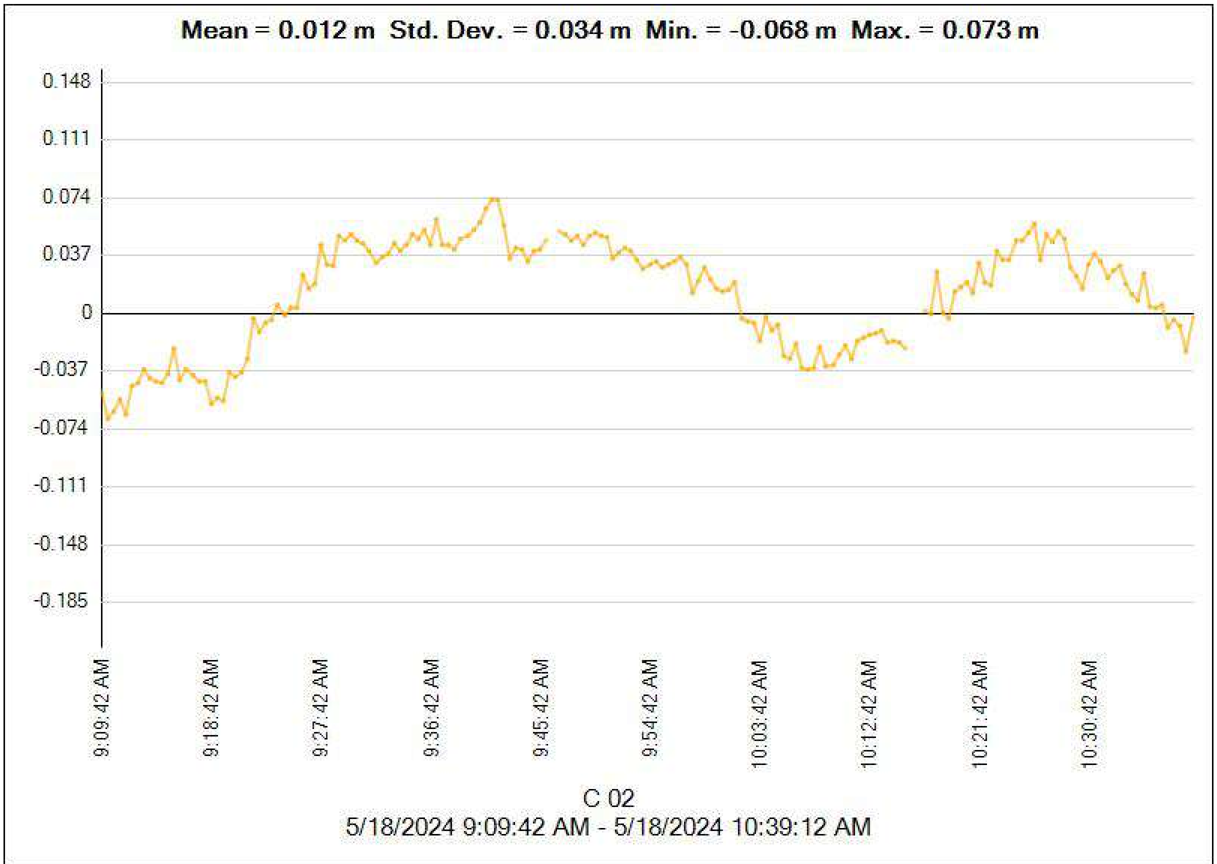

Mean = 0.005 m Std. Dev. = 0.029 m Min. = -0.056 m Max. = 0.061 m
0.148
0.111
0.074
0.037
0
-0.037
-0.074
-0.111
-0.148
-0.185
9:09:42 AM
9:18:42 AM
9:27:42 AM
9:36:42 AM
9:45:42 AM
9:54:42 AM
10:03:42 AM
10:12:42 AM
10:21:42 AM
10:30:42 AM
R 19
5/18/2024 9:09:42 AM - 5/18/2024 10:39:12 AM

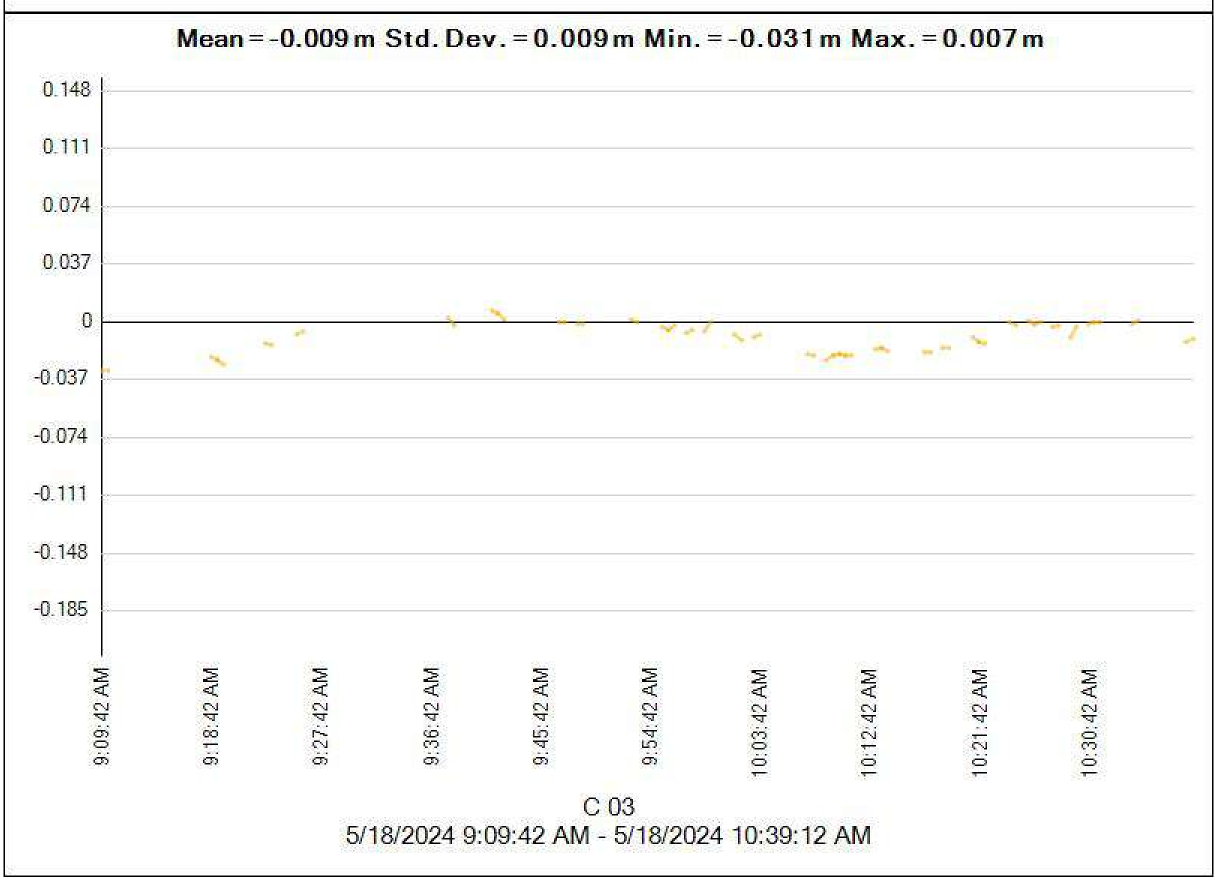

Mean = -0.037 m Std. Dev. = 0.053 m Min. = -0.213 m Max. = 0.050 m
0.148
0.111
0.074
0.037
0
-0.037
-0.074
-0.111
-0.148
-0.185
9:09:42 AM
9:18:42 AM
9:27:42 AM
9:36:42 AM
9:45:42 AM
9:54:42 AM
10:03:42 AM
10:12:42 AM
10:21:42 AM
10:30:42 AM
R 24
5/18/2024 9:09:42 AM - 5/18/2024 10:39:12 AM

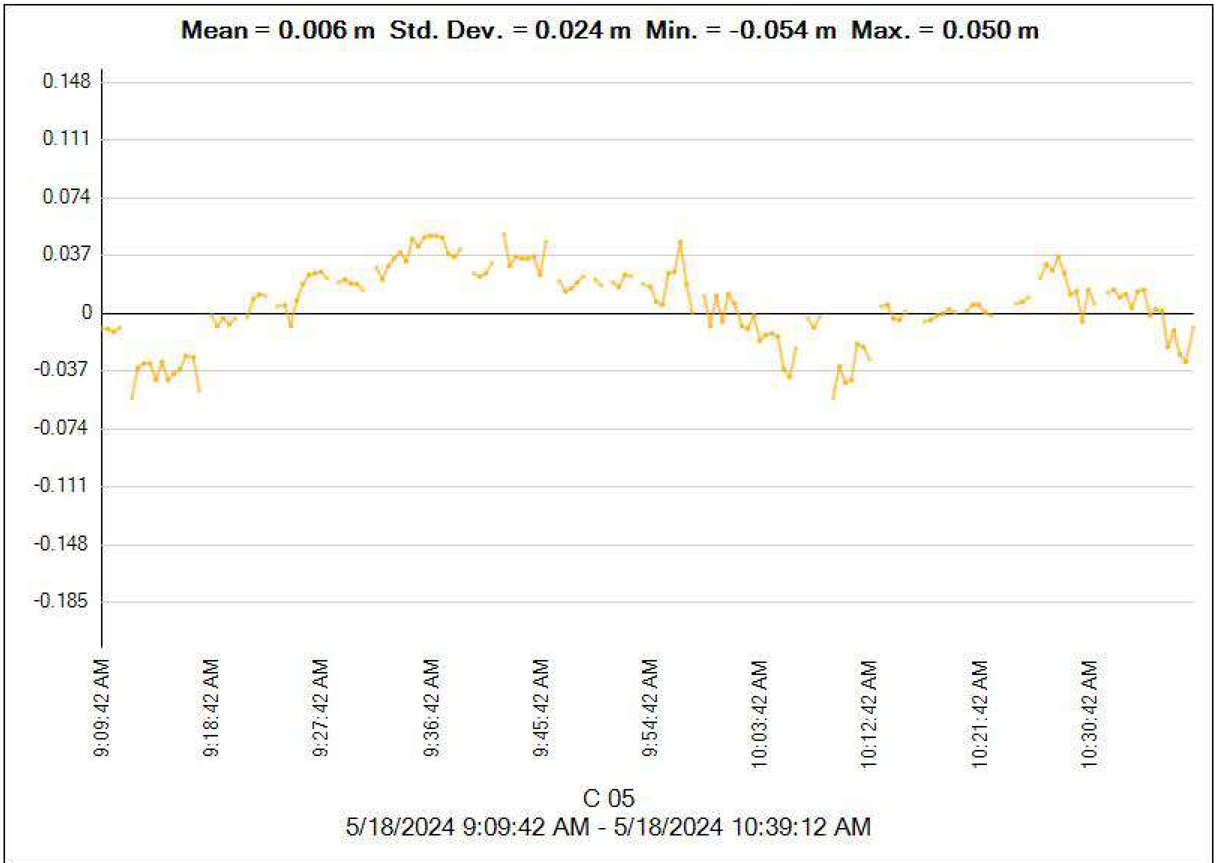

Mean = 0.015 m Std. Dev. = 0.030 m Min. = -0.032 m Max. = 0.108 m
0.148
0.111
0.074
0.037
0
-0.037
-0.074
-0.111
-0.148
-0.185
9:09:42 AM
9:18:42 AM
9:27:42 AM
9:36:42 AM
9:45:42 AM
9:54:42 AM
10:03:42 AM
10:12:42 AM
10:21:42 AM
10:30:42 AM
J 02
5/18/2024 9:09:42 AM - 5/18/2024 10:39:12 AM

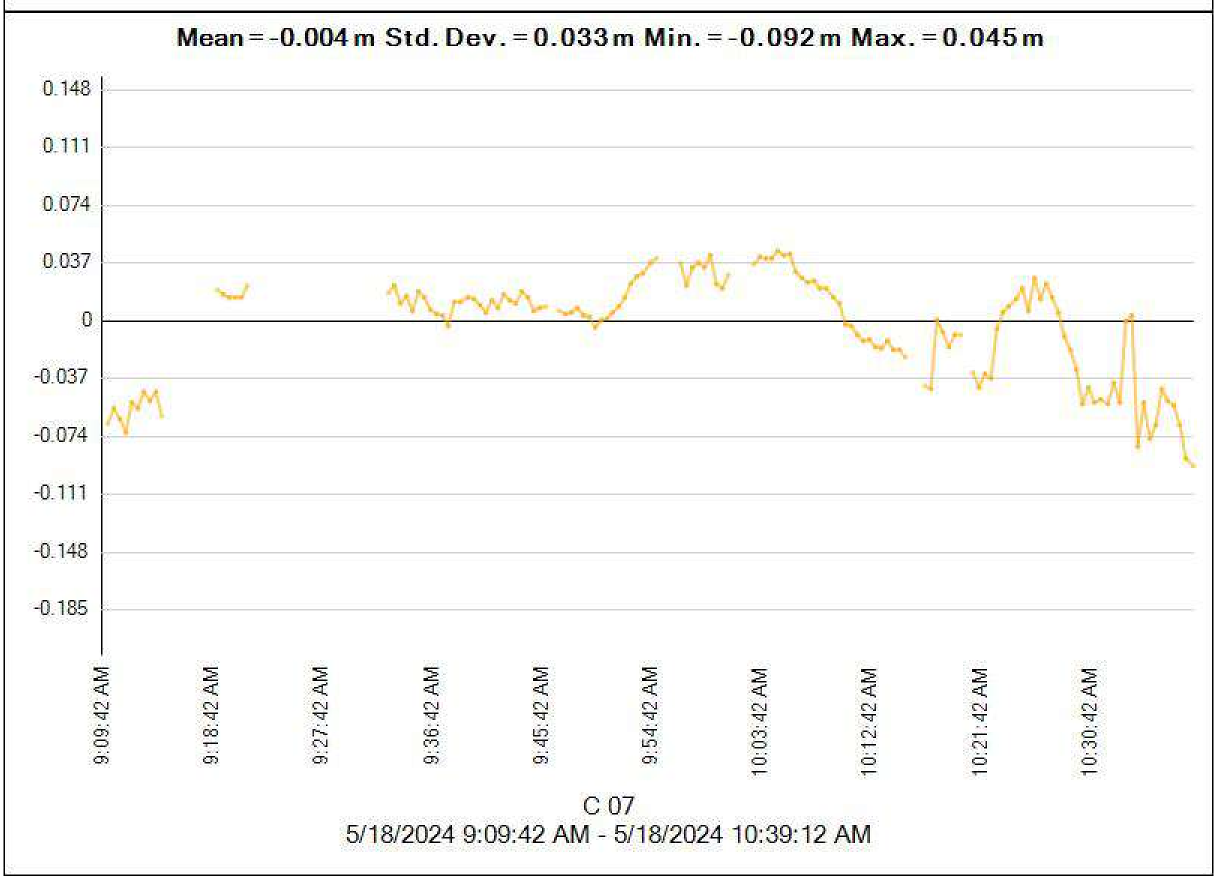

Mean = -0.001 m Std. Dev. = 0.039 m Min. = -0.111 m Max. = 0.085 m
0.148
0.111
0.074
0.037
0
-0.037
-0.074
-0.111
-0.148
-0.185
9:09:42 AM
9:18:42 AM
9:27:42 AM
9:36:42 AM
9:45:42 AM
9:54:42 AM
10:03:42 AM
10:12:42 AM
10:21:42 AM
10:30:42 AM
J 03
5/18/2024 9:09:42 AM - 5/18/2024 10:39:12 AM

