Transmission Line Survey in Nepal (No 11809)

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Key words- Transmission line, Lidar survey, Environmental studies, Cadastral data,

1. SUMMARY

Nepal has estimated capacity of 83,290 MW to produce hydropower out of which 42,133MW could be economically feasible of production. All these hydropower energies produced could not be used in Nepal and majority of hydropower projects are located remote areas. Therefore, transmission lines are need to evacuate the power to main transmission grids and to neighbouring country like India, Bangladesh and other countries. Nepal Government have enacted regulations and agreement of transmission of high voltage power to India and Bangladesh to supply electricity.

The east-west transmission lines (132 KVA) is already exist in Nepal and north south and east-west transmission lines 132 or 400 KVA are planned. The main transmission lines will also be better used, if they are planned in middle mountain highway areas.

The preliminary planning of transmission line will be carried on topographical maps at the scale 1:25,000, which will be updated using recent satellite imagery. After decision of suitable route, DGPS Survey for main control points and Total Station survey carried out for location of angle points.

The detail survey will be carried out for by Total Station survey or Aerial Lidar Survey. Strip map of 100m of width will be carried out for location of pylons and detail study of areas. Sections and profile of transmission line will be prepared at the scale of 1:2,000 and vertical section 1:200 using recently prepared topographical maps at the scale of 1:500 or digital data base and DEM.

The cadastral data will be supper imposed on strip maps. They will be used in land acquisition and will be used to carry out environmental and social safeguard studies. The land will be acquired for the position of Pylons and right of way of transmission line using supper imposed cadastral maps.

Land acquisition and its implementation is slow process and it is affecting the progress of project implementation or construction. In this article, it is reviewed all the processes and legislation of transmission line construction that need to revise to expedite the decision making and construction works.

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2. BACKGROUND

Nepal's water resources potential including hydropower is sufficient which could be developed for rapid socio-economic growth of the Country. The gross hydropower potential of Nepal is considered as economically effective based on the fuel power balance, multipurpose utilization of water resources and preserving ecological balance in the country. In spite of the presence of sufficient hydropower potential within the country, Nepal could not meet the production schedule of power and energy supply. The ever-increasing demand of power and energy in Nepal and outside has promoted the decision makers of the country to harness the sufficient water resources potential.

