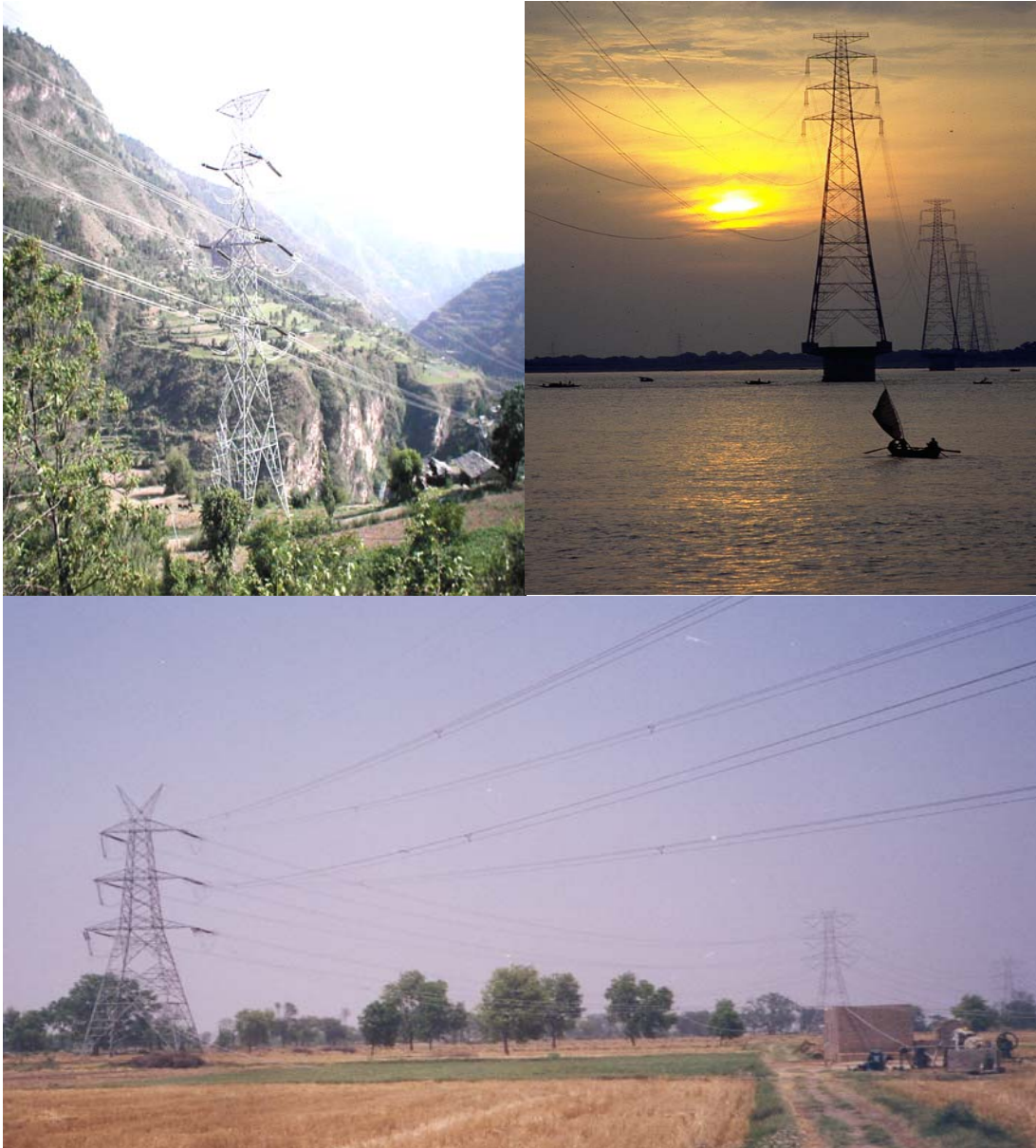


Report of Task Force on Transmission Projects



**Task Force Constituted by Ministry of Power, Govt. of India
Under Chairmanship of Member(Power Systems),CEA**

Report No. MOP/CEA/TF-001 August 2005

REPORT

OF

TASK FORCE

ON

TRANSMISSION PROJECTS

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EXECUTIVE SUMMARY

REPORT OF THE TASK FORCE ON

TRANSMISSION PROJECTS

EXECUTIVE SUMMARY

Ministry of Power, Government of India vide Office Order No. 11/2/2005-PG, dated 28th February, 2005 constituted a Task Force on transmission projects with the following terms of reference:

- a). To analyze the critical elements in transmission project implementation.
- b). To recommend ways to curtail delays in transmission project implementation from the best practices of CTU and STUs and
- c). To suggest a model transmission project schedule for 24 months duration.

The Task Force comprised of the following members :-

1. Member(Power Systems), CEA - Chairman
2. Director(Projects), POWERGRID
3. Ms. Rachel Chatterjee, CMD, APTRANSCO
4. Shri A.D.Palamwar, Member(T&D),MSEB
5. Shri M.Durairaj / Shri V.N. Mathiyalagan, Member(T&D), TNEB
6. Smt. V.L.Joshi, CMD, GETCO, Gujarat
7. Shri S.Ahmed / Shri Shreemat Pandey, CMD, RVPNL, Rajasthan
8. Shri Jiwesh Nandan, Director(Trans), MOP
9. Shri R.N. Nayak, ED(Engg), POWERGRID - Convener

The Task Force reviewed various practices presently followed for project execution, activities involved in project formulation, approval and its implementation, time required for various stages of project execution viz. pre-award, post-award, detailed engineering, forest clearance, construction etc for identifying ways and means to implement transmission projects within 24 months time frame.

Through detailed deliberations, the Task Force identified following major factors/issues leading to delays and prolonging the project execution period :-

- Commencement of project related activities after approval/sanction of project, taking up various activities in series
- Non-standardization of packaging concept
- Non-standardization of tower & foundations, designs kept in scope of contractor
- Non-implementation of state-of art techniques in survey & construction activities
- Non-standardization of practices/procedures
- Delays in scrutiny of designs/drawings, testing, inspection

The Task Force also identified the potential areas where strategic initiatives are required to accelerate project implementation. The observations and recommendations are elaborated in the Task Force report.

Salient findings & suggestions by the Task Force are summarized below :-

- **Parallel Processing of Activities**

A transmission project involves various activities from concept to commissioning. The Task Force observed that major reduction in project implementation schedule is possible by undertaking various preparatory activities (viz. surveys, design & testing, processing for forest & other statutory clearances, tendering activities etc.) in advance/parallel to project appraisal & approval phase and go ahead with construction activities once Transmission Line Project sanction/approval is received.

- **Packaging Concept**

Total transmission project should be broken down to clearly defined packages such that the packages could be procured & implemented requiring least co-ordination & interfacing and at same time it attracts competition facilitating cost effective procurement. The size & scope of the different packages will therefore depend on magnitude & location of project. However, the packages should be few and supply-cum-erection type contracts should be preferred to avoid co-

ordination problems. The Task Force suggested typical packages for procurement/construction of Transmission system.

- **Standardization of Designs**

To avoid repetitive work and uncertainties during testing, the tower designs should be standardized. It is desirable that the designs are standardized and developed by Utilities prior to floating of tenders for tower fabrication and construction so that 6-12 months or more time can be saved in project execution.

Standardization of designs/drawings for other transmission line materials & substation structures, equipments, control room building etc. also should be standardized to the extent possible.

- **Qualifying requirements for Vendors/Bidders**

In order to select contractors of appropriate capability & capacity it is required that Qualifying requirements in respect of technical resources, financial capability, production capacity, tools & plants etc are stipulated in bidding documents and contractors are selected accordingly.

- **Bidding Document & Bidding Philosophy**

The bidding documents should furnish all information necessary for a prospective bidder to prepare a bid for the goods and works/services to be provided. The technical specifications and conditions of contract need to be unambiguous. Considering volatility of the input cost, it is desirable that contracts are invited with suitable price variation provisions such that contract price is adjusted based on published indices of raw materials & labour.

Single stage bidding may be practiced for transmission line & substation works with appropriate packaging and qualification requirement.

- **Route Alignment, Detailed Survey & Soil Investigations**

It is desirable that the project is defined to finer details to the extent possible at the FR / Notice Inviting Tender (NIT) stage for effective planning and scheduling of project(s) besides optimization of resources.

New technology/ techniques such as use of satellite imagery, GPS, total stations, computer-aided tower spotting etc. for getting realistic information/details leading to selection of optimum route alignment and facilitating realistic estimation of bill of quantities have been suggested. To avoid large quantity variations during execution stage, which can be a cause of dispute/delay, it would be desirable to carryout detailed survey before NIT.

- **Mechanization in Construction, Quality Management System etc.**

Thrust is to be given towards use of new technologies & mechanized means for construction of transmission projects to reduce time.

Besides implementation of standardized Manufacturing & Field Quality Plans, utilities should also adopt prompt and transparent Inspection Management System for smooth implementation of the project.

- **Environment & Forest Clearance and Rehabilitation & Resettlement (R&R)**

Advance action should be taken for processing forest clearances. With adoption of modern survey techniques, it is possible to minimize the infringement with forest as various alternatives can be analyzed. It is also helpful in convincing the concerned Authorities for expediting clearances as better evaluation of forest involvement is possible.

It is also desirable that Environment & Social Policy & Procedures (ESPP) are required to be framed by utilities through consultative process. Such initiatives would assist in settlement of R&R and environmental issues expeditiously and avoid delays on this account.

- **Vendor Development**

A large number of projects would be taken up by many utilities concurrently for construction due to the large transmission programme to be implemented in limited time frame. It is, therefore, recommended that active vendor development initiatives are to be taken by all utilities so that indigenous

capabilities are effectively developed and adequate supplier/ vendor base is created to have competitive prices and timely completion of projects.

- **Project Monitoring**

A master network for the entire project from concept to commissioning need to be prepared and monitored regularly with reference to the target and required actions are taken. Similar detailed network is also to be prepared for each package for monitoring activities at micro level. Regular reviews should be done at Project Manager level and quarterly review at Chief Executive level also is recommended.

Various aspects as brought out above have been deliberated by the Task Force and recommendations have been made. However, project authorities need to review and adopt depending upon the size nature, location and complexities of the project on case to case basis. A reasonable time schedule for a specific project is required to be tailor made for each project element like transmission line, substations, HVDC terminals etc. depending on its size, nature & complexity. Further, in case of large projects where many such project elements are involved, suitable time periods need to be provided for each element and the overall project completion schedule is to be accordingly decided.

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TRANSMISSION PROJECTS

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REPORT OF THE TASK FORCE ON

TRANSMISSION PROJECTS

1.0 INTRODUCTION

An addition of about 100,000 MW generating capacity and matching large power transmission network of more than 100,000 kms of various voltage levels viz. 765 kV, 400 kV, 220 kV AC & HVDC systems has been envisaged to be added during the Xth Plan and XIth Plan periods. The targets to be achieved within the coming decade is almost equivalent to the total development the Indian Power System has witnessed in the last five (5) decades. In order to ensure the development of such a large quantum of capacity addition, construction practices have been improved to achieve a gestation period of about 3 years in case of thermal and 4 – 6 years in case of hydro units respectively. Accordingly, the time available for implementation of cross-country transmission systems is also required to be compressed to a shorter period in comparison to earlier time. Moreover, construction of transmission lines has become more complex and uncertain due to increasing right of way constraints, awareness of public on environment and procedural complexities for environmental & forest clearances etc.

Keeping this in view, Ministry of Power, Government of India vide Office Order No. 11/2/2005-PG, dated 28th February, 2005 constituted a Task Force on Transmission Projects with the following terms of reference:

- a). To analyze the critical elements in transmission project implementation.
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- c). To suggest a model transmission project schedule for 24 months duration.

A copy of the Office Order is enclosed at **Annexure-I**.

