No. L-1/30/2010 - CERC
CENTRAL ELECTRICITY REGULATORY COMMISSION
NEW DELHI

CORAM :

Dr. Pramod Deo, Chairperson
Shri S. Jayaraman, Member
Shri V. S. Verma, Member
Shri M.Deena Dayalan, Member

IN THE MATTER OF

Benchmark Capital Cost for 400/ 765 Kv Transmission Lines.

ORDER (Suo-Motu)

A. BACKGROUND

1. The Tariff Policy notified by the Central Government on 6th January, 2006 under Section 3 of the Electricity Act, 2003 provides that when allowing the total capital cost of the project, the Appropriate Commission would ensure that these are reasonable and to achieve this objective, requisite benchmarks on capital costs should be evolved by the Regulatory Commissions.

2. Taking cognizance of the above as per provisions of Section 61 (i) of Electricity Act, 2003 and in exercise of the powers conferred under Section 178 of the Act and after previous publication, the Commission had notified the Central Electricity Regulatory Commission (Terms and Conditions of Tariff) Regulations, 2009, (hereinafter referred to as "the Tariff Regulations"). The Regulations provide for the terms and conditions and the procedure for determination of tariff of cases covered under Section 62 of the Act read with section 79 thereof.

3. As per second proviso under Regulation 7 of the Tariff Regulations, 2009, the benchmark capital cost of Thermal generating station and the transmission system to be specified by the Commission from time to time may be used for the purpose of prudence check.

4. The Commission had initiated the process of determining Benchmark costs of 400/765 Kv Transmission lines, associated substations with 400/765 Kv Transmission system and Thermal power units of 500/600/660/800 MW in June 2008. Commission had engaged consortium of consultants (M/s Evonik Energy Services (India) Pvt. Ltd; M/s PRDC and M/s KPMG) with the objective of developing benchmark norms for transmission lines of 400/765 Kv amongst others in rupees per circuit kms. The above objective was to be achieved by collecting reliably available data, analyzing the data, creation of data base, defining Disaggregated Packages of Hard Cost of a Project to be sufficient for benchmarking, recommending appropriate methodology through which a bench mark cost of a completed project would be arrived at for the purpose of prudence check and developing financial/pricing model with identified escalation factors assigning due weightage for various material/factors etc. The financing cost, interest during construction, taxes and duties, right of way charges, cost of Rehabilitation & Resettlement etc. would be additional and were not to be factored in benchmark cost being developed. Model so developed was to be tested for accuracy with historical data from data base.

5. The Consortium developed a self validating pricing model with escalation formulas after collection of reliably available data, analysis and tested the model for accuracy.

6. The pricing model along with explanatory memorandum was up loaded on CERC website for public scrutiny and comments through public notice dated 08.12.2009.

7. A public hearing was held on 17th March 2010. Presentation in this regard was made by Power Grid Corporation of India Limited. Comments received from stakeholder/s along with discussion, analysis and ruling of the Commission are enclosed.

The list of participants in the public hearing is enclosed in Annexure – I.

B. COMMENT/SUGGESTION RECEIVED DISCUSSION, ANALYSIS AND COMMISSION'S RULING –

1. Applicability of Benchmarking as a tool for prudence check of capital cost of a Transmission Project.

1.1 Stakeholder Comment

Capital cost benchmarking for individual Transmission projects on a *post facto* basis finds no parallel anywhere in the world. The exercise being contemplated brings in a certain level of apprehension as to the risks involved in investment in transmission sector which needs to be addressed.

As regards hard costs of projects developed by Power Grid Corporation of India Limited, the same emerges consequent to a transparent competitive bidding process and this process in Power Grid Corporation of India Limited,a Central Public Sector Undertaking, is invariably bound by definite rules and are subjected to a host of mandatory checks and balances across the entire value chain which *interalia* includes the statutory agencies, funding agencies etc. Thus, the outcome of such bidding process is the best that the market could offer at a particular point of time depending on the prevailing market forces and, as such, comparison with a benchmark developed through a normative and subjective methodology is not rationally supported.

Discussion, Analysis and Commission's Ruling

Benchmarking can broadly be defined as *comparison of some measure of actual value/performance against a reference benchmark value/performance*.

For Cost of service regulation Capital cost is the driving factor on which all other elements of tariff are determined. Efficient and objective control over the same is thus of paramount importance. What the cost ought to be and not what the cost claimed is the driving force. Model created based on unit cost approach will help in drawing inference as to what the attainable cost level is possible albeit subject to additional regulatory checks as needed.

Model as developed for working out Benchmarks uses reliably available national data. Model will be used to identify outliers as possible cases for carrying out further/detailed prudence (which is resource and time consuming) thereby reducing Regulatory cost (by following Management by exception principle). Model created and tested is based on National data of Transmission players including Power Grid Corporation of India Limited. Indexation used is industry acceptable standard suitably modified for the subject under study. Model objectively covers standard variable/s affecting Transmission line cost.

Worldwide unit cost approach has been relied upon by regulators while examining regulatory practice of converting asset valuation into annual use of system charges. References exist wherein benchmark numbers have been used as a tool of regulatory prudence. An example is quoted below:
Quote from Economic Regulation Authority of Western Australia

Quote

Considerations of the Authority

28. In assessing whether the proposed transmission line meets the efficiency test of section 6.52(a) of the Access Code, the Authority has given consideration to issues of both the choice of project and the timing of the project and technical efficiency (whether costs are minimized for the particular project).

29. On the choice of project, the Authority accepts that satisfaction of the regulatory test is an adequate demonstration that the proposed transmission line represents an efficient choice of project.

30. On the matter of technical efficiency, a demonstration of the efficiency of new facilities investment could include:

- *demonstration of the optimal design and construction of the new facility, taking into account forecast demand for covered services and economies of scale and scope;*
- *demonstration of consistency of unit rates of construction with historical unit rates for the covered network and unit rates of similar works in other*

networks, taking into account trends in productivity improvements and underlying costs; and/or

- *demonstration that the procedures of construction planning, contracting and cost control are consistent with minimizing costs.*

31. Western Power has provided a general description of its alliance arrangements to support a claim that its procedures of construction planning, contracting and cost control are consistent with minimizing costs. Several submissions from interested parties indicate support for this contracting strategy being consistent with minimizing costs.