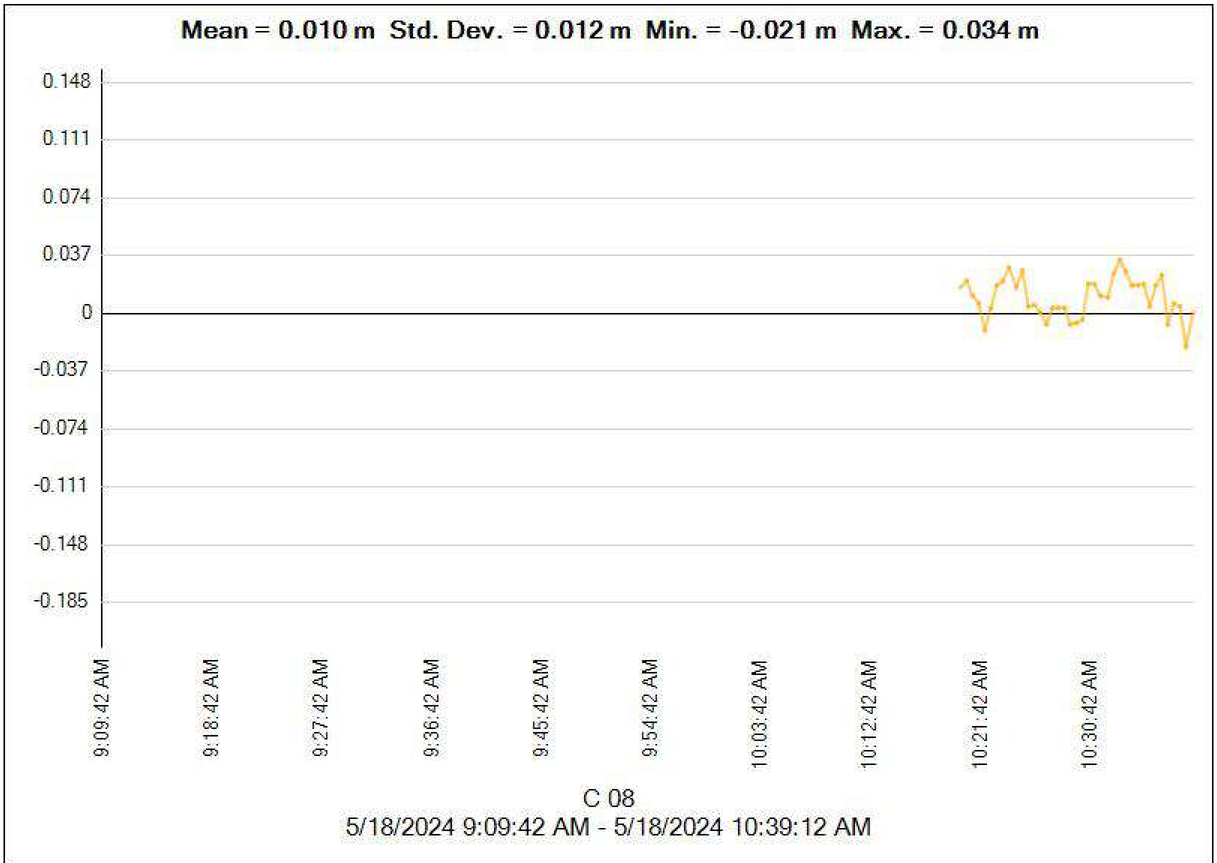

Mean = -0.040 m Std. Dev. = 0.039 m Min. = -0.096 m Max. = 0.024 m
0.148
0.111
0.074
0.037
0
-0.037
-0.074
-0.111
-0.148
-0.185
9:09:42 AM
9:18:42 AM
9:27:42 AM
9:36:42 AM
9:45:42 AM
9:54:42 AM
10:03:42 AM
10:12:42 AM
10:21:42 AM
10:30:42 AM
J 04
5/18/2024 9:09:42 AM - 5/18/2024 10:39:12 AM

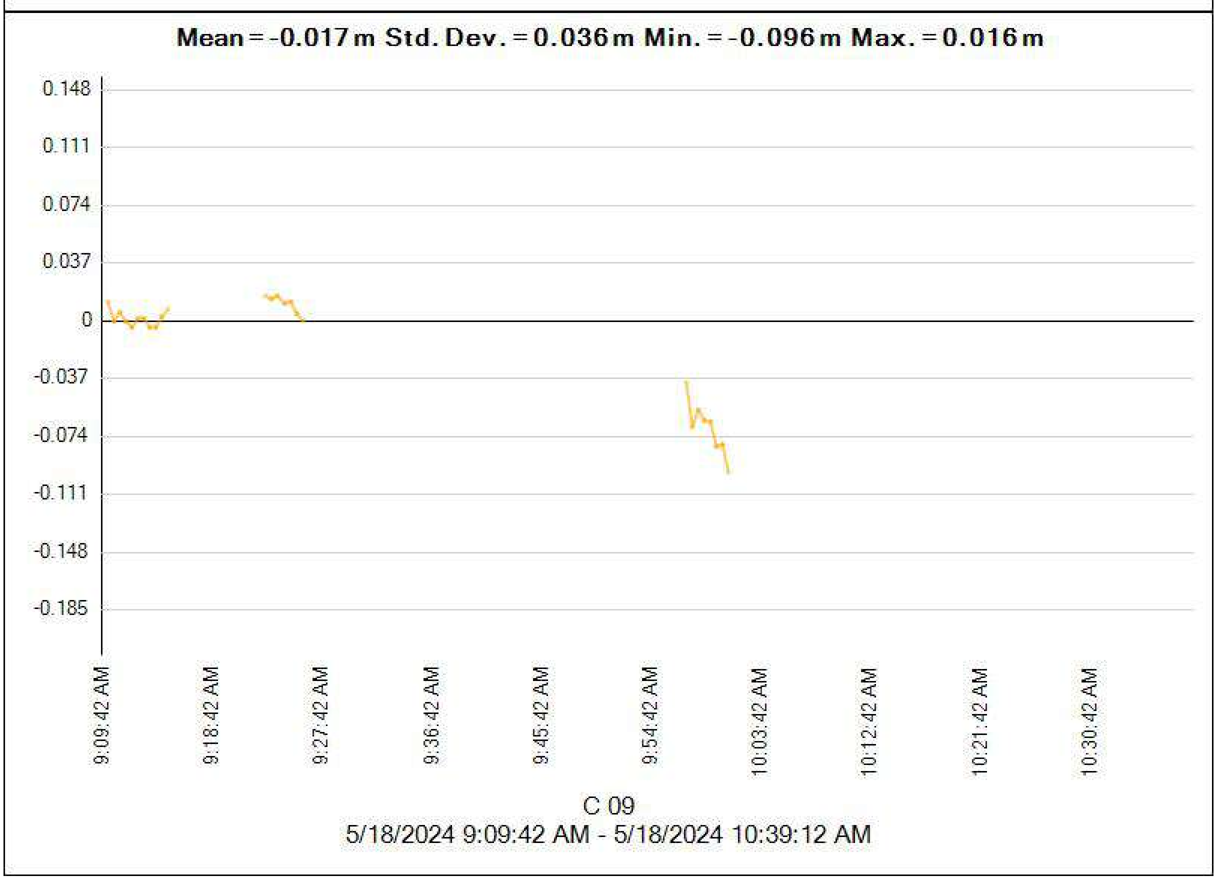

Mean = 0.012 m Std. Dev. = 0.034 m Min. = -0.068 m Max. = 0.073 m
0.148
0.111
0.074
0.037
0
-0.037
-0.074
-0.111
-0.148
-0.185
9:09:42 AM
9:18:42 AM
9:27:42 AM
9:36:42 AM
9:45:42 AM
9:54:42 AM
10:03:42 AM
10:12:42 AM
10:21:42 AM
10:30:42 AM
C 02
5/18/2024 9:09:42 AM - 5/18/2024 10:39:12 AM

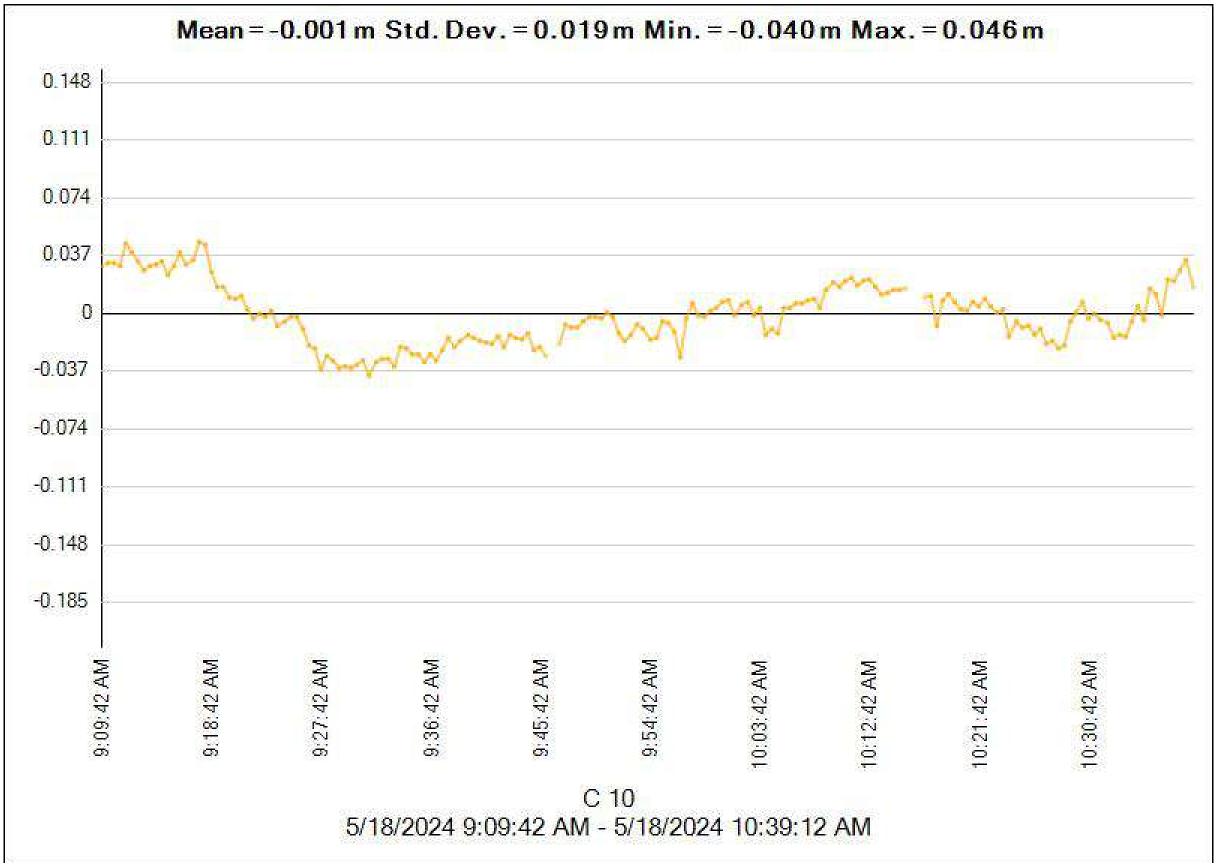

Mean = -0.009 m Std. Dev. = 0.009 m Min. = -0.031 m Max. = 0.007 m
0.148
0.111
0.074
0.037
0
-0.037
-0.074
-0.111
-0.148
-0.185
9:09:42 AM
9:18:42 AM
9:27:42 AM
9:36:42 AM
9:45:42 AM
9:54:42 AM
10:03:42 AM
10:12:42 AM
10:21:42 AM
10:30:42 AM
C 03
5/18/2024 9:09:42 AM - 5/18/2024 10:39:12 AM

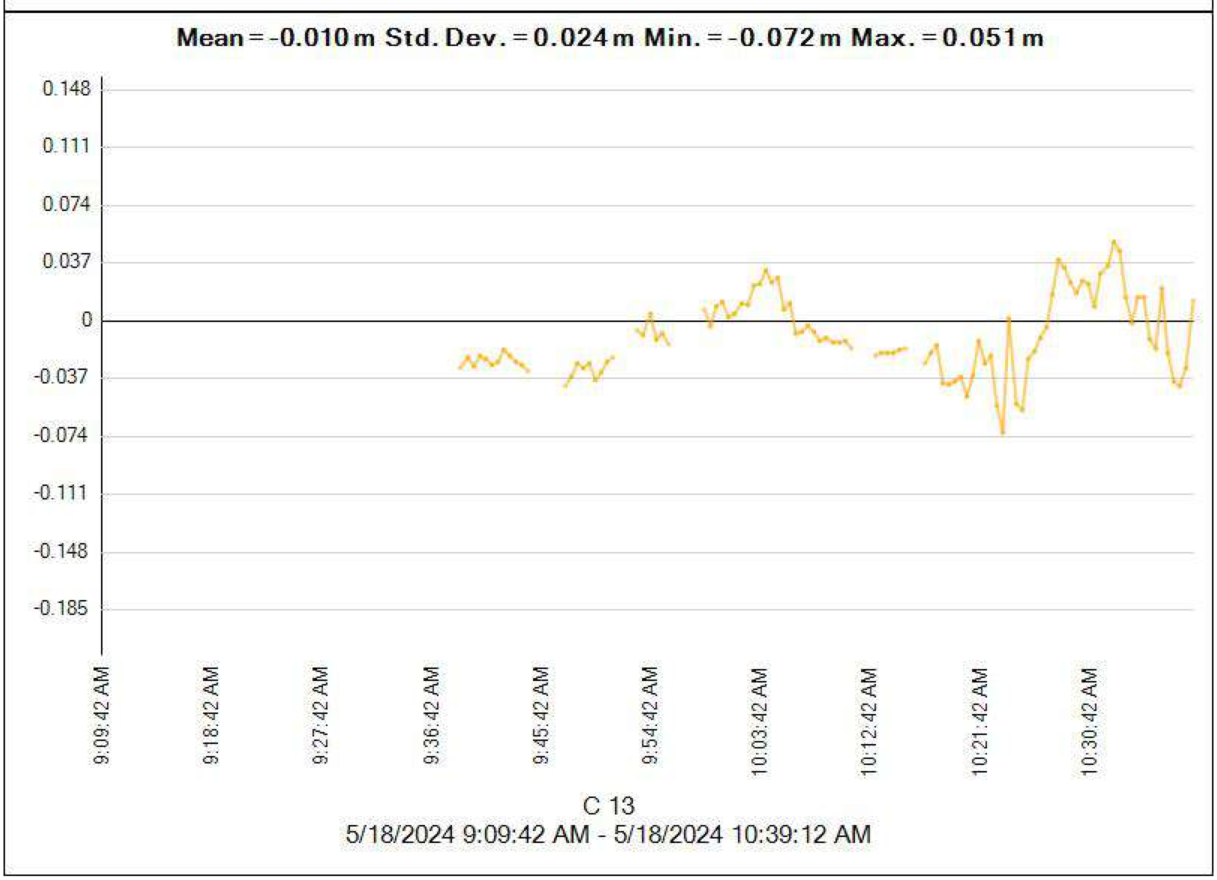

Mean = 0.006 m Std. Dev. = 0.024 m Min. = -0.054 m Max. = 0.050 m
0.148
0.111
0.074
0.037
0
-0.037
-0.074
-0.111
-0.148
-0.185
9:09:42 AM
9:18:42 AM
9:27:42 AM
9:36:42 AM
9:45:42 AM
9:54:42 AM
10:03:42 AM
10:12:42 AM
10:21:42 AM
10:30:42 AM
C 05
5/18/2024 9:09:42 AM - 5/18/2024 10:39:12 AM


Mean = -0.004 m Std. Dev. = 0.033 m Min. = -0.092 m Max. = 0.045 m
0.148
0.111
0.074
0.037
0
-0.037
-0.074
-0.111
-0.148
-0.185
9:09:42 AM
9:18:42 AM
9:27:42 AM
9:36:42 AM
9:45:42 AM
9:54:42 AM
10:03:42 AM
10:12:42 AM
10:21:42 AM
10:30:42 AM
C 07
5/18/2024 9:09:42 AM - 5/18/2024 10:39:12 AM


Mean = 0.010 m Std. Dev. = 0.012 m Min. = -0.021 m Max. = 0.034 m
0.148
0.111
0.074
0.037
0
-0.037
-0.074
-0.111
-0.148
-0.185
9:09:42 AM
9:18:42 AM
9:27:42 AM
9:36:42 AM
9:45:42 AM
9:54:42 AM
10:03:42 AM
10:12:42 AM
10:21:42 AM
10:30:42 AM
C 08
5/18/2024 9:09:42 AM - 5/18/2024 10:39:12 AM


Mean = -0.017 m Std. Dev. = 0.036 m Min. = -0.096 m Max. = 0.016 m
0.148
0.111
0.074
0.037
0
-0.037
-0.074
-0.111
-0.148
-0.185
9:09:42 AM
9:18:42 AM
9:27:42 AM
9:36:42 AM
9:45:42 AM
9:54:42 AM
10:03:42 AM
10:12:42 AM
10:21:42 AM
10:30:42 AM
C 09
5/18/2024 9:09:42 AM - 5/18/2024 10:39:12 AM

