No. L-1/36/2010 - 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

Date of Hearing : 30. 3.2010 **Date of Order: 16.6.2010**

IN THE MATTER OF

Benchmark Capital Cost for Substation associated with 400/765 Kv Transmission system.

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 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 first proviso to clause (2) of Regulation 7 of the tariff Regulations, the benchmark norms in case of the 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 of capital cost.

4. In the background of the above stated regulatory framework, the Commission had initiated, in June 2008, 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. 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 capital cost of Substations associated with 400/765 Kv transmission system amongst others. The above objective was to be achieved by collecting reliably available data, analyzing the data, creating a data base, defining Disaggregated Packages of Hard Cost of a Project to be sufficient for benchmarking, recommending appropriate methodology through which a bench mark capital 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 materials/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 validated based on the historical data from the database.

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

6. The pricing model along with explanatory memorandum was placed on the website of the Commission, through public notice dated 11.1.2010, for public scrutiny and comments.

7. A public hearing was held on 30.3.2010. The list of participants in the public hearing is enclosed in Annexure – I. 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 given in the succeeding paragraphs. .

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

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

8. Powergrid corporation of India Ltd (hereinafter "the stakeholder") has raised a moot question viz. the applicability of benchmarking as a tool for prudence check of capital cost of transmission projects. According to the stakeholder, capital cost benchmarking for individual transmission projects on a *post facto* basis finds no parallel anywhere in the world. It has been stated that 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.

9. It has been contended that the hard cost of projects developed by Power Grid Corporation of India Limited, emerges consequent to a transparent competitive bidding process. Power Grid Corporation of India Limited, being a Central Public Sector Undertaking, is invariably bound by definite rules and is subjected to a host of mandatory checks and balances across the entire value chain which *inter-alia* 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.

10. We have carefully considered the views of the stakeholder, but are unable to accept the same for the reasons detailed hereinbelow.

11. At the outset, it needs to be appreciated that benchmarking may broadly be defined as *comparison of some measure of actual value/performance against a reference benchmark value/performance*.

12. Capital cost is the driving factor based on which the various elements of tariff are determined. Efficient and objective control over the same is therefore, of paramount importance. What the cost ought to be and not the cost claimed is the driving force. We are firmly of the view that the 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.

13. The model developed for working out benchmark capital cost uses reliably available national data. Model will be used to identify outliers as possible cases for carrying out further/detailed prudence check. Based on the principle of Management by exception principle, this process will lead to saving of resource and time spent on conducting prudence check. We would also like to impress that the 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 as analyzed from data collected suitably modified as explained in explanatory memorandum for the subject under study. Model objectively covers standard variable/s affecting Substation cost.

14. It also needs to be appreciated that unit cost approach is being relied upon by regulators, world wide, 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.

15. 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 this Commission in both cases i.e. where execution is taken up with prior regulatory approval or where execution is taken up with signing of Bulk Power Transmission Agreement with stakeholders/beneficiaries.

16. Importance of regulatory checks on admissible asset value hardly needs any emphasis under cost of service regulations. Cost as per books are not necessarily the input cost for regulatory purpose. At best they may serve 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 Section 63 of Electricity Act, 2003 and is necessarily to be dealt under Section 62 of Electricity Act, 2003.

17. Even traditional methods of prudence check used at present are on *post facto* basis. Even today onus lies on the utility to provide 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 the stakeholder as regards post facto comparison with developed benchmark norms is not relevant 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.

18. In view of the above, the apprehensions of the stakeholder about the appropriateness of process of bench marking is unfounded.

Relevance of the specific methodology for benchmarking

19. The stakeholder has further contended that there are numerous errors and shortcomings in the proposed model and has urged that 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.

20. While we will deal with the alleged errors and shortcomings in detail in the later part of this order, we would like to clear the misconception about the inapplicability of the model. At the outset, it is clarified that 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.

21. As already stated in the tariff regulations, benchmark norms 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 utility to the extent and in such manner as desired by the Commission.

22. As regards the specific methodology for benchmarking proposed in the explanatory memorandum, the stakeholder has opined that the proposed specific methodology may not capture the variables appropriately, that transmission projects are often subjected to.