32. In its assessment of the major augmentation proposal for the proposed transmission line under the requirements of the Access Code for the regulatory test, the Authority considered the unit costs underlying the forecast cost for the proposed transmission line and accepted that the unit costs are consistent with benchmarks for unit costs for transmission lines in Australian conditions.

33. Taking into account both Western Power's procedures for contracting and cost control and consistency with benchmark unit rates, the Authority accepts that forecast new facilities investment for the proposed transmission line of $300 million is consistent with minimizing costs for a given project.

UnQuote

Network expansion / augmentation in Indian context is to be carried out by Central Transmission Utility after identifying requirements in consonance with National Electricity Plan as notified by Central Government in consultation with all stakeholders. Execution is to be taken up after due regulatory approvals in cases where Bulk Power Transmission Agreement has not been signed. Cost aspect for the purpose of converting asset valuation into annual use of system charges is dealt by Central Electricity Regulatory Commission in both cases i.e. where execution is taken up with prior regulatory approval or where execution is taken with signing of Bulk Power Transmission Agreement with stakeholders/beneficiaries.

For the purpose of tariff in cost of service regulations regulatory checks on admissible asset value/cost is of prime importance. Cost as per books are not necessarily the input costs for regulatory purpose. They are relied upon by regulatory process as one of the tools for prudence. Every statutory agency looks at the process and data from its point of view as mandated by Law.

Cost as claimed by Power Grid Corporation of India Limited for tariff, irrespective of the competitive process with host of mandatory internal and external checks used does not fall under the Section 63 of Electricity Act, 2003 and is necessarily to be dealt under Section 62 of Electricity Act, 2003.

Ruling

Even traditional methods of prudence check used at present are on *post facto* basis. Even today onus lies on the utility to provide for details along with necessary proofs as and when called for by the Commission before any expenditure is admitted for the purpose of tariff.

Apprehension of Stakeholder as regards post facto comparison with developed benchmark norms is gratuitous as the benchmark will be used for prudence check and variance analysis to identify the factors along with underlying reasons causing deviations in the claimed cost.

1.2 Stakeholder Comment

In case benchmarking is to be taken up, firstly the various shortcomings identified needs to be addressed. Further two stage benchmarking is to be considered wherein, in the first stage, benchmark of Capital cost of projects shall be available for comparison before investment decision. During the second stage i.e. after completion of the project, benchmarks shall be compared with the completed cost taking into due consideration the various factors that influenced the cost of the project.

Discussion, Analysis and Commission's Ruling

Corrections to the extent of removing minor inconsistencies have been carried out in the model. Corrected model is being uploaded on the website along with this order.

The benchmark numbers along with updated model will be available to stakeholders. By insertion of Current Price Indices values from Indian Electrical and Electronics Manufacturers Association (IEEMA) publication stakeholders can ascertain the cost workable by the model. This can be used as another internal check for ascertaining deviations and causes and feasible action if any to be taken for redressal. This can be used for both projects already under construction and future projects. Benchmark numbers will be updated and notified as per need and decision in this regard as and when taken by the Commission.

As already stated in tariff regulations benchmark numbers will be used for carrying out prudence checks while admitting completed cost of the project. Variance analysis that will be carried out will take into consideration the various factors which affected/influenced the cost. Details of such factors will have to be furnished by the stakeholder to the extent and in such manner as desired by the Commission.

2. Relevance of the specific methodology for benchmarking as proposed in the explanatory memorandum

Stakeholder Comment

It appears that the proposed specific methodology may not capture the variables appropriately, that Transmission projects are often subjected to.

Commission's Analysis and Ruling

While up loading the model for public comments, explanatory memorandum giving the detailed methodology used for developing the model was also up loaded.

The main model contents include the Structure with major components, Bill of Quantities, combinations of lines with wind zones and terrains, the essential features, main variables, data inputs, assumptions, validation.

One of the objections by stakeholder was on dynamic nature of model. According to the utility it is impossible for the utility to contain/steer the capital cost of the project once the awards are placed consequent to a competitive transparent bidding process.

Intention on keeping the Model dynamic is to work out what the current cost ought to be based on changes due to factors influencing capital cost including but not limited to material prices and changes in technical particulars. Apprehension of the utility that Commission intends to contain the Capital cost is not correct. Variations in completed cost as claimed versus the expected current cost as per model will be computed and further analyzed if found beyond permissible limits.

Another objection by stakeholder was on extended use of Price Variation formula. Intention behind this is to keep the model in sync with Market. To capture the Market conditions provision has been made in the model for adding/deleting/modifying data base including indices, Price Variation formulae's so that the benchmark numbers derived reflect the current market scenario.

One of the issues raised by the stakeholder was sufficiency of sample size. In this context our analysis on this issue is as under:
As noted in the explanatory memorandum model has been prepared based on a sample drawn from "projects which have been completed or were under construction during the financial years 2004-05, 2005-06, 2006-07, 2007-08 and 2008-09 …". The model has been developed for 400 Kv and 765 Kv. For assessment, data as per project monitoring division of CEA available on its website was used. During this period, lines constructed/under construction were found in terms of circuit kilometers (Ckms) as per table compiled below:

		Length in CKMs	
		765 kV	400 kV
2004-05 to 2006-07			
Central Sector		733	12,858
State Sector			2376
	Sub-total	733	15234
2007-08			
Central Sector		160	4895
State Sector			2039
	Sub-total	160	6934
2008-09			
Central Sector		435	3589
State Sector			
	Sub-total	435	3589
2004-05 to 2008-09	Total	1328	25757

Further, analysis showed in 400 Kv it is predominantly Double Circuit. Also trend of 765 Kv will grow in coming years. Final list of projects/lines (37 nos) selected as sample and used for model creation (listed in explanatory memorandum) was chosen based on above details, analysis and quality of data to ascertain representativeness. Further the model has been developed for mostly used conductors ACSR Moose and Bersimis and all other attributes normally associated with transmission lines. To take care of towers which depend on wind zone, terrain category, model has considered feeding of actually used number of towers as input to work out the cost.