The Task force committee was constituted with the following members :-

1.	Shri V. Ramakrishna, Member(Power System), Central Electricity AuthorityChairman	2.	Director(Projects) POWERGRID Member
3.	Ms Rachel Chatterjee, Chairman & Managing Director, APTRANSCO Member	4.	Shri A.D.Palamwar, Member(T&D), Maharashtra State Electricity Board Member
5.	Shri M.Durairaj / Shri V.N.Mathiyalagan Member (T&D), Tamil Nadu Electricity Board, Member	6.	Smt. V.L.Joshi, Chairman & Managing Director, Gujrat Energy Transmission Corporation Member
7.	Shri S. Ahmed / Shri Shreemat Pandey Chairman & Managing Director, Rajasthan Rajya Vidyut Parishad Nigam Ltd Member	8.	Shri Jiwesh Nandan, Director (Trans.), Ministry of Power, Govt. Of India Member
9.	Shri R.N.Nayak Executive Director (Engineering) POWERGRID Convener		

The Task Force had sittings on 14.03.05, 02.06.05 & 22.07.05 and deliberated various issues in the implementation of a transmission project. During the discussions, it emerged that as Power Grid Corporation of India Ltd. (POWERGRID) have been involved in construction of large number of transmission projects and have also adopted a number of good practices and emergent & new technologies, the Committee felt that these practices may be delineated in detail and also examine the feasibility of improving / modifying the practices to compress the construction time of transmission lines. Besides above, best practices/experiences of some of the other Corporations/ State Transmission Utilities in expeditious implementation of transmission projects may also be incorporated.

2.0 MAJOR ACTIVITIES IN A TRANSMISSION PROJECT

The Committee identified various activities involved in a Transmission Project.

The major activities for a transmission system project are :-

Phase-I : Project Formulation And Approval Phase

- i). System Planning and Feasibility Studies including preliminary surveys.
- ii). Agreement with Beneficiary/ Constituents, wherever required
- iii). Preparation of Feasibility Report/ Detailed Project Report including Cost Estimates.
- iv). Project Financing Tie up.
- v). Investment approval of Competent authority i.e. Power Transmission Company / Regulator/ Government , as applicable.

Phase-II : Project Execution Phase

- i). Route alignment, Detailed survey and soil investigations for transmission lines
- ii). Initiating Forest, Environmental, PTCC, Railway crossings & other statutory clearances
- iii). a) Identification of land for Sub Stations and initiation of formalities for land acquisition.
 b) Contouring & leveling of substation land and construction of boundary wall.
- iv). Basic Engineering & Technical specifications

- v). Packaging (total scope of work divided into various packages for procurement)
- vi). Finalizing scope of work, bill of quantities & bidding documents for various packages.
- vii). Tendering, Bid evaluation, and award of contracts
- viii). Design, Engineering & Tower Testing, scrutiny of drawings/type test reports
- ix). Manufacturing
- x). Type testing of equipments
- xi). Quality Assurance & Inspection
- xii). Supply Management
- xiii). Construction Management
- xiv). Testing & commissioning

3.0 GENERAL PROJECT IMPLEMENTATION PRACTICES FOLLOWED BY POWER UTILITIES

Generally Utilities take up Phase-I i.e. project formulation & approval phase initially and commence activities related to project execution/construction after receipt of investment approval. It may be mentioned that this process in case of inter-State transmission projects takes at least 6-12 months or more depending upon nature & complexity of the project and subsequently execution period takes about 24-30 months totaling to more than three (3) years for completion of the project.

In addition to the above, the following also lead to delay in execution :-

- Non-standardized Packaging concept of the Transmission Project adopted by various utilities.
- Non-standardization of tower & foundations leading to different tower & foundation designs for every package and designs generally kept in contractor's scope resulting in more time for preparation, testing and approval.

- Taking up various activities in series and not taking up the activities in parallel. Preparatory work/activities such as survey, testing of towers, processing for environmental & forest clearance, invitation of tender, readiness for award could be taken up during the project appraisal & approval phase.
- Non-implementation of state-of-art techniques in survey & construction activities.
- Non-standardized practices/procedures.
- Delays in scrutiny of designs/drawings, testing, inspection

4.0 STRATEGY FOR REDUCTION IN PROJECT IMPLEMENTATION PERIOD

4.1 Parallel Processing of Activities

Certain preparatory activities which are usually taken up after investment approval can be taken up simultaneously during the process of investment approval as it takes around 6-12 months for appraisal from various agencies and for obtaining necessary administrative & finance approval from Competent Authority. Though the cost involved in the preparatory activities is minimal compared to the project cost, this goes a long way in expediting the project execution.

Activities which can be taken up simultaneously are :-

- i). Route alignment, Detailed survey and soil investigations for transmission lines & substations.
- ii). Initiating Forest, Environmental & other statutory clearances after detailed survey
- iii). a) Identification of land for Sub Stations and initiation of formalities for land acquisition and also acquisition

- b) Contouring & leveling of substation land and construction of boundary wall
- iv. Basic Engineering & Technical specifications
- v). Packaging (total scope of work divided into various packages for procurement)
- vi). Finalizing scope of work, bill of quantities & bidding documents for various packages.
- vii). Tendering, Bid evaluation
- viii). Design, Engineering & Tower Testing

All these activities can be completed in advance and award recommendations can be kept ready so that award can be made at the earliest on receipt of Investment approval of the Competent Authority. This expedites the execution & avoid delays in execution. This has the potential to reduce the completion period by at least 12 months.

Various preparatory & design activities should be taken up in advance/parallel not only for large transmission projects but also for smaller substation works. Faster implementation of 48 nos. of 66 kV substations by GEB(GETCO) by undertaking advance/parallel action is an example in this respect. Brief details are enclosed at **Annexure-II**.

4.2 Packaging Concept

The total transmission project should be broken down to clearly defined packages such that the packages could be procured & implemented requiring least co-ordination & interfacing and at same time it attracts competition facilitating cost effective procurement. The size & scope of the different packages will therefore depend on magnitude & location of project.

For projects requiring a variety of goods & works, separate contracts are generally awarded for the supply and/or installation of different items of equipments & machinery for the works.

The construction work of Transmission system comprise mainly of following :-

- (i) Transmission line portion – Survey; supply of towers, conductor, earthwire, insulator, hardware & accessories ; construction of foundations ; erection of towers and stringing of conductor & earthwire.
- (ii) Substation portion – Supply & installation of major electrical equipments viz. transformer, reactor, circuit breaker, CT, CVT, Isolator, LA etc; other auxiliaries such as structures, fire protection, control cables, control & relay panels, SCADA, PLCC, lighting, air-conditioning; and civil works such as road, drains, trenches, foundations and control room building.

It has been seen that for the transmission line, the major items/works are foundations, tower supply & erection; conductor; & stringing ; insulator, which constitute about 15-20 %, 35-40 % , 40-45 %, & 5-7 % respectively of total cost for a typical 400 kV transmission line. In a transmission line, it is not desirable to separate the supply of towers and other related works like foundations, erection & stringing, as it will lead to various interfacing and co-ordination problems particularly considering the cross-country nature of the work. It is desirable that tower supply & erection and all associated work viz. foundations and minor items i.e. earthwire, hardware & accessories, is covered in one package for better co-ordination & execution. The conductor which is a high value item constituting about 40% of the transmission line cost (in 400 kV) and which does not pose major interfacing problems could be procured in separate package. Similarly, insulators also can be procured in separate package.

In regard to substation packages, earlier, substation equipments were procured separately and other items were kept in substation erection package. It has been experienced that this practice also lead to similar interfacing and co-ordination problems & delays in certain items. The turnkey package covering all the items (except supply of major items viz. transformer & reactor) therefore should be preferred.

The various options were deliberated and it emerged that the packages should be few and turnkey type of contracts should be preferred to avoid co-ordination problems.

The suggested/typical packages for procurement / construction of a Transmission System are :-

- Route Alignment, Detailed Survey & Soil Investigation
- Transmission Line Tower Packages (including earthwire, hardware & accessories) – Supply cum erection including foundation & stringing
- Conductor packages – Supply
- Insulator packages – Supply
- Substation packages (excluding supply of transformer & reactors*) – Supply cum erection including civil works
- Transformer packages – Supply cum supervision or with installation
- Reactor packages – Supply cum supervision or with installation

* In case transformer & reactors are to be procured in large number, the same to be procured as separate package.

During discussions, it emerged that various SEBs/State Corporations viz. TNEB, APTRANSCO, GEB who had earlier been procuring different items separately and getting execution work separately through smaller packages faced lot of co-ordination problems & delays and have now started adopting supply cum erection packages generally as proposed above.

During deliberations, it also emerged that for small lines (say upto 40-50 kms), total turnkey package including conductor & insulator may be considered.

However, project authorities may review & decide the packaging depending upon the nature, location & complexities of the project. Sometimes, funding agency may also stipulate certain packaging concept which are also required to be followed.

4.3 Standardization of Designs

4.3.1 Transmission Towers

It has been seen that testing of towers is very time consuming process taking about 6-12 months or more from order stage to successful testing. It takes further more time to test towers for various voltage levels & wind zones. In case of any eventuality such as tower failure during testing, this period gets prolonged. Requirement of design and testing of towers for all transmission lines lead to multiplicity of designs and non-availability of test beds to complete testing etc. adding to project delays.

In this context, it may be mentioned that during mid 90's, in many projects tower designs were kept in the scope of the contractor with an objective that the utility might get optimized tower designs leading to substantial savings due to the use of mix of efficient grades of steel particularly in case of International Competitive Bidding under multilateral funding. However, the experience has indicated that this has not been the case but on the contrary resulted in considerable time being taken for completion of tower tests and also increase of inventory for spare towers and in certain cases has resulted in delay in completion of project . It may be further added here that this has also led to multiplicity of designs and complexities in deployment of these in future projects.

Therefore, to avoid repetitive work and uncertainties during testing, the tower designs may be standardized for a group of prospective projects together so that repeated activities of design & testing also could be avoided. While standardizing designs it is desirable that details of designs available with other utilities may also be considered so that the number of designs to be developed and tested by any utility can be minimized. This is important specifically when designs of towers for various voltage levels would have to be developed in a limited time frame. It is desirable that the designs are standardized prior to floating of tenders for tower fabrication and construction so that 6-12 months or more time can be saved in project execution.

A case study on reduction in time schedule by adoption of Utility's designs taken up in advance is enclosed at **Annexure-III**.

In case of hilly terrain, towers with unequal leg/raised chimney extensions should be adopted to reduce the benching & revetment requirements which would lead to expeditious execution of the project. It may be mentioned that this requirement should be envisaged during design of the towers.

With adoption of Owner's designs for towers & foundations, the quantities of towers/foundations in the contracts shall be on tonnage/cubic meter basis. To avoid non-sequential supplies by the contractors, which in the past resulted in delay in completion of works, it is suggested that payments should be made on per tower/foundation basis on completion of supply/erection as applicable based on approved drawings/Bill of Materials.

4.3.2 Insulators, Hardware Fitting & Accessories for Transmission Line

The designs and drawings may be standardized to the extent possible with each contractor so that repetitive approval is avoided. Further, insulators & hardware fitting combinations can also be tested in advance so that material could be supplied expeditiously.

4.3.3 Sub Station structures

It will be advantageous if sub station structures which are regularly used are also standardized. The standard beams and columns can be procured as and when required without going through the process of design, its verification, proto assembly etc saving considerable effort and time during project execution. Further, foundation designs may also be standardized to the extent possible.

4.3.4 Sub Station Equipments

The designs, drawings of various substation equipments such as CB, CT, CVT, LA & Isolators etc. may be standardized with each contractor (as they are very limited) so that repetitive approval is avoided.

4.3.5 Control room Buildings, Other Buildings & Colony

Standardization also need to be done for control room building as well as other buildings of regular nature in a sub station to achieve overall saving in effort and time. Standardization can be taken up for sub stations of each voltage level.

4.3.6 Compact sub-stations

In order to reduce problems of land acquisition and related R&R, efforts should be made to reduce substation land requirement by evolving & adopting compact layouts, compact switchgear & GIS substations. During deliberations, it emerged that GIS substation price have come down considerably in the recent times. Therefore, in the urban areas, GIS substations should be considered as a viable option.

