

Study Committee B2

Overhead Lines, PS3- Environmental & Safety aspects from OHL (Joint PS with C3)

Paper 489_2022

Innovative engineering solutions to overcome environmental and safety challenges and use of helicopter in construction of transmission line and substation in northeast of India.

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Motivation

- Substantial lowering the number of tree cuttings in Transmission line corridor & reduction of carbon footprint.
- Speed up construction work in hilly terrain
- Reduce land development & land stabilization work to construct Substation.

Importance of the project

This project deliver 3000 MW of power to 53 million people in North-Eastern region of India. Heli-operation were a key features of this project in order to drastically reduce the construction time.

The project was successfully completed with the implementation of innovative approach to sensitively deal with environment, forest, wildlife issues. In absence of 400kV Grid network this project was commissioned from 132kV side of Transformer & down stream power flow continuity was made.

Method/Approach

- Replacement of two transmission lines with a single multi circuit multi voltage line (MCMV). This resulted in substantial lowering the number of tree cuttings thereby preserving forest land by approximately one million square meters. Consequently, this also lead to significantly lower CO2 emissions on yearly basis.
- Helicopters were used for transportation of materials for execution of foundations and tower erections at high altitudes
- Multi level substation to reduce land development & land stabilization work.



Figure 2: Heli crane operation



Figure 1: Multi ckt. Multi voltage Line



Figure 3 Multi level Substation

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Challenges & Innovative solution

- The first challenge was to find the most economical route connecting the two sub-stations with the accuracy of survey for two 400 kV and 132 kV transmission lines passing through three big clusters in a thick forest. Authorities asked us to devise a solution which would have least impact on the environment and the forest ecosystem
- Engineering design experts had to go back to the drawing board to brainstorm. After few iterations, an interesting solution was developed by preparing two feeder incoming lines of 400 kV and 132 kV from sub-stations and combining it into a 400/132 multi-voltage-multi-circuit line, branching out as outgoing lines to connect to two substations. Tower configuration was created as a vertical formation for 400 kV and a delta formation of conductors for 132 kV. The transmission line was optimized by using intermediate angle towers to suit the angle deviations as needed as per the route instead of taking a conventional route of three standard angle towers.
- Multi Voltage (400kV and 132kV), multi circuit towers (MCMV) were used. This resulted in substantially lower impingement into the forest corridor.



Figure 4: Two D/c lines joining on M/c line

- Availability of land in the dense forest was the biggest challenge for as AIS substation layout with incoming and outgoing transmission lines. Constructing access roads to transport very heavy substation equipment like transformers and reactors from the manufacturers factory 1000 kms away was also a challenge.

Heli-crane operation for construction of transmission line

Since the transmission line spanned virgin forest in undulated and hilly terrain, transporting construction materials to top of the mountains was a challenge. Making things more complex, was the outbreak of the Covid 19 global pandemic, an unprecedented event which led to a strict, nation-wide lockdown in March 2020.

Manually moving thousands of tons of material would have meant an estimated 1500 workers to be deployed for a period of 12 months. This would have increased the risk of Covid 19 infection.

Adhering to the stringent guidelines imposed by the State Government of Arunachal Pradesh during the pandemic, Helicopter service was deployed to lift the material to eliminate the requirement of 1500 Plus manpower.

The helicopters transported all the construction materials to tough and unapproachable hilly locations. The operation took less than 3 months to deliver over 3000 MT of material across 40+ locations in about 400 flying hours. Helicopter operations from marshalling yard to location is shown in (Figure 5 & Figure 6).



Figure 5: Material lifting using Heli-crane



Figure 6: Transport to hill top location

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Construction challenges for stability of foundation on the riverbed with high water table

Upper Assam region is also called Brahmaputra River valley - one of the largest rivers of India. All the locations in this section had very high-water table level which made civil work extremely difficult within stipulated project timelines.

Most of the foundation locations presented the challenge of sinking of foundations or unequal settlements. Heavy duty pumps were installed for day and night de-watering activity. Soil condition were such that conventional pad & chimney was not possible. Solution was developed using innovative design of raft foundation as a common foundation for all four legs in consultation with Indian Institute of Technology at Guwahati, a premium technological educational institution in India, having good knowledge about building foundations in this area. This solution helped in ramping up the execution work and reduced the time of each foundation by 50% when compared to conventional design as shown in (Figure 6).