In relation to the total length of lines constructed or under construction during the period the length of the sample lines is shown in the table below:

	Length in CKM		
	765 kV	400 kV	Total
New lines during 2004-05 to 2008-09	1328	25757	27085
Model sample	923.50	3379.11	4302.61
Share of sample (%)	69.5	13.1	15.9

Therefore, the sample of transmission lines chosen for the benchmarking model in terms of length and all other attribute is sufficiently large and representative.

As noted above the benchmark numbers will be used for prudence check, to carry out variance analysis and seek additional clarifications/information as deemed fit. Even in traditional systems of prudency checks clarifications/information as and when asked for are to be provided by the utility. As such apprehension of the utility –"bestowing the burden of proof on the utility may not be appropriate" is gratuitous.

3. Clarifications in the Model for benchmarking.

3.1 Stakeholder: Is there any factor included for lines passing through or near to the urban areas?

Analysis/ruling: Notified Benchmark numbers are based on standard number of towers. However in the model actual Number of different types of towers which takes care of the terrain or area where it is passing through is kept as an input parameter to be fed to know the resultant Cost.

3.2 Stakeholder: How the factoring for special foundations such as well foundations / pile foundations for large river crossings is provided? These special conditions are not addressed.

Analysis/ruling: The total cost of river crossing will be based on the river crossing span, type of soil etc. and hence will vary. An assessed value has been incorporated in the model based on analysis of probable possibilities and the previous costs involved. The model gives values with and without river crossings for detailed examination. Variation in costs on this count will be small percentage of total project cost and will get addressed during prudence of cases involving such costs.

3.3 Stakeholder: In the concept paper It is stated that "Thus, within the cost estimates of the project, there is a tendency to build in additional risk factor". The application for tariff (by POWERGRID) for a Project is not on any cost estimates but on the actual audited cost incurred by POWERGRID which is discovered through a transparent competitive bidding process. As such the aforementioned statement in the concept paper appears misleading.

Analysis/ruling: The statement was made in the concept paper. Usually while preparing cost estimates while taking up any project all perceived risks are factored. Apart from the perceived risks provisions are made for unforeseen risks through contingencies etc. However the model prepared is based on actually incurred cost.

3.4 Stakeholder: It is stated that "These uncertainties vary in degree and size for each specific project. Mitigation of these uncertainties by more thorough investigation, analysis and planning could bring down the risks / capital costs and operating costs of projects." Owing to the short project time cycle of the projects, learning of one is built into another as a part of continuous improvement. In case of any specific mitigation measures, the same may be brought out.

Analysis/ruling: General statement as a part of concept. In model building reliable national level data has been used which already takes care of these issues. As noted by stakeholder learning of one is built into another, model has been kept dynamic so that further learning's as and when captured will be taken into account to reflect benchmark norms appropriate with latest developments.

3.5 Stakeholder: Concept of common and uncommon packages is not clear.

Analysis/ruling: This was a general statement made with reference to both transmission systems & thermal stations. The transmission line model does not have such common & uncommon packages. The transmission model has about 10 major items only.

3.6 Stakeholder: The entire process of developing benchmarks needs elaboration.

Analysis/ruling: It has been elaborated in the explanatory memorandum Para's 4 to 9.

3.7 Stakeholder: The purpose / contents may be elaborated.

Analysis/ruling: The procedure & step by step methodology followed in developing the model has been narrated along with flow diagram in

explanatory memorandum to have more transparency. Assumptions made, sag ten/sag ten calculations/tower weights calculations/wind on tower etc. are clearly elaborated in the model.

3.8 Stakeholder: It is stated that the model was validated for lines commissioned prior to 2003. The details may be elaborated.

Analysis/ruling: The validation was done at CERC end for few selected projects with the data furnished by Power Grid and found satisfactory. The same is enclosed as Annexure-II.

3.9 Stakeholder: i) Foundation volumes also depend upon load on the towers/foundations and soil classification.

Load on the towers also depends upon ice loading (for lines in snow zone, and design wind & weight spans.

Analysis/ruling: i) Foundation volumes depend on the compressive and uplift forces acting at the footing. These forces depend on the total moments acting at the footing. A relation has been developed with respect to the moments of wind load, self weight, and transverse and longitudinal loads acting at the footing based on the type of conductor, wind zone etc. and accordingly the volume of concrete and reinforcements have been assessed. The assessment of foundation volumes by method used in model building closely matches with actual volumes.

The areas with ice loading are very few in Indian contexts & hence Ice loading has not been considered for the present. As and when need arises same will be incorporated. Any claim during this period on this count will be dealt appropriately.

3.10 Stakeholder: Other variable factors which influence the weights are Reliability factor (as per IS-802), snow zones (light/medium or heavy), plain or hilly/mountainous terrain (hilly/mountainous terrain requires larger weight & uplift spans).

Analysis/ruling: The mountainous terrain will have more' weight spans requiring strengthening of cross arms. The increase in the weight of towers will be dealt as deviation. The model gives values with general parameters, and deviations with its impact on cost will be dealt during prudence checks.

3.11 Stakeholder: Reg. the three terrain categories indicated as variable factors, it may be mentioned that the three terrain categories referred in the IS-802 are based on roughness coefficient of the ground (terrain category-2 being most commonly used for tower design) and it is different from the general classification of plain, hilly or mountainous terrain which otherwise effect number of towers, type of towers, required wind/weight spans.