23. In this connection, it may be recalled that 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, Various standard configuration termed as alternates and provision for creating required configuration from standard ones using combination through addition/deletion of components, the essential features, main variables, data inputs, assumptions, validation.

24. One of the objections by stakeholder is on the dynamic nature of the 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. In this connection, it is clarified that the intention behind 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 unfounded. 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.

25. 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.

26. The stakeholder has also questioned the sufficiency of sample size. In this connection, it may be inferred that 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 …". Accordingly a final sample of 30 substations was selected based on representativeness and quality of data. In terms of the transformation ratio the sample contains 24 substations of 400/220 kV and 6 substations of 765/400 kV. For the representativeness of the sample it is appropriate to consider the MVA capacity of the sample substations in relation to the capacity created and planned to be created in the relevant years. The figures have been compiled from various reports of the Project Monitoring division of the CEA.

400/220 kV Substation Capacity Creation	Unit: MW/MVA		
Year	Central	State	Total
2004-05	1250	1760	3010
2005-06	4725	5540	10265
2006-07	5355	3832	9187
2007-08	16816	7395	24211
2008-09	4095		4095
Total	32241	18527	50768
765/400 kV Substation Capacity Creation	Unit: MW/MVA		
Year	Central	State	Total
2007-08	2169	-	2169
2008-09	-	-	-
2009-10	-	-	-
2010-11	21000	-	21000
2011-12	25500	-	25500
Total	48669	-	48669

Sources: CEA tables 'TABLE-3.2(b) TRANSFORMATION CAPACITY (MVA) ADDITIONS OF 400 kV AND 220 kV IN INDIA', 'TABLE-5.4 SUBSTATION PROGRAMME FOR 07-08', 'TABLE-5.6 SUBSTATION PROGRAMME FOR 08-12'.

27. In relation to the total capacity created or planned to be created in the relevant period, the capacity of the sample substations is shown in the table below:

Capacity in MVA		
400 kV	765 kV	Total

Substation capacity created & planned	50768	48669	99437
Model sample	15490	21000	36490
Share of sample (%)	30.5	43.1	36.6

28. From the foregoing, it may be appreciated that the sample of substations chosen for the benchmarking model of 400/220 kV and 765/400 kV substations 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 prudence 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 unwarranted.

Alleged shortcomings in the model

29. The stakeholder has drawn attention to the statement "Thus, within the cost estimates of the project, there is a tendency to build in additional risk factor" in the concept paper and has pointed out that its tariff petitions are not based on any cost estimates but on the actual audited cost incurred by Power Grid Corporation of India Limited which is discovered through a transparent competitive bidding process. As such the aforementioned statement in the concept paper appears misleading.

30. In this regard we would like to clarify that the above extracted statement was made in the concept paper and explained in paragraph 4.1.6 of the explanatory memorandum. Usually while preparing cost estimates while taking up any project, all perceived risks are factored. Apart from the perceived risks, provisions are also made for unforeseen risks through contingencies etc. However the model prepared is based on actually incurred cost.

31. Inviting attention to the statement "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," as occurring in para 4.1.7 of the explanatory memorandum, the stakeholder has contended that owing to the short time cycle of the projects, learning of one is built into another as a part of continuous improvement. The stakeholder has urged that in case of any specific mitigation measures, the same may be brought out.

32. In this regard, it is clarified that this is also a part of concept explained as a general statement in paragraph 4.1.7 of the explanatory memorandum. While building the model in question, reliable national level data has been used as the base data. As noted by the stakeholder, learning of one is built into another. Thus, the model has been kept dynamic so that further learnings, as and when captured, can also be taken into account to reflect modified benchmark norms appropriate with latest developments.

33. The stakeholder has stated that the concept of common and uncommon packages is not clear. It is clarified that, this was a general statement made with reference to both transmission systems and thermal stations. The substation model prepared does not have such common and uncommon packages.

34. The stakeholder has opined that the entire process of developing benchmarks needs elaboration. The stakeholder may refer to paras 4 to 9 of the explanatory memorandum wherein process has been elaborated.

35. The stakeholder has also sought elaboration of the purpose / contents. In this regard we would like to clarify that the procedure and step by step methodology followed in developing the model have been elaborated with the aid of flow diagram in explanatory memorandum to have more transparency. Essential features, assumptions made, etc. are clearly elaborated in the model.