4.4 Qualifying Requirements for Vendors/Bidders

Time is essence in Project Management. As these works are of specialized nature, it is possible to implement the project without delay only if right contractor is engaged. It is imperative that the contractors engaged for construction do have adequate resources and experience to undertake the job and complete the same in stipulated time schedule. In this regard, apart from technical experiences in projects of similar nature and complexity, the vendor's production capacity, manpower, tools & plants etc for construction as well as financial capability play important roles. Therefore, the qualifying requirements should adjudge the capability and resources of prospective bidders to perform the particular contract satisfactorily, taking into account their (a) experience & past performance in similar contracts, (b) capabilities with respect to personnel experience, availability of adequate tools and equipment, construction or manufacturing facilities and (c) financial resources. Further, the contractor's order book and projects in hand for concurrent execution also needs to be considered while awarding the job.

In order to select contractors of appropriate capability & capacity it is required that Qualifying requirements in respect of technical resources, financial capability, production capacity, tools & plants etc are stipulated in bidding documents and contractors are selected accordingly.

4.5 Bidding Document

The bidding documents shall furnish all information necessary for a prospective bidder to prepare a bid for the goods and works/services to be provided. While the detail and complexity of these documents may vary with the size and nature of the proposed bid package and contract, they generally include: invitation to bid; instruction to bidders; form of bid; form of contract; conditions of contract, both general and special; specifications and drawings; relevant technical data (including of geological and environmental nature); list of goods or bill of quantities; delivery time or schedule of completion; and necessary appendices such as formats for various securities. The basis of bid evaluation and selection of the lowest evaluated bid shall be clearly outlined in the instructions to bidders and/or the specifications.

During the discussions of the Committee, it emerged that ambiguous provisions in the technical specifications and conditions of contract leads to disputes which delay project execution. Therefore, the technical specifications and conditions of contract need to be unambiguous and should not be one sided. Risk sharing between utility & contractor should be reasonable & balanced. The Bid Documents should be standardized.

The execution period of a contract is about two(2) years and the bids are required to be invited few months before submission of bid, evaluation by the Utility & award. Therefore, it is almost about 2 to 2.5 years from the submission of price bids. Considering volatility of the input cost and to avoid padding up of the cost by the vendors for future variations in input costs, it is desirable that contracts are invited with suitable price variation provisions such that contract price is adjusted based on published indices of raw materials & labour. However, contracts with one (1) year or less completion period could be on firm price basis except conductor/tower material/transformer/reactor which usually cover major part/cost of the project.

4.6 Bidding Philosophy

The two stage bidding process involves considerable time in contract award and hence should be adopted only in case of contracts for large / complex facilities or works of a special nature.

On the other hand, the transmission line & substation works are of regular nature and its specifications are generally well defined. As preliminary investigations, surveys etc. are carried out in advance and relevant details are included in the bidding documents, the project complexities would be well addressed at the time of bidding. As such, single stage bidding can be practiced if appropriate packaging and bidder's qualifying requirements are adopted. This would reduce the time required for tendering and placement of orders.

4.7 Route Alignment, Detailed Survey & Soil Investigations

It has been observed that the activity of route survey has not received / given adequate importance in the construction of transmission lines. It is to be highlighted that this is one of the most important activity influencing the time & cost of a transmission project and is also a tool to minimize the impact of environmental issues at the initial stage itself. Therefore the Committee is of the view that due importance should be given by all utilities to this aspect.

It is desirable that the project is defined to finer details to the extent possible at the FR / Notice Inviting Tender (NIT) stage for effective planning and scheduling of project(s) besides optimization of resources. Such project definition would also bring out constraints and special site conditions specific to the project in advance so that appropriate measures can be taken for avoiding delays in project execution.

The topographic maps of Survey of India based on which route alignment for transmission line is carried out at walkover/preliminary survey stage are generally very old and do not depict present ground conditions. It would therefore be desirable to adopt new technology/ techniques such as use of

satellite imagery etc. for getting realistic information/details for optimum route alignment. To avoid large quantity variations during execution stage, which can be a cause of dispute/delay, it would be desirable to carryout detailed survey before NIT. Specially, for hilly / mountainous areas, requirement of carrying out detailed survey at NIT stage is essential for correct estimation of bill of quantities including that of unequal leg extensions, benching & revetment etc. To increase accuracy & reduce time, modern survey techniques involving detailed survey using total stations, Global positioning system (GPS) etc., tower spotting/optimization through computer-aided techniques etc. should be adopted.

The implementation of such techniques in some of the recent projects has indicated that appreciable optimization of route length is possible and also assessment of route constraints in a more realistic manner can be done. Therefore, it could be possible to float the procurement & construction packages with realistic estimate of bill of quantities and better definition of project constraints, facilitating bidders to quote competitive prices and the utility to execute project with minimum /reasonable variations in project cost & time.

A flow chart showing the methodology of survey and data processing using modern techniques is enclosed at **Annexure-IV**. Indicative diagrams of satellite imageries, ground profiles, computerized tower spotting, digital terrain models etc. are also enclosed at **Annexure-IV**. A case study highlighting the advantages of route alignment using satellite imagery is enclosed at **Annexure-V**.

4.8 Mechanization in Construction

Thrust is to be given towards use of new technologies & mechanized means for construction of transmission projects to reduce time. Tension Stringing Equipments are commonly used for stringing of bundle conductor & earthwire. In regard to soil investigation, new techniques such as Electric Cone Penetration Test (ECPT) for faster & accurate investigations have emerged and are being used in India for other applications like highways, bridges etc. Such techniques can be adopted in case of transmission line & substations also. For construction of pile foundations, which is a time taking activity, the

contractors may be asked to deploy hydraulic rotary rigs. As per the experience, hydraulic rotary rigs can construct pile foundation much faster, few days in place of few weeks with conventional techniques. However, only concern would be approach for transport of such rigs to work site. Further, use of other mechanized means viz. Excavators for foundation excavation work, cranes for tower erection etc. may be looked into by project authorities.

4.9 Environment & forest Clearance

Effort should be made to avoid forest and National Park/Wild Life Sanctuary while finalizing the route alignment of transmission line to the extent possible. Wherever, it is not possible to avoid forest, effort should be made to minimize the effected forest area. In case routing of the transmission line through forest is unavoidable, it is mandatory to follow Forest (Conservation) Act 1980 and clearance need to be taken from appropriate Authorities depending upon quantum of forest planned to be encroached. Further, Hon'ble Supreme Court clearance is also required in case the line is routed through a Wild Life Sanctuary/National Park which is very time consuming process. It may be mentioned that as per the Forest (Conservation) Rules, the minimum 210 days period is required for getting clearance from the receipt of application. Therefore, action needs to be taken well in advance so that execution does not suffer on this account. Further, it has been observed that with adoption of modern survey techniques, it is possible to minimize the infringement with forest as various alternatives can be analyzed. It is also helpful in convincing the concerned Authorities for expediting clearances as better evaluation of forest affected area is possible.

It has been observed that tall towers, compact towers, multi-circuit towers etc. can be effectively used for reducing environmental impact and therefore such options should be explored & considered wherever required. This will also facilitate expeditious forest clearances.

A general flow chart for Forest Clearance is enclosed at **Annexure-VI**.

4.10 Rehabilitation & Resettlement (R&R) Plan

It has been seen that sometimes acquisition of land for substation gets delayed, and consequently delay in finalizing R&R plan for affected people resulting in delay in completion of the transmission project. Therefore, each utility should possess R&R Plan commensurate with National Policy to avoid disputes in acquiring substation land. R&R should be prepared in consultation with Expert Environmentalists, NGOs, Govt., funding agencies & public consultation process.

It is desirable that Environment & Social Policy & Procedures (ESPP) are framed by utilities through consultative process so that uniform approach is followed in this regard. Such initiatives would assist in settlement of R&R and environmental issues expeditiously.

Implementation of ESPP also help in conservation of natural resources particularly forests. It has been seen that with successful implementation of ESPP in POWERGRID, by proactive & systematic approach, the forest involvement which was about 6% of total circuit km. lines till 1998 has come down to 2% for the lines constructed in last 6 years.

4.11 Vendor Development

A large number of projects would be taken up by many utilities concurrently for construction due to the large transmission programme to be implemented in limited time frame. It is apprehended that the present capability for project execution might fall short of the requirement. It is, therefore, recommended that active vendor development initiatives are to be taken by all utilities so that indigenous capabilities are effectively developed and adequate supplier/vendor base is created to have competitive prices and timely completion of projects.

It is also desirable that training modules are designed by power utilities to impart training to vendors' personnel for enhancing human resources capable of taking up such unprecedented large scale project execution. It has been

noted that presently no such organized training modules or programs are available in the country to deliver training needs of construction personnel for transmission systems.

4.12 Quality Management System

The transmission projects with compressed implementation schedules necessitates implementation of appropriate Quality Management Systems for providing adequate assurance of the manufactured item / equipment meeting the project specific requirements. The focus therefore needs to be on Quality Assurance rather than on Inspection after manufacturing of the equipment. Time is essence, hence rejection at any stage, including final product will delay the project implementation. Therefore the utilities should:

- i) Include the Quality requirements in the specification,
- ii) Select capable vendors/sub-vendors through suitable Qualifying requirements and transparent vendor assessment system.
- iii) Maintain database of acceptable vendors / manufacturers for selection by main Contractor.
- iv) Standardized unambiguous Manufacturing Quality Plan (MQP) indicating Customer Inspection Checks for each equipment/process
- v) Standardized Field Quality Plans (FQP) indicating Customer Inspection Checks for each area of activities viz. construction of sub-stations & transmission lines and civil works
- vi) Ensure regular, timely and consistent inspection at critical stages, viz. raw material, in- process and final acceptance stage (both at main contractor's and its sub-vendor's works)
- vii) Root-cause analysis of equipment failures and initiating appropriate corrective & preventive actions to prevent recurrence.

Delay in inspection has a multiplying effect on projects schedule; hence the concerned utilities should adopt prompt and transparent Inspection Management System for smooth implementation of the project. In this regard POWERGRID has developed a web-based online Inspection Management System (IMS). A flow chart is given at **Annexure-VII**. The benefit of this system, apart from transparency, is that all concerned have real time access to the IMS avoiding dependence on individuals; letters, faxes & phones etc and in turn delays.

Further, implementation of Quality Management System (QMS) meeting requirements of ISO 9001:2000 shall ensure finalization of systems and

procedures and specify responsibilities and interaction within various groups leading to quicker decision making and faster execution as the dependency on the individual is avoided. Moreover implementation of ISO 14001: 2004 (Environmental Management System) and OHSAS 18001: 1999 (Occupational Health and Safety Management System) is also recommended so as to ensure the good industry practices.

4.13 Project Monitoring

A master network for the entire project from concept to commissioning need to be prepared and monitored regularly with the target & required actions to achieve progress. Similar detailed network is to be prepared for each package for monitoring & remedial actions. Each project should be headed by a “Project Manager” who shall be single source responsible for execution of the entire work. He should be a senior officer of the Utility (level to be finalized depending upon size of the project) and shall be fully responsible for co-ordination with internal depts. as well as external agencies for the execution of the project. Project review meeting should be held periodically including at the level of Chief Executive of the Utility for corrective action. Project Review Meeting alongwith all the relevant depts. such as Engineering, Procurement, Finance, Quality Assurance & Inspection and project site should be held monthly by the Project Manager and quarterly at Chief Executive Level. Exception report & action plan for remedial measures need to be put up to CEO every month. Presently, various established software such as MS Project etc. are available which could act as a good tool for monitoring.

4.14 Project Schedule

Typical PERT network has been prepared for completion of a transmission project from concept to commissioning for completing the transmission execution work in a 24 months schedule and the same is enclosed at **Annexure-VIII**. This schedule envisages adoption of various strategies for reduction in project implementation period as suggested in the report.