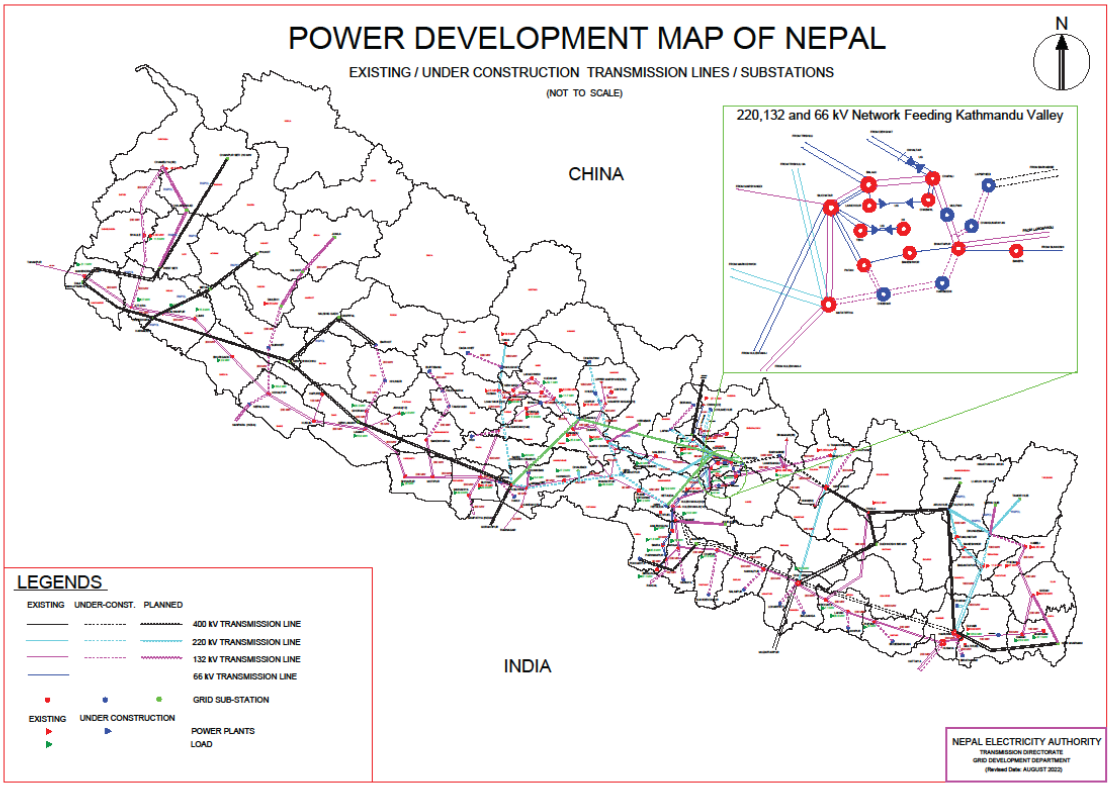

Fig .1: Power Development Map of Nepal

The investment required for the development of the Hydropower project is quite high because of the difficult terrain and the risks posed by the young geology of the Himalayas as well as foreign dependability in the hydropower construction technology. The government of Nepal has set an

encouraging investment environment for private sector. As per the Hydropower Development Policy, 2001 and Water Resources Strategy, 2002, the government envisages maximum involvement of private sector in hydropower development for large, medium and small-scale projects.

It is also policy of government to evacuate the power to central/ national grid from where the power is supplied to deficient areas. Hydroelectric Projects are the project undertaken by government, corporation or private organization and are planned to be developed in storage type to serve the peak load demand or run of the river. The contract for the Detailed Feasibility Study of Transmission Line Power for Evacuation from power station to substation work of the project has been awarded to private surveying companies.

Planned and developed situation of power evacuation by transmission line is shown above map (Fig. 1). Sometime power evacuation by transmission line is carried out longer distances as some project delayed in the construction.

Prefeasibility and feasibility study of most of the hydropower projects carried out or being carried out. The location of powerhouse and transmission line are shown in previous study. The geological map at the scale of 1: 250,000, topographical and land resources maps at the scale of 1: 25,000- 1:50,000, and cadastral maps at the scale of 1: 2500 are available. The road networks are being developed all over Nepal. It is visible in Google Images. Usually, hydropower projects are in remote areas which need good road during construction and maintenance phases.

3. OBJECTIVE AND SCOPES OF STUDY

The main objective of power evacuation study is to develop methodology for surveying and establish an optimal transmission line / power evacuation arrangement and to conduct the detail feasibility study from the power house/ take-off yard of Hydroelectric Project by 132 - 400 kVA transmission line to proposed Sub-station of Integrated Nepal Power System (INPS) under Nepal Electricity Authority (NEA)/Department of Electricity Development and to furnish the technical details.

4. LEGISLATION

There is various legislation to guide the survey, construction, maintenance and use of transmission line. The following are the main legislation related to survey:

Electricity Act, 2049(1992) para 4, 5 & 20 and Electricity Rules, 2050(1993) para 5, 6 and so on will guide the power evacuation procedure.

Hydropower Development Policy, 2058 (2001), Government of Nepal describes on para 6.3, and 6.12 provide Provision for Investment in Generation, Transmission and Distribution.

"Guidelines for Operation and Maintenance of Hydropower Plants, Substations and Transmission Lines " the Department of Electricity Development, Ministry of Energy,

Government of Nepal, Jan. 2017. Manual related to evaluation of Initial Environmental Assessment and Environmental Effect Evaluation of energy and transmission line.

TERMS OF REFERENCEs (TOR) for Various Transmission Line to Evacuate Power From power house to connect Substation will also guide the transmission line survey.

Data collection survey on transmission line and distribution Network Development in Nepal, Final report, July 2019, Japan International Cooperation Agency NEWJEC Inc., The Kansai Electric Power Co., Inc will also describe the transmission line survey.