36. The stakeholder has pointed out the following voltage levels in India:

(a) 400/220kV sub-station,

(b) 765/400/220kV sub-station,

(c) 400/132kV sub-station,

(d) 220/132kV sub-station,

(e) 132/33kV sub-station.

It is clarified that main features considered for evolving the model are mentioned and not voltage levels in the country. It is also significant that the models are confined to only 765 / 400 /220 kV sub-stations, and 400/220 kV Conventional (Air Insulated Substations) and series compensation. Gas Insulated substations and series compensation for 765 Kv for the present are not being benchmarked for non availability of sufficient data of these categories.

37. Referring to the list of the determinants of the configuration of the substation as given in para 5 of the explanatory memorandum, the stakeholder: has also pointed out that the configuration of a sub-station also depends on:

- Line bays (with or without Reactors)
- Bus Reactor Bays

38. In this regard it is pointed out that only main features are mentioned in the said para of the explanatory memorandum. The model, however, has been developed considering the above mentioned aspect also namely line bays including extension of line bays with and without reactors and also bus reactors in the existing substations. It is further clarified that 20 Alternates with various combinations of Bus Reactors and Shunt(Line)Reactors are reckoned for 400/220 kV sub-stations and 6 Numbers various bay combinations i.e., 400 kV Line bay, 400 kV Line bay with Shunt Reactor, 400 kV Bus Reactor bay, ICT bay & 200 kV line bays

etc., have been fitted into models. Most of the samples (To be Benchmarked shall fall into any of the 20 alternate configurations. If any sample to be Benchmarked falls outside the ambit of these 20 configurations, then provision for adding or subtracting required number of bay components, for exact matching to the sample(to be benchmarked) has been made. Similarly for 765/400/220 kV sub-stations, 3 alternates and 11 bay combinations have been developed.

39. The stakeholder has further pointed out that Extra High Voltage sub-station – categorization of works shall also include: 220kV Transfer Bus Coupler & Bus Coupler Bays and Gas Insulated Substation & Series Compensation. It is clarified that 220 kV Transfer Bus Coupler and 220KV Bus Coupler is configured in all 400/220KV and 765/400/220KV Substation models. Models for Gas Insulated Substation & Series Compensation (400 kV) have been developed separately. Except for Gas Insulated Substation all models were up loaded on the CERC web site. Benchmark Capital cost for Gas Insulated Substation and Series Compensation (765 kV) for the present is not being notified as sufficient data which can be relied upon is not there.

40. The stakeholder has brought to our notice the following deviations in the Base date of Price Index in the work award as indicated in the table and the Price Index in the award

Sl. No.	Sub-station name	Base date of PI indicated in the table	Base date of PI in the award
1	Karaikudi	August, 2005	April, 2006
2	Ludhiana	October, 2004	September, 2004
3	Fatehabad	October, 2004	September, 2004
4	Gwalior	October, 2004	September, 2004
5	Narendra	September, 2003	August, 2003
6	S'Gram	September, 2003	August, 2003
7	Amritsar	September, 2003	August, 2003

Necessary corrections have been made based on the details submitted by the stakeholder.

41. The stakeholder has sought elaboration of the details based on which the model was validated for data commissioned prior to 2003 as stated in para 6.2.2 of the explanatory memorandum.

42. It is clarified that the data in respect of projects awarded in 2002 and 2003 have been included in the data base itself and validated. Details and results were furnished in Para 7.7 of explanatory memorandum itself.

43. Referring to the statement "However the model has a provision to update the rates to any base date as desired." in para 7.1.6 of the explanatory memorandum, the stakeholder has stated that 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 And has requested that a calculation be shown for clarity.

44. In this regard, it is pointed out that the model has a provision to update the costs for any date provided respective Indices are keyed in to the model. In the model, there is a sheet with tab name < Indices>. The user may enter the 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.