A reasonable time schedule for a specific project is required to be tailor made for each project element like transmission line, substations, HVDC terminals etc. depending on its size, terrain & complexity. Further, in case of large projects where many such project elements are involved, suitable time periods need to be provided for each element and the overall project completion schedule is to be accordingly decided. Further, reasonable time is to be provided for commissioning every element of the project.

Indicative construction schedules of different transmission lines, sub-stations, HVDC etc. are tabulated below :-

A. Transmission Lines

Sl. No.	Transmission Line	Plain Terrain Lines less than 100 km length	Plain Terrain Lines more than 100 km length Hilly / Mountainous Terrain Lines less than 50 km length	Hilly / Mountainous Terrain Lines more than 50 km length
1.	132 kV / 220 kV TL 400 kV S/C TL	16 – 20	22 – 26	31 – 35
2.	220 kV D/C (Twin bundle) TL 400 kV D/C TL 400 kV S/C (Quad bundle) TL	22 – 26	28 – 32	37 – 41
3.	400 kV D/C (Triple/Quad bundle) TL 500 kV HVDC TL 765 kV S/C TL	28 – 32	34 – 38	40 – 44

Note: The above schedules indicate construction time of a transmission line, therefore, suitable margins need to be kept for completion of all the elements of a Project/System.

In the cases where a portion of transmission line falls in plain as well as hilly/mountain terrain, a reasonable time period may be considered based on the transmission line length falling in such area/terrain and other constraints.

Further, suitable margins in the construction schedules are required to be kept depending upon involvement of forest, National Parks/Wild Life Sanctuaries; right of way / land acquisition constraints; law & order problems, very difficult snowbound mountainous terrain etc.

B. Sub-stations

Sl. No.	Sub-station Works	Plain Area	Hilly / Mountainous Terrain
1.	AC Sub-station (upto 400 kV) Extension	16 – 20	20 – 24
2.	New AC Sub-station (upto 400 kV)	22 – 26	31 – 35
3.	765 kV Sub-station HVDC Back to Back	28 – 32	37 – 41
4.	HVDC Bipole Terminal	34 – 38	40 – 44

Note: The above schedules indicate the construction time of a sub-station , therefore, suitable margins need to be kept for completion of all elements of a Project/System.

In case a sub-station involves tough hilly terrain with various stepped levels, forest, difficult approach roads, law & order problems, land acquisition constraints etc. adequate margins should be kept in the construction schedules.

However, in case certain project necessitates lesser completion schedule to match generation project / grid strengthening, suitable adjustment may be made on case to case with adequate resource mobilization and other expeditious measures.

Acknowledgement

The Task Force is thankful to Shri A. Verghese, Chief Engineer, Central Electricity Authority, Shri M. Krishnakumar, Addl General Manager and Shri Anish Anand, Chief Design Engineer, Power Grid Corporation of India, Gurgaon for their assistance and support in preparation of the Report.

- | | |
|---|---|
| 1. Executive Director (Engg.),
POWERGRID,
Gurgaon.
- Convener of the Task Force | 2. Director (Trans.),
Ministry of Power,
New Delhi. |
| 3. Member (T&D),
MSEB,
Mumbai. | 4. Member (T&D),
TNEB,
Chennai. |
| 5. Director (Projects),
POWERGRID,
Gurgaon. | 6. Chairman & Managing Director
RRVPL,
Jaipur. |
| 7. Chairman & Managing Director
GETCO,
Vadodra. | 8. Chairman & Managing Director
APTRANSCO,
Hyderabad. |
| 9. Member (Power Systems),
CEA,
New Delhi.
- Chairman of the Task Force | |

ANNEXURE – I

Copy of Office Order dated 28th February 2005 from MOP

No. 11/2/2005-PG
Government of India
Ministry of Power

....
New Delhi, the 28th February, 2005

Office Order

Sub : Constitution of a Task Force on Transmission Projects

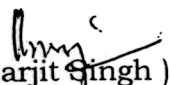
In supersession of this Ministry's Office Order of even no. dated 4.2.005 on the above subject, it has been decided that the composition of the Task Force on transmission projects would be as under:

1.	Member (Power Systems), CEA	...	Chairman
2.	Director (Projects), PGCIL	...	Member
3.	Ms. Rachel Chatterjee, CMD, APTRANSCO	...	Member
4.	Shri A.D. Palamwar, Member (T&D), MSEB	...	Member
5.	Shri M. Durairaj, Member (T&D), TNEB	...	Member
6.	Smt. V.L. Joshi, CMD, GETCO, Gujarat	...	Member
7.	Shri S. Ahmed, CMD, RVPNL, Rajasthan	...	Member
8.	Shri Jiresh Nandan, Director(Trans.), MOP	...	Member
✓ 9.	Shri R.N. Nayak, ED(Engg), PGCIL	...	Convener

The terms of reference (TOR) of the above Task Force will be as under:

- (a) To analyze the critical elements in transmission project implementation;
- (b) To recommend ways to curtail delays in transmission project implementation from the best practices of CTU and STUs; and
- (c) To suggest a model transmission project schedule for 24 months duration.

The Task Force will submit its report within two months. All the expenditure related to the functions of the Task Force will be borne by PGCIL.


(Harjit Singh)
Under Secretary to the Govt. of India
Tel: 2332 4357

To

1. All Member of the Task Force
2. Chairperson, CEA, New Delhi
3. CMDs of all CPSUs under Ministry of Power

ANNEXURE – II

Brief Details on Faster Implementation of TL & S/S projects in GEB(GETCO)

ANNEXURE-II

Brief Details on Faster Implementation of TL & S/s Projects in GEB(GETCO)

48 Nos. of 66 kV S/S were constructed and commissioned during 2004-05. Completion of so many S/s alongwith the connected lines in a short period was possible by adopting, among others, the following steps :-

1. Advance possession of land through special Government Orders.
2. Standard designs and specification for all substations and equipments.
3. Simultaneous parallel action on procurement and civil works right at the beginning of the financial year.
4. Development of local contractors to enable them undertake S/s installation works without hassles.
5. Periodic review/co-ordination meetings between head office and Site (i.e. Circle & Division) offices to enable co-ordination of procurement and installation activities.

ANNEXURE – III

**A Case Study of Reduction in Time Schedule by Adoption of
Owner's Design taken up in Advance**

ANNEXURE-III

A CASE STUDY ON REDUCTION IN TIME SCHEDULE BY ADOPTION OF OWNER'S DESIGN TAKEN UP IN ADVANCE

Tower Designs in Contractor's Scope

Project	:	Vindhyachal Additional Transmission System
Transmission Line	:	400 kV D/C Vindhyachal-Jabalpur-Itarsi-Dhule
TL Contracts placed in	:	August 1994
LOA Completion Schedule	:	33 months from LOA i.e. by April 1997
Tower Testing Time	:	Schedule as per LOA – 6 months Actual - 10 to 20 months
Transmission Lines Completed/Commissioned	:	January/February 1998
Actual Construction Period :		42 months from LOA

Tower Designs in POWERGRID's Scope

Project	:	East West Interconnector
Transmission Line	:	400 kV D/C Raipur-Rourkela

TL Contracts placed in : January 2001

LOA Completion Schedule : 20 months from LOA
i.e. by September 2002

Tower Testing Time : N/A

Towers designed & tested by POWERGRID in advance.

Transmission Lines : January 2003
Completed/Commissioned

Actual Construction Period : 24 months from LOA

ANNEXURE – IV

Route Alignment & Detailed Survey using Modern Techniques

ANNEXURE-IV

ROUTE ALIGNMENT & DETAILED SURVEY **USING MODERN TECHNIQUES**

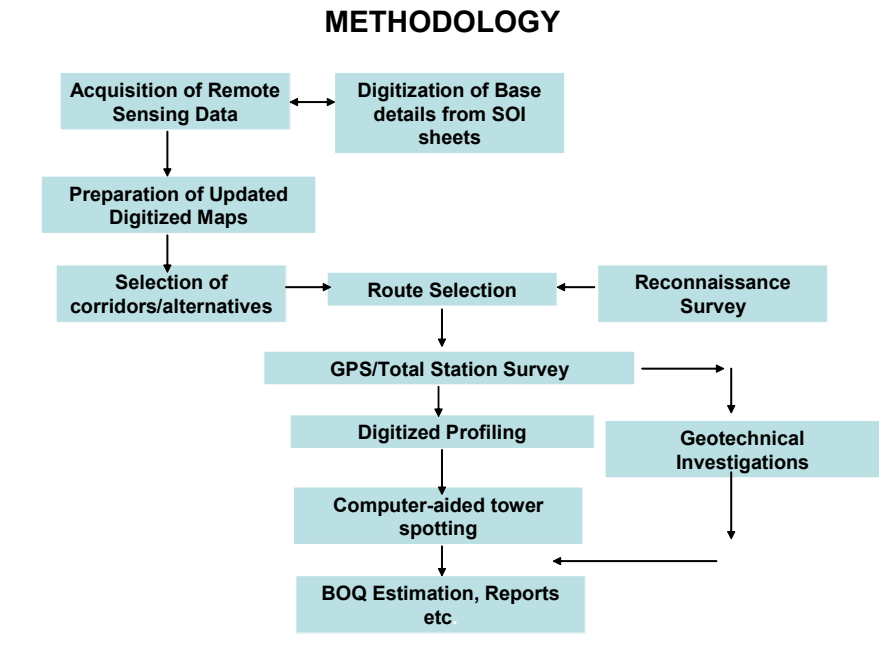
Modern techniques for route alignment and detailed survey of transmission lines primarily involve selection of transmission line route after examining various alternatives with the help of GIS techniques after updating topographic maps from Survey of India using latest Satellite imagery obtained from NRSA (National Remote Sensing Agency). After route selection, detailed survey and ground profiling is carried out using Total Stations, Geo Positioning Systems (GPS) etc. and tower locations are optimized using computer-aided techniques.

The salient activities covered under the modern survey techniques are as follows :-

- a) Route Alignment using low-resolution satellite imageries (1:25000, PAN+LISS merged) of NRSA and Survey of India maps including digital terrain modeling in hilly terrain along the proposed route using contour data from topographical maps. High resolution imagery may be used wherever required.
- b) Detailed Survey using GPS, Total stations / Digital theodolites of reasonable accuracies and related software.
- c) Tower spotting with latitude and longitude & optimization of tower locations using computer-aided techniques
- d) Digitized contouring at undulated / hilly tower locations
- e) Soil Investigation
- f) Estimation of BOQ

- g) Identification and detailing of Route constraints, infrastructure details etc. available enroute.
- h) Preparation of Survey reports

A Flow-diagram of the methodology is shown below :

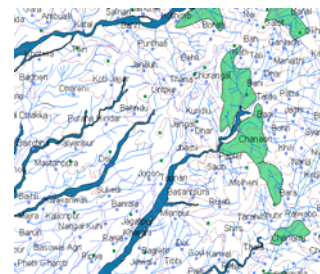


Indicative pictures/diagrams of various activities involved are shown below :

Digitized Toposheet

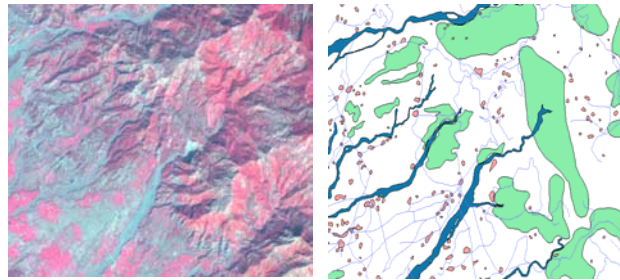


Survey of India Topo Sheet



Corresponding Digitized Map
indicating relevant information

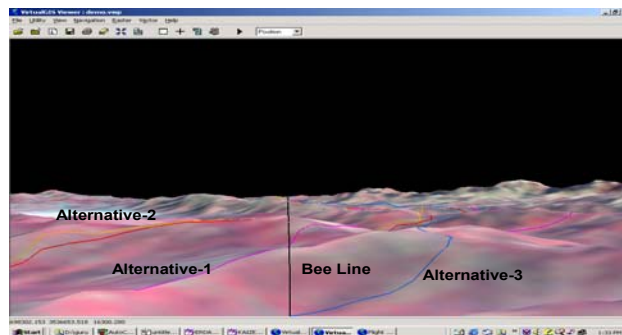
Digitized Satellite Image



Satellite Imagery
(5.8/20 m resolution)