5. BASIC DESIGN PRINCIPLE OF TRANSMISSION LINE

While designing the Transmission Line the following aspects are taken into consideration:

Low capital cost.
Reliability of the supply power.
Low operating cost
High efficiency
Simplicity of design.
Reserve capacity to meet future requirements

5.1 Voltage level for the transmission line

NEA transmission development plan has a crucial role in adopting the power evacuation voltage level. Moreover, NEA proposed nearby substation is of 132 -400 kV level. So, from techno-economic point of view, 132 kV voltage level is found to be more appropriate and hence recommended to adopt in this project.

For example, 132 kV transmission lines and appurtenant structures shall be of the following particulars:

Electrical System Parameters**:**
Rated service voltage: 132 kV

Highest system voltage: 145 kV

Impulse voltage withstand level: 650 kV

Number of phases: 3

Frequency: 50 Hz

Climatic Conditions
The transmission line shall be suitable for the climatic conditions prevailing at site:

- Atmospheric pollution is low and special insulator design or washing is not required.
- Maximum ambient shade temperature 45-degree C
- Minimum ambient shade temperature 0-degree C
- Annual average temperature 32-degree C

- Design wind velocity: 29.053 m/sec
- Rainfall: 1,000 mm/annum
- Relative humidity Maximum: 100 %
- Minimum: 20 %
- Isocyanic level (thunderstorm days) 50

Seismic Condition:

All structure shall be designed with the seismic factor 0.15g.

All the designs shall incorporate required data.

5.2 Route selection criteria

Selection of alignment has been carried out considering different criteria. Three alternatives were identified from the desk study, the walkover survey was carried out for the three different alignments, and preferred route between the three options was studied considering the below mentioned route criteria:

1. The alignment of the transmission line shall be most economical from the construction and maintenance point of view.
2. Routing of transmission line through protected/ reserved forest area should be avoided.
3. In case it is not possible to avoid forest or areas having large trees, and then keeping in view of the overall economy, the route should be aligned in such a way that cutting number of tress in minimum.
4. The route should have minimum crossings of Major River, National/State highways, overhead EHV power line and communication lines.
5. The number of angle points shall be kept to a minimum.
6. The distance between the terminal points specified shall be kept shortest possible, consistent with the terrain that is encountered.
7. Avoiding high hills/steep hilly areas and areas involving abrupt changes in levels and requiring too long spans.
8. Marshy and low-lying areas, riverbeds and earth slip zones shall be avoided to minimize risk to the foundation and towers.
9. It would be preferable to utilize level ground for the alignment.
10. Alignment will be kept at a minimum distance of 3m from power lines to avoid induction problems on the lower voltage lines.
11. All alignment should be easily accessible both in dry and rainy seasons to enable maintenance throughout the year.
12. Angle points should be selected such that shifting of the point within 100m radius is possible at the time of construction of the line.
13. The line routing should avoid large habitations, densely populated areas as far as possible.

14. Access and transportation: For the purpose of line route planning, manual hauling is assumed, but emphasis has been put on minimizing the hauling distances from existing and/or planned roads to the extent possible.
15. Foundations: It is advantageous to avoid tower sites requiring piled foundations or rock blasting, to the extent possible, in order to limit costs.

6. METHODOLOGY FOR DETAILED FEASIBILITY STUDY

6.1 General Approach

The ToR, national practice and the standard guidelines will be the main basis of the project study. The Transmission Line Design sector will also guide for carrying out the detailed feasibility study of the project.

It intends to embark upon the works with the following general approaches:

- Selection of those methods and technologies which have been tested and proven to be optimum and appropriate in successful on-going projects;
- Use of ToR, the national/international technical standards, guidelines and norms.
- Application of an optimal combination of the methods and technologies based on practicality, Client's requirements, and sound professional judgment;
- General management approach to accomplish the objectives of the services by clear responsibility distribution and farsighted management of resources; and
- Preparation and use of standard workable formats for ensuring uniform data collection, for minimizing subjective deviations, and for establishing effective and objective interpretation of the data. The formats will be suitable for analysis by using computer software, as appropriate.