45. The stakeholder has pointed out that Series compensation for 765kV Transmission lines is not mentioned in the list of substation models composition in para 7.1.1 of the explanatory memorandum. The stakeholder may be informed that the model of series compensation for 765 kV has not been developed since required cost data, which is the hallmark of this exercise is not available to the extent required for benchmarking. The

same will be considered/notified along with Gas Insulated Substation model as and when sufficient sample data is available to carry out benchmarking exercise.

46. The stakeholder has pointed out that in para 7.1.2, Communication (PLCC) equipment is not mentioned. It may be noted that only major components were indicated in explanatory memorandum. However, PLCC component with cost is incorporated in the models. Basis of the same is also given in the model.

47. The stakeholder has made the following observations on para 7.1.3 of the explanatory memorandum:

a) Bus reactor bay is not mentioned as a separate 400kv Bay. It shall be counted.

b) Due to space constraints, 3x167MVA, 1-phase & 3x105MVA, 1-phase transformer units are also adopted. Cost of 3x1-phase transformer bank instead of 3-phase transformer may increase in wide range. In addition, due to more requirement of fire fighting, Aux scheme, the cost of 3x1-phase bank will increase.

48. In this connection, it is informed that, cost for Bus reactor bay has been considered in the model. Besides, in the 1X500 MVA 400/220 kV sub-station, 4X167 MVA S-Ph ICTs are provided; in the 2X500 MVA 400/220 kV Sub-Station, 7X167 MVA S-Ph ICTs have been provided and in the 1500 MVA, 765/400 kV sub-stations , 4 X 500 MVA S-Ph units are provided.

49. The stakeholder has pointed out that Civil Engineering works, substation buildings & colonies are not mentioned in para 7.1.4.(b)(i). According to the stakeholder, leveling cost varies in wide range from site to site based on HFL. Many other equipments like Security equipments, air conditioning equipments etc also increase costs which are not mentioned.

The utility is informed that provision has been made in the substation model for Soil Investigation, Initial Civil Engineering Works like yard Leveling, Retaining walls, Approach Road, Anti weed treatment & Site Surfing Storm water drain, Road culverts drain crossing, cable trench crossing, Switch yard fencing, Peripheral Fencing, DG room & Fire fighting Room, Control room with cable vaults, Cable ducts, Providing water supply including drinking water & water for firefighting system and sewage system, Parking sheds, Rain water Harvesting systems & land scaping, all foundations & air conditioning etc. No provision, however, has been made for colonies in the model as it is not considered as part of hard cost of sub-station in the model. Besides, leveling cost has been shown in the model depending upon sub-station site area, which in turn has been computed upon the number of bays, ICTs etc

50. The stakeholder has questioned non-mentioning of 3-phase of 1 phase ICT and 3-phase of 1 phase Reactors under Group -2 and Group 3 respectively in para 7.1.4 of the explanatory memorandum. In this connection, it is clarified that in model 315 MVA ICTs are all 3-Ph units and 500 MVA and above are S-Ph units. Besides, both S-Ph and 3 Ph reactors are incorporated separately in the model. The 420 kV 3 Ph units of 125, 80, 63 and 50 MVAR are considered and 3 Nos of 110, 80 and 50 MVAR, S-Ph units of 765 KV /√3, units are considered as per industry practice based on the data analysis carried out.

51. The observation of the stakeholder that Steel Structures, Bus Bar Materials are considered in Group-I: Common General Works is incorrect because , they are considered in Group-IV and not in Group-I. It has further been suggested that in para 7.4.(c) and 7.4.(d), type of ICT and Reactor i.e whether 3-phase or 1-phase shall also be mentioned. It is clarified that the type viz. whether 3-phase or 1-phase ICT or Reactor has been clearly mentioned in the model.

52. In connection with para 7.6 (a) (iii) the stakeholder has stated that factor for addition of 400kV CB (7.6%) & 220kV CB (6.8%) varies and these cannot be fixed. It is clarified that this factor has been arrived at after a thorough study and the details are furnished in Para No 7.6. (a) of the explanatory memorandum.

53. With regard to sub-station automation under para 7.6 (a) of the explanatory memorandum the stakeholder has stated "If only bay extension works are involved, the substation automation poses integration problem and many cases the cost for integration of additional bay is comparable with main substation automation system." In this connection, it is clarified that in the developed model additional bay costs are also developed and automation costs also considered.