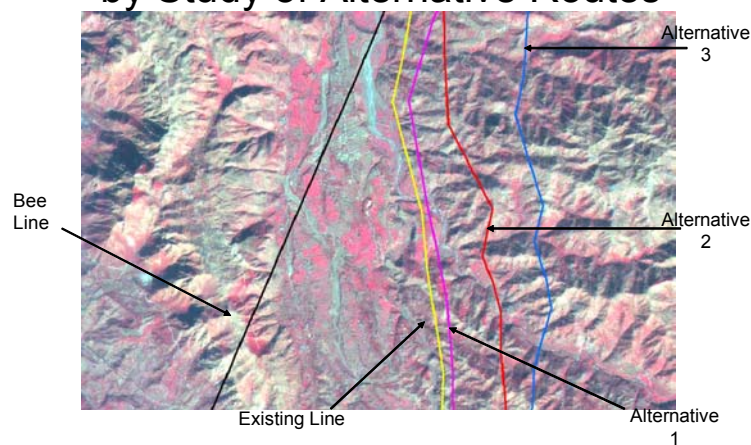
Corresponding Digitized Image
indicating relevant information

Digital Terrain Model



Computerized Three Dimensional Image

Computerized Route Optimization by Study of Alternative Routes



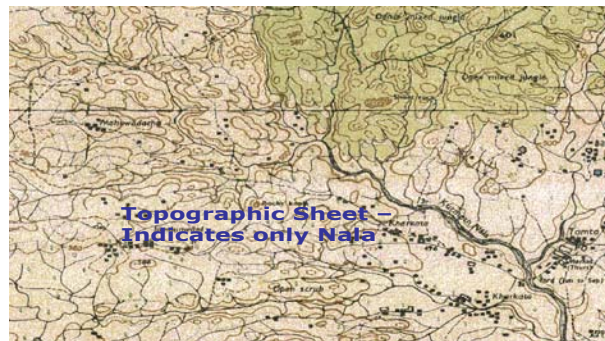
With the help of the updated information & details available from latest Satellite images, various alternatives can be examined for route selection facilitating selection of optimum line route.

Using the above methods, details regarding constraints related to the line route, topographical and geotechnical details, forest & environmental constraints etc. can also be obtained well in advance of

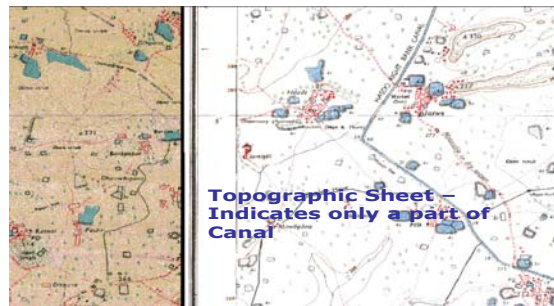
project execution so that the project requirements are clearly defined before it is taken up for execution. Clear definition of the project through advance surveys also facilitate preparation of realistic bill of quantities for tendering, identification of appropriate strategies for project execution, scheduling & optimization of project cost.

Indicative pictures depicting salient advantages of GIS techniques in gathering updated site details helping selection of appropriate route alignment are shown below as examples :

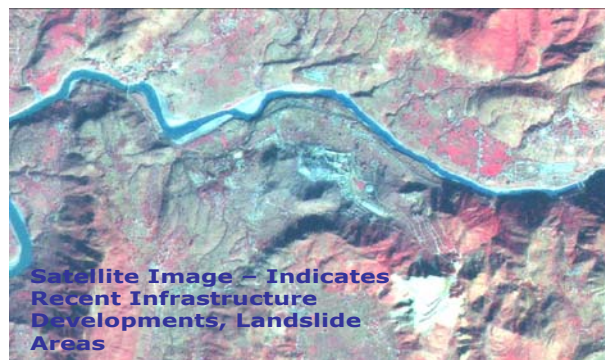
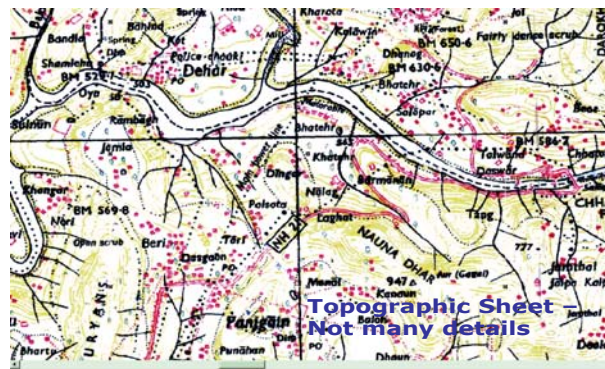
Satellite Image reveals presence of large water body instead of nala



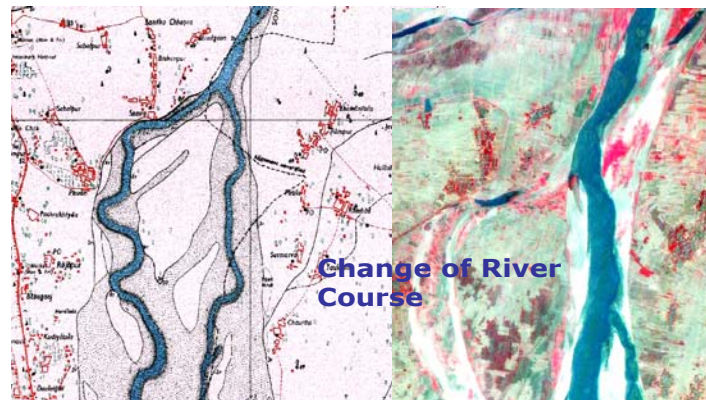
Satellite Image indicates addition of another branch to canal



Recent Infrastructure Developments, Land Slide Areas etc.



Changes in River Course



ANNEXURE – V

A Case Study on Route Alignment using Satellite Imagery

ANNEXURE-V

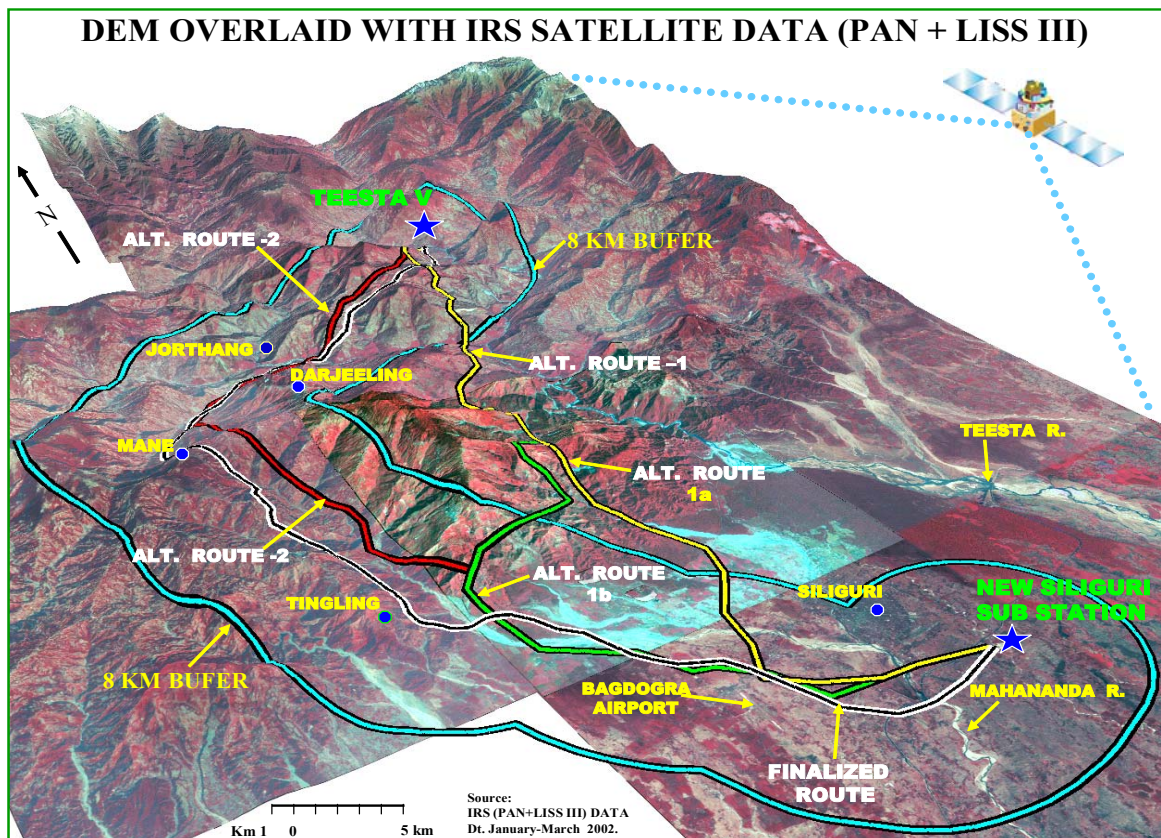
A CASE STUDY ON ROUTE ALIGNMENT USING SATELLITE IMAGERY

Project : TEESTA-V Transmission System

Transmission Line : 400 kV D/C Teesta – Siliguri

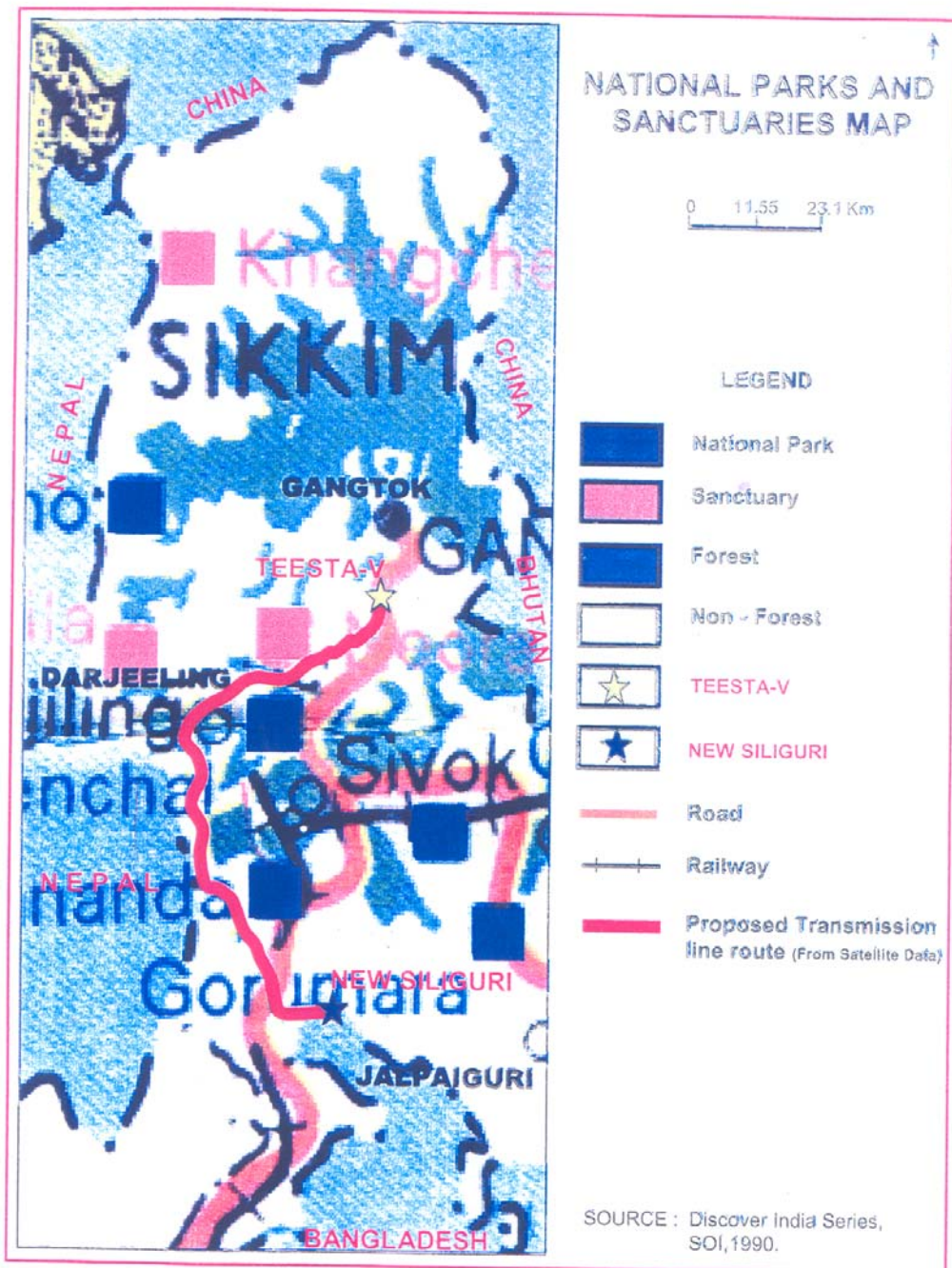
Methodology of Route Alignment Survey using Satellite Imagery & GIS Techniques