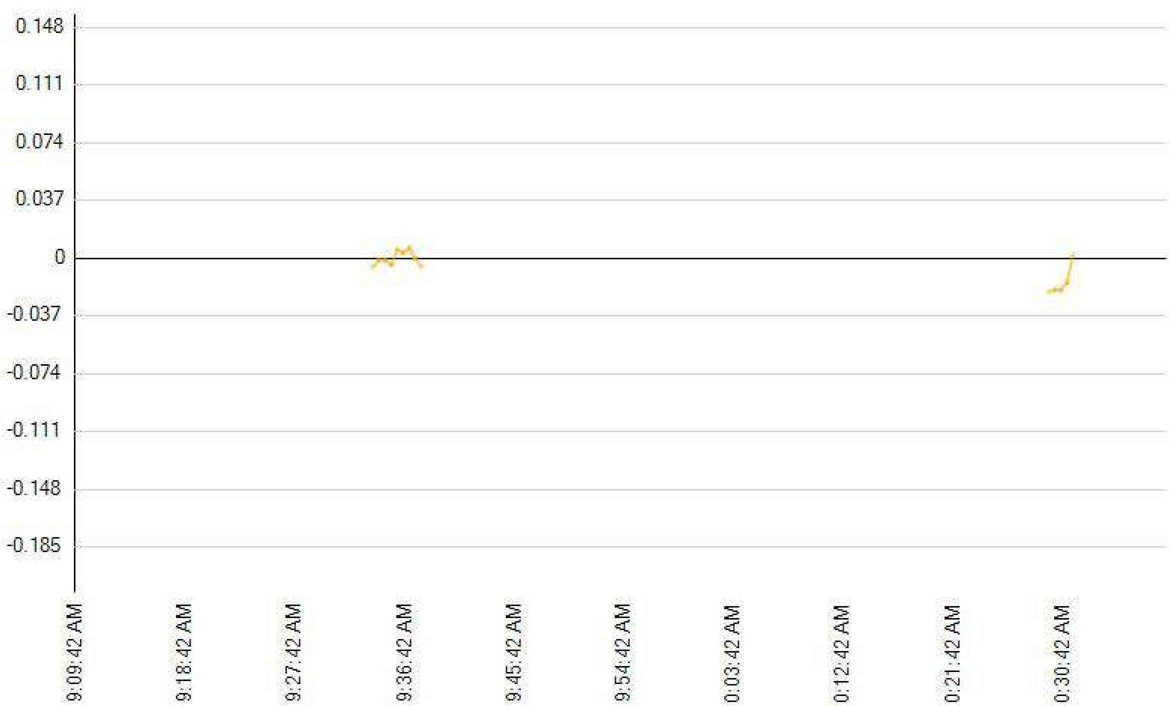

Mean = -0.001 m Std. Dev. = 0.019 m Min. = -0.040 m Max. = 0.046 m
0.148
0.111
0.074
0.037
0
-0.037
-0.074
-0.111
-0.148
-0.185
9:09:42 AM
9:18:42 AM
9:27:42 AM
9:36:42 AM
9:45:42 AM
9:54:42 AM
10:03:42 AM
10:12:42 AM
10:21:42 AM
10:30:42 AM
C 10
5/18/2024 9:09:42 AM - 5/18/2024 10:39:12 AM


Mean = -0.010 m Std. Dev. = 0.024 m Min. = -0.072 m Max. = 0.051 m
0.148
0.111
0.074
0.037
0
-0.037
-0.074
-0.111
-0.148
-0.185
9:09:42 AM
9:18:42 AM
9:27:42 AM
9:36:42 AM
9:45:42 AM
9:54:42 AM
10:03:42 AM
10:12:42 AM
10:21:42 AM
10:30:42 AM
C 13
5/18/2024 9:09:42 AM - 5/18/2024 10:39:12 AM

Mean = -0.008 m Std. Dev. = 0.016 m Min. = -0.040 m Max. = 0.031 m

C 27
5/18/2024 9:09:42 AM - 5/18/2024 10:39:12 AM

Mean = -0.006 m Std. Dev. = 0.009 m Min. = -0.021 m Max. = 0.006 m



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GIS processing type:	Automatic Carrier and Code Processing

Acceptance Criteria

Vector Component	Flag	Fail
Horizontal Precision >	0.050 m + 1.000 ppm	0.100 m + 1.000 ppm
Vertical Precision >	0.100 m + 1.000 ppm	0.200 m + 1.000 ppm

NEPAL ELETRICITY AUTHORITY

Transmission Grid Development Department

Project Title: Urban Transmission & Distribution System Improvement Project in Nepal

Report on: Geotechnical Investigation Work on Birauta Substation and Transmission line (Pokhara)

Submitted To: Nippon Koei Co. Ltd., Japan

Submitted By: Pashupati Drilling & Geo-Technical Services Pvt. Ltd, Bhaktapur, Nepal

(June 2024)

ACKNOWLEDGEMENT

Pashupati Drilling & Geo- Technical Services Pvt. Ltd., Lokanthali, Bhaktapur is very much grateful to ***Nippon Koei Co. Ltd., 5-4 Kokimachi, Chiyoda-ku, Tokyo 102-8539 JAPAN*** on behalf of ***Nepal Electricity Authority (NEA), Nepal*** for entrusting the job of ***Geotechnical Investigation Work for Birauta 132/11 kV GIS Substation Site & Transmission Line at Birauta, Pokhara – 17 of Kaski District*** to reveal the facts and figures relating to the sub–soil exploration of Substation Site for the foundation design.

We hope this report will bring some useful parameters for a safe design of proposed Structures. This report shall also be useful in positioning the depth of foundation, in assuming the size of the foundation and corresponding safe bearing capacity.

Last but not the least, we hope for an early and successful completion of the project.

Sanoj Bhattarai
Geotech. Engineer

Pashupati Drilling and Geo- Technical Services Pvt. Ltd.

Contents

1.0 GENERAL INTRODUCTION

1.1 Background

The Government of Nepal has received a loan from the Japan International Cooperation Agency (hereinafter referred to as "JICA") to finance “Detailed Design and Construction Supervision of Urban Transmission and Distribution System Improvement Project in Nepal” (hereinafter referred to as “the Project”) which is to improve the transmission and distribution system in urban areas of Nepal. Thus, this report is prepared under the agreement of Nippon Koei Co. Ltd., Japan (hereinafter referred to as “the Consultant”) on behalf of Nepal Electricity Authority (NEA), Nepal (hereinafter referred to as “the Client”).

From the project subproject named Pokhara Package where the geotechnical investigation works for the proposed Birauta 132/11kV GIS Substation Site & Transmission Line at Birauta, Pokhara – 17 of Kaski District. One (1) nos. of bore hole and ERT test has been proposed in each substation and transmission line site for the sub-soil investigation program, which are nearer to the vehicular approach from District Road Network of Kaski District.

1.2 General Geology and Geomorphology

The site is located in Kaski District in the mountainous Western Region of Nepal which is also a part of Kuncha Group of the Lesser Himalayan Metasediments.

The geological formation of the Kuncha Group is Precambrian. It contains mainly flyschoid sequence (beded schists, phylites and meta sandstones), locally shallow water quartize beds and basic sills and dykes.

As a matter of fact, the project site is in a flat area formed by old alluvial and residual soils having clayey silts, gravelly sands and silty gravels with cobbles, boulders etc. are seen in their textures around the vicinity of the site. The deposits are in medium to stiff consistency and medium to very dense in state. Moreover, the foundation structure on these soil layers would be comparatively economical.

Moreover, the different data of epicenter and magnitude of the historical earthquakes show that Nepal is located on high seismic zones. Further, for this site from the figure of seismicity map of Nepal (attached in ***annexes***-), lies in the weakness zone from the past seismic records and passes far from the fault zones. The epicentral distance is quite nearer from minor to major earthquakes. So, we may conclude that the proposed site should be made safe from the devasting earthquake.

2.0 OBJECTIVES

The main objective of this investigation is to explore geotechnical characteristics of the sub–soil strata, (i) to assess the engineering properties of the sub-soil; (ii) to confirm bearing capacity value of the ground strata during design of foundation, and (iii) to confirm the design parameters to be used during the detailed design of the Civil & Electrical Structure’s foundation in the proposed sub-station site and transmission line angle point.

3.0 SCOPE OF THE WORK

The main scopes of the works are:-

(i) To carryout the field and laboratory tests of each bore hole and ERT Tests.

(ii) To find out genetic background of the sub-surface layers.

(iii) To collect the engineering, electrical and geotechnical properties of the soil.

(iv) To design the foundation types for Civil & Electrical structures.

4.0 METHODOLOGY

The following are the methodology adopted to meet the objectives:

4.1 Field Work Procedure

The core drilling method involved Rotary Drilling Method for drilling and sampling of the boreholes inside the sub-station area and transmission line angle point where it was applicable to the maximum depth of 20.0m from the ground levels and SPT/DCPT observations were taken at every 0.5m and then 1.5m intervals and were recorded. Borehole logs were prepared at the site on the basis of the visual observation of the soil obtained from the boreholes. The bore hole logs are attached to the ***annexes*** are later verified by lab test results.

Method of Drilling

Rotary Drilling Method (IS : 4464 – 1985, IS : 1892, IS : 6926 – 1973) :-

Rotary Drilling Method is used by rotating the core bit fixed at the lower end of the drill rod i.e. barrel with drilling fluid; water or bentonite slurry. This method is widely used in the project area where the cohesionless soil layers having sandy gravels with pebbles, cobbles, boulders and rockmass etc. should be encounter in the vicinity of the sites.

The drilling will be carried out with NX series diamond tipped drill bits (IS : 6929) on core barrel with core catchers for core recovery. This method is suitable for all types of soil layers and rockmass.

Earth Resistivity Test (ERT) :-

Soil resistivity is a measure of how much the soil resists the flow of electricity. An understanding of the soil resistivity and how it varies with depth in soil is a necessary to design the grounding system in an electrical tower or for lighting conductor. It is needed for design of earthing system for tower and substation structures.

Soil resistivity testing is the process of measuring a volume of soil to determine the conductivity of the soil. The resulting soil resistivity is expressed in ohm-meter or ohm-centimeter.

The method adopted to calculate the ground resistivity is Wenner Four-Pin Method which was developed by Dr. Frank Wenner US Bureau of Standards in 1915, (this study also follows IS 3043:1987 Code of Practice for Earthing). In this method four electrode are used, two electrodes C1 and C2 for current injection into the ground and other two electrodes P1 and P2 for voltage measurements respectively. While calculating the data on the field, the four electrodes are embedded into the ground in the straight line and two outer electrodes are used as current electrode and used to inject the current into the ground and two inner electrodes are used as potential electrode and help to measure the voltage drop due to resistance of soil path when current passes between the outer electrodes. The schematic diagram of the Wenner Four Pin Configurations can be shown in figure - 1.

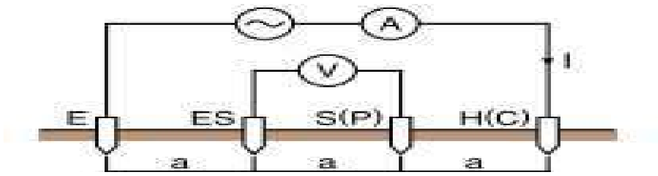

Fig. 1 : Schematic Diagram of the Wenner Four Pin Configurations

The resistivity can be calculated from the measured resistance value by using the following formula

$\rho = 2 \pi a R$

Where, ρ = Resistivity in ohm-m

a = Spacing between two adjacent electrodes/spikes

R = Resistance measured in ohm

It should be noted that measurements made in this manner indicate average resistivity over a depth of soil corresponding to the spacing between adjacent electrodes.

In general, Resistivity values of different soil/rock types are listed below:

Type of Soil & Rock	**Mean Value of Resistivity in Ωm**
Swampy soil, bogs	1 - 30
Silt alluvium	20 - 100
Humus, leaf mould	10 - 150
Peat, turf	5 - 100
Soft clay	50
Marl and compacted clay	100 - 200
Jurassic marl	30 - 40
Clayey sand	50 - 500
Siliceous sand	200 - 300
Stoney ground	1,500 - 3,000
Grass-covered-stoney sub-soil	300 - 500
Chalky soil	100 - 300
Limestone	1,000 - 5,000
Fissured limestone	500 - 1,000
Schist, shale	50 - 300
Mica schist	800
Granite and sandstone	1,500 - 10,000
Modified granite and sandstone	100 - 600
Fertile soil, compacted damp fill	50
Arid soil, gravel, uncompacted non-uniform fill	500
Stoney soil, bare, dry sand, fissured rocks	3,000

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4.1.1 In-situ Tests

Standard Penetration Test (SPT) IS : 2131: It consists of driving a Split Spoon sampler with an outside dia. of 50 mm into the soil at the base of borehole. Driving is accomplished by a drop of hammer weighing 63.5 kg falling freely through a height of 750 mm onto the drive head. First of all the spoon is driven 150mm into the soil at the bottom of the borehole. It is then driven further 300mm and the number of blows (N values) required to drive this distance is recorded. The first 150mm penetration blow counts for SPT Value will not be considered for getting total SPT Value only two successive blow count readings 150 – 300 and 300 to 450mm penetration were added for getting total (N) value.

Dynamic Cone penetration Test (DCPT) IS : 4968 part I & II: it was performed using a 62.5mm cone. The cone was driven with 63.5 kg hammer falling through a height of 75 cm. The recorded number of blows required to penetrate the least 300 mm is taken as DCPT values. DCPT all three readings 0 – 100, 100 – 200 & 200 – 300mm penetration blow count values added for total DCPT Values.

The refusal will be count when the blow count exceeds 100 for 300mm penetration or exceed 50 blows for initial 150mm penetration respectively. If refusal count continues for two successive readings then the core drilling will be stopped after 3.0m drilling works. The field values of SPT (N) are mentioned in the attached log sheets which are used for bearing capacity (B.C.) analysis.

Cohesion (c) & Angle of Internal Friction (ϕ) :-

The cohesion (c) and angle of internal friction (ϕ) of the cohesive and semi cohesive layers are found by lab test results. Whereas, for the cohesionless and semi cohesionless soils having sands, gravels, cobbles, pebbles, boulders and jointed rockmass; the value of (ϕ) could be found by using relationship developed by Halanakar & Uchida (1996);

$$(\phi) = \sqrt{20N_{60}} + 17 \text{ degree} \qquad \text{(i)}$$

N_{60} = corrected (N) value.

But, in actual the field condition of sub- surface layers could not be found homogenous and identical. So, the approximate 80 % of the above value will be used for the general design purpose.

Hence,

$$(\phi) = 0.8\,(\sqrt{20N_{cor}} + 17) \text{ degree} \qquad \text{(ii)}$$

4.1.2 Sampling (IS : 2132, IS : 1498, IS : 11594))

(i) Disturbed Sample:

Before any sample was taken, the boreholes were cleaned up of loose disturbed soil deposited during drilling operation. The samples that were obtained from representative sludge, barrel and the SPT tubes were preserved as representative disturbed samples for finding out physical properties. The samples thus obtained were placed in airtight double plastic bags, labeled properly for identification and later transported to the laboratory for analysis.

(ii) Undisturbed Sample:

The UD soil samples were not taken effectively below the probable foundation depth in bore holes due to the presence of coarse grained soils with pebbles, cobbles, boulders etc.

4.2 Laboratory Test

Following laboratory tests were conducted for the retrieved soil samples to get the physical and strength properties of the sub soil, as per IS & ASTM standards code of practice.

a) Grain Size Distribution Analysis
b) Atterberg's Limit
c) Natural Moisture Contents
d) Bulk & Dry Density
e) Specific Gravity Tests
f) Direct Shear Tests
g) Consolidation Tests and,
h) Chemical Tests of Water & Soil Samples

Briefly Description:-

Grain size Analysis

Grain size distribution was determined by wet and dry mechanical process. Sieve analysis was carried out by sieving a soil sample through a set of sieves kept one over the other, the largest size being kept at the top and the smallest size at the bottom. The soil retained on each sieve was weighed and expressed as a percentage of the weight of sample. Finally, the gradation curve was found using % finer and corresponding particle size (D), dia.

Atterberg's Limit

Liquid Limits (LL) and plastic limits (PL) were conducted on fine grained soils by standard methods. Casagrande's Plasticity Chart was used to classify the fine grained soil according to the Unified Soil Classification System (USCS).

Natural Moisture Content and Bulk Density

The natural water content and bulk density was determined from samples recovered through the split spoon sampler and the UD samples respectively.

Specific Gravity Test

The specific gravity test was conducted of the dry soil samples which passes the No. 200 mm sieve. The density bottle method is widely used in the laboratory test for finding out Specific Gravity (G) value of soil samples.

Direct Shear Test

Direct shear tests were conducted on UD and representative disturbed samples collected from the boreholes. The samples were carefully molded using standard moulds of 6.0 x 6.0 cm^2 cross-sectional areas and trimmed to 2.5 cm high solid metal plates were placed on both surfaces of the samples to prevent the dissipation of pore water during shearing. The direct shear test equipment was mechanically-operated and shearing was applied at more or less constant strain rate. The samples were sheared at three different normal stresses. The direct shear test results were presented in terms of the failure envelops to obtain the angle of internal frictions (ϕ) and the cohesion intercepts (c).