Immediately after approval of the project, it will carry on the following field activity:

1. Reconnaissance Survey and Alternative route analysis
2. Geological mapping and Tower Spotting Verification of Transmission Line
3. Topographical Detail survey;
4. Cadastral data superimposition and updating road
5. Design and analysis of Transmission Line and Line Bay Extension Works with Construction Plan along with Cost Estimate
6. Construction Plan

6.2 Reconnaissance survey and data base generation

It will conduct the topographical survey and mapping, the work primarily consists of four major components enlisted hereunder i.e. connection to national network, monumentation of AP and DGPS observation of angle points and control points, topographical mapping of strip and preparation of cadastral maps of strip area and data.

These works will be carried out for successful evacuation of power from Hydroelectric Project to Substation of Nepal Electricity Authority.

The topographical maps at the scale of 1:25000 / 1:50,000 contour interval 20m/40m with supplementary contour 5m /10m respectively, published on 1992 and 2001 are available both printed and digital form. Trig Control Points are established during cadastral survey at the scale at the scale of 1:2500 of 1964 to 1995 BS of Nepal with or without trig control points.

The survey methodology will be as following:

6.3 Desk Study

The services in desk study includes desk-based route determination and detailed review of the same. At least three alternatives will be proposed with detail description of the routes from at least the following perspective (with inputs from Experts in relevant fields).

- Geological
- Environmental
- Sociological
- Transportation and Accessibility
- Technical perspective (Tower Spotting)

The alternatives proposed will be distinct with acceptable level of difference while viewing from different perspectives. These alignments will be selected based on the general criteria for alignment selection of the transmission line. Some of these criteria are as follows:

- Minimal use of forest sector
- Distant from settlement areas yet closer to the track or road
- Minimization of crossings like river crossing, road crossing, line crossing
- Lower number of angle towers

Shorter route alignment

It will require to provide enough information, logic and reference to back up these general criteria and for any other criteria adopted for route selection. The desk study is carried out on existing topographical maps and updated with satellite imagery or Google image.

Topographical maps are geo-referenced to coordinates of map sheet corners. If the topographical maps of transmission line were fall on both side of margin of two or more central meridians, one the central meridian with largest area will be used in plotting. These maps are prepared at the scale of 1:25,000 and used to plan and plot the transmission lines as well as to field survey work.

6.4 Reconnaissance Survey

The reconnaissance survey is carried out with site visit of experts to assess the alternative alignments from different perspective using printed at the scale of 1:25,000. The team for reconnaissance survey included at least the following experts Transmission Line Engineer, Geomatics Engineer, Geologist, Environmentalist and Sociologist.

The team will submit reports of the Reconnaissance survey incorporating the findings of their investigation and at the same time recommend the final route alignment for the transmission lines. The reconnaissance survey report will include the detail analysis of alternatives with separate evaluation of each route. The report will include at least Geological, Environmental, Sociological aspects for the Detailed Alternative Analysis of at least three distinct alternative routes. The team will recommend final alignment for the transmission line and provide enough information/logic/reference to back up the recommendation for route. The site visit will also include visit to the terminal locations of the transmission line powerhouse and substation site and the report will include recommendations for bay extension at the substation end.

6.5 Engineering Geological Studies

The engineering geological studies at this level of investigation was carried out in order to collect the relevant information about weakness zones (faults, folds and any other kind of discontinuities) that may cause difficulties for the project. The reliability of results of field mapping depends on the complexity of the geology, the experience of the personnel involved and the possibility of observing representative rock masses in outcrops, and involvement of a competent engineering geologist and the use of aerial photographs. The engineering geological map at the scale of 1:2,000 and 1:10,000 accompanied with sufficient cross sections will be developed using field topographic survey maps covering an area such that the regional geological picture would be clear. The geological fieldwork will cover an appreciable amount of the surrounding area such that the regional geological picture would again be clear. The existing 1:25,000 or 1: 50,000 topographical maps will be used as a base map for the purpose of mapping the larger areas.

The engineering geological part of the detailed feasibility report will include the engineering geological maps accompanied with one or more cross sections and relevant photographs. The angle points will be decided with geologist before monumentation of positions.

6.6 Monumentation

Each angle points and control point will be maintained with D-card. The D-card will be furnished with clear photograph, location details, XYZ co-ordinates,

names of landowner and reference with permanent structures or marks available in vicinity. However, each angle and control point then will be marked with concrete pillar of depth and height 30 cm with 10 cm breadth and 10 cm width.