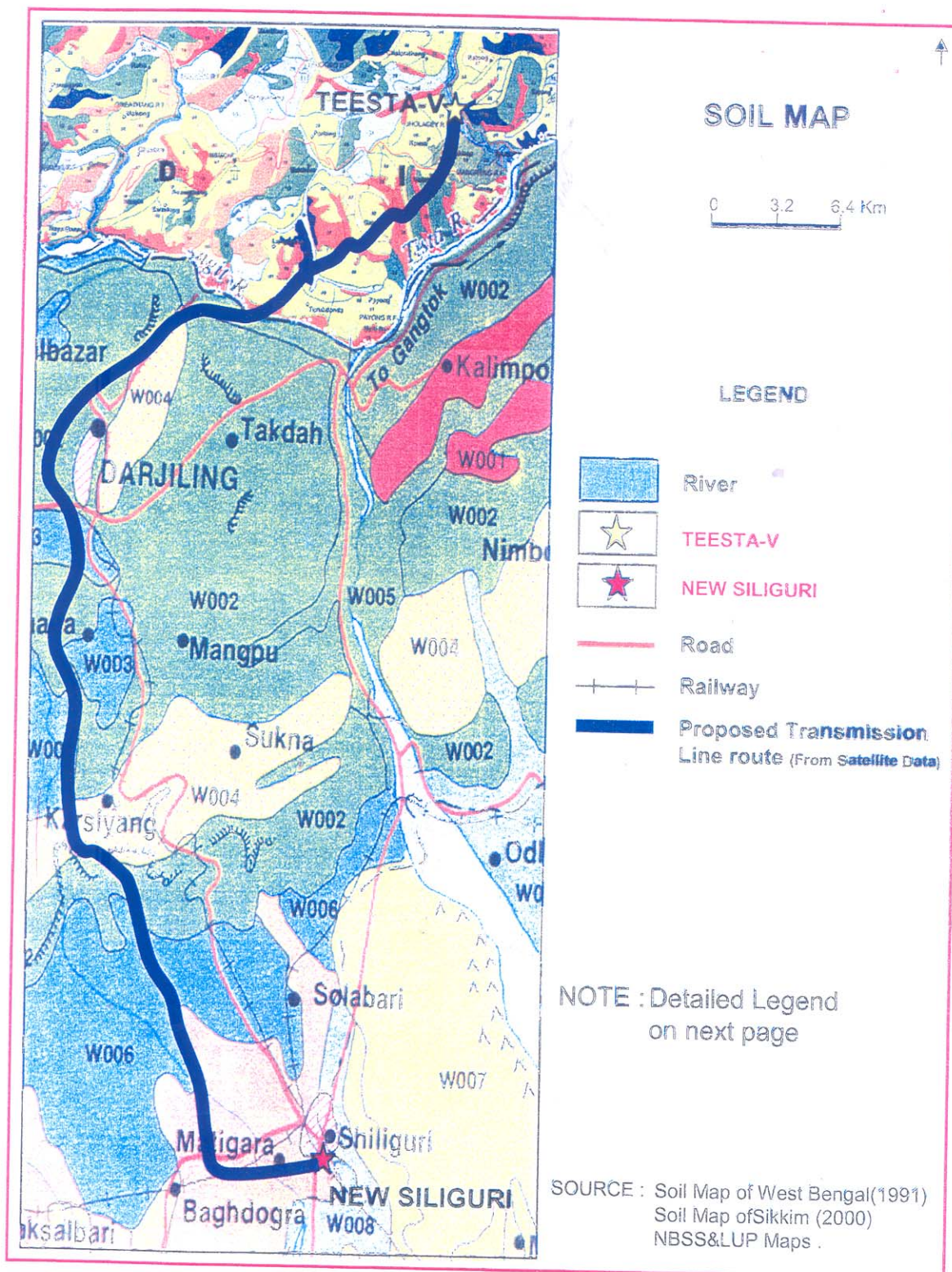
- Route alignment study carried out using Survey of India Topo Maps (1:50,000 scale) , IRS PAN+LISS satellite data & ground verification data
- Three alternative routes examined & most optimum route selected
- Digital Elevation Model study conducted in the required areas



Salient Benefits of Route Alignment Survey using Satellite Imagery & GIS Techniques

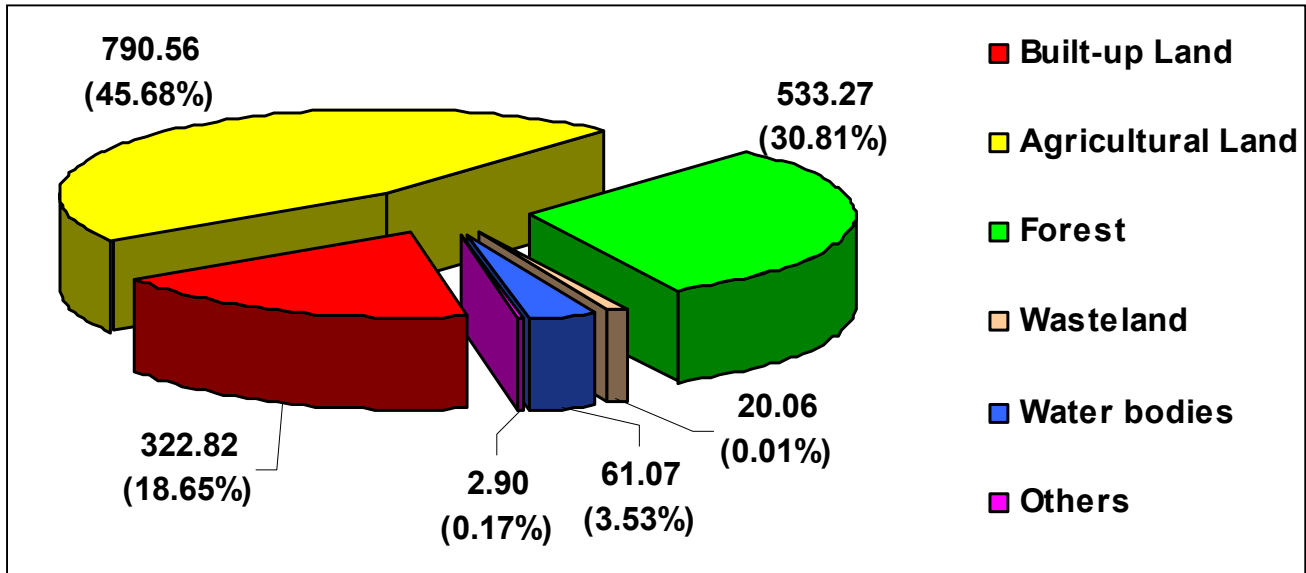
Line length	Reduced from 120 kms (considered at the time of FR based on walkover survey) to 111 kms
Forest	National Park, Wild Life sanctuary avoided Forest crossing stretches optimized. (9 kms) Line routed through low tree density areas
Pile Foundations	Envisaged for Mahananda & Balason River crossings. Number of locations reduced from 4 (in FR) to 2.
Route Constraints	Minimized by selection of route avoiding land slide prone areas, steeper slopes, flood prone areas.
More Information/details	Details in respect of land use, soil strata, forest/vegetation density etc. possible.





**DISTRIBUTION OF LAND USE / LAND COVER ALONG THE FINAL
TRANSMISSION LINE ROUTE ALIGNMENT BUFFER CORRIDOR (8kmX8km)
BETWEEN TEESTA-V AND NEW SILIGURI**

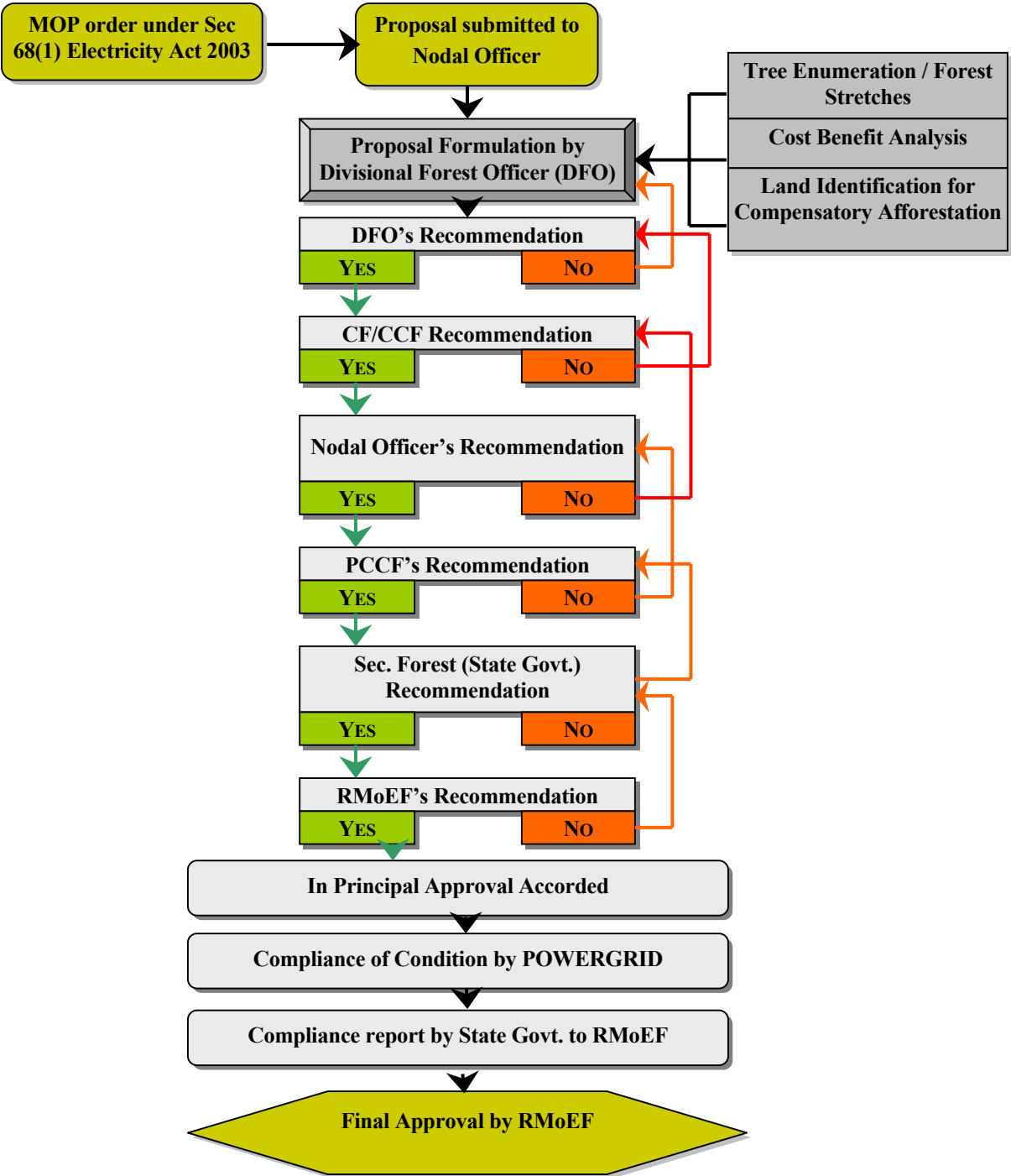
Area in sq. km.