Consolidation Test

The consolidation tests were performed on UD and re-moulded samples of 75mm diameter and 22mm height as per laboratory requirements. Two way drainages were provided and each increment of load was maintained until sufficient period beyond the primary consolidation has been reached.

Chemical Tests of Water & Soil Samples

The water and soil samples from the bore holes of the project site area were collected are tested for finding out the carbonate, sulphates, nitrates, chlorides, pH values, total solid and organic materials etc. which may cause harmful ingredients for the foundation materials.

The detail test results are presented in the Laboratory Test Result Sheets in the ***annexes***-.

5.0 BORE HOLES OBSERVATIONS AND RESULTS

5.1 Field Investigation Results

Logging of the bore holes were carried out at the site during drilling periods. The logs were reconfirmed and suitably corrected based on the laboratory test results. The logs of the boreholes are provided in the ***annexes-.***

Measured Standard Penetration Test (SPT) N-values were found at each borehole an interval of 0.5m & 1.5m. These values shows that the soils are in medium to stiff and medium to very dense/hard in state, which may give medium to higher load bearing capacity values.

The ground water tables/piezometric surfaces were not found in each bore hole location**.**

5.2 Laboratory Investigation Results

5.2.1 Index Properties

The grain size distribution curve of the soil sample is classified as Unified Soil Classification System (USCS). Each soil types are shown in the boreholes which are presented in ***annexes***-.

The specific gravity and moisture content values show that the soils are inorganic soils with lower voids.

6.0 BEARING CAPACITY

The allowable safe bearing capacities considering permissible settlement are shown below.

6.1 Type and Depth of Foundation

The different types of foundation depend on types of soil, sub soil water level and super structural-load are provided as per technical specification.

Similarly, the depth of foundation should be proposed at different depths from the original ground level. The bearing capacities of soil at the boreholes for those depths are calculated spread & mat/raft foundation as per the requirements.

Standardize Field Penetration Value IS : 2131 – 1981:

Dilatancy Correction:

Terzaghi and Peck (1967)

If $N_r \leq 15$ Use $N = N_r$

If $N_r \geq 15$ then,

$N_c = 15+1/2\ (N-15)$

Correction for overburden pressure,

From Peck, Hansen and Thornburn (1974)

$N_{corr} = 0.77\ Nr \log (2000/\sigma')$

Where,

N_r = SPT value from field after dilatancy correction

σ' = effective overburden pressure in KN/m^2

Unit Weight of the Soil Layers (γ) KN/m^3 (Peck et. Al. 1974; Bowles, 1977)

The unit weight of the soil layers are directly found from the retrieved soil samples through the UD & SPT Tubes in the field or as per the observed N value from the field test. The unit weight of the soilmass as per their denseness from (N) Value assumed practically as below:

γ_{sat} = Saturated Unit weight of the soil (KN/m^3)

If, $N \leq 10$ ($\gamma_{sat} = 16\ KN/m^3$)

$10 < N \leq 15$ ($\gamma_{sat} = 17\ KN/m^3$)

$15 < N \leq 20$ ($\gamma_{sat} = 18\ KN/m^3$)

$20 < N \leq 30$ ($\gamma_{sat} = 19\ KN/m^3$)

$N > 30$ ($\gamma_{sat} = 20\ KN/m^3$)

CALCULATION OF BEARING CAPACITY

A) For Spread Footing

Assuming a typical (1.5 x 1.5, 2.0 x 2.0, 2.5 x 2.5, 3.0 x 3.0 & 4.0 x 4.0)m^2 Square Open Isolated Shallow Foundation for light to medium load bearing structures.

For Spread Footing

(i) From IS Code (IS : 6403 - 1981)

$q_{ult(net)} = cN_c\, s_c\, d_c\, i_c + \gamma\, D_f\, (N_q-1)\, s_q\, d_q\, i_q + 0.5\, \gamma\, BN_\gamma\, s_\gamma\, d_\gamma\, i_\gamma\, R_{w2}$ ……….(I)

$q_{safe} = (q_{ult}) / F.S.$

Where,

γ_{sat} = Saturated Unit weight of the soil (KN/m^3)

N_c, N_γ & N_q are bearing capacity factors

d_c, d_γ & d_q are depth factors

s_c, s_γ & s_q are Shape factors (s_c = 1.30, s_γ = 0.80 & s_q = 1.20)

i_c, i_γ & i_q are inclination factors (i.e. 1.0)

B = Width of foundation (m)

D_f = Depth of foundation (m)

C = Cohesion (KN/m^2)

F.S. = Factor of safety i.e., 3.0

R_{w2} = Water correction factor (0.5)

(ii) Using Meyerhof's (1956, 1974) Correlation

For 25mm Settlement

q_{safe} = $8.1\ N_{60}\ d_f\ ((B+0.3)/B)^2\ R_{w1}$ KN/m^2 for B >1.2m …….(II)

Where,

d_f = Depth Factor (f_d)

= $1+0.33\ (D/B) \leq 1.33$

B & D = Breadth and depth of foundation

R$_{w1}$ = Water correction factors

= 0.5 (for worst water condition)

B) For Mat/Raft Foundation

Considering a typical (5.0 x 5.0, 6.0 x 6.0, 7.0 x 7.0 & 8.0 x 8.0) m^2 mat/raft foundation for the heavy loaded structures.

(i) From IS Code (IS 6403 : 1981)

$q_{ult(net)}$ = $cN_c\, s_c\, d_c\, i_c + \gamma\, D_f\, (N_q-1)\, s_q\, d_q\, i_q + 0.5\, \gamma\, BN_\gamma\, s_\gamma\, d_\gamma\, i_\gamma\, R_{w2}$ ……….(I)

q_{safe} = (q_{ult}) / F.S. (for Net SBC)

Where,

γ_{sat} = Saturated Unit weight of the soil (KN/m^3)

N_c, N_γ & N_q are bearing capacity factors

d_c, d_γ & d_q are depth factors

s_c, s_γ & s_q are Shape factors (s_c = 1.30, s_γ = 0.80 & s_q = 1.20)

i_c, i_γ & i_q are inclination factors (i.e. 1.0)

B = Width of foundation (m)

D_f = Depth of foundation (m)

C = Cohesion (KN/m^2)

F.S. = Factor of safety i.e., 3.0

R_{w2} = Water correction factor (0.5)

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If soils have loose to medium denseness and soft to medium stiff consistency then the foundation fails according as the local shear failure (LSF) and intermediate share failure (ISF) otherwise fails in general shear failure (GSF) criterion.

(ii) Using Meyerhof's (1965) & Bowles (1977) Correlation

$$q_{safe} = 11.98\, N_{60} \left(\frac{3.28B+1}{3.28B}\right)^2 f_d \left(\frac{S}{25}\right) x\, R_{w1} \quad KN/m^2 \text{ ……(II)}$$

Where,

N = Standard Penetration Value

B = width (m)

S = Settlement (mm)

f_d = Depth Factor

= $1+0.33\,(D/B) \leq 1.33$

R_{w1} = water correction factor i.e. 0.5

From the above both testing methods, the bearing capacity and other relevant data’s are found and then correlated to each other that helps to verify the final product.

The both types of foundation their BC values and design parameters are given in the ***annexes-***.

6.2 Settlement

As described above ground strata are dominated by sandy silts, silty sands, sands with gravel, pebble, cobble, boulder etc. layers just below the probable foundation depth. The strata are generally compressible for general loading condition thus; settlement analysis should be considered for the project sites. So, the settlement of the foundation could be checked for maximum permissible values of 65/75 mm for cohesive layers and 40/50mm for semi cohesionless to cohesionless soil layers respectively.

For Cohesive Layer:

For heavier and important structures consolidation settlement should be predicted by the following equation;

$$SO_c = \Sigma\, Hi * Cc/(1+e_o) \log \{(P'o+\Delta P)/P'o\}$$

Where, SO_c = long term settlement, cm

H_i = thickness of each layer

P'_o = effective overburden pressure at the middle of each layer

C_c = compression index

e_o = initial void ratio

ΔP = the excess pressure at the middle of each layer due to superposition of load.

$$= \frac{qB^2}{(B+Z)^2} \quad \text{(for square load pattern)}$$

Now, with average pore pressure coefficients for the clayey soil,

β = 0.7

S_f = $\beta * SO_c$

This total amount of settlement that will takes place continuously for hundred of years and should be lie within the ranges of permissible value (65/75 mm).

For Semi-Cohesion and Cohesionless Layer:

$\Delta = 2.84q / N [B/ (B+ 0.3)]^2$

Where, q is KN/m^2 and B in meters.

The B.C. Values are found with in the permissible values (40/50 mm).

6.3 Subgrade Modulus

The modulus of sub grade reaction is a conceptual relationship between pressure and deflection. It is defined as the ratio between the soil pressure and the corresponding settlement mathematically.

Ks = qn/Sv

Different researchers have suggested empirical approaches to get Ks.

Bowles method,

Ks = qnu/0.025

= 40 qnu KN/m^3

The values of Ks are presented in the ***annexes.***

Modulus of Deformation (E) :

a) Coarse grained soil, E = (220 + 11 x N) 0.098 MPa

b) Fine grained soil, E = 0.6 x N MPa

Coefficient of Earth Pressure

The horizontal earth pressure co-efficient exerted by the soilmass could be found in three stages:-

a) Co-efficient of Earth Pressure at rest (k_0) = $1 - \sin \phi$

b) Co-efficient of Active Earth Pressure (ka) = $\frac{1-\sin\phi}{1+\sin\phi}$

c) Co-efficient of Passive Earth Pressure (kp) = $\frac{1+\sin\phi}{1-\sin\phi}$

where,

ϕ = angle of shearing or interal friction

7. SEISMICITY

7.1 Peak Ground Acceleration

For the study, according to the report of JICA (2002) scenario of three earthquakes of different magnitude and setting are selected. Based on the seismic, seismotectonic and geological condition, scenarios of these three earthquakes are compared with the large Bihar state of India-Nepal earthquake of 1934 (Ms -8.4). The scenarios considered are Mid Nepal earthquake (Ms - 8.0), North Bagmati earthquake (Ms - 6.0) and KV Local earthquake (Ms - 5.7).

Assuming Peak Ground Acceleration to Different Scales of Earthquakes

Name of Earthquake	Mid Nepal Earthquake	North Bagmati Earthquake	KV Local Earthquake	Bihar Nepal Earthquake
PGA (gal)	200-300	100-200	200-300	200-300
Ms	8.0	6.0	5.7	8.4

7.2 Liquefaction

Soil liquefaction is the major cause of damage to the foundation structure during an earthquake. Liquefaction potential depends upon factors, like the nature of shaking intensity, duration and material susceptibility to liquefaction. Liquefaction potential assessment is carried out in the following steps.

Estimation of liquefaction resistance of soil deposit,

Estimation of maximum or equivalent cyclic shear stress likely to be induced in the soil deposit during an earthquake.

The liquefaction potential of sand layer subjected to earthquake load is evaluated using the following equation by See`d et al. (1971)

$$\frac{\tau_{cyc}}{\sigma'_{v0}} \equiv 0.65 \frac{a_{\max}}{g} \frac{\sigma_{v0}}{\sigma'_{v0}} r_d$$

where

τ_{cyc} = average cyclic shear stress developed in horizontal sand layer due to earthquake

σ_{vo} = effective overburden stress at a depth under consideration

σ_{vo}' = total overburden pressure

a_{max} = peak horizontal ground acceleration by the earthquake at ground surface

g = acceleration due to gravity

r_d = stress reduction factor (function of depth and rigidity of soil column)

The estimation of cyclic strength of soil deposit is based on the empirical correlations with Standard Penetration Test value. N value is corrected for effective overburden pressure of 1 ton/ft^2, the following equation is used :

$$(N_1)_{60} \equiv N_m C_N$$

N_m = measured SPT N value

C_N = overburden correction factor

Based on the cyclic loading imposed by an earthquake, and liquefaction characteristics of soil, the liquefaction potential is evaluated. Liquefaction at any depth is expected where the loading by earthquake exceeds the resisting capacity of soil to liquefaction. The factor of safety against liquefaction is expressed as the ratio of cyclic shear stress required to cause liquefaction and equivalent cyclic shear stress induced by earthquake.

$$FS_l \equiv \frac{\tau_{cyc,L}}{\tau_{cyc}} = \frac{CSR_L}{CSR}$$

In the present study for project sites, the computation of the liquefaction susceptibility could not be seen due to the presence of medium to very dense gravelly layers and absence of water table.

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8.0 CONCLUSION

The sub-soil strata with field observations are mentioned in the bore hole logs in the ***annexes-***. Thus, based on field and laboratory tests following inferences have been made.

i) Adopt a safe bearing capacity for ***Spread*** and ***Mat/Raft foundation*** at different depths of project site locations are given in the tabulated form:

Spread Foundation for 40/65mm Permissible Settlement (SBC Values) for BH - 1 (Birauta Substation) :

Depth (m)	Recommended Allowable B.C. Values (KN/m^2) for Different Sizes					Saturated Density, γ_{sat} (KN/m^3)	Sub-grade Modulus K_s (KN/m^3) B = 2.0m
	1.5 x 1.5	2.0 x 2.0	2.5 x 2.5	3.0 x 3.0	4.0 x 4.0		
0.5	415.06	371.74	347.23	331.48	312.46	19	52294.23
0.8	453.32	410.04	385.34	369.40	350.04	19	76909.24
1.5	529.85	486.62	461.56	445.22	425.22	20	69320.51
2.5	564.69	518.61	491.91	474.50	453.17	20	65526.15
3.0	582.11	534.61	507.08	489.13	467.15	20	63320.04
3.5	559.67	514.01	487.54	470.28	449.15	20	58907.83
4.5	514.80	472.79	448.45	432.58	413.14	20	39986.72

Spread Foundation for 40/65mm Permissible Settlement (SBC Values) for AP - 1 (Power House) :

Depth (m)	Recommended Allowable B.C. Values (KN/m^2) for Different Sizes					Saturated Density, γ_{sat} (KN/m^3)	Sub-grade Modulus K_s (KN/m^3) B = 2.0m
	1.5 x 1.5	2.0 x 2.0	2.5 x 2.5	3.0 x 3.0	4.0 x 4.0		
0.5	217.95	259.57	248.02	236.77	223.18	19	55981.41
0.8	373.05	382.20	363.74	349.22	331.56	20	57202.24
1.5	683.23	627.48	595.17	574.11	548.31	20	59643.90
2.5	615.82	565.57	536.45	517.46	494.20	20	63565.40
3.0	582.11	534.61	507.08	489.13	467.15	20	65526.15
3.5	562.51	516.61	490.01	472.67	451.43	19	63000.54
4.5	523.32	480.61	455.87	439.73	419.97	19	57949.33

Mat/Raft Foundation 75/100mm Permissible Settlement (SBC Values) for BH - 1 (Birauta Substation) :

Recommended Allowable B.C. Values (KN/m^2) for Different Sizes	Depth (m)									
	0.5	1.0	1.5	2.5	3.0	3.5	4.5	6.0	7.5	9.0
5.0 x 5.0	555.26	589.25	623.25	699.02	736.90	723.88	697.84	674.97	621.44	577.70
6.0 x 6.0	544.67	578.02	611.37	685.69	722.85	710.08	684.54	662.11	609.59	566.68
7.0 x 7.0	537.17	570.06	602.95	676.25	712.90	700.30	675.11	652.99	601.20	558.88
8.0 x 8.0	531.58	564.13	596.68	669.21	705.48	693.02	668.09	646.19	594.94	553.07
Saturated Density, γ_{sat}	19	20	20	20	20	20	20	20	20	20
Sub-grade Modulus K_s (KN/m^3) B = 5.0m	46686	48213	49741	53011	54646	52540	48327	43844	40367	37525

Mat/Raft Foundation 75/100mm Permissible Settlement (SBC Values) for AP - 1 (Power House) :

Recommended Allowable B.C. Values (KN/m^2) for Different Sizes	Depth (m)									
	0.5	1.0	1.5	2.5	3.0	3.5	4.5	6.0	7.5	9.0
5.0 x 5.0	396.61	600.14	803.67	759.16	736.90	727.73	709.39	674.97	621.44	577.70
6.0 x 6.0	389.05	588.70	788.34	744.68	722.85	713.86	695.86	662.11	609.59	566.68
7.0 x 7.0	383.69	580.59	777.49	734.43	712.90	704.03	686.28	652.99	601.20	558.88
8.0 x 8.0	379.70	574.55	769.40	726.79	705.48	696.70	679.14	646.19	594.94	553.07
Saturated Density, γ_{sat}	19	20	20	20	20	20	19	20	20	20
Sub-grade Modulus K_s (KN/m^3) B = 5.0m	33347	48743	64139	57811	54646	52806	49127	43844	40367	37525

ii) The factor of safety 3.0 is used for calculation of SBC Values.

iii) The minimum depth of foundation should be 1.2m for light to medium load bearing structure below from NGL.

iv) The average measured soil resistivity value of proposed ***BH - 1 (Birauta Substation) is found 1475.90 Ohm-m*** and ***AP - 1 (Power House) is found 747.38 Ohm-m***, which are provided in the ***annexes.***

v) The average soil resistivity value shows that the ground type should be **fissured limestones fragments**.

vi) The water tables were not encounter in both bore holes respectively.

vii) Liquefaction susceptibility could not be exists in the both project site area.

viii) The Pile foundation is not considered for the foundation design.

ix) The soil Type II - Medium Soils were found in both project site area as per IS : 1893 (Part 1) : 2002.

x) The excavated soilmass (original soils) is suitable for backfilling works.

xi) The chemical test values are acceptable so, the extra preservative coats/additives should not have to be applied/mixed to the foundation materials in the substation and transmission line premises.

xii) All the relevant geotechnical values, relationships etc. are directly used as per requirement from relevant codes, author's books, published journals and papers.