54. The stakeholder has pointed out that the tonnage (weight of structures) depends on wind zones of the substation locations and civil foundations also change accordingly. In this connection it is clarified that the weights of station structures have been computed based on weights indicated in sample sub-station data and the same is considered in the model. These weights are found to be closer to higher wind Zones design weights. Hence the same weights are adopted in all alternates and combinations. It is also significant that there will not be such huge variation of station structures weights between various wind Zones, as encountered in Transmission lines, since the span lengths in the sub-stations are about 54 meters for Jack bus against normal span lengths of 400 Meters in the transmission lines.

55. According to the stakeholder, in large substations, there will be upward quantity variations due to distance from control room to individual bays. It is clarified that this aspect has been considered in the model. For example as number of bays increases; the increase in Control cable has been computed taking in to account the total sub-station area for increased number of bays. The stakeholder has also pointed out that Civil works like

Township area development, boundary wall, security systems etc. are not considered. The civil foundations depend on soil conditions and wind zone of the substation location. It is clarified that Security fencing has been considered in the model but not town ship which is not considered a part of hard cost of sub-station in the model. Stakeholder's observation about non-consideration of 400/132kV Substations, Bus Reactor & Line Reactor at 220kV, Bus Reactors for 132kV & ICT ratings of 200MVA etc. is not relevant because the model has been developed only for 400/220 kV and 765/440/220 kV sub-stations and not for 400/132 kV sub-stations.

56. The stakeholder has commented that the list of assumptions considered for validation appears a highly subjective and debatable exercise. It has been contended that validity and extension of the assumptions to cover for all future projects to be undertaken in the country during the block year 2009-14 is not rationally supported. We are unable to agree because this apprehension is not correct considering the fact that the results of validation of executed projects with respect to Model values are within the acceptable limits.

57. It has been pointed out that only 18 out of the total 24 samples have been validated for 400/220kV substations, 2 out of total 5 samples have been validated for 765kV/400/220kV substations and also for series compensation. The stakeholder has desired to know the reason for not extending the self validation on the balance samples which has not been elaborated. It has been urged that the details of this validation need to be presented. The variation with the input database in itself ranges from -5.1% to +8.51%

58. **Analysis/ruling**: It is clarified that data relating to any 765 kV & 400 kV sub-station work can be validated. In fact the validation has been done for two sub-stations of Bareilly & Agra which were not part of data base considered for model creation and were randomly selected by the Commission as a test case ,with the data furnished by Power Grid before

accepting the model and results are found to be about -1.54% and +2.08% respectively, which are well within the acceptable limits. Standard Deviation (STDEV) is within ±5 %. This fact will be kept in sight while carrying out prudence check.

59. Commenting on para 8.2 of the explanatory memorandum, the stakeholder has stated that construction steel indices as shown in Basic raw material is now discontinued by Indian Electrical and Electronics Manufacturers Association from Jan'2002. It is clarified that the Price Indice values of iron and steel are considered against Construction steel and the same has been corrected in the model.

60. With regard to price variation formula regarding Circuit Breakers, Isolators, Capacitor Voltage Transformer, Current Transformer & Structural Steel, the stakeholder has pointed out that the co-efficient as shown is not fixed in all the contracts and the same varies from one award to another. It is clarified that the model was developed using Price Variation formulae with different co-efficient as per the various work awards of Power Grid Corporation of India Limited and the computed results found to be closer to work award price are considered for developing the model and the validation results are found to be satisfactory

61. The stakeholder has stated that all the PV formulae used in the model are not as followed by CTU and are not designed for subject matter of study. It is clarified that PV formulae were devised based on data collected, and industry interaction. Further, the validation results using these PV formulae were found to be within the acceptable limits and hence these formulae are used for preparation of model.

62. As regards accuracy, the stakeholder has stated that the accuracy with the data base used for developing the model itself ranges more than ±5%. The stakeholder has further stated as per Table shown at Para 7.7, out of the 18 samples of 400/220kV substations tabulated, validation results of 8 projects indicate a variation of more than + 5% range. In this

regard it is clarified that 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 view at the time of prudence check.