Analysis/ruling: The three terrain coefficients have been considered in the model separately as per IS:802. However the three different land classifications viz. plain, hilly and very hilly are considered for purpose of classification of foundations only. The terrain category will not have any impact on the model as the Number of towers will be one of the inputs which will take care of terrains viz plain, hilly and very hilly etc.

3.12 Stakeholder: Conductors of other types/sizes viz. Snowbird conductor, Lapwing conductor etc. are also being used and the same needs to be covered in the model

Analysis/ruling: For the present Model has been developed for Aluminium Conductors Steel Reinforced (ACSR) Moose and Bersimis conductors. Model is flexible to incorporate any type of conductors as and when need arises.

3.13 Stakeholder: Multi-circuit towers are also being used/planned in some of the ongoing/forthcoming projects. The same should be covered in the model.

Analysis/ruling: As stated above by the stakeholder that multi-circuit towers are also being used/planned to be used. Model is developed based on actual cost data. As and when sufficient data on multicircuit towers will be available the model will be suitably modified incorporating such towers.

3.14 Stakeholder: Ryle's formula is generally for broad estimation of tower weights. Large variation may occur in estimated & design weights in case of different type of towers, configurations & loading conditions. Validation of tower weights estimated using Ryle's formula vis-a-vis weights of actual designed & tested towers of various types under different wind/snow zones (available with Power Grid Corporation of India Limited. & utilities) therefore should be carried out by the consultants before incorporating the same in the model.

Analysis/ruling: Ryle's formula gives broad estimation of tower weights and has been used for assessment of tower weights. The value of constant "K" is used based on the available tower designs after due discussions with utilities and manufacturers. Value of "K" considered in the model was clearly shown in the model assumptions sheet. Validation of Ryle's formula has been done with all the available tower designs and found to be almost matching.

3.15 Stakeholder: Some of the categories of towers mentioned at 7.1.2 a} v) are not applicable viz. 765 kV line with twin & triple Moose conductor. Twin ACSR Lapwing & triple ACSR Snowbird conductor is also used in 400 kV lines. 765 kV lines are generally with quad ACSR Bersimis conductor.

Analysis/ruling: Model has been developed for all such types & if required can be made use of. Model is flexible to incorporate any type of conductor as and when need arises. Further model will result in value as N.A. in particular combination which is not used.

3.16 Stakeholder: Validation of estimated foundation volumes for different type of towers & soils vis-a-vis foundation volumes as per detailed designs (available with –Power Grid Corporation of India Limited & utilities) should be done before incorporating the same in the model.

Analysis/ruling: Validation of foundation volumes has been done with the available data collected from utilities & turnkey contractors of large transmission lines.

3.17 Stakeholder: It appears that the Moose conductor under the ACSR Bersimis conductor has been stated inadvertently.

Analysis/ruling: It has been corrected.

3.18 Stakeholder: Type of land has been considered as hilly or plain area. However, benchmarking has not been done for snow bound hilly terrain and remote areas having local law & order problems viz. Jammu & Kashmir and North Eastern Region. The model should capture all the relevant parameters.

Analysis/ruling: Such rare & special cases have not been incorporated in the model and shall be dealt as exception.

3.19 Stakeholder: Number of different type of foundations, terrain (in terms of plain, hilly/mountainous), snow zone etc. also should be included in the model as variables.

Analysis/ruling: Calculations used in model along with explanation are for different types of foundations, terrain generally encountered. Any deviation on account of special conditions for foundations/snow zone will be handled as exception/deviation while carrying out prudence check.

3.20 Stakeholder: It has been stated that the materials have been updated to a common base as on September, 2009. However, at para 4.2,1 page 6 of 21, it has been stated that 1st January, 2009 is considered as the date for normalization of costs through price variation process. It is mentioned "However the Model has a provision to update the rates to any base date as desired." It is not clear how the model updates the indices for a future date and calculates the updated cost at a future date say January 2011. A calculation is required to be shown for clarity.

Analysis/ruling: The model has a provision to update the costs for any date provided respective Price Indices is keyed in to the model. In the model, there is a sheet with tab name <price indices>. The user may enter the Price Variation indices in the respective month and year. Once the indices have been entered, user can choose from month and year of escalation from drop

down list. The model is designed in the manner that as soon as month and year of escalation are changed, model gets updated. The details can be understood through workings in model itself.

3.21 Stakeholder: No mention on the length of line has been stated against the quantum of towers. The quantum of towers appears to be assumed as 100km as has been stated in the User Guide. In the hilly/mountainous terrain, quantity of suspension towers is almost Nil (as suspension towers cannot take any uplift loads). The no. of towers per 100 km assumed in the model can vary to a great extent in case of lines passing through urban areas or other areas having Right Of Way constraints. In the urban areas, more no. of angle towers (tension towers) is required. Correctness of Model under such situations may be affected.

Analysis/ruling: The input to the model requires length of line and no. of different types of towers as used in actual. The model will give cost based on inputs fed including no. of different towers used. Right Of Way has not been factored in benchmarks as already stated above and will be additional.

3.22 Stakeholder: Number of different type of foundations should be based on type of soils generally encountered in different areas/regions/terrain (to be ascertained based on the data/details for different lines collected/to be collected from Power Grid Corporation of India Limited & utilities).

Analysis/ruling: Exact foundation volumes can be assessed after detailed soil survey. The assumption sheet in the model shows values of volumes and weights of foundations used. The model has been tested by validation of total cost of more than 30 lines and results are within the acceptable/ reasonable limits. Deviations in actual on this count can be taken care of during prudence check.

3.23 Stakeholder: Foundation loads depend upon tower moments/loads as well as tower configuration, base width etc. The foundation volumes considered in the model should be assessed / validated based on foundation detailed design data before incorporating the same in the model.

Analysis/ruling: Foundation volumes depend on the compressive and uplift forces acting at the footing. These forces depend on the total moments acting at the footing. A relation has been developed with respect to the moments of wind load, self weight, transverse and longitudinal loads acting at the footing based on the type of conductor, wind zone etc. and accordingly the volume of concrete and reinforcements have been assessed. The same have been validated with available actual quantities /volumes and closely matches.