Pashupati Drilling and Geo- Technical Services Pvt. Ltd.

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Pashupati Drilling and Geo-Technical Services Pvt. Ltd.

ANNEXES

A. Site Maps

B. Bore Hole Logs

C. Analysis of Bearing Capacity

- Spread Foundation
- Mat Foundation
- Design Parameters

D. Design Parameter Summary Sheet

E. Soil Dynamic Parameters

F. Laboratory Test Result Summary Sheets

G. Chemical Test Results

H. Liquefaction Analysis

I. Earth Resistivity Test Results

J. Figure

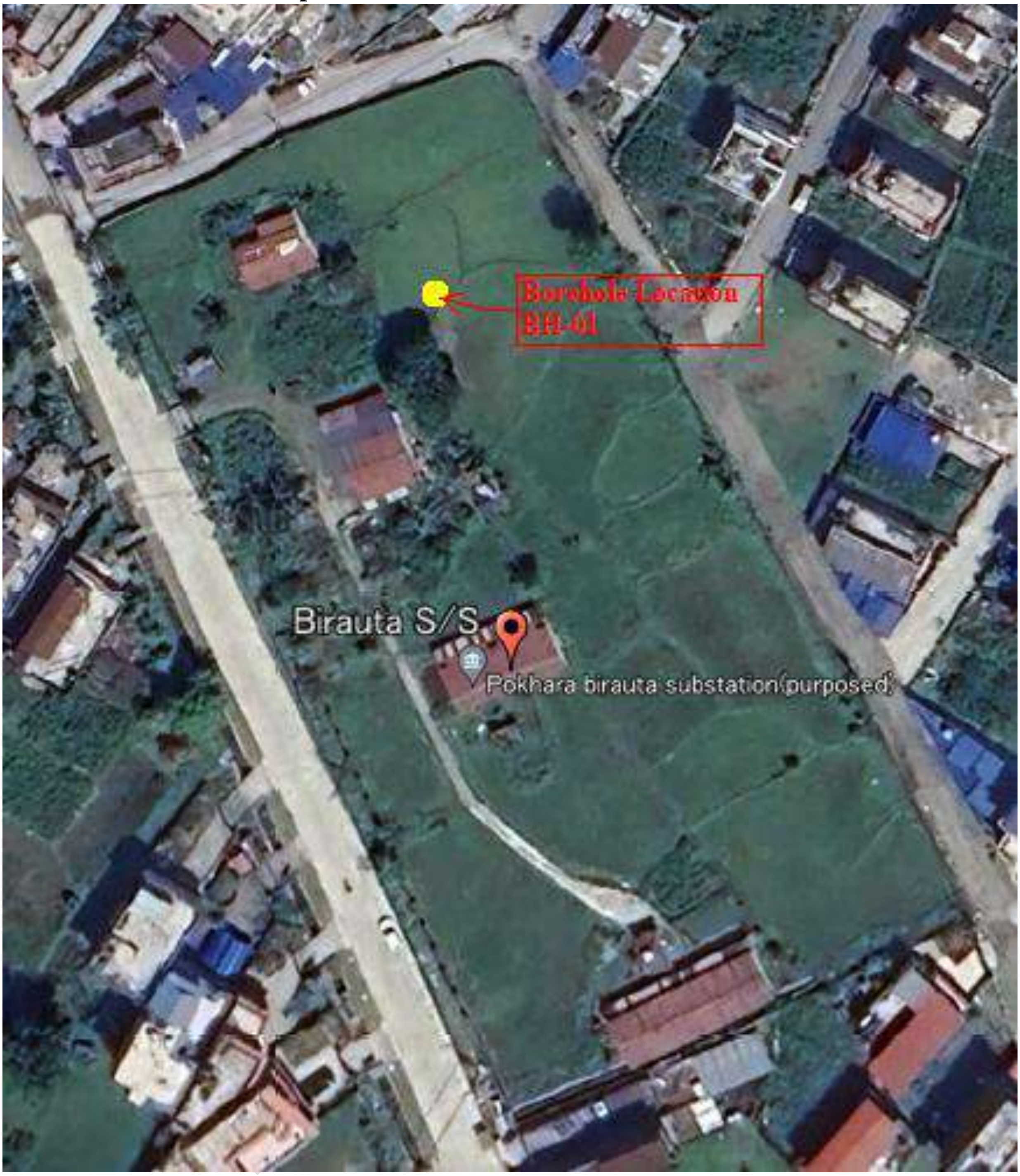
K. Photographs

L. Field Data

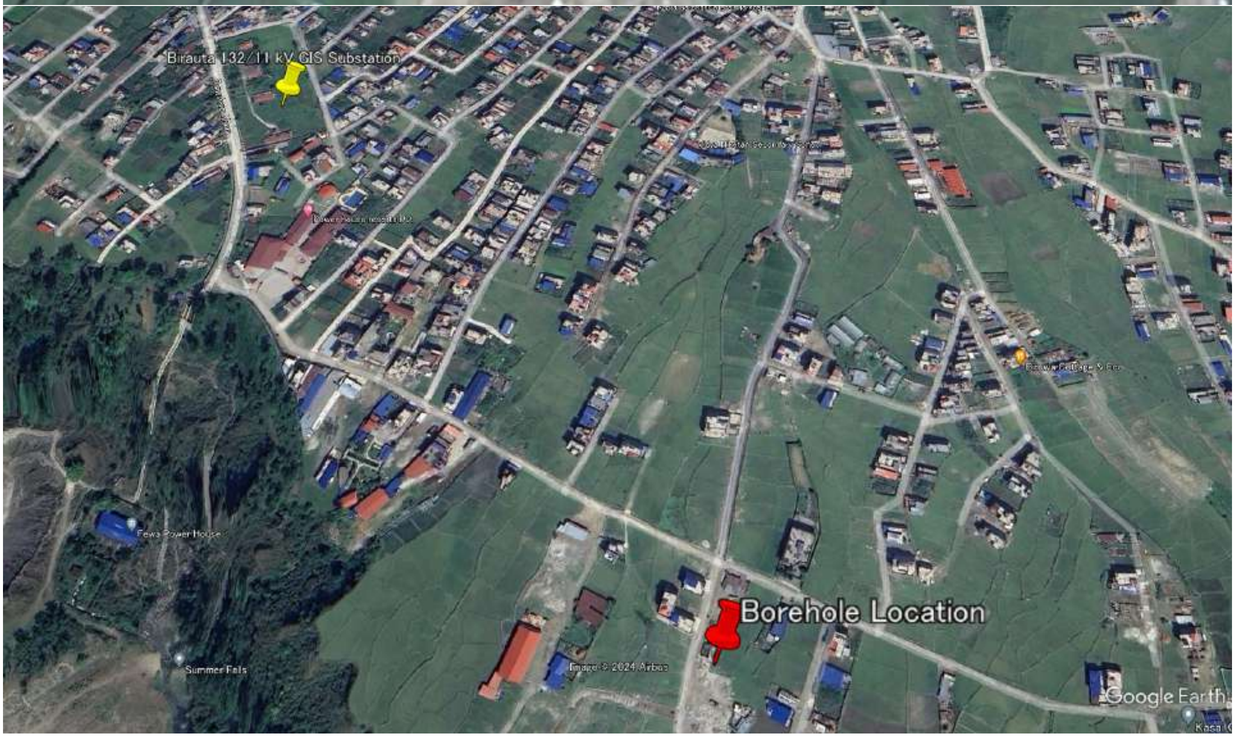
ANNEX - A

SITE MAP

Borehole Location for Proposed Birauta 132/11 kV GIS Substation site



Borehole Location for Proposed Site of under 132kV Transmission Line



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NEPAL ELECTRICITY AUTHORITY

ANNEX - B
BORE HOLE LOGS

BORE HOLE LOG

Start Date : 2081/02/02

Project: Geotechnical Investigation Works for Birauta 132/11 kV GIS Substation Site

Client: Nepal Electricity Authority (NEA), Nepal

Consutant : Nippon Koei Co. Ltd., Japan

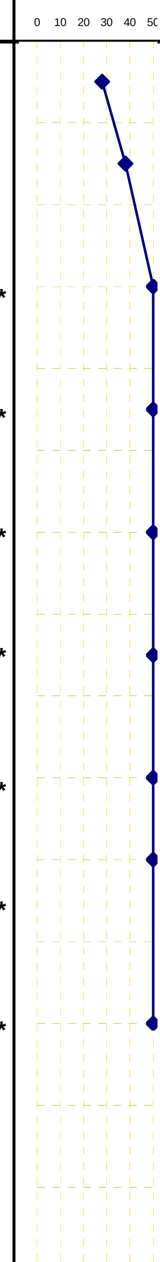
Location: Birauta Substation, Pokhara - 17, Kaski

Position: 791708.228 E, 3121129.523 N

RL (m) : 792.0

Bore Hole No.: 1

Depth (m)	Thickness (m)	Classification	SOIL DESCRIPTION	Water Table (m)	SPT/DCP at (m)	No. of Blows per 15/10 cm Penetration: 15/10	30/20	45/30	Total SPT/DCPT Value	Total SPT Value
3.5	3.5	SM - GM	Gray brownish medium to very dense silty sands /fine gravels with pebbles, cobbles (Dolomites & Schist)	No Water Table was Found	SPT 0.5	9	11	17	28	**28**
					SPT 1.5	10	19	19	38	**38**
					SPT 3.0	7	22	38	60	**≥50***
12.5	9.0	SP - GP	Grayish very dense sandy gravels with pebbles, cobbles and some boulders (Dolomite) and dust particles		DCPT 4.5	50/7.0	-	-	-	**≥50***
					DCPT 6.0	50/1.0	-	-	-	**≥50***
					DCPT 7.5	50/5.0	-	-	-	**≥50***
					DCPT 9.0	50/0.5	-	-	-	**≥50***
					DCPT 10.5	50/0.0	-	-	-	**≥50***
					12.0	50/8.0	-	-	-	**≥50***



*** Maximum SPT Value.**

Pashupati Drilling & Geo- Technical Services Pvt. Ltd.

Krishna Kunj, Ramnagar, Lokanthali-15, Bhaktapur

Tel : 00977-1-5182310, 9851026210 E-mail: pashupatidrilling@gmail.com

BORE HOLE LOG

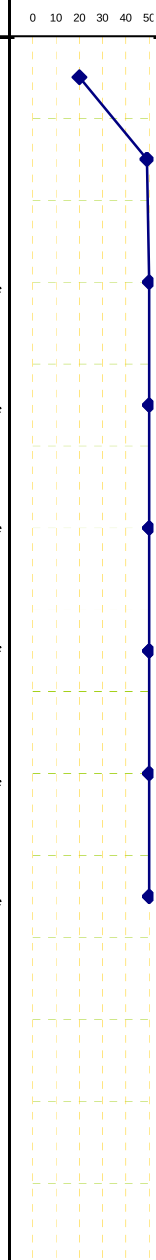
Start Date : 2081/02/05

Project: Geotechnical Investigation Works for Existing 132kV Transmission Line
Client: Nepal Electricity Authority (NEA), Nepal
Consutant : Nippon Koei Co. Ltd., Japan
Location: Power House, Pokhara - 17, Kaski

Position : 792094.030 E
3120693.071 N
RL (m) : 789.855
Bore Hole No.: AP - 1

Depth (m)	Thickness (m)	Classification	SOIL DESCRIPTION	Water Table (m)	SPT/DCP at (m)	No. of Blows per 15/10 cm Penetration 15/10	30/20	45/30	Total SPT/DCPT Value	**Total SPT Value**
0.5	0.5	ML - SM	Gray brownish medium dense, slight plastic silty sands with fine gravels (Sandy loam)	No Water Table was Found	**SPT** 0.5	7	7	13	20	**20**
3.5	3.0	SM - GM	Grayish very dense silty sands with gravels, pebbles, cobbles (Dolomite) etc.		**SPT** 1.5	9	14	35	49	**49**
					SPT 3.0	3	14	50/1.0	-	**≥50***
11.0	8.0	GW	Grayish very dense sandy gravels with pebbles, cobbles and some boulders (Schist & Dolomite) etc. having dust particles		**DCPT** 4.5	50/0.0	-	-	-	**≥50***
					DCPT 6.0	50/0.5	-	-	-	**≥50***
					DCPT 7.5	50/1.5	-	-	-	**≥50***
					DCPT 9.0	50/5.0	-	-	-	**≥50***
					DCPT 10.5	-	-	-	-	**≥50***

SPT



*** Maximum SPT Value.**

Pashupati Drilling & Geo- Technical Services Pvt. Ltd.
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ANNEX - C

Analysis of Bearing Capacity

- **Spread Foundation**
- **Mat Foundation**
- **Design Parameters**

SPREAD FOUNDATION

Pashupati Drilling and Geo- Technical Services Pvt. Ltd.

Analysis of Bearing Capacity at Different Depths for Spread Foundation

Bore Hole	Depth (m)	B. C. Values (KN/m^2) for different size of Foundation (m)					Cohesion (C), KN/m^2	Angle of friction (ϕ), Degree	Saturated Density, γsat (KN/m^3)	Allowable Settlement (mm)	Subgrade Modulus, K_s (KN/m^3) B = 2.0m
		1.5 x 1.5	2.0 x 2.0	2.5 x 2.5	3.0 x 3.0	4.0 x 4.0					
BH - 1	0.5	415.06	371.74	347.23	331.48	312.46	0	41	19	40	55981.41
	1.0	472.45	429.18	404.39	388.35	368.84	0	41	20	40	57812.65
	1.5	529.85	486.62	461.56	445.22	425.22	0	42	20	40	59643.90
	2.5	564.69	518.61	491.91	474.50	453.17	0	42	20	40	63565.40
	3.0	582.11	534.61	507.08	489.13	467.15	0	43	20	40	65526.15
	3.5	559.67	514.01	487.54	470.28	449.15	0	42	20	40	63000.54
	4.5	514.80	472.79	448.45	432.58	413.14	0	41	20	40	57949.33

Bore Hole	Depth (m)	B. C. Values (KN/m^2) for different size of Foundation (m)					Cohesion (C), KN/m^2	Angle of friction (ϕ), Degree	Saturated Density, γsat (KN/m^3)	Allowable Settlement (mm)	Subgrade Modulus, K_s (KN/m^3) B = 2.0m
		1.5 x 1.5	2.0 x 2.0	2.5 x 2.5	3.0 x 3.0	4.0 x 4.0					
AP - 1	0.5	217.95	259.57	248.02	236.77	223.18	0	37	19	40	39986.72
	1.0	450.59	443.52	421.60	405.44	385.75	0	41	20	40	58447.98
	1.5	683.23	627.48	595.17	574.11	548.31	0	45	20	40	76909.24
	2.5	615.82	565.57	536.45	517.46	494.20	0	44	20	40	69320.51
	3.0	582.11	534.61	507.08	489.13	467.15	0	43	20	40	65526.15
	3.5	562.51	516.61	490.01	472.67	451.43	0	42	20	40	63320.04
	4.5	523.32	480.61	455.87	439.73	419.97	0	41	19	40	58907.83

Pashupati Drilling and Geo- Technical Services Pvt. Ltd.

