Chhattisgarh State Electricity Regulatory Commission
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Suo Motu Petition No. 39/2006(M)

In the matter of determination of parallel operation charges

Urla Industries Association — Respondents
M/s Bharat Aluminium Company Ltd
M/s Jayaswals Neco Ltd
M/s Bajrang Power & Ispat Ltd
Chhattisgarh State Electricity Board

Present: S.K. Misra, Chairman
B.K. Sharma, Member

ORDER
(Passed on 31.12.2008)

INTRODUCTION AND BACKGROUND:

This suo motu petition was taken up by this Commission for determination of parallel operation charges (POC) for captive power plants (CPPs) operating in parallel with the State grid. Parallel operation is an activity where one electrical system operates with connectivity to another system in similar operating conditions. In this process the power system operates in tandem with all the connected generators for better operational efficiency and ease of the generators. Chhattisgarh has a large number of CPPs (more than 40) and most of the plants operate in parallel with the grid of the Chhattisgarh State Electricity Board (CSEB, for short). However, the captive generating stations can also run their plant in islanding mode without any connectivity with the grid. The CPPs are required to pay parallel operation charges to the CSEB because of the benefits they derive from their parallel operation with the grid. In the very first tariff order for the year 2005-06, passed on 15.06.2005 in petition No. 5 of 2005, this Commission had fixed parallel operation charges at Rs. 16 per KVA on the installed capacity of the CPPs, in place of the Board's proposal to fix the rate at 7.5% of the demand charges on the installed capacity of the CPP. No appeal was filed against this order of the Commission. However, while considering the matter regarding power purchase and relative dispensation in respect of captive generating plants in the State, the Commission modified this rate and reduced it to Rs.10 in its order dated 6.2.2006, passed in petition No. 17 of 2005(M) (hereinafter referred to as 'CPP order'). Thus the parallel operation charges were reduced to 60% of their prevailing rate (Rs. 10 from Rs. 16 per KVA per month), keeping in view the objections of the CPPs to the rate fixed in the tariff order aforementioned. This was done on an adhoc basis till the rate was reviewed and revised, if necessary, in the next tariff order, on the basis of a realistic study. The Urla Industries Association, which was the petitioner in petition No. 17 of 2005 aforementioned, preferred an appeal before the Hon'ble Appellate Tribunal for Electricity (ATE) against the Commission's above CPP order dated

6.2.2006. The Hon'ble ATE agreed with the justification for levy of parallel operation charges in their judgement of 12th September, 2006, passed in appeal No. 19 of 2006. In para 12 and 18 of their judgement the Hon'ble ATE observed as under:-

"12. The contention that no charges at all is payable for parallel operation or transmission system can not be sustained and such a claim is contrary to factual position. There is no escape of CPP to pay charges for parallel operation by which the CPP gains while the transmission system of the second respondent CSEB is affected apart from the admitted fact the transmission grid is strengthened by the power injected by CPP……."

"18. However, we make it clear that in the tariff petition which is pending consideration, the Commission may fix the charges for parallel operation on the basis of the data, materials and scientific inputs relating to parallel operation charges already placed by the parties or that may be placed by the parties before the conclusion of hearing and such exercise shall be carried out by the first respondent Regulatory Commission independently and without in any manner being influenced by this judgment."

By the time this judgement was received by the Commission, the tariff order for the year 2006-07 was already passed by the Commission on the 13th September, 2006. Although in their tariff petition for the year 2006-07, the Board had proposed Rs. 20 per KVA per month as parallel operation charges, the Commission did not take any decision on the charges proposed, in its tariff order aforementioned passed on 13.9.2006 in petition No. 24 of 2006 (T), as the case was under consideration of the Hon'ble ATE. However, as already mentioned, the parallel operation charges were already reduced to Rs. 10 per KVA and this rate was maintained.

02. In view of the observations of the Hon'ble ATE the Commission took up the task of determination of parallel operation charges and registered this suo motu petition. Notice was issued to CSEB for submission of proposal in the light of the Hon'ble ATE's judgement. M/s Bharat Aluminium Company Limited (BALCO), M/s Bajrang Power & Ispat Limited, M/s Jayaswals Neco Limited along with Urla Industries Association were made co-respondents in this case as they were parties to petition No. 17 of 2005(M) aforementioned, in which parallel operation charges were fixed by this Commission. In course of hearing of the present case the Commission realized that while the benefits to the CPPs from parallel operation with the grid could be found out through a technical study, quantification in financial terms of charges to be levied on the CPPs for the same, involved a highly technical exercise. The nature of parallel operation charges is not to be confused with demand charges. Demand charges are levied for the demand of electricity supply contracted from the utility; it can also be levied from those CPPs who have opted for availing some power (such as start-up power from the utility). The CPPs opted for parallel operation to seek safety, security and reliability of operation with the support of a much larger and stable system as afforded by the grid. The grid has to make investment so that a number of CPPs may operate in parallel with it. It may be mentioned here that the installed capacity of captive generating plants in the State is almost as much as the plants of CSEB. As a CPP opted for parallel operation, it lays its claim on a part of the infrastructure of the power system. As already mentioned, enumerating techno-financial co-relation of this service requires detailed system study. During the course of hearing, Urla Industries Association and M/s Jayaswals

Neco Limited pleaded that it would be necessary to go in for a detailed technical study. The Commission also felt that a detailed technical study was required, as the various inputs received from the parties, although valuable, did not help the Commission in quantifying charges for parallel operation. Therefore, the Commission decided on 11.7.2007 to seek the assistance of a technical consultant to study the various system data and system parameters of some representative CPPs in the State, and suggest what should be the rate of parallel operation charges. In the light of this decision, the Commission called for enquiries and assigned the task to M/s Electrical Research & Development Association (ERDA), Vadodara, an eminent research and testing organization in the field of power accredited by the Government of India.