Figure 6: Raft foundation under construction

Grid constraints for charging of substations

Due to grid constraints, one of the 400/132 kV substation was charged from the 132KV side and subsequently connected to the 400kV line. A detailed study was done to understand the charging currents and Interconnecting transformer stability in the event of charging from a very weak 132kV network. Charging of 125 MVAR Bus Reactor at 400kV Level was done using innovative state-of-the-art SPS protection scheme as per grid operator requirement.



Figure 7: Surajmaninagar substation

Challenges of wildlife protection

In Assam, the transmission line corridor intersects into the traditional elephant corridors causing a human - Elephant conflict. As a precaution, Professor and an elephant behavior scientist from Indian Institute of Science was consulted to eliminate potential incidents. As per his advice, camp sites were kept litter free. Tents were raised above ground level to prevent snakes and other animals from entering. The overall tower footprint was minimized; overall tower height was raised to permit free movement of Elephants under them. Safety of the workers was ensured from Elephant movement near site.



Figure 8: Elephant movement near construction site

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Details of project construction area on Indian geography map

400 kV & 132 kV Transmission line elements, 400/132 kV two nos. green field substation and 132 kV brown field stations are marked on Indian geography map. These elements are spread over 3 states in North-Eastern region of India

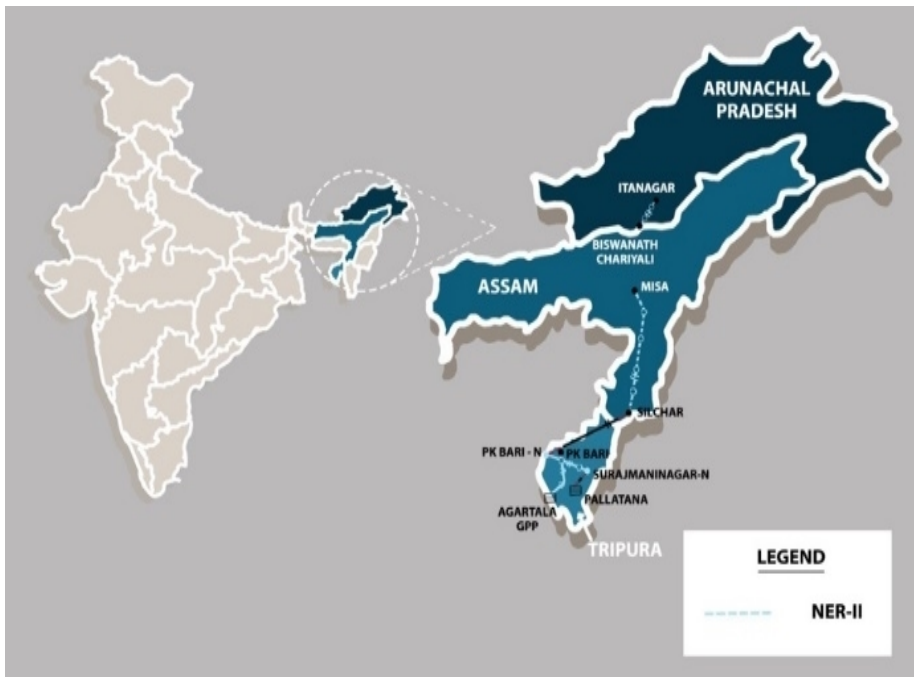


Figure 9: Project elements on Map

Conclusion

NER II project, is a prime example of best of technological innovations and out of box thinking in project delivery, creating tremendous social impact. Billions of people were directly impacted with reliable and quality power in the remotest parts of the country.

These efforts resulted in the North - East - Region emerging brighter on the power map of India, with stronger reliability of power systems in the region. All transmission lines and connecting substations were successfully completed and the lines were charged in the first attempt without any tripping.

The NER II project goes a long way in ensuring sustainable and affordable energy delivery, by connecting the North-Eastern- Region with the National Grid.

This contributes to one of the U.N. Sustainable Development Goals of “Affordable & Clean Energy”, along with least impact to the environment and forest cover in the region.

All of the above actions resulted in the NER-II project receiving the Golden Peacock Award 2020 for Occupational Health and Safety and IPMA Global project Excellence Award.