MAT/RAFT FOUNDATION

Analysis of Bearing Capacity at Different Depths for Raft Foundation

Bore Hole	Depth (m)	Safe B. C. Values (KN/m^2)	Safe B. C. Values (KN/m^2)	Safe B. C. Values (KN/m^2)	Safe B. C. Values (KN/m^2)	Cohesion (C), KN/m^2	Angle of friction (ϕ), Degree	Saturated Density, γsat (KN/m^3)	Allowable Settlement (mm)	Subgrade Modulus, K_s (KN/m^3) B = 5.0m
		5.0 x 5.0	6.0 x 6.0	7.0 x 7.0	8.0 x 8.0					
BH – 1	0.5	555.26	544.67	537.17	531.58	0	41	19	50	46686.28
	1.0	589.25	578.02	570.06	564.13	0	41	20	50	48213.46
	1.5	623.25	611.37	602.95	596.68	0	42	20	50	49740.65
	2.5	699.02	685.69	676.25	669.21	0	42	20	50	53011.02
	3.0	736.90	722.85	712.90	705.48	0	43	20	50	54646.21
	3.5	723.88	710.08	700.30	693.02	0	42	20	50	52539.96
	4.5	697.84	684.54	675.11	668.09	0	41	20	50	48327.44
	6.0	674.97	662.11	652.99	646.19	0	40	20	50	43844.20
	7.5	621.44	609.59	601.20	594.94	0	39	20	50	40366.73
	9.0	577.70	566.68	558.88	553.07	0	39	20	50	37525.43

Bore Hole	Depth (m)	Safe B. C. Values (KN/m^2)	Safe B. C. Values (KN/m^2)	Safe B. C. Values (KN/m^2)	Safe B. C. Values (KN/m^2)	Cohesion (C), KN/m^2	Angle of friction (ϕ), Degree	Saturated Density, γsat (KN/m^3)	Allowable Settlement (mm)	Subgrade Modulus, K_s (KN/m^3) B = 5.0m
		5.0 x 5.0	6.0 x 6.0	7.0 x 7.0	8.0 x 8.0					
AP – 1	0.5	396.61	389.05	383.69	379.70	0	37	19	50	33347.34
	1.0	600.14	588.70	580.59	574.55	0	41	20	50	48743.30
	1.5	803.67	788.34	777.49	769.40	0	45	20	50	64139.26
	2.5	759.16	744.68	734.43	726.79	0	44	20	50	57810.56
	3.0	736.90	722.85	712.90	705.48	0	43	20	50	54646.21
	3.5	727.73	713.86	704.03	696.70	0	42	20	50	52806.41
	4.5	709.39	695.86	686.28	679.14	0	41	19	50	49126.80
	6.0	674.97	662.11	652.99	646.19	0	40	20	50	43844.20
	7.5	621.44	609.59	601.20	594.94	0	39	20	50	40366.73
	9.0	577.70	566.68	558.88	553.07	0	39	20	50	37525.43

Pashupati Drilling and Geo-Technical Services Pvt. Ltd.

DESIGN PARAMETERS

Design Parameters for Different Depths

Bore Hole No.	BH - 1								
Depth, Df (m)	**0.5**	**1.5**	**3.0**	**4.5**	**6.0**	**7.5**	**9.0**	**10.5**	**12.0**
Saturated Density up to depth, γ_{sat} (KN/m^3)	19	20	20	20	20	20	20	20	20
Net SPT Value, N_{60}	40	43	47	41	38	35	32	30	28
Angle of friction (ϕ), Degree	41	42	43	41	40	39	38	37	37
Cohesion (C.), KN/m^2	0	0	0	0	0	0	0	0	0

Bore Hole No.	AP – 1							
Depth, Df (m)	**0.5**	**1.5**	**3.0**	**4.5**	**6.0**	**7.5**	**9.0**	**10.5**
Saturated Density up to depth, γ_{sat} (KN/m^3)	19	20	20	19	20	20	20	20
Net SPT Value, N_{60}	29	55	47	42	38	35	32	30
Angle of friction (ϕ), Degree	37	45	43	41	40	39	38	37
Cohesion (C.), KN/m^2	0	0	0	0	0	0	0	0

ANNEX - D

DESIGN PARAMETER SUMMARY SHEETS

Pashupati Drilling & Geo- Technical Services Pvt. Ltd.

Krishna Kunj, Ramnagar, Lokanthali-15, Bhaktapur

Tel : 00977-1-5182310, 9851026210 E-mail: pashupatidrilling@gmail.com

DESIGN PARAMETER SUMMARY SHEET

Project: Geotechnical Investigation Works for Birauta 132/11 kV GIS Substation Site & Transmission Line

Date : May., 2024

Client: Nepal Electricity Authority (NEA), Nepal

Placement (mm): 150

Consutant: Nippon Koei Co. Ltd., Japan

Location: Birauta, Pokhara - 17, Kaski

Bore Hole No.	Depth	USCS Classi-fication	Direct Shear Test C	Direct Shear Test ϕ	$N_{min.}$ Value	Earth Pressure Co-efficient K_0	Earth Pressure Co-efficient K_a	Earth Pressure Co-efficient K_p	Friction Factor Concrete	Friction Factor Steel	Modulus of Deformation (E)	Fill Selection	CBR Value	Unit Dry Weight γ_d	Frost Depth	Dewatering upto 3.0m depths	Temporary Excavation upto 3.0m depths	Compaction Charateristics and Equipments
	(m)		KN/m^2	Degree	Nos.						Mpa		%	gm/cc	m			
BH - 1	0.0 - 3.5	SM - GM	0	41	38	0.34	0.21	4.81	0.35	0.25	62.52	Good to Excellent	≥20	2.0 - 2.32	Negligible	Pumping not required	Support system required	Vibratory Roller/Jumper with close OMC
	3.5 - 12.5	SP - GP	0	38	50	0.38	0.24	4.20	0.35	0.25	75.46	Good to Excellent	≥20	2.0 - 2.32				
AP - 1	0.0 - 0.5	ML - SM	0	37	20	0.40	0.25	4.02	0.35	0.25	43.12	Fair	≥20	1.60 - 2.08	Negligible	Pumping not required	Support system required	Vibratory Roller/Jumper with close OMC
	0.5 - 3.5	SM - GM	0	43	49	0.32	0.19	5.29	0.35	0.25	74.38	Good to Excellent	≥20	2.0 - 2.32				
	3.5 - 11.0	GW	0	38	50	0.38	0.24	4.20	0.35	0.25	75.46	Good to Excellent	≥20	2.0 - 2.32				

ANNEX - E

SOIL DYNAMIC PARAMETERS

Pashupati Drilling & Geo- Technical Services Pvt. Ltd.

Krishna Kunj, Ramnagar, Lokanthali-15, Bhaktapur
Tel : 00977-1-5182310, 9851026210 E-mail: pashupatidrilling@gmail.com

Shear Wave Velocity (Vs) & Maximum Shear Modulus (G_{max})

Date : May, 2024

Project: Geotechnical Investigation Works for Birauta 132/11 kV GIS Substation Site & Transmission Line

Client: Nepal Electricity Authority (NEA), Nepal

Consutant: Nippon Koei Co. Ltd., Japan

Location: Birauta, Pokhara - 17, Kaski

Bore Hole No. : 1 (Birauta Substation)

S. No.	Depth (m)	Soil Type	Avg. Shear Wave Velocity (Vs) (m/s)	Avg. Maximum Shear Modulus (G_{max}) (Mpa)
1	0.0 - 12.5	Silty/Sandy/Gravelly Boulder mix Soils	293.24	190.77

Bore Hole No. : AP - 1 (Power House)

S. No.	Depth (m)	Soil Type	Avg. Shear Wave Velocity (Vs) (m/s)	Avg. Maximum Shear Modulus (G_{max}) (Mpa)
1	0.0 - 11.0	Silty/Sandy/Gravelly Boulder mix Soils	291.93	189.85

Pashupati Drilling and Geo- Technical Services Pvt. Ltd.

NEPAL ELECTRICITY AUTHORITY

ANNEX - F

LABORATORY TEST RESULT SUMMARY SHEETS

Pashupati Drilling & Geo- Technical Services Pvt. Ltd.

Krishna Kunj, Ramnagar, Lokanthali-15, Bhaktapur

Tel : 00977-1-5182310, 9851026210 E-mail: pashupatidrilling@gmail.com

LABORATORY TEST RESULT SUMMARY SHEET

Date : May, 2024

Project: Geotechnical Investigation Works for Birauta 132/11 kV GIS Substation Site & Transmission Line

Client: Nepal Electricity Authority (NEA), Nepal

Consutant: Nippon Koei Co. Ltd., Japan

Location: Birauta, Pokhara - 17, Kaski

Bore Hole No.	Depth	USCS Classi-fication	Percentage of				Atterberg Limits			Natural Moisture content	Moist Density	Dry Density	Specific Gravity	Direct Shear Test (*analytical)		Consolidation	
			Gravel	Sand		Silt & Clay	Liquid Limit	Plastic Limit	Plasticity Index					C	ϕ		
				Coarse to medium	Fine												
	(m)		%	%	%	%	%	%	%	%	gm/cc	gm/cc		KN/m^2	Degree	C_c	e_O
BH - 1	0.0 - 3.5	SM - GM	34.86	25.21	19.59	20.34				8.47	1.71	1.58	2.633	0	41*		
	3.5 - 12.5	SP - GP	40.31	32.87	19.38	7.44				5.33	1.82	1.73	2.684	0	38*		
AP - 1	0.0 - 0.5	ML - SM	13.69	9.48	36.32	40.51	26.50	No PL	-	17.24	1.59	1.36	2.406	0	37*		
	0.5 - 3.5	SM - GM	26.10	32.91	24.13	16.86				9.31	1.73	1.59	2.652	0	43*		
	3.5 - 11.0	GW	43.58	27.66	22.63	6.13				6.38	1.89	1.78	2.667	0	38*		

ANNEX - G

CHEMICAL TEST RESULTS

Regd. No. 53875/064/065

AASTHA SCIENTIFIC RESEARCH SERVICE PVT. LTD.

Maitidevi, Kathmandu, Nepal, Tel: +977-1-4533748
E-mail: aasthalab2079@gmail.com

(C e n t e r f o r c o m p l e t e s c i e n t i f i c s o l u t i o n)

Test Report

Report No. : 249A/2081
Entry No. : AASTHA – 214 – 2081
Sample : Sand
Client : Nepal Electricity Authority (NEA) Nepal
Project : Soil Investigation Works for Birauta 132/11 KV GIS Station Site
Consultant : Nippon Koei Co. Ltd., Japan
Bore Hole No. : 1
Location : Birauta Substation, Pokhara-17, Kaski
RL (m) : 792.0

Date received : 18/02/2081
Date completed : 20-30/02/2081
Sampled by : Pashupati Drilling
Issue Date : 06/03/2081

S. N.	Parameters	Test Method	Observed Values
1.	pH	pH Meter	11.71
2.	Organic Matter (%)	Titration	0.25
3.	Sulphate (%)	Gravimetric	<0.01
4.	Nitrate (%)	Spectrophotometric	0.0016
5.	Carbonates as $CaCO_3$ (%)	Titration	80.0
6.	Chloride (%)	Titration	0.021

Analyzed By

Checked By

Authorized By
(Chairperson)

Regd. No. 53875/064/065

AASTHA SCIENTIFIC RESEARCH SERVICE PVT. LTD.

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(C e n t e r f o r c o m p l e t e s c i e n t i f i c s o l u t i o n)

Test Report

Report No. : 249B/2081
Entry No. : AASTHA – 214 – 2081
Sample : Sand
Client : Nepal Electricity Authority (NEA) Nepal
Project : Soil Investigation Works for Birauta 132/11 KV GIS Station Site
Consultant : Nippon Koei Co. Ltd., Japan
Bore Hole No. : AP-1
Location : Power House, Pokhara-17, Kaski
RL (m) : 789.855

Date received : 18/02/2081
Date completed : 20-30/02/2081
Sampled by : Pashupati Drilling
Issue Date : 06/03/2081

S. N.	Parameters	Test Method	Observed Values
1.	pH	pH Meter	12.64
2.	Organic Matter (%)	Titration	0.26
3.	Sulphate (%)	Gravimetric	<0.01
4.	SO_3 (%)	Gravimetric	<0.01
5.	Nitrate (%)	Spectrophotometric	0.0034
6.	Carbonates as $CaCO_3$ (%)	Titration	79.0
7.	Chloride (%)	Titration	0.017

Analyzed By

Checked By

Authorized By
(Chairperson)

Note : 1. The issued report refers only to the tested sample and applicable parameters. Endorsement of products is neither inferred nor implied.
2. Liability of our institute is limited to the invoiced detrimands and amount only.
3. Even in the case of stable samples such as limestone, minerals, soil etc. they will not be stored more than two months unless specially requested by the client.
4. This report is neither to be reproduced wholly or partially nor can be used as an evidence in the court of law.

ANNEX - H

LIQUEFACTION ANALYSIS

Computation of FS against Liquefaction (Bore Hole No.: 1 (Birauta Substation)

North Bagmati Earthquake PGA=200 gal M=6.0

Depth	SPT (N)	Density	Effective stress (s'_{no})	C_N	$(N_1)_{60}$	Total Vertical stress (s_{no})	r_d	t_{cyc}	$CSR_{L\ (M=7.5)}$	$CSR_{L\ (M=6.0)}$	$t_{cyc,L}$	FS
0.5	28	1.9	4.66	2.00	56.00	9.32	0.993	1.20	0.50	0.63	5.82	4.84
1.5	38	2.0	14.47	2.00	76.00	28.94	0.978	3.68	1.00	1.25	36.17	9.84
3.0	50	2.0	29.18	1.81	90.58	58.37	0.955	7.25	1.00	1.25	72.96	10.07
4.5	50	2.0	43.90	1.48	73.86	87.80	0.933	10.64	1.00	1.25	109.75	10.31
6.0	50	2.0	58.61	1.28	63.92	117.23	0.910	13.87	1.00	1.25	146.54	10.57
7.5	50	2.0	73.33	1.14	57.15	146.66	0.888	16.92	1.00	1.25	183.32	10.83
9.0	50	2.0	88.04	1.04	52.15	176.09	0.865	19.80	1.00	1.25	220.11	11.12
10.5	50	2.0	102.76	0.97	48.27	205.52	0.843	22.51	1.00	1.25	256.90	11.41
12.0	50	2.0	117.47	0.90	45.15	234.95	0.820	25.05	1.00	1.25	293.69	11.73

8.2 - KV Local Earthquake PGA=275 gal M=5.7

Depth	SPT (N)	Density	Effective stress (s'_{no})	C_N	$(N_1)_{60}$	Total Vertical stress (s_{no})	r_d	t_{cyc}	$CSR_{L\ (M=7.5)}$	$CSR_{L\ (M=5.7)}$	$t_{cyc,L}$	FS
0.5	28	1.90	4.66	2.00	56.00	9.32	0.993	1.65	0.50	0.66	6.13	3.71
1.5	38	2.00	14.47	2.00	76.00	28.94	0.978	5.06	1.00	1.32	38.08	7.53
3.0	50	2.00	29.18	1.81	90.58	58.37	0.955	9.96	1.00	1.32	76.80	7.71
4.5	50	2.00	43.90	1.48	73.86	87.80	0.933	14.63	1.00	1.32	115.53	7.89
6.0	50	2.00	58.61	1.28	63.92	117.23	0.910	19.07	1.00	1.32	154.25	8.09
7.5	50	2.00	73.33	1.14	57.15	146.66	0.888	23.27	1.00	1.32	192.97	8.29
9.0	50	2.00	88.04	1.04	52.15	176.09	0.865	27.23	1.00	1.32	231.70	8.51
10.5	50	2.00	102.76	0.97	48.27	205.52	0.843	30.95	1.00	1.32	270.42	8.74
12.0	50	2.00	117.47	0.90	45.15	234.95	0.820	34.44	1.00	1.32	309.15	8.98

1934 Bihar Nepal Earthquake PGA=300 gal M=8.4

Depth	SPT (N)	Density	Effective stress (s'_{no})	C_N	$(N_1)_{60}$	Total Vertical stress (s_{no})	r_d	t_{cyc}	$CSR_{L\ (M=7.5)}$	$CSR_{L\ (M=8.4)}$	$t_{cyc,L}$	FS
0.5	28	1.90	4.66	2.00	56.00	9.32	0.993	1.80	0.50	0.45	4.16	2.31
1.5	38	2.00	14.47	2.00	76.00	28.94	0.978	5.52	1.00	0.89	25.84	4.68
3.0	50	2.00	29.18	1.81	90.58	58.37	0.955	10.87	1.00	0.89	52.12	4.79
4.5	50	2.00	43.90	1.48	73.86	87.80	0.933	15.97	1.00	0.89	78.39	4.91
6.0	50	2.00	58.61	1.28	63.92	117.23	0.910	20.80	1.00	0.89	104.67	5.03
7.5	50	2.00	73.33	1.14	57.15	146.66	0.888	25.38	1.00	0.89	130.95	5.16
9.0	50	2.00	88.04	1.04	52.15	176.09	0.865	29.70	1.00	0.89	157.22	5.29
10.5	50	2.00	102.76	0.97	48.27	205.52	0.843	33.76	1.00	0.89	183.50	5.43
12.0	50	2.00	117.47	0.90	45.15	234.95	0.820	37.57	1.00	0.89	209.78	5.58