63. The stakeholder has also complained that various other cost drivers have not been captured in the model viz. different terrain category for substation not done. (High altitude sub-station (Wagoora etc.). It has been contended that Geographical locations of the substation and local law and order position will also affect the cost. We are of the view that the factors mentioned by the stakeholder are rare and special cases which will be dealt as exception. Abnormal cost on account of law and order position if any has to be brought out at the time of petition filing giving details and justification for consideration of the Commission.

Clarifications in the Model Workings.

64. Before parting, we also reiterate that apart from carrying out corrections to the extent of removing minor inconsistencies, the following are also clarified:

(a) All the unit Prices are inclusive of freight and insurance only and transportation is not assumed as % of supply cost anywhere in the model.

(b) Separate POs were issued for ICTs, Reactors in some of the projects. Other projects were ordered on total turn-key package including all the equipments & materials. Hence numbers in data base appears more than the list of projects.

(c) Cell C9 of computation sheet earlier indicated as month and year of commissioning has now been correctly indicated as base date of price index in the model.

(d) Once again all the Price Indices are verified and correct Price Indice values are incorporated.

(e) Price variation formulas were used correctly in the model (sum total of all coefficients equal to 1) but were wrongly mentioned in the list. This has now been correctly mentioned.

65. In view of the forgoing, we approve the benchmark norms for capital cost for sub-stations associated with 400/765 kV transmission system which shall be taken into consideration which determining the capital cost in basis of clause (2) of Regulation 7 of the tariff regulations. We further direct that the transmission licensees involving the deemed transmission licensees and the Central Transmission Utility shall be required to submit information on the forms attached as Annexure III to this order in addition to the existing formats being submitted as per the tariff regulations.

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

New Delhi

ANNEXURE- I

List of participants in public hearing on "**Benchmarking of Capital cost, of Substations associated with 400/765 Kv Transmission system" held on 30.03.2010**

Sl. No.	Name	Party Represented
1	Mr. R.T.Agarwal	POWER GRID
2	Mr. U.K.Tyagi	POWER GRID
3	Mr. M.M.Mondal	POWER GRID
4	Mr. V.K.Sehgal	POWER GRID
5	Mr. D.K.Sarkar	POWER GRID
6	Mr. Mukesh Khanna	POWER GRID
7	My. Y. Sudhakar	POWER GRID
8	Mr. Sounik Banerjee	BHEL
9	Mr. Varun Sharma	NDPL
10	Mr. Sankaran Nambiar V.S.	TNEB Chennai
11	Mr. A.L.N.Rao	GMR
12	Mr.J.K. Jethani	RRVPNL
13	Mr. M.K.Garg	RRVPNL

ANNEXURE –II

Hard Cost (Excluding Taxes & Duties) in Rs lakhs of 400/220 Kv Substations with Price Indice values of Dec-2009 as per latest Indian Electrical & Electronics Manufacturers Association Journal of March-2010.		
Sl No	**SUB- STATIONS ALTERNATE Nos As Specified /Detailed in Model**	
1	Alternate No-1	7154.31
2	Alternate No-2	8178.58
3	Alternate No-3	9146.79
4	Alternate No-4	7641.74
5	Alternate No-5	6800.28
6	Alternate No-6	5728.74
7	Alternate No-7	9075.00
8	Alternate No-8	10183.01
9	Alternate No-9	15796.43
10	Alternate No-10	10267.92
11	Alternate No-11	6511.70
12	Alternate No-12	6595.14
13	Alternate No-13	5697.39
14	Alternate No-14	12356.63
15	Alternate No-15	10069.41
16	Alternate No-16	5765.73
17	Alternate No-17	7359.18
18	Alternate No-18	14384.3
19	Alternate No-19	5360.62
20	Alternate No-20	4364.36
21	**SUB- STATIONS COMBINATION**	
a	Combination – 1- 400 kV Line Bay with Shunt Reactor	848.29
b	Combination – 1- 400 kV Line Bay	416.19
c	Combination - 3- 220 kV line Bay	204.21
d	Combination – 4- 1X 315 MVA ICT with 400 kv & 220 kv Bays	1525.97
e	Combination -5- Addition of Shunt Reactor to 400 KV line Bay	577.10
f	Combination – 6- 400 kv Bus Reactor Bay	787.01