3.24 Stakeholder: Only 33 out of the total 37 samples have been validated and the reason for not extending the self validation on the balance 4 samples has not been elaborated. A detailed examination of the list of lines in the table brings out that 3 new lines (sl.no.26,27 & 28) have come into the picture in place of a 7 sample lines. Details of this validation need to be presented. The variation with the input database in itself ranges from -9.37% to +6.2%. Also it is found that the base date as in the excel sheets and in validation data vary for lines like Sasaram-Biharshariff, Bokaro Koderma, Bokaro-Gaya etc.

Analysis/ruling: It is again verified and found that the data in both models & validation sheets are one & the same.

It can be validated for any 765 kV & 400 kV lines. In fact the validation has been done for two Transmission lines a) 400 kV Agra–Jaipur D/C Line and b) 400 kV D/C line to Bareily by LILO of Lucknow–Moradabad S/C line randomly selected by Central Electricity Regulatory Commission as a test case, with the data furnished by Power Grid before accepting the model and results were found to be about 5.57 % & 4.4 % respectively, which are well within the acceptable/permissible limits.

3.25 Stakeholder: Accuracy is stated to be a maximum of ±5% however; the accuracy with the data base used for developing the model itself ranges more than ±5%. However, as per Table shown at Para 7.6, out of the 33 lines tabulated, validation results of 11 lines indicate a variation of more than + 5% range.

Analysis/ruling: The accuracy of the benchmarked cost in relation to the escalated cost is established by testing whether the underlying distributions are close to each other at a given confidence level i.e. 95%. Here too the confidence level could increase with more data being added to the database.

The results of validations like standard deviation etc are within the acceptable limits. Above fact will be kept in sight at the time of prudence check.

4. <u>Clarifications in the Model Workings.</u>

Corrections to the extent of removing minor inconsistencies as regards inclusion of sales tax on item, irrelevant numbers, PV indices linkages, indices values, Escalated cost, average rates etc. have been carried out in the model.

4.1 Separate columns are provided for – i) Rates without taxes & duties and without transportation charges; ii) Prevailing taxes; iii) Total rates including Taxes & Duties and transportation charges; iv) One can get total cost of Transmission lines with Taxes or without Taxes respectively by deleting or indicating prevailing % of taxes in the column C-38 to C-40 of computation sheet.

4.2 The weight of extensions (15% value), cost of transportation is based on data analysis, survey. Validation results based on above are within limits.

The quantum of conductor used for the line is computed on the route length of line, number of circuits, number of conductors in a bunch (twin, triple & quad) and extra 1.5% for sag etc. per kM cost of conductor has been computed as per the Purchase Orders/Detailed Work Award of Central Transmission Utility & state utilities.

The data in respect of various work awards & Purchase Orders for both Conductor & insulators are brought in actual cost sheet of the model from a separate computed sheet as this will facilitate for keying in new data in to the model as needed.

4.3 No specific formula for soil investigation is there. Normal formula of Tower erection is used as both activities involve only labour.

4.4 The assumption of 0.5% of capital cost towards statutory clearances is from the practical experience.

4.5 In Indices and Price Variation sheets the model incorporates a general formula for Tower steel and zinc based on validation.

4.6 Many of the transmission towers require only MS and many may require both HT and MS. Hence an average has been worked out based on data analysis and the final output based on this found to be within acceptable limits.

4.7 Where separate insulators are used for different sections of the line, the model has to be run separately for these sections and total costs summed up.

Based on the discussion, analysis and ruling as noted above we hereby direct to notify the following benchmark norms (Annexure-III) in terms of requirement of regulation 7 of the Tariff Regulations, 2009. Additional forms (Annexure-IV) which the project proponents will submit along with existing forms as per Tariff Regulations are also notified.

Sd/-	**Sd/-**	**Sd/-**	**Sd/-**
(M. DEENA DAYALAN)	**(V.S.VERMA)**	**(S.JAYARAMAN)**	**(DR. PRAMOD DEO)**
MEMBER	**MEMBER**	**MEMBER**	**CHAIRPERSON**

New Delhi Dated 27th April, 2010.

ANNEXURE- I

List of participants in public hearing on "**Benchmarking of Capital cost , of Transmission Lines " held on 17.03.2010**

Sl. No.	Name	Party Represented
1	Mr. B.Vamsi	POWER GRID
2	Mr. U.K.Tyagi	POWER GRID
3	Mr. M.M.Mondal	POWER GRID
4	Mr. Sounik Baneree	BHEL
5	Ms. Priyanka	GMR
6	Mr. G.M.Gupta	GMR
7	Mr. A.L.N.Rao	GMR
8	Mr. R.K. Agarwal	SJVN
9	Mr. Prashant	SJVN
10	Mr. K.Kapoor	SJVN
11	Mr. Rahul Sharma	Adani Power Ltd.
12	Mr. Yasir Altaf	ICF International
13	Mr. S.S.Sharma	PTC
14	Mr. Roop Kumar	DTC
15	Mr. V.Venugopal	Delhi SLDC