(Average values of density have been considered)

Computation of FS against Liquefaction (Bore Hole No.: AP - 1 (Power House)

North Bagmati Earthquake PGA=200 gal M=6.0

Depth	SPT (N)	Density	Effective stress (s'_{no})	C_N	$(N_1)_{60}$	Total Vertical stress (s_{no})	r_d	t_{cyc}	$CSR_{L\ (M=7.5)}$	$CSR_{L\ (M=6.0)}$	$t_{cyc,L}$	FS
0.5	20	1.9	4.66	2.00	40.00	9.32	0.993	1.20	0.50	0.63	5.82	4.84
1.5	49	2.0	14.47	2.00	98.00	28.94	0.978	3.68	1.00	1.25	36.17	9.84
3.0	50	2.0	29.18	1.81	90.58	58.37	0.955	7.25	1.00	1.25	72.96	10.07
4.5	50	2.0	43.90	1.48	73.86	87.80	0.933	10.64	1.00	1.25	109.75	10.31
6.0	50	2.0	58.61	1.28	63.92	117.23	0.910	13.87	1.00	1.25	146.54	10.57
7.5	33	2.0	73.33	1.14	37.14	146.66	0.888	16.92	1.00	1.25	183.32	10.83
9.0	50	2.0	88.04	1.04	52.15	176.09	0.865	19.80	1.00	1.25	220.11	11.12
10.5	50	2.0	102.76	0.97	48.27	205.52	0.843	22.51	1.00	1.25	256.90	11.41

8.2 - KV Local Earthquake PGA=275 gal M=5.7

Depth	SPT (N)	Density	Effective stress (s'_{no})	C_N	$(N_1)_{60}$	Total Vertical stress (s_{no})	r_d	t_{cyc}	$CSR_{L\ (M=7.5)}$	$CSR_{L\ (M=5.7)}$	$t_{cyc,L}$	FS
0.5	20	1.90	4.66	2.00	40.00	9.32	0.993	1.65	0.50	0.66	6.13	3.71
1.5	49	2.00	14.47	2.00	98.00	28.94	0.978	5.06	1.00	1.32	38.08	7.53
3.0	50	2.00	29.18	1.81	90.58	58.37	0.955	9.96	1.00	1.32	76.80	7.71
4.5	50	2.00	43.90	1.48	73.86	87.80	0.933	14.63	1.00	1.32	115.53	7.89
6.0	50	2.00	58.61	1.28	63.92	117.23	0.910	19.07	1.00	1.32	154.25	8.09
7.5	33	2.00	73.33	1.14	37.14	146.66	0.888	23.27	1.00	1.32	192.97	8.29
9.0	50	2.00	88.04	1.04	52.15	176.09	0.865	27.23	1.00	1.32	231.70	8.51
10.5	50	2.00	102.76	0.97	48.27	205.52	0.843	30.95	1.00	1.32	270.42	8.74

1934 Bihar Nepal Earthquake PGA=300 gal M=8.4

Depth	SPT (N)	Density	Effective stress (s'_{no})	C_N	$(N_1)_{60}$	Total Vertical stress (s_{no})	r_d	t_{cyc}	$CSR_{L\ (M=7.5)}$	$CSR_{L\ (M=8.4)}$	$t_{cyc,L}$	FS
0.5	20	1.90	4.66	2.00	40.00	9.32	0.993	1.80	0.50	0.45	4.16	2.31
1.5	49	2.00	14.47	2.00	98.00	28.94	0.978	5.52	1.00	0.89	25.84	4.68
3.0	50	2.00	29.18	1.81	90.58	58.37	0.955	10.87	1.00	0.89	52.12	4.79
4.5	50	2.00	43.90	1.48	73.86	87.80	0.933	15.97	1.00	0.89	78.39	4.91
6.0	50	2.00	58.61	1.28	63.92	117.23	0.910	20.80	1.00	0.89	104.67	5.03
7.5	33	2.00	73.33	1.14	37.14	146.66	0.888	25.38	1.00	0.89	130.95	5.16
9.0	50	2.00	88.04	1.04	52.15	176.09	0.865	29.70	1.00	0.89	157.22	5.29
10.5	50	2.00	102.76	0.97	48.27	205.52	0.843	33.76	1.00	0.89	183.50	5.43

(Average values of density have been considered)

ANNEX - I

EARTH RESISTIVITY TEST RESULTS

ERT Point : BH - 1 **Depth of electrode penetrated** : *20 cms* **Test Date :** 2081- 02- 04

Position :

Project: ERT Works for Birauta 132/11 kV GIS Substation Site
Client: Nepal Electricity Authority (NEA), Nepal
Consutant: Nippon Koei Co. Ltd., Japan
Location: Birauta, Pokhara - 17, Kaski

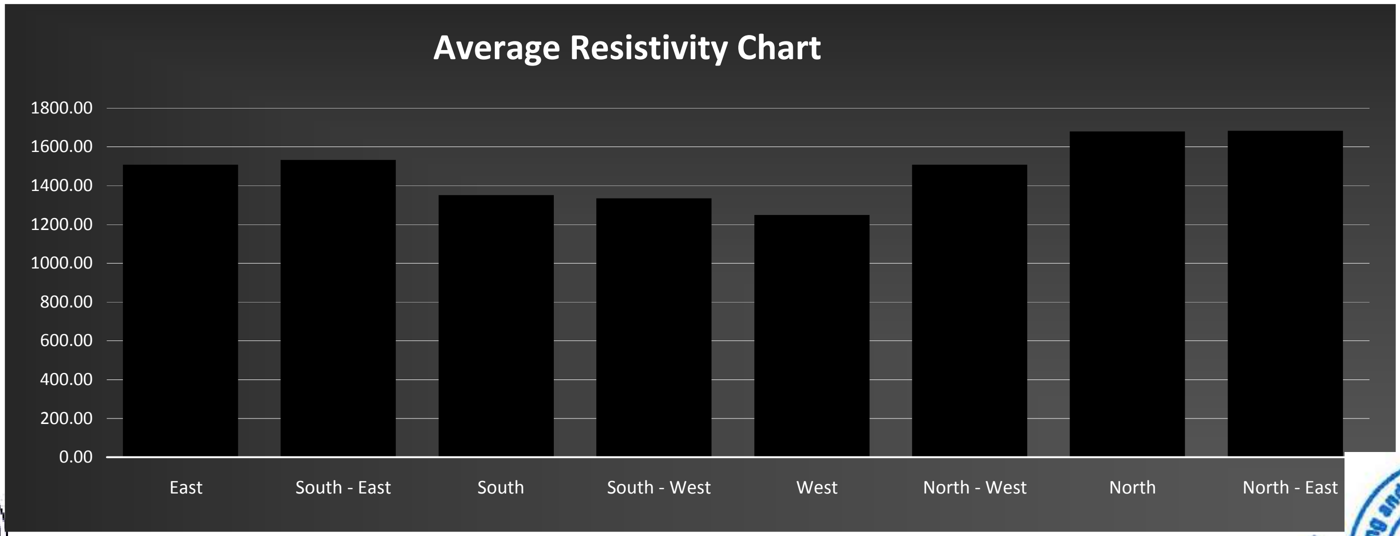
Model : KYORITSU, KEW 4106
Method : Wenner Four-Pin Method
Temperature(^{0}C): 32
Humidity (%) : 42

Reduced Level (m) :
Soil Condition : Dry
Soil Type : Silty/sandy/silts with pebbles, cobbles, boulders

RESULT

	East		South - East		South		South - West		West		North - West		North		North - East	
Spacing (m)	Resistance (Ohm)	Resistivity (Ohm-m)	Resistance (Ohm)	Resistivity (Ohm-m)	Resistance (Ohm)	Resistivity (Ohm-m)	Resistance (Ohm)	Resistivity (Ohm-m)	Resistance (Ohm)	Resistivity (Ohm-m)	Resistance (Ohm)	Resistivity (Ohm-m)	Resistance (Ohm)	Resistivity (Ohm-m)	Resistance (Ohm)	Resistivity (Ohm-m)
1	120.5	756.74	122.4	768.67	99.9	627.37	98.6	619.21	79	496.12	89.9	564.57	116	728.48	119.9	752.97
2	93.9	1179.38	101.3	1272.33	107.6	1351.46	81.7	1026.15	69	866.64	83.4	1047.50	85.7	1076.39	99	1243.44
3	82.1	1546.76	82.5	1554.30	98.4	1853.86	66.7	1256.63	73.3	1380.97	81.5	1535.46	83.2	1567.49	88.8	1672.99
5	60.5	1899.70	63.9	2006.46	55.7	1748.98	64.4	2022.16	55.3	1736.42	67.7	2125.78	71	2229.40	76.1	2389.54
7	41.4	1819.94	46.5	2044.14	42.6	1872.70	40	1758.40	37.3	1639.71	47.4	2083.70	54.2	2382.63	53	2329.88
10	28.9	1814.92	32.1	2015.88	25.3	1588.84	20.7	1299.96	23.7	1488.36	26.5	1664.20	32.8	2059.84		
15			11	1036.20	9.5	894.90			11.7	1102.14						
20					6.6	828.96										
Minimum Resistivity		***756.74***		***768.67***		***627.37***		***619.21***		***496.12***		***564.57***		***728.48***		***752.97***
Maximum Resistivity		***1899.70***		***2044.14***		***1872.70***		***2022.16***		***1736.42***		***2125.78***		***2382.63***		***2389.54***
Average		***1502.91***		***1528.28***		***1345.88***		***1330.42***		***1244.34***		***1503.54***		***1674.04***		***1677.76***

Direction	Average Resistivity (Ohm-m)
East	1502.91
South - East	1528.28
South	1345.88
South - West	1330.42
West	1244.34
North - West	1503.54
North	1674.04
North - East	1677.76
	1475.90



ERT Point : AP - 1

Depth of electrode penetrated : *20 cms*

Test Date : 2081- 02- 07

Position :

Project: ERT Works for Existing 132kV Transmission Line

Client: Nepal Electricity Authority (NEA), Nepal

Consutant: Nippon Koei Co. Ltd., Japan

Location: Birauta, Pokhara - 17, Kaski

Model : KYORITSU, KEW 4106

Method : Wenner Four-Pin Method

Temperature(^{0}C): 25

Humidity (%) : 65

Reduced Level (m) :

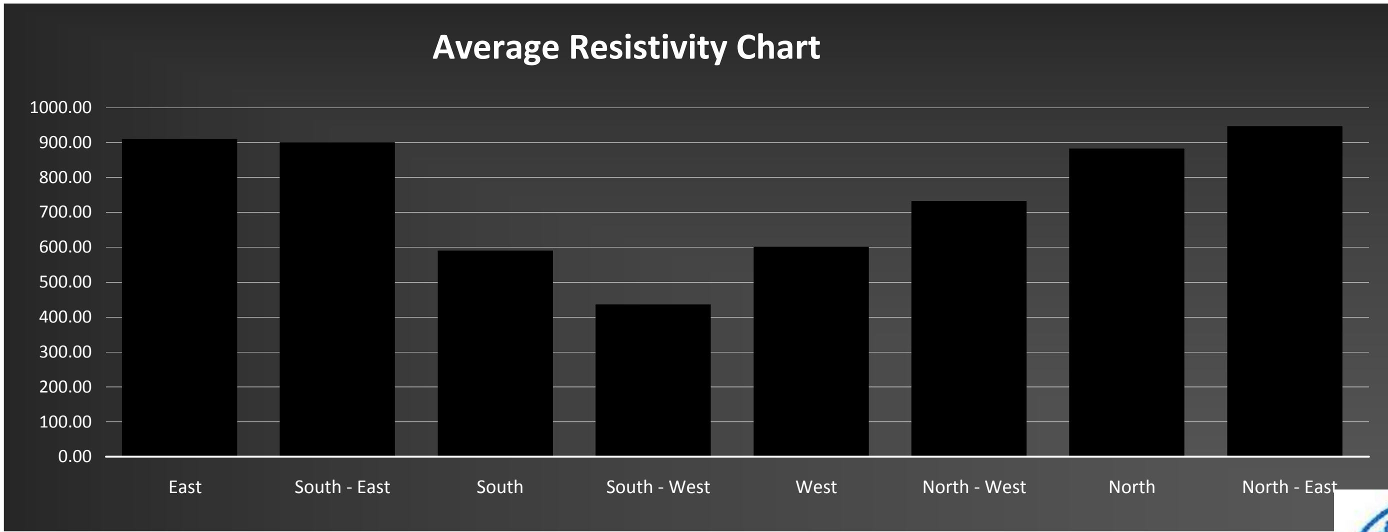
Soil Condition : Dry

Soil Type : Silty/sandy/silts with pebbles, cobbles etc.

RESULT

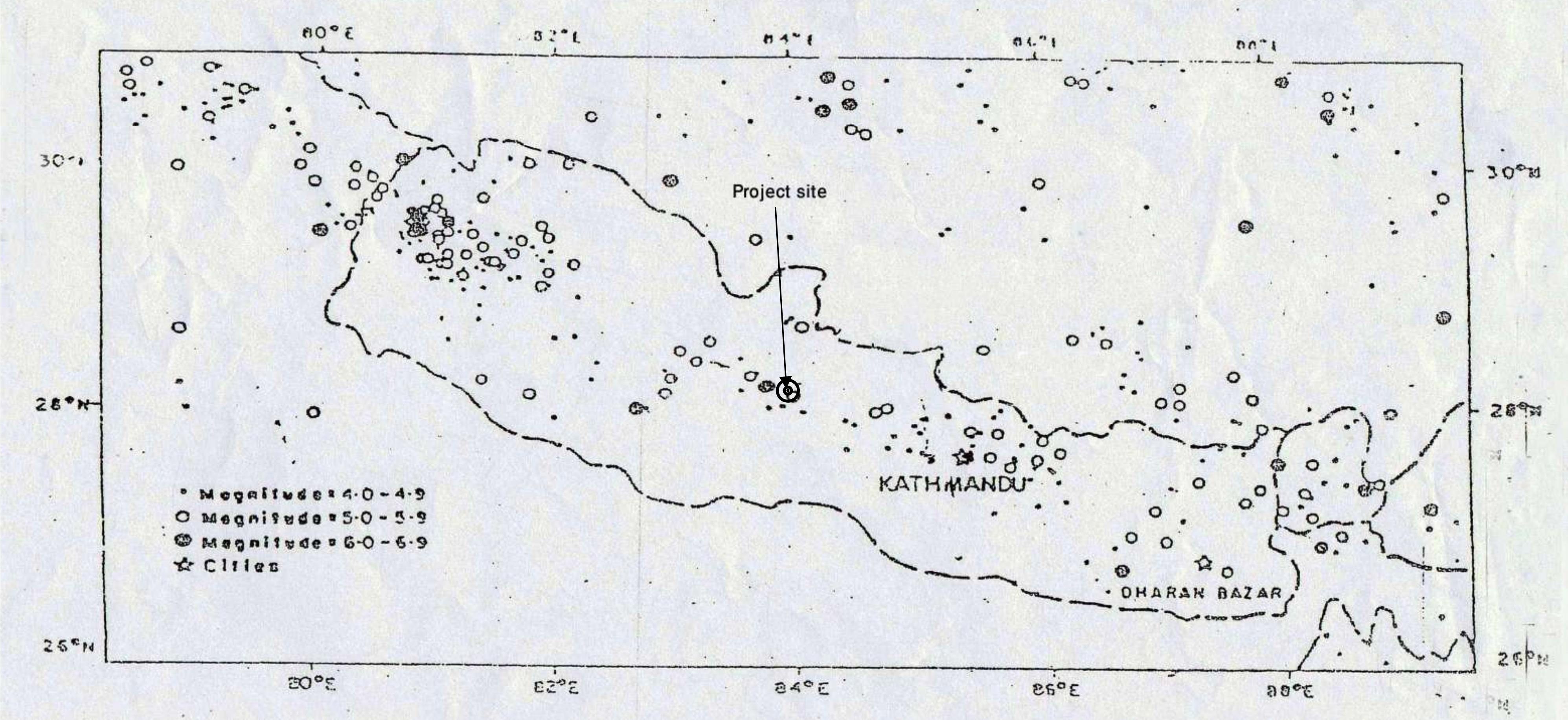
	East		South - East		South		South - West		West		North - West		North		North - East	
Spacing (m)	Resistance (Ohm)	Resistivity (Ohm-m)	Resistance (Ohm)	Resistivity (Ohm-m)	Resistance (Ohm)	Resistivity (Ohm-m)	Resistance (Ohm)	Resistivity (Ohm-m)	Resistance (Ohm)	Resistivity (Ohm-m)	Resistance (Ohm)	Resistivity (Ohm-m)	Resistance (Ohm)	Resistivity (Ohm-m)	Resistance (Ohm)	Resistivity (Ohm-m)
1	78.8	494.86	76.9	482.93	61.5	386.22	54.2	340.38	59.9	376.17	60.7	381.20	76.1	477.91	77.2	484.82
2	59.6	748.58	55.5	697.08	41.3	518.73	41.9	526.26	43.3	543.85	62.9	790.02	56.8	713.41	61.5	772.44
3	47.1	887.36	49.4	930.70	30.7	578.39			35	659.40	41.3	778.09	47.5	894.90	47.7	898.67
5	29.2	916.88	35.5	1114.70	23.1	725.34			23.7	744.18	30.9	970.26	34.6	1086.44	35.2	1105.28
7	23.2	1019.87	21.7	953.93	16.6	729.74			15.2	668.19			23.3	1024.27	22.1	971.52
10	22.6	1419.28	19.3	1212.04									17.2	1080.16	22.8	1431.84
15	9.2	866.64														
Minimum Resistivity		***494.86***		***482.93***		***386.22***		***340.38***		***376.17***		***381.20***		***477.91***		***484.82***
Maximum Resistivity		***1419.28***		***1212.04***		***729.74***		***526.26***		***744.18***		***970.26***		***1086.44***		***1431.84***
Average		***907.64***		***898.56***		***587.68***		***433.32***		***598.36***		***729.89***		***879.51***		***944.09***

Direction	Average Resistivity (Ohm-m)
East	907.64
South - East	898.56
South	587.68
South - West	433.32
West	598.36
North - West	729.89
North	879.51
North - East	944.09
	747.38



ANNEX - J

FIGURE



Pashupati Drilling and Geo- Technical Services Pvt. Ltd.