ANNEXURE –II

Hard Cost (Excluding Taxes & Duties) in Rs lakhs of 765/400/220 Kv Substations with Price Indice values of Dec-2009 as per latest Indian Electrical & Electronics Manufacturers Association Journal of March-2010.		
Sl No	**SUB- STATIONS ALTERNATE Nos As Specified /Detailed in model**	
1	Alternate No-1	41015.92
2	Alternate No-2	28383.87
3	Alternate No-3	39719.77
4	**SUB - STATIONS COMBINATION**	
a	Combination -1 -765 KV Line Ter. Bay with Shunt Reactor	3298.77
b	Combination -2- 765 KV Line Ter. Bay without Shunt. Reactor	1566.27
c	combination -3- 765 /400 KV ICTr with 765 & 400 kV Bays	8081.26
d	Combination -4 -765KV Bus Reactor Bay	1812.03
e	Combination -5- Additional 765KV Shunt Reactor	

ANNEXURE –II

Hard Cost (Excluding Taxes & Duties) in Rs lakhs for series compensation of 400 Kv Lines with Price Indice values of Dec-2009 as per latest Indian Electrical & Electronics Manufacturers Association Journal of March -2010.		
1	D/C line Twin Moose ACSR- 300 Km -40 % Compensation	3071.13
2	A/C line Twin Moose ACSR- 300 Km - 40 % Compensation	1611.45

ANNEXURE - III

PART-III
Form 2

Name of the Project :

Section II –SUBSTATIONS

Part-II A

S.No.	Name of Sub-Station	Type of Substation Conventional/ GIS/HVDC TERMINAL/BACK TO BACK	Voltage level kV	No. of transformers / Reactors / SVC etc (with capacity)	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

SECTION - IIIB

Benchmarking Of 400/220 kV Sub-Station cost		
Information required for testing the Sub-Station Model		
1	Name of the Sub-Station	
2	Date of DWA / PO	
3	Base date of indices for purpose of PV (One month prior to date of opening of Bids	
4	IEEMA indices for all materials as on the base dates of both DWA/PO and date of Commercial operation to be furnished.	***

S.N.	Particulars	Parameters required	
		As per DWA/PO	As filed with CERC
4	**Type of Switching scheme**		
	a) 400 kV		
	b) 220 kV		
5	**No. of diameters**		
	a) 400 kV		
	b) 220 kV		
7	**Line bays**		
	a) 400 kV		

S.N.	Particulars	Parameters required	
		As per DWA/PO	As filed with CERC
	b) 220 kV		
8	**400 / 220 kV, ICTs.**		
	i) Capacity (MVA)		
	ii) Single phase or 3 phase units (Nos.)		
	iii) No. of ICTs		
9	**400 kV Reactors**		
	i) Shunt Reactor		
	a) Number		
	b) Capacity		
	ii) Bus Reactor		
	a) Number		
	b) Capacity		
	iii) NGR (Numbers)		
10	**Hard Cost of Sub-Station with F&I and without Taxes, Duties, IDC etc,**		
	a) Total for sub-station, including, supply, erection & civil works		
	b) ICT		
	c) Reactor		
	d) 400 kV Equipment		
	e) 220 kV Equipment		
	f) Control & Protection Panels and S/S Automation		

S.N.	Particulars	Parameters required	
		As per DWA/PO	As filed with CERC
	g) Other materials like PLCC, Bus bars, Cables, Fire fighting, Illumination etc.		
	h)) Erection		
	i) Civil engineering works		
11	**Taxes and duties**		

Note:

Details shall pertain to that of a total new sub-station without associated transmission lines and any other extension work pertaining to same or other sub-station.