ANNEXURE-II		
BENCHMARKING OF TRANSMISSION LINES		
Infromation from Powergrid		
1	Name of the line	**Kolhapur-Mapusa (IDB order)**
2	Voltage class (765 kV or 400 kV)	400 kV
3	No. of Circuits (DC or SC)	DC
4	Length of line (kM)	Wind zone-2
	a) Hilly area	
	b) Plain Area	Plain area
	TOTAL LENGTH (kM)	160
5	Terrain Category (1,2 or 3)	2
6	No. of Towers	
	a) Hilly area	
	i) 'A' Type towers	-
	ii) 'B' Type towers	-
	iii) 'C' Type towers	-
	iv) 'D' Type towers	-
	b) Plain area	
	i) 'A' Type towers	310
	ii) 'B' Type towers	100
	iii) 'C' Type towers	25
	iv) 'D' Type towers	25
7	Conductor type - ACSR Moose,	ACSR Moose
8	No. of conductors in the Bundle (Twin, Tripple, Quad)	Twin
9	No. of River crossing towers (Nos)	Nil
10	Pile foundation for river crossing (Nos)	Nil
11	Insulator type (Standard porcelein, Antifog, Polymer)	Standard
12	Base date of indices for purpose of PV (One month prior to date of opening of Bids	Jun/00
	IEEMA indices for all materials for the base date may be furnished in a separate annexure	Furnished
13	Total Completion time in months	21 months
14	TOTAL HARD COST OF LINE AS PER LOAs with F& I in Rs Lakhs without Taxes & Duties, IDC Etc.**in Rs lakhs**	**7527.60**
	TOTAL COST AS PER MODEL	8917
	Percentage difference	15.58
Reasons for difference:		
1	This is an ADB order in which all materials have exemptions such as deemed export benefit etc. The rates obtained are very much on the lower side.	
2	Rate of Tower parts Rs. 22826 per MT as against Rs.31815	-39%
3	Rate of ACSR Moose conductor Rs. 140373 as against Rs. 193330	-38%
4	Rate of Ground Wire - Rs. 13283 as against Rs.26026 pe kM	-96%
5	Rate of Insulators Rs. 287 & 384 as against Rs. 457 & 548	59.23% & 42.71%
	Results after quantifying the Deemed Export benefit	
	TOTAL HARD COST OF LINE after quantifying the Deemed Export Benefit.	**9323.43**
	TOTAL COST AS PER MODEL	**8917**
	Percentage difference	**-4.56**

ANNEXURE-II		
BENCHMARKING OF TRANSMISSION LINES		
Infromation from Powergrid		
1	Name of the line	**Agra(UPPCL)-Agra (Powergrid)**
2	Voltage class (765 kV or 400 kV)	400 kV
3	No. of Circuits (DC or SC)	DC
4	Length of line (kM)	Wind zone-4
	a) Hilly area	
	b) Plain Area	Plain area
	TOTAL LENGTH (kM)	35
5	Terrain Category (1,2 or 3)	2
6	No. of Towers	
	a) Hilly area	
	i) 'A' Type towers	-
	ii) 'B' Type towers	-
	iii) 'C' Type towers	-
	iv) 'D' Type towers	-
	b) Plain area	
	i) 'A' Type towers	94
	ii) 'B' Type towers	16
	iii) 'C' Type towers	10
	iv) 'D' Type towers	4
7	Conductor type - ACSR Moose,	ACSR Moose
8	No. of conductors in the Bundle (Twin, Tripple, Quad)	Twin
9	No. of River crossing towers (Nos)	Nil
10	Pile foundation for river crossing (Nos)	Nil
11	Insulator type (Standard porcelein, Antifog, Polymer)	Standard
12	Base date of indices for purpose of PV (One month prior to date of opening of Bids	May/01
	IEEMA indices for all materials for the base date may be furnishe in a separate annexur	Furnished
13	Total Completion time in months	21 months
14	TOTAL HARD COST OF LINE AS PER LOAs with F& I in Rs Lakhs without Taxes & Duties, IDC Etc**in Rs lakhs**	**2142.00**
	TOTAL COST AS PER MODEL	2376
	Percentage difference	9.85
Reasons for difference:		
	1. Ungalvanised steel structures have been used as against the present practive of fully galvanised towers. The Model also	52.49
	Other reasons for possible increase in cost of Transmission lines.	
	1. The rate of ACSR Moose has enormously increased from Rs. 178003 to 231000 (30%) from 2001 to 2007 whereas the indices of Al. Ingots show an increase from 83767 to 142325 (70%)	70%
	2. The Insulator cost has increased. The Insulator index has increased from 115 to 170 (48%)	48%
	3 Electrolytic High grade zinc has increased from 68500 to 228000	233%
	4 The increase in Structural steel is from 14360 to 51000	255%
Increase in indices of some important items from 2001 to 2004		
1	Aluminium Ingots (from Rs. 83767 to 91190)	9%
2	Insulator index (115 to 145)	26%
3	Electrolytic High grade Zinc (68500 to 59400)	-13%
4	Structural Heavy Angles (14360 to 29323)	104%
5	Labour (105 to 119)	13%
6	Wholesale prices of iron and steel (137.5 to 201.8)	47%
7		

ANNEXURE-III

Maximum & Minimum Cost (Excluding Taxes & Duties) in Rs lakhs per Circuit kM of 400 kV Transmission line for 75 ° C conductor temperature with Price Indice values of Dec-2009 as per latest Indian Electrical & Electronics Manufacturers Association Journal of March -2010 considering 6 wind zones & 3 terrain categories.