6.7 Control Survey

The national grid (MUTM) coordinate system will be maintained with by connecting new survey control points with trig points/and 5-10 km and nearby BM if available by joint DGPS observations. The coordinates will be transferred to National Grid Coordinates. The trig points are either purchased from Survey Department of Government of Nepal.

The survey team will conduct DGPS survey of the transmission line using modern survey techniques and instruments having error within the standard acceptable limit. For DGPS survey, GNSS instrument is used with double frequency and accuracy of better than 5mm+- 1ppm. A pair of points established every about 10km interval. The time for observation will be at least 24 hours for base line point and 3 hours for other points. The coordinates of angle points will be fixed by DGPS or 1" total station traverses in between 10 km distance.

Other control points for detail survey and establishment of control points be carried out by total station traverse. The accuracy of such traverse be at least 1: 10,000 -1:100,000 as per TOR. The MUTM of Nepal, three coordinates (latitude, longitude, elevation or Northing, Easting and Elevation) of all identified tower positions will be determined.

6.8 Detailed Survey

The survey team will be undertaken by a detail survey of the approved route alignment using the closed traverse survey method. It will prepare strip map at the scale of 1:500 -1:2000 and longitudinal sections for the complete line with an appropriate interval (the contour interval for plain and hilly terrain will be 1 meter and 5 meters respectively). It will conduct detail survey of the transmission line using modern survey techniques and instruments having error within the standard acceptable limit for the detailed survey to 25 m on both sides of the recommended alignment.

Further, major features (switchyard, substation, angle points and all intermediate points, river crossings, line crossings, road crossing, houses/sheds/other structures, and any other major crossings) will be surveyed with latest details/features up to 25 m on both sides of the recommended alignment. The GIS maps will be prepared at the scale of with contour interval 1m or 5m, all detail and annotations of names etc.

The data will be further processed in any compatible software to AutoCAD (ver. 2007 or latest) and the output will be presented in the approved scale format.
The survey team will prepare survey report including, identification and explanation of route constraints, infrastructure details available on route etc.

6.9 Other Survey Works for the transmission line:

The Consultant will carry out at least following set of activities for design works of the transmission line.

a. Cadastral survey of transmission line

It is prepared for the Right-of-Way plan along the transmission line covering land plots, name of land holders, land area to be acquired /affected as per the current practice.
Cadastral map of the transmission line area is collected, geo-referenced and vectorized the parcels required for the project. The affected areas with land owner names are calculated by super imposition of cadastral maps on design of transmission line.
The areas of land to be acquired for each tower 20m*20m area and land for 24m either side transmission line for the project are calculated and recorded by Parcel no, Land owner's name, type(kisim) and ward, municipality and district.

b. Road Access survey of transmission line

Road access description for each tower location, including existing road, road to be constructed will be described and shown on topographical maps. Each tower will be described with road access separately in the detail design report. This will also be used as basis for cost estimation for the towers separately.
A map will be prepared at the scale of 1:25,000 updating existing maps with all existing roads and other details using Lidar survey data, satellite imagery or Google image and field data.

c. Environmental and Social Safeguard studies

It is carried out as per Land Acquisition Act 2034. The tower construction area (20m* 20m) and houses and other constructions below right of way are required fully acquired and compensated, and land parcels below right of way (48m strip) are paid one quarter of land value. The land owners would continue for cultivation or grazing uses on the land under the transmission line.

Social safe guard study is carried out completing the questionnaires by all land owners and interviews of stakeholders by FGD techniques. This information will be included on the report of the transmission line survey.

7. CONCLUSIONS AND RECOMMENDATIONS

On the basis field visit and desk study, the alternative analysis has been conducted for the different alternative routes and one of the alternatives with least cost and environmental affects will be selected.

Based on the study carried at the Inception phase, Transmission Line to evacuate power from power house to substation is recommended for the detailed feasibility study. The Lidar survey may be carried of transmission line during the topographical survey of reservoir, dam site and power house areas. It is also need to recommends satellite / aerial imagery required in the specification/TOR. The transmission line tower foundation profile is also needed nearly flat and geologically stable land for tower erection works.

8. REFERENCE

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