Benchmarking of 765/400/220 kV Sub-Station cost		
Information required for testing the Sub-Station Model		
1	Name of the Sub-Station	
2	Date of DWA	
3	Base date of indices for purpose of PV (One month prior to date of opening of Bids	
4	IEEMA indices for all materials as on the base dates of both DWA/PO and date of Commercial operation to be furnished.	***

S.N.	PARTICULARS	Parameters required	
		As per DWA	As filed with CERC
4	**Type of Switching scheme**		
	a) 765 kV		
	b) 400 kV		

S.N.	PARTICULARS	Parameters required	
		As per DWA	As filed with CERC
	c) 220 kV		
5	**No. of diameters**		
	a) 765 kV		
	b) 400 kV		
	c) 220 kV		
6	**Line bays**		
	a) 765 kV		
	b) 400 kV		
	c) 220 kV		
7	**ICTs.**		
	a) 765/400 kV Class		
	i) Capacity (MVA)		
	ii) Single phase or 3 phase units (Nos.)		
	iii) No. of ICTs		
	b) 400/220 kV Class		
	i) Capacity (MVA)		
	ii) Single phase or 3 phase units (Nos.)		
	iii) No. of ICTs		
8	**Reactors**		
	i) 765KV Shunt Reactor		
	a) Single phase or Three phase		
	b) Number		

S.N.	PARTICULARS	Parameters required	
		As per DWA	As filed with CERC
	c) Capacity		
	ii) 765K Bus Reactor		
	a) Single phase or Three phase		
	b) Number		
	c) Capacity		
	iii) NGR (No.)		
	i) 400KV Shunt Reactor		
	a) Number		
	b) Capacity		
	ii) 400KV Bus Reactor		
	a) Number		
	b) Capacity		
	iii) NGR (Numbers)		
10	**Hard Cost of Sub-Station with F&I and without Taxes, Duties & IDC**		
	a) Total for sub-station, including, supply, erection & civil works		
	b) ICT		
	c) Reactor		
	d) 765 kV Equipment		
	e) 400 kV Equipment		
	f) 220 kV Equipment		
	g) Control & Protection Panels and S/S		

S.N.	PARTICULARS	Parameters required	
		As per DWA	As filed with CERC
	Automation		
	h) Other materials like PLCC, Bus bars, Cables, Fire fighting, Illumination etc.		
	i) Erection		
	j) Civil engineering works		
11	**Taxes and duties**		

Note:

Details shall pertain to that of a total new sub-station without associated transmission lines and any other extension work pertaining to same or other sub-station.

***

S.N.	Equipments	Material	Indices values
1	**LT Transformer**	Copper	
2		CRGO – Electrical Steel Sheets	
3		Iron & Steel	
4		Insulating Material	
5		Transformer Oil	
6		Index of Labour	
1	**Power Transformer**	Copper	
2		CRGO – Electrical Steel Sheets	
3		Iron & Steel	
4		Insulating Material	
5		Transformer Oil	

S.N.	Equipments	Material	Indices values
6		Index of Labour	
1	Circuit Breaker	Iron & Steel	
2		Copper	
3		Aluminum	
4		Epoxy Resin	
5		Index of Labour	
1	CTs & CVTs	Iron & Steel	
2		Transformer Oil	
3		Index No. for Insulator	
4		CRGO-Electrical Steel Sheets	
5		Copper	
6		Aluminum	
7		Epoxy Resin	
8		Index of Labour	
1	Isolator	Construction Steel	
2		Copper	
3		Aluminum	
4		Epoxy Resin	
5		Index of Labour	
6		Index No of Insulator	

S.N.	Equipments	Material	Indices values
1	Surge Arrester	Zinc	
2		Cobalt	
3		Aluminum	
4		Ball clay	
5		Bismath	
6		Fuels/power	
7		Index of Labour	
1	Substation Structures including bolts and Nuts	Published Price Index of Structural Steel	
2		Published Price Index of Electrolytic Zinc	
3		Index of Labour	
1	PVC/XLPE Insulated power and control cables.	PVC Compound	
2		Metal	
3		Aluminum	
4		Copper	
5		weight in MT of metal KM	
1	Index for civil works	IOC _HST basic ceiling selling price ex -refinery issued by IOC Norgen region New Delhi.	
2		All india average consumer price index for industrial worker(base 1982=100)as published by a labour bureau, Govt. of india and circulated by IEEMA.	
3		Index No. of whole sell price in india for iron and steel as published by reserve bank of india bulletin	

S.N.	Equipments	Material	Indices values
4		Index No. of whole sell price in india for non metallic mineral products (Structural clay product) as published by RBI.	
5		Index of Cement	
6		Index of Diesel	