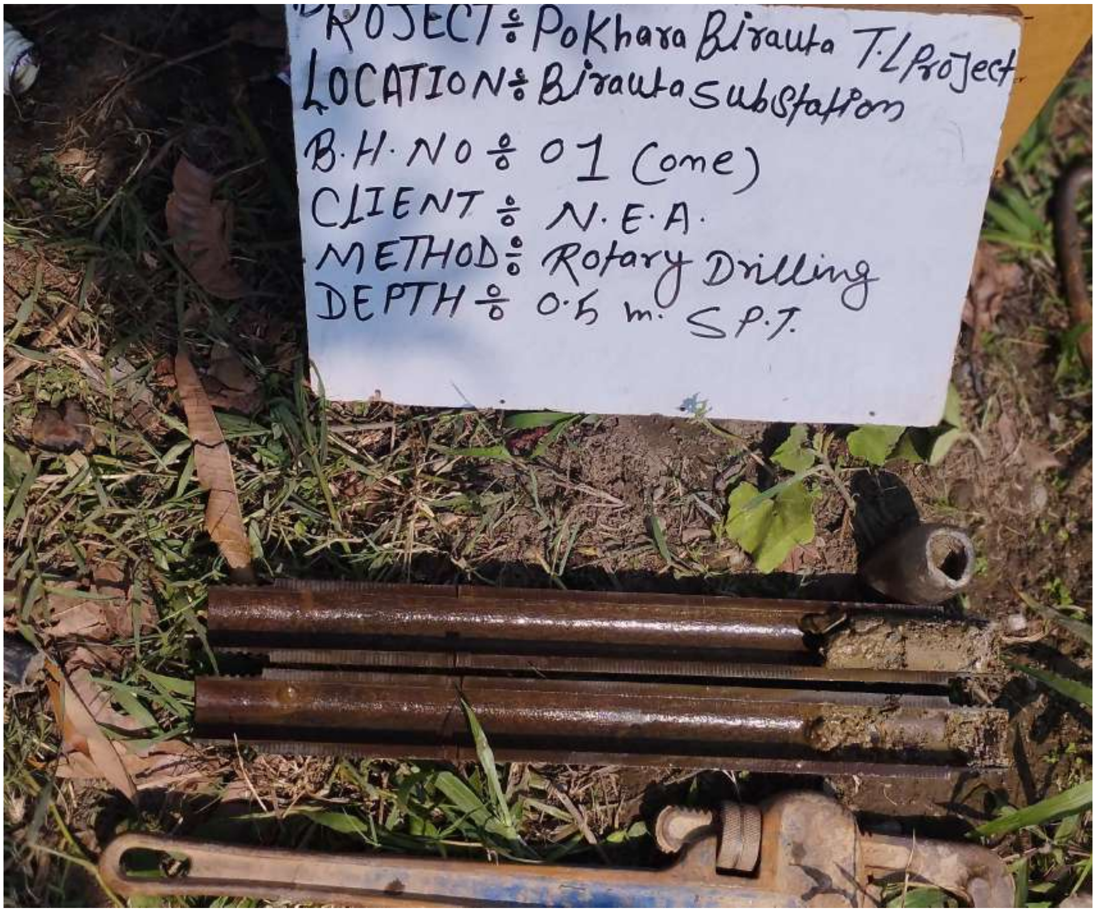
<u>ANNEX - K</u>

PHOTOGRAPHS

Drilling a Hole by Rotary Drilling Method (BH – 1 & AP – 1)

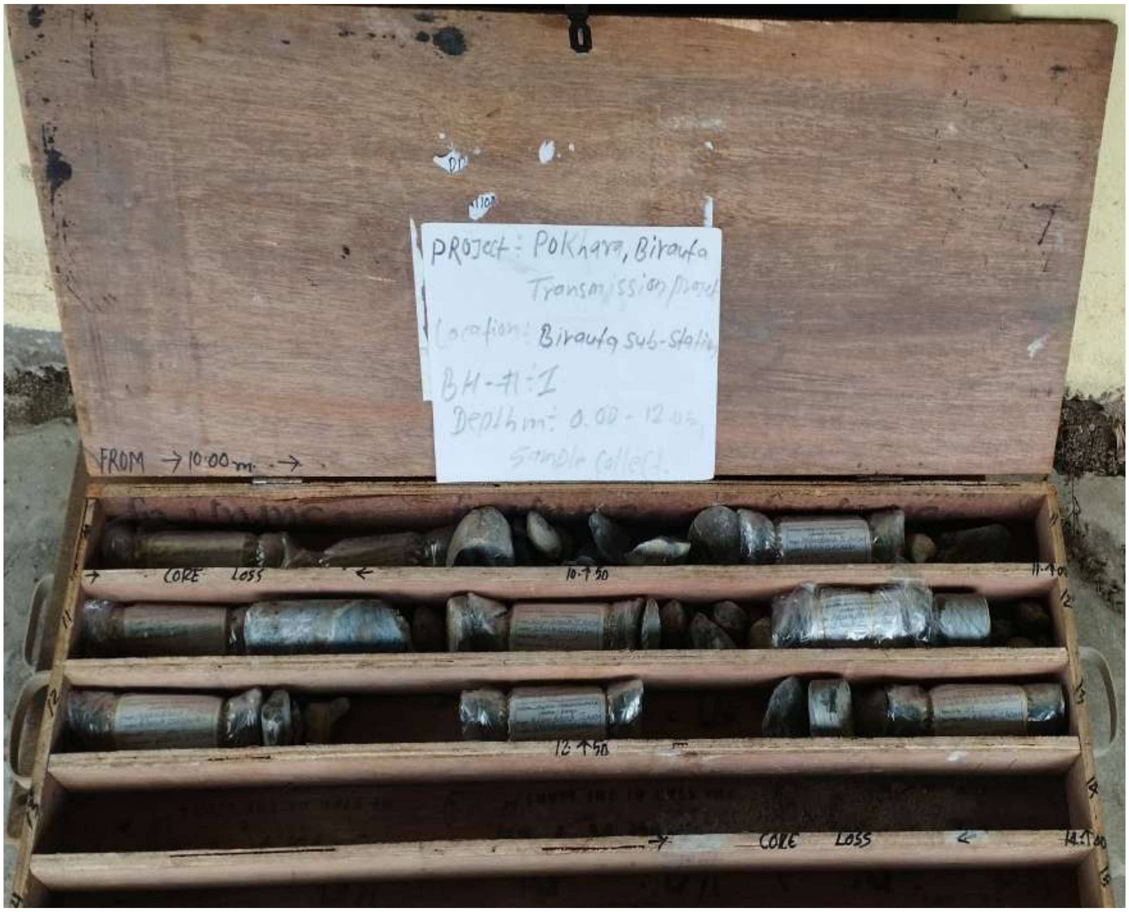
Pashupati Drilling and Geo- Technical Services Pvt. Ltd.

Conducting SPT/DCPT Test for getting (N) Value by Dropping a 63.5 kg Hammer from 750mm height (BH – 1 & AP – 1)



Retrieving SPT Samples through SPT Tubes (BH – 1 & AP – 1)

Conducting ERT Tests at (ERT (BH -1) & ERT AP – 1)



Preserving Soil/Core Samples in Polythene Bags and Core Box (BH – 1 & AP – 1)

<u>ANNEX - L</u>

FIELD DATA

BORE HOLE LOG

St ÷ 2081-02-02
END ÷ 2081-02-05

PROJECT: pokhara Birauta Transmission line project.   Date:

CLIENT: N.E.A   Bore Hole No.: 01

LOCATION: Birauta sub-station Birauta 17, Pokhara.

Depth	Thickness	Soil Classification	Water Table	SPT / DCP	0-15 / 0-10	15-30 / 10-20	30-45 / 20-30
0.00	0.5 m	silty sand / fine		0.5m SPT	9	11	17
		gravel pebbles.					
0.5 m	1.5 m	silty sand / fine		1.5m SPT	10	19	19
		gravel pebble cobbles.					
1.5 m	3m	" "		3m SPT	7	22	38
3m	4.5m	sandy gravel cobbles-		4.5m DCPT	50 / 7cm		
		Boulder.					
4.5m	6m	" "		6m DCPT	50 / 1cm		
6m	7.5m	" "		7.5m DCPT	50 / 5cm		
7.5m	9m	sandy gravel pebbles-		9m DCPT	50 / 0.5cm		
		cobbles.					
9m	10.5 m	sandy gravel pebbles		10.5m D.CPT	50 / 0cm		
		cobbles Boulder.	Loss				
10.5 m	12m	" "		12m D.CPT	50 / 8cm		

J Pradhan
Jeevan P. Pradhan
NK/TMS.
18 May 2024

Finjo Tamang

Pashupati Drilling & Geo- Technical Services Pvt. Ltd.
Krishna Kunj, Ramnagar, Lokanthali-15, Bhaktapur
Tel.: 00977-1-5182310, 9851026210; E-mail: pashupatidrilling@gmail.com

Pashupati Drilling and Geo-Technical Services Pvt. Ltd.

BORE HOLE LOG

ST÷2081-02-05
END÷2081-02-07

PROJECT: Pokhara Birauta Transmission Line project
Date:
CLIENT: NEA
Bore Hole No.: AP-1
LOCATION: Power house 17 Pokhara

Depth	Thickness	Soil Classification	Water Table	SPT / DCP	0-15 / 0-10	15-30 / 10-20	30-45 / 20-30
0.00	0.5m	Silty clay + fine gravel.		0.5m SPT	7	7	13
0.5m	1.5m	Silty sand/gravel pebble-cobble.		1.5m SPT	9	14	35
1.5m	3m	" "		3m SPT	3	14	50/1cm
3m	4.5m	Sandy gravel pebble cobble-Boulders.		4.5m DCPT	50/0cm		
4.5m	6m	" "		6m DCPT	50/0.5cm		
6m	7.5m	" "		7.5m DCPT	50/1.5cm		
7.5m	9m	" "		9m DCPT	50/5cm		
9m	10m	" "	Loss	10m	—		

Ground water not see at 8am.
No ground water level not found after 24 hrs.
21 May 2024

Jeevan P. Pradhan
NK/TMS
20 May 2024

Finto Tamang
Site supervisor

Pashupati Drilling & Geo- Technical Services Pvt. Ltd.
Krishna Kunj, Ramnagar, Lokanthali- 01, Bhaktapur
Tel : 00977-1-5182310, 9851026210 E-mail: pashupatidrilling@gmail.com

ERT Point : 01
Model : KYORITSU, KEW 4106 (4 Points Method)
Depth of electrode penetrated : *20 cms*

Project : Pokhara Biraufa T.L
Testing Date : 2081-02-04
Soil Condition :

Client: NEA
Position :
Soil Type : Sandy gravel pebble cobble.

Test Location : Biyaulfa sub-station
Temperation : 32° Degree (⁰)
Humidity : 42% Percentage (%)

FIELD MEASUREMENT TABLE

RESULT									
Direction		EAST	South- East	South	South- West	West	West- North	North	North- East
S.N	Spacing (m)	Resistance (Ohm)	Resistance (Ohm)	Resistance (Ohm)	Resistance (Ohm)	Resistance (Ohm)	Resistance (Ohm)	Resistance (Ohm)	Resistance (Ohm)
1	1	120.5	122.4	99.9	98.6	79.0	89.9	116.0	119.9
2	2	93.9	101.3	107.6	81.7	69.0	83.4	85.7	99.0
3	3	82.1	82.5	98.4	66.7	73.3	81.5	83.2	88.8
4	5	60.5	63.9	55.7	64.4	55.3	67.7	71.0	76.1
5	7	41.4	46.5	42.6	40.0	37.3	47.4	54.2	53.0
6	10	28.9	32.1	25.3	20.7	23.7	26.5	32.8	-
7	15	out of S/S-	11.0	9.5	-	11.7	-	-	-
8	20	Area.	-	6.6	-	-	-	-	-
Average									

* Soil Condition : a. Normal Dry Soil b. Wet (Moist) Soil c. Saturated Soil

* Soil Type : a. Normal Dry Soil (NDS) b. Wet (Moist) Soil (WS) c. Saturated Soil (SS) d. Sand

e. Dry Fissured Rock (DFR) f. Wet Fissured Rock (WFR) g. Hard Rock (HR)

Pashupati Drilling and Geo-Technical Services Pvt. Ltd.

J.P.Pradhan
Jeevan P. Pradhan
NIC/TMS
17 May 2024

Pashupati Drilling & Geo- Technical Services Pvt. Ltd.

Krishna Kunj, Ramnagar, Lokanthali- 01, Bhaktapur
Tel : 00977-1-5182310, 9851026210 E-mail: pashupatidrilling@gmail.com

ERT Point : AP-1 ERT-2
Project : pokhara Bireuta TL.
Client: NEA
Test Location : power house 17, pokhara.

Model : KYORITSU, KEW 4106 (4 Points Method)
Testing Date : 2081-02-07
Position :
Temperation : 25°C Degree (°)

Depth of electrode penetrated : *20 cms*
Soil Condition :
Soil Type : Sandy gravel pebble cobbles.
Humidity : 65% Percentage (%)

FIELD MEASUREMENT TABLE

		RESULT							
Direction		EAST	South- East	South	South- West	West	West- North	North	North- East
S.N	Spacing (m)	Resistance (Ohm)	Resistance (Ohm)	Resistance (Ohm)	Resistance (Ohm)	Resistance (Ohm)	Resistance (Ohm)	Resistance (Ohm)	Resistance (Ohm)
1	1	78.8	76.9	61.5	54.2	59.9	60.7	76.1	77.2
2	2	59.6	55.5	41.3	41.9	43.3	62.9	56.8	61.5
3	3	47.1	49.4	30.7	house.	35.0	41.3	47.5	47.7
4	5	29.2	35.5	23.1	behind	23.7	30.9	34.6	35.2
5	7	23.2	21.7	16.6	6.5mtr.	15.2	-OL-	23.3	22.1
6	10	22.6	19.3	/	/	-OL-	/	17.2	22.8
7	15	9.2	-OL.			–		-OL-	O.L Shade beyond 30m
8	20	-OL-	-OL-	–	–	–	–	–	
	Average								

* Soil Condition : a. Normal Dry Soil b. Wet (Moist) Soil c. Saturated Soil

* Soil Type : a. Normal Dry Soil (NDS) b. Wet (Moist) Soil (WS) c. Saturated

e. Dry Fissured Rock (DFR) f. Wet Fissured Rock (WFR) g. Hard Rock

site supervisor Anup Jamuny

J.Pradhan Jeevan. P. Pradhan civil Engineer NK/TMS 20 May 2024

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