ANNEXURE-VI

Forest Clearance Flow Chart

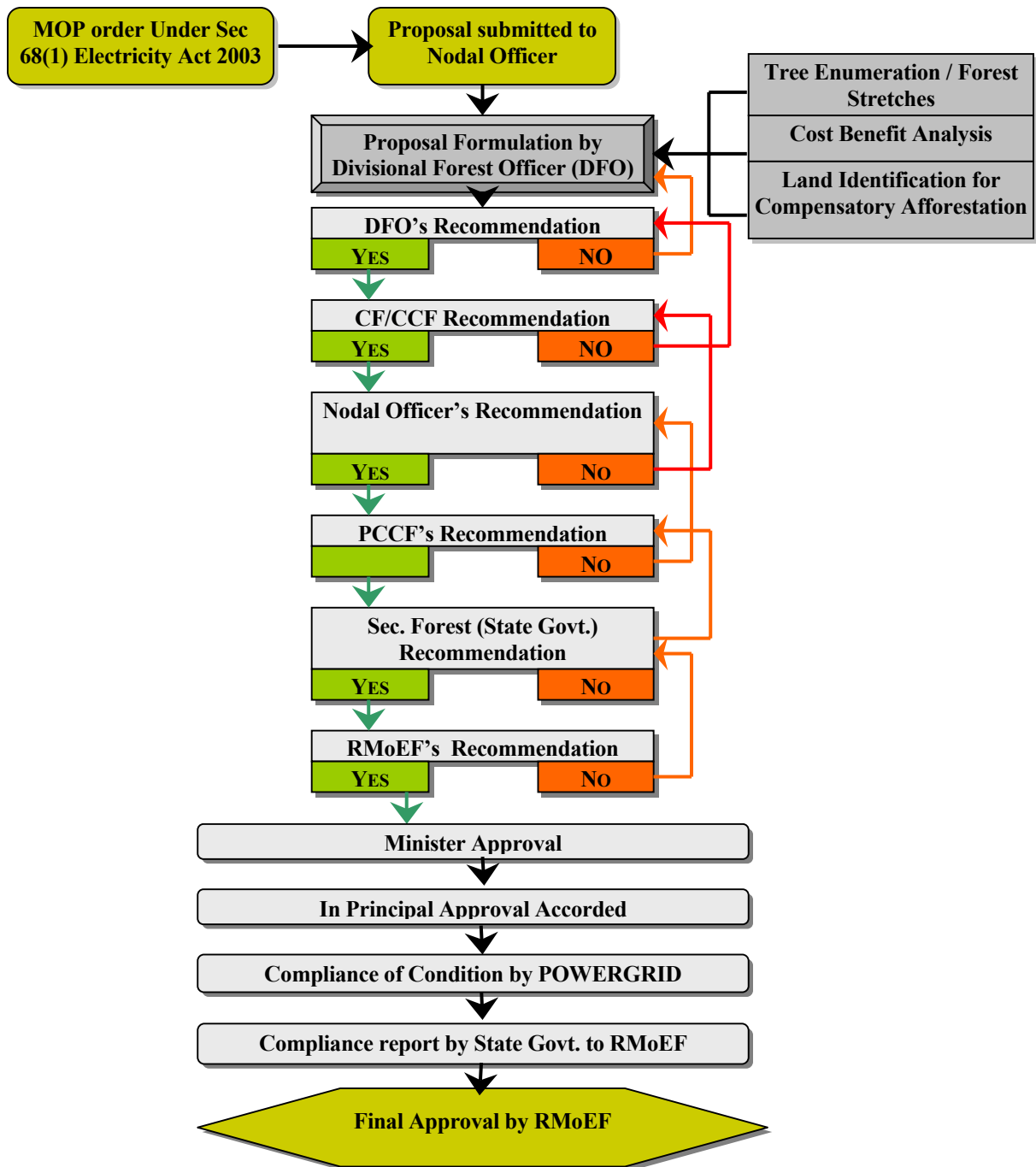
FOREST CLEARANCE FLOW CHART (FOREST AREA UP TO 5 HECTARE)



ANNEXURE-VI

PAGE-2 OF 3

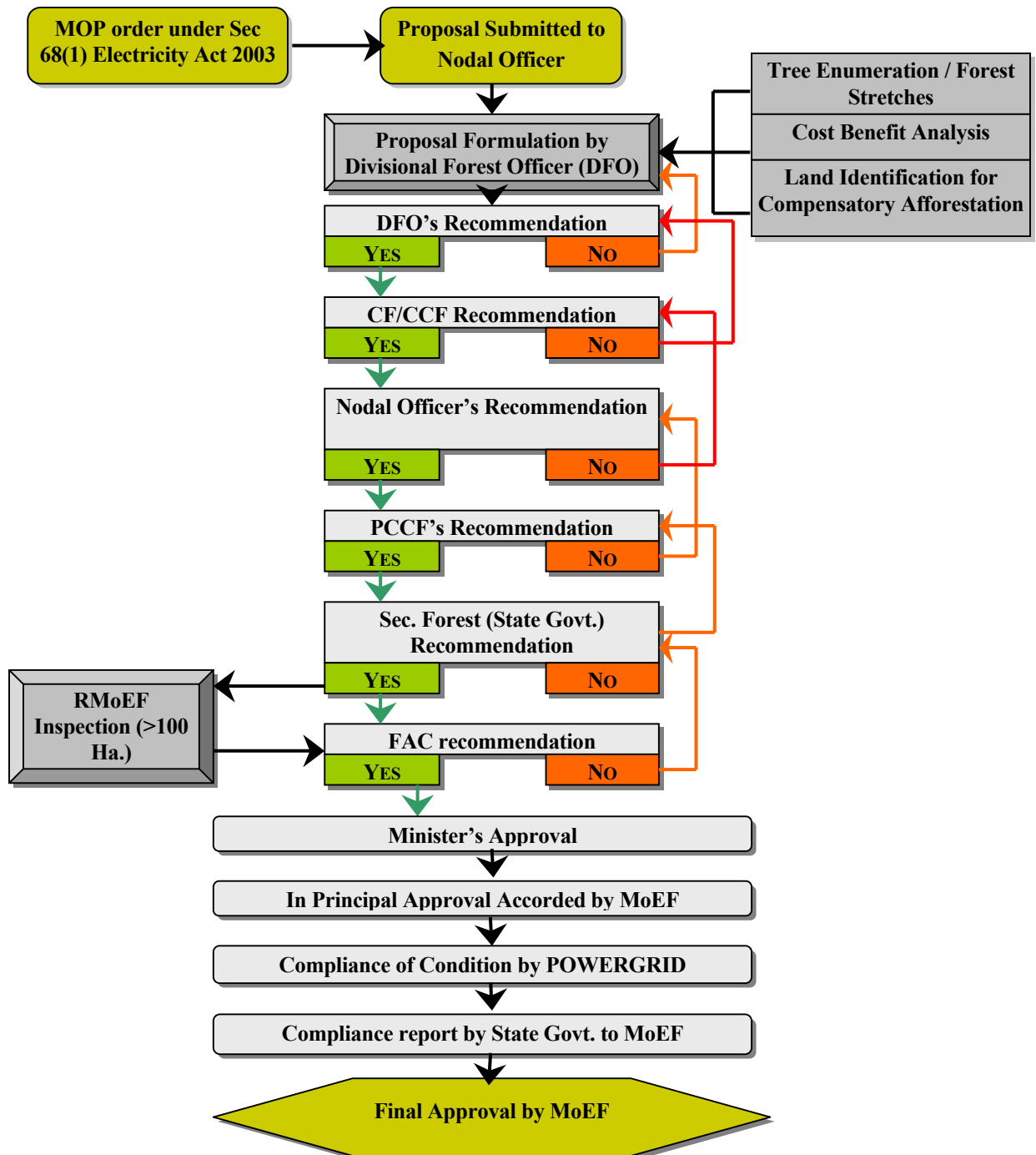
**FOREST CLEARANCE FLOW CHART (FOREST AREA MORE THAN 5 HECTARE UP TO 40
HECTARE)**



ANNEXURE-VI

PAGE-3 OF 3

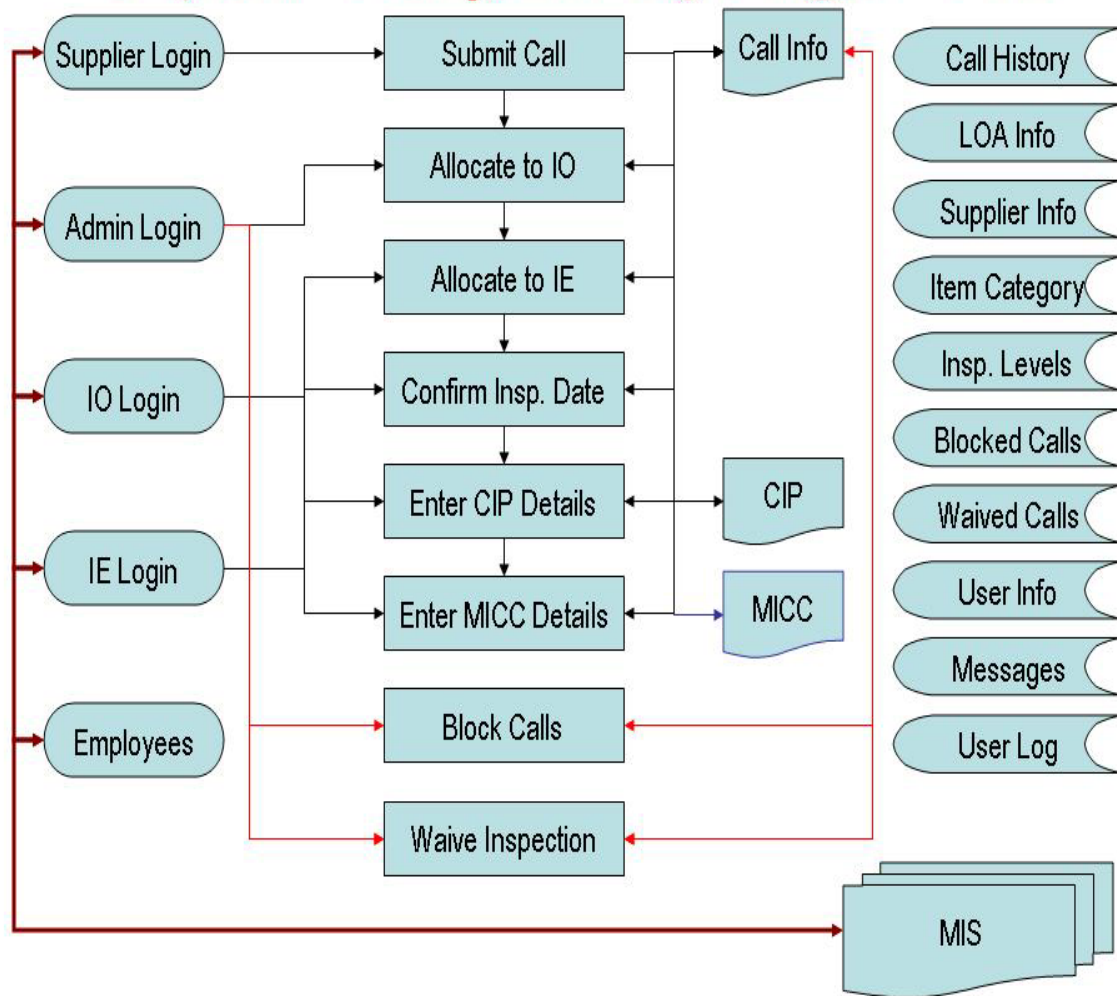
FOREST CLEARANCE FLOW CHART (FOREST AREA MORE THAN 40 HECTARES)