SL No	Particulars						
	Number of towers assumed per 100 kM Line for benchmark numbers	Type "A"	Type "B"	Type "C"	Type "D"		
		210	40	20	10		
1		Table-I					
2	Insulator Type	Standard Porcelain					
3	Type of Terrain	Plain					
4	Voltage Level	400 kV					
5	Conductor Type	ACSR Moose					
6	Circuit Type	Single Circuit			Double Circuit		
7	Conductor Configuration	Twin	Triple	Quad	Twin	Triple	Quad
8	Max	58.37	74.06	92.01	108.65	141.67	180.09
9	Min	43.97	56.18	70.91	80.43	105.40	135.52
10	Conductor Type	ACSR Bersimis					
11	Circuit Type	Single Circuit			Double Circuit		
12	Conductor Configuration	Twin	Triple	Quad	Twin	Triple	Quad
13	Max	60.96	77.7596	95.97	116.29	149.45	190.25
14	Min	45.75	58.7921	73.52	84.70	110.68	142.50
1		Table-II					
2	Insulator Type	Antifog - Plain					
3	Type of Terrain	Plain					
4	Voltage Level	400 kV					
5	Conductor Type	ACSR Moose					
6	Circuit Type	Single Circuit			Double Circuit		
7	Conductor Configuration	Twin	Triple	Quad	Twin	Triple	Quad
8	Max	59.24	74.92	93.31	110.32	143.35	182.63
9	Min	44.84	57.05	72.21	82.10	107.07	138.05
10	Conductor Type	ACSR Bersimis					
11	Circuit Type	Single Circuit			Double Circuit		
12	Conductor Configuration	Twin	Triple	Quad	Twin	Triple	Quad
13	Max	61.82	78.63	98.09	117.97	151.13	192.79
14	Min	46.62	59.66	75.65	86.38	112.35	145.03
1		Table-III					
2	Insulator Type	Polymer					
3	Type of Terrain	Plain					
4	Voltage Level	400 kV					
5	Conductor Type	ACSR Moose					
6	Circuit Type	Single Circuit			Double Circuit		
7	Conductor Configuration	Twin	Triple	Quad	Twin	Triple	Quad
8	Max	57.04	72.73	89.82	106.05	139.08	175.77
9	Min	42.64	54.85	68.72	77.84	102.81	131.20
10	Conductor Type	ACSR Bersimis					
11	Circuit Type	Single Circuit			Double Circuit		
12	Conductor Configuration	Twin	Triple	Quad	Twin	Triple	Quad
13	Max	59.63	76.43	93.78	113.70	146.86	185.93
14	Min	44.43	57.47	71.33	82.11	108.09	138.18

For intermediate values arising out of other combinations refer to model database sheet. Filters provided for ease of search

ANNEXURE-III

Maximum & Minimum Cost (Excluding Taxes & Duties) in Rs lakhs per Circuit kM of 765 kV Transmission line for 75 ° C conductor temperature with Price Indice values of Dec-2009 as per latest Indian Electrical & Electronics Manufacturers Association Journal of March -2010 considering 6 wind zones & 3 terrain categories.

Sl No	Particulars						
1	**Number of towers assumed per 100 kM Line for benchmark numbers**	Type "A"	Type "B"	Type "C"	Type "D"		
		210	40	20	10		
2	**Table-I**						
3	Insulator Type	**Standard Porcelain**					
4	Type of Terrain	**Plain**					
5	Voltage Level	**765 kV**					
6	Conductor Type	**ACSR Moose**					
7	Circuit Type	Single Circuit					
8	Conductor Configuration	Twin	Triple	Quad			
9	Max	**86.91**	**106.71**	**132.26**			
10	Min	**60.65**	**74.98**	**94.61**			
11	Conductor Type	**ACSR Bersimis**					
12	Circuit Type	Single Circuit					
13	Conductor Configuration	Twin	Triple	Quad			
14	Max	**90.37**	**112.56**	**139.10**			
15	Min	**62.67**	**78.25**	**98.71**			
1	**Table-II**						
2	Insulator Type	**Antifog**					
3	Type of Terrain	**Plain**					
4	Voltage Level	**765 kV**					
5	Conductor Type	**ACSR Moose**					
6	Circuit Type	Single Circuit					
7	Conductor Configuration	Twin	Triple	Quad			
8	Max	**89.49**	**107.98**	**136.67**			
9	Min	**63.23**	**76.25**	**99.02**			
10	Conductor Type	**ACSR Bersimis**					
11	Circuit Type	Single Circuit					
12	Conductor Configuration	Twin	Triple	Quad			
13	Max	**92.95**	**115.14**	**143.51**			
14	Min	**65.26**	**80.84**	**103.12**			

Model not developed for 765 kV line with Polymer insulators

For intermediate values arising out of other combinations refer to model database sheet. Filters provided for ease of search

ANNEXURE-III

Maximum & Minimum Cost (Excluding Taxes & Duties) in Rs lakhs per Circuit kM of 400 kV Transmission line for 85 ° C conductor temperature with Price Indice values of Dec-2009 as per latest Indian Electrical & Electronics Manufacturers Association Journal of March -2010 considering 6 wind zones & 3 terrain categories.

SL No	Particulars						
1	Number of towers assumed per 100 kM Line for benchmark numbers	Type "A"	Type "B"	Type "C"	Type "D"		
		210	40	20	10		
2		Table-I					
3	Insulator Type	Standard Porcelain					
4	Type of Terrain	Plain					
5	Voltage Level	400 kV					
6	Conductor Type	ACSR Moose					
7	Circuit Type	Single Circuit			Double Circuit		
8	Conductor Configuration	Twin	Triple	Quad	Twin	Triple	Quad
9	Max	58.89	74.6748	92.71	109.28	142.44	180.994
10	Min	44.27	56.5315	71.31	80.80	105.84	136.043
11	Conductor Type	ACSR Bersimis					
12	Circuit Type	Single Circuit			Double Circuit		
13	Conductor Configuration	Twin	Triple	Quad	Twin	Triple	Quad
14	Max	61.27	78.13	96.39	116.68	149.90	190.78
15	Min	45.93	59.00	73.76	84.92	110.94	142.81
1		Table-II					
2	Insulator Type	Antifog					
3	Type of Terrain	Plain					
4	Voltage Level	400 kV					
5	Conductor Type	ACSR Moose					
6	Circuit Type	Single Circuit			Double Circuit		
7	Conductor Configuration	Twin	Triple	Quad	Twin	Triple	Quad
8	Max	59.76	75.54	94.01	110.96	144.11	183.53
9	Min	45.14	57.40	72.61	82.47	107.52	138.58
10	Conductor Type	ACSR Bersimis					
11	Circuit Type	Single Circuit			Double Circuit		
12	Conductor Configuration	Twin	Triple	Quad	Twin	Triple	Quad
13	Max	62.14	79.00	98.52	118.36	151.58	193.32
14	Min	46.80	59.87	75.89	86.60	112.61	145.34
1		Table-III					
2	Insulator Type	Polymer					
3	Type of Terrain	Plain					
4	Voltage Level	400 kV					
5	Conductor Type	ACSR Moose					
6	Circuit Type	Single Circuit			Double Circuit		
7	Conductor Configuration	Twin	Triple	Quad	Twin	Triple	Quad
8	Max	57.56	73.35	90.52	106.69	139.84	176.68
9	Min	42.94	55.20	69.12	78.21	103.25	131.72
10	Conductor Type	ACSR Bersimis					
11	Circuit Type	Single Circuit			Double Circuit		
12	Conductor Configuration	Twin	Triple	Quad	Twin	Triple	Quad
13	Max	59.95	76.81	94.20	114.09	147.31	186.47
14	Min	44.60	57.68	71.57	82.33	108.35	138.49

For intermediate values arising out of other combinations refer to model database sheet. Filters provided for ease of search

ANNEXURE-III

Maximum & Minimum Cost (Excluding Taxes & Duties) in Rs lakhs per Circuit kM of 765 kV Transmission line for 85 ° C conductor temperature with Price Indice values of Dec-2009 as per latest Indian Electrical & Electronics Manufacturers Association Journal of March -2010 considering 6 wind zones & 3 terrain categories.

Sl No	Particulars					
1	**Number of towers assumed per 100 kM Line for benchmark numbers**	Type "A"	Type "B"	Type "C"	Type "D"	
		210	40	20	10	
2		**Table-I**				
3	Insulator Type	**Standard Porcelain**				
4	Type of Terrain	**Plain**				
5	Voltage Level	**765 kV**				
6	Conductor Type	**ACSR Moose**				
7	Circuit Type	Single Circuit				
8	Conductor Configuration	Twin	Triple	Quad		
9	Max	**87.73**	**107.68**	**133.37**		
10	Min	**61.12**	**75.54**	**95.24**		
11	Conductor Type	**ACSR Bersimis**				
12	Circuit Type	Single Circuit				
13	Conductor Configuration	Twin	Triple	Quad		
14	Max	**90.87**	**113.15**	**139.78**		
15	Min	**62.96**	**78.59**	**99.09**		
1		**Table-II**				
2	Insulator Type	**Antifog**				
3	Type of Terrain	**Plain**				
4	Voltage Level	**765 kV**				
5	Conductor Type	**ACSR Moose**				
6	Circuit Type	Single Circuit				
7	Conductor Configuration	Twin	Triple	Quad		
8	Max	**90.32**	**108.95**	**137.78**		
9	Min	**63.71**	**76.81**	**99.66**		
10	Conductor Type	**ACSR Bersimis**				
11	Circuit Type	Single Circuit				
12	Conductor Configuration	Twin	Triple	Quad		
13	Max	**93.46**	**115.74**	**144.19**		
14	Min	**65.55**	**81.18**	**103.50**		

Model not developed for 765 kV line with Polymer insulators

For intermediate values arising out of other combinations refer to model database sheet. Filters provided for ease of search

ANNEXURE - IV

PART-III
Form 2

DETAILS OF TRANSMISSION LINES

SECTION I – DETAILS OF TRANMISSION LINES

Name of the transmission licensee :

Name of region :

Name of the Project :

Section I –Transmission Lines

Part-I A

S.No.	Name of line	Type of line AC/HVDC	S/C or D/C	Voltage level kV	Line length Ckt - Km.	Date of Commercial operation	Covered in this petition (Yes/No)
1							
2							
3							
4							
-							
-							
-							

PETITIONER

FORMAT TO BE FURNISHED ALONG WITH THE PETITION FOR PRUDENCE CHECK

PART –I B

1	Name of the line	
2	Voltage class (765 kV or 400 kV)	
3	No. of Circuits (DC or SC)	

S.N.	Particulars	Wind zone-1	Wind zone-2	Wind zone-3	Wind zone-4	Wind zone-5	Wind zone-6	Total
4	Length of line (kM)							
	a) Hilly area							
	b) Plain Area							
	TOTAL LENGTH (kM)							
5	Terrain Category (1,2 or 3)							
6	No. of Towers							
	a) Hilly area							
	i) 'A' Type towers							
	ii) 'B' Type towers							
	iii) 'C' Type towers							
	iv) 'D' Type towers							
	b) Plain area							
	i) 'A' Type towers							
	ii) 'B' Type towers							
	iii) 'C' Type towers							
	iv) 'D' Type towers							
7	Conductor type (ACSR							

	Moose, Bersimis)							
8	Number of conductors in the Bundle (Twin, Triple, Quad)							
9	Number of River crossing towers							
10	Number Pile foundation for river crossing							
11	Insulator type (Standard porcelain, Antifog, Polymer)							
12	Base date of indices for purpose of PV (One month prior to date of opening of Bids)							
	IEEMA indices for all materials for the base date to be furnished in a separate annexure							
13	Total Completion time in months							
14	TOTAL HARD COST OF LINE AS PER Detailed Work Award/Purchase Order (Rs.) without Taxes, Duties, F&I IDC Etc.							
	a) Taxes and Duties							
	b) Freight and Insurance.							
	TOTAL COST INCLUDING TAXES AND DUTIES, F&I							
15	TOTAL HARD COST (Rs.)							
16	Reasons for increase or decrease in the cost at							

	the time of filing.							
17	Price indices of following	As on one month before bid opening date (as per DWA/PO)			As on date of commercial operation			
a	Structural Steel Heavy Angles							
b	Electrolytic High Grade Zinc							
c	Labour-Consumer Price Index							
d	High Tensile Galv. Steel Wire							
e	Wholesale Prices of Fuel etc.(Base 93-94=100)							
f	EC Grade Al Ingots							
g	Wholesale prices of Iron and Steel							
h	Whole Sale Price Index : (HSD)							
i	Cement							
k	Non Metallic mineral products							
l	Index No. of Insulators (Base 2003= 100)							

Note:

- *In case the total length of the line runs through different wind zones etc, the data may please be given separately.*
- *If the total line consists of combination of SC and DC lines/ towers the data to be given separately.*

The total hard cost for different combinations of the line may be given separately if available. Otherwise the total cost of the line may be furnished.