ANNEXURE-VII

Inspection Management System Flow Chart

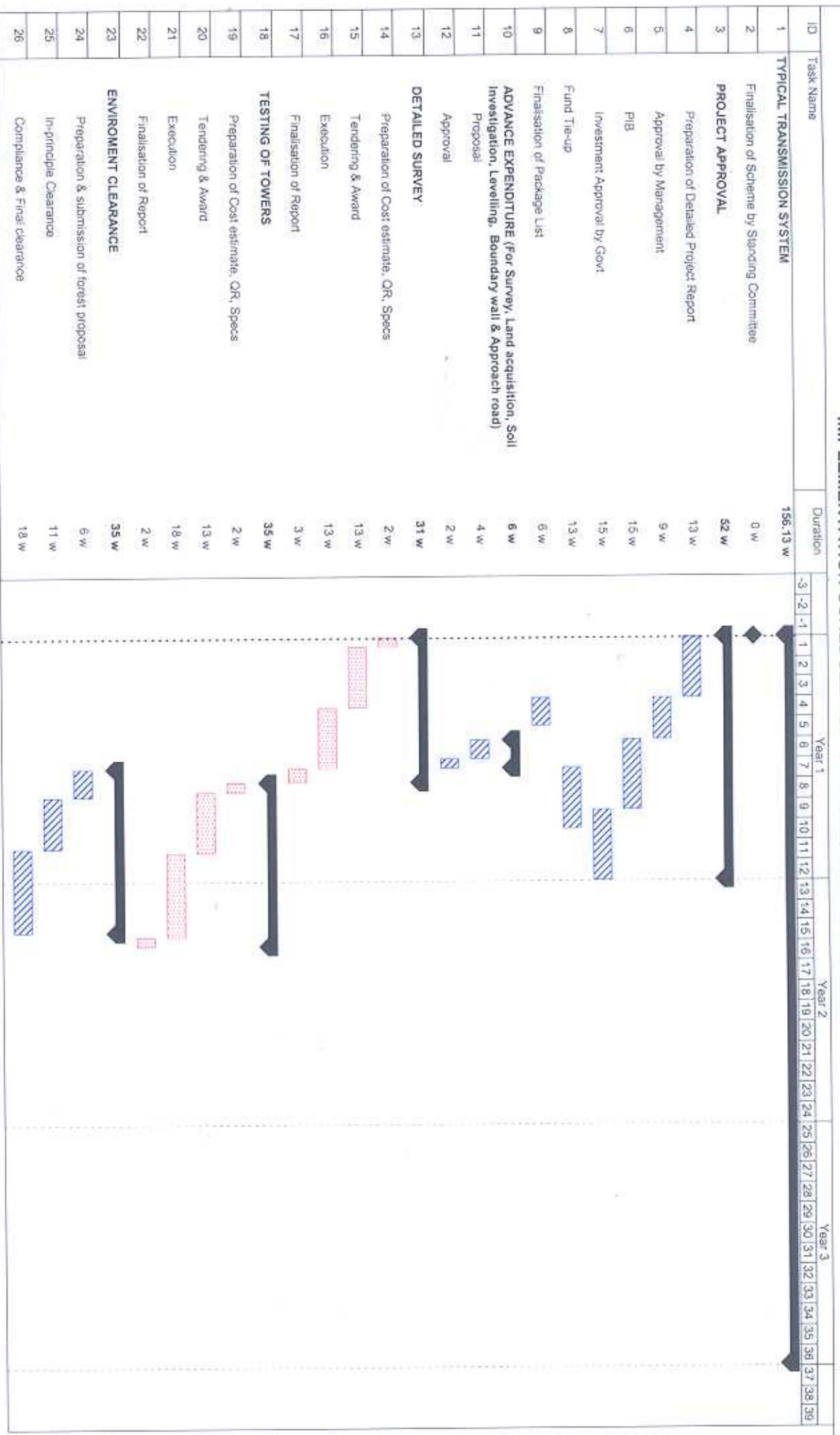
Inspection Management System Flow Chart



ANNEXURE-VIII

Typical Pert Network for Project Implementation

IMPLEMENTATION SCHEDULE FOR TRANSMISSION LINE SYSTEM



Critical Task Progress Summary
 Non-critical Task Milestone Project Summary

IMPLEMENTATION SCHEDULE FOR TRANSMISSION LINE SYSTEM

ID	Task Name	Duration	Year 1Year 2Year 3																																			
27	TRANSMISSION LINE	156.13 w																																				
28																																						
29	TOWER PACKAGE	156.13 w																																				
29	Finalisation of BOQ	3 w																																				
30	Preparation of Bidding Document & Approval, as reqd.	13 w																																				
31	Preparation of CE & Approval	3 w																																				
32	Preparation of QR & Approval	3 w																																				
33	NIT	0 w																																				
34	OBD	0 w																																				
35	LOA	0 w																																				
36	EXECUTION (22 Months)	95.63 w																																				
37	LOA	0 w																																				
38	Handing over of Structural / BOM / Foundation Drawings	8 w																																				
39	Mobilisation	2 w																																				
40	Survey	30 w																																				
41	TOWER	67 w																																				
42	Proto assembly of towers	12 w																																				
43	Manufacturing, Testing & Inspection	50 w																																				
44	Despatch & Receipt at Site	58 w																																				
45	LINE MATERIALS (Excluding Conductor & Insulator)	68 w																																				
46	Finalisation of Sub-vendor	4 w																																				
47	Engineering	7 w																																				
48	Type Testing	6 w																																				
49	Manufacturing, Testing & Inspection	44 w																																				
50	Despatch & Receipt at Site	43 w																																				
51	Supply of stubs	50 w																																				
52	Foundations	68 w																																				

IMPLEMENTATION SCHEDULE FOR TRANSMISSION LINE SYSTEM

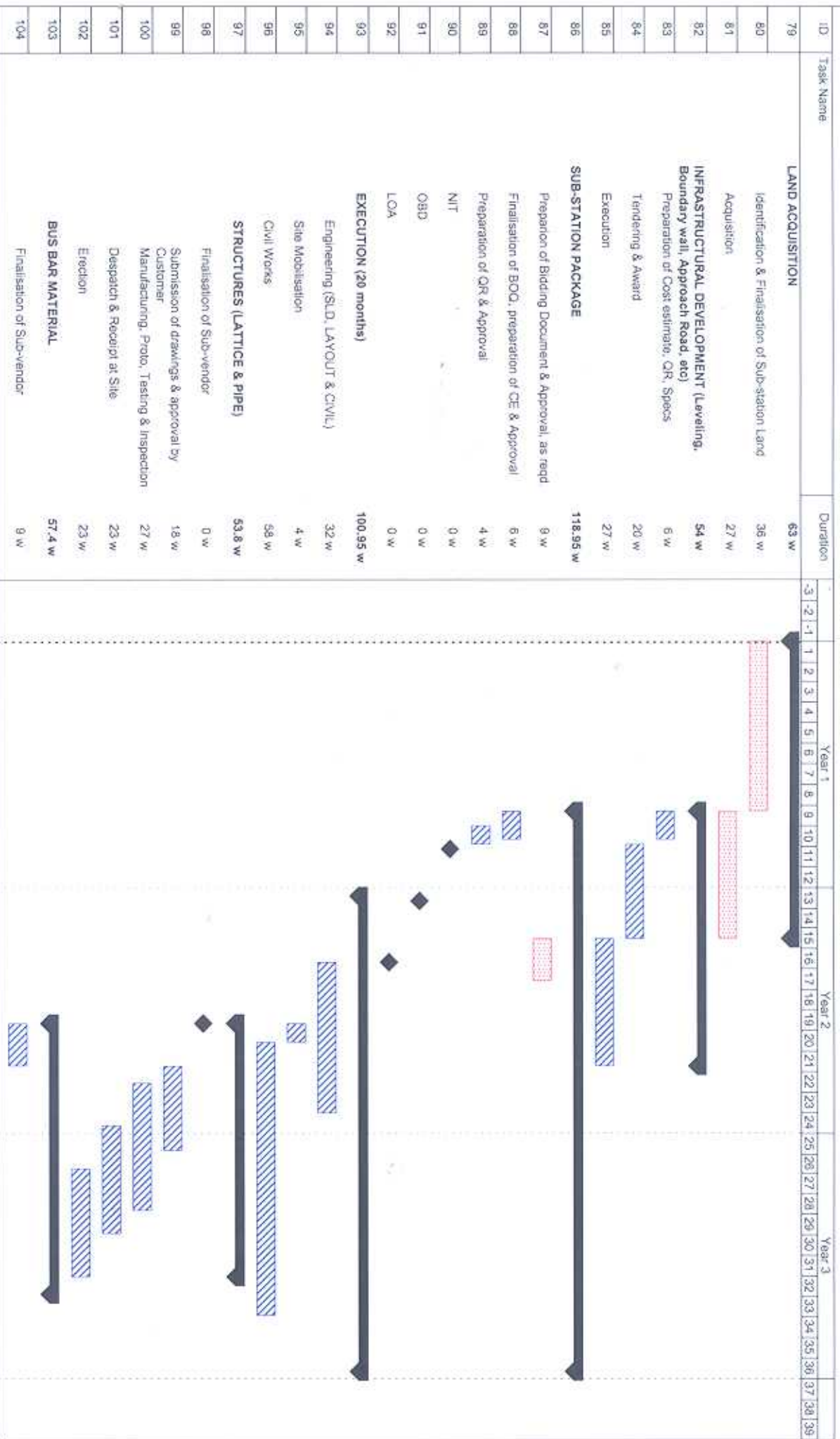
ID	Task Name	Duration
53	Tower Erection	59 w
54	Stringing	50 w
55	TESTING & COMMISSIONING	3 w
56	CONDUCTOR PACKAGE	100.5 w
57	Finalisation of BOQ.	2 w
58	Preparation of Bidding Document & Approval, as reqd.	6 w
59	Preparation of CE & Approval	7 w
60	Preparation of CR & Approval	6 w
61	NIT	0 w
62	OBD	0 w
63	LQA	0 w
64	Engineering	12 w
65	Manufacturing, Testing & Inspection	48 w
66	Dispatch & Receipt at Site	45 w
67	INSULATOR PACKAGE	100.5 w
68	Finalisation of BOQ, preparation of CE & Approval	2 w
69	Preparation of Bidding Document & Approval, as reqd.	6 w
70	Finalisation of BOQ, preparation of CE & Approval	6 w
71	Preparation of CR & Approval	4 w
72	NIT	0 w
73	OBD	0 w
74	LQA	0 w
75	Engineering	12 w
76	Manufacturing, Testing & Inspection	48 w
77	Dispatch & Receipt at Site	45 w
78	SUB-STATION	154.95 w

The Gantt chart displays the timeline for various tasks across three years:

- Year 1:** Includes Tower Erection (ID 53) and Stringing (ID 54).
- Year 2:** Includes CONDUCTOR PACKAGE (ID 56) and INSULATOR PACKAGE (ID 67).
- Year 3:** Includes SUB-STATION (ID 78).

Tasks are color-coded: blue hatched bars represent construction activities like Tower Erection, Stringing, Manufacturing, and Dispatch; solid black bars represent administrative or preparatory work like Finalisation of BOQ, Preparation of documents, NIT, OBD, LQA, Engineering, and Commissioning.

IMPLEMENTATION SCHEDULE FOR TRANSMISSION LINE SYSTEM



Critical Task

Non-critical Task

Progress

Milestone

Summary

Project Summary

IMPLEMENTATION SCHEDULE FOR TRANSMISSION LINE SYSTEM

[illegible]

IMPLEMENTATION SCHEDULE FOR TRANSMISSION LINE SYSTEM

[illegible]

Critical Task	Non-critical Task	Progress	Milestone
			

Summary
Project Summary