03. TECHNICAL STUDY:

ERDA conducted tests and took several measurements on ten selected captive power plants (CPPs) in the state as part of the techno-economic study covering CPPs of almost all types of load. ERDA carried out the study as per the following scope of work:

(a) Critical analysis of various data and technical details of CSEB's generation, distribution and transmission system and of captive power plants in the State.

(b) Detailed studies for 10 sample industries, which draw power from their CPPs. The industries were so selected that they represented almost all types of loads of CPPs:

Sr. No.	Type of industry	Total No. of industrial units in the State having CPPs	Units to be selected for study
1.	Sponge iron	13	2
2.	Arc furnace	4	2
3.	Aluminum	1	1
4.	Ferro-alloy	5	2
5.	Rolling mill	1	1
6.	Cement	8	2
	Total	**32**	**10**

The following studies were to be carried out in these industries:

(i) Study of load cycle of each type of industry.

(ii) Study of generating plant's load factor for each type of industry

a. While running in isolation.

b. While running in parallel with licensee's supply system

(iii) Study of electrical parameters i.e. change in voltage, frequency, power factor, MVAr, MW loading for industries (having high intensity fluctuating loads) during incidence of high intensity peaking load.

(iv) Study of harmonics produced by industries having fluctuating and unbalanced loads.

(v) Study of voltage unbalance and negative phase sequence current and voltage during operation for each type of industries.

(vi) Study for requirement of installation of SVC and harmonics filters.

(c) Enumeration and quantification of benefits to CPPs and CSEB separately due to parallel operation of CPPs and the grid.

(d) Assessment of benefits and services accruing to CPP in financial terms for suggesting levy of parallel operation / grid support charges payable by CPPs.

04. METHODOLOGY FOR TECHNICAL STUDY:

The following captive power plants were selected by this Commission in consultation with CSEB for detailed study:

Sr. No.	Name of selected captive power plants	Total Installed Capacity of generators in MW	Total Installed Capacity of generators in MVA	Contract demand of CPP with CSEB in MVA
1	M/s BALCO, Korba	810	993.1	120
2	M/s Jindal Steel & Power Ltd., Raigarh	325.7	364.6	1
3	M/s Heera Ferro Alloys	20	25.0	1.8
4	M/s SKS Ispat & Power Ltd.	55	68.8	10
5	M/s Jaiswals Neco Ltd.	21.5	26.9	8
6	M/s Hindustan Electro Graphite Ltd.	14.3	16.0	2.75
7	M/s Century Cement	26	33.375	6
8	M/s Lafarge India Ltd., Bilaspur	43	57.8	3.125
9	M/s Lafarge India Ltd., Raipur	NA	0.0	16
10	M/s API Ispat Powertech Ltd.	15	10	2

It was decided to carry out measurements at the point of common coupling with

(a) Grid interconnection (parallel operating condition), i.e. CPP connected with the Board's grid and both connected to captive load.

(b) Without grid interconnection (islanding operating condition),

(i) Only the CPP supplying power to captive load and Utility's grid disconnected,

(ii) Only grid supplying power to captive load and CPP disconnected.

But ERDA faced difficulties in getting permission from the concerned CPPs for measurements in islanding mode as the CPPs expressed their inability to run captive generators in isolated mode. Hence, ERDA carried out the measurements at following two locations under grid interconnection-

(1) Point of common coupling,

(2) Generator output terminals.

ERDA carried out measurements for 24 hours period at the above two locations for the selected 10 CPPs. The technical report of the results of the measurements were submitted to the Commission. ERDA also collected required

data for power system studies from the transmission wing of CSEB for carrying out the study for load flow and for fault level calculations.

05. STUDY AND DISCUSSION PAPER:

The consultant after carrying out the study, submitted a report to the Commission, and prepared a discussion paper giving details of the methodology of study, observations made and proposed three alternative methods for calculation of parallel operation charges. This discussion paper was floated by the Commission in the public domain on 09.06.08 and copies were sent to the objectors of the petition as well to CSEB for obtaining their comments, if any, on the outcome of study and methods proposed for calculation of parallel operation charges. All the CPPs connected to the CSEB's grid were also intimated individually through a letter. The discussion paper was also up-loaded on the web-site of the Commission. Notice inviting objections / comments on the discussion paper was published in the three leading newspapers of the State i.e. Dainik Bhaskar, Raipur; The Hitavada, Raipur; and Navbharat, Bilaspur. The Commission also arranged a presentation by the consultant on 19.06.08, to help the objectors in understanding the methodology and the procedure of computation of the parallel operation charge and the study conducted by the consultant. The representatives of the following organizations / industries were present:-

1. M/s Jayaswals Neco Pvt. Ltd., Raipur.
2. M/s Jindal Steel and Power Ltd., Raigarh.
3. M/s SKS Ispat & Power Ltd.
4. Chhattisgarh State Electricity Board, Raipur
   The objections / comments were invited upto 30.06.2008.

06. Written objections / comments were received from the following stakeholders:

(a) Urla Industries Association, Raipur

(b) M/s Bhilai Steel Plant, Bhilai

(c) M/s Jindal Steel and Power Limited, Raigarh

(d) M/s Sarda Energy and Minerals Limited, Raipur

(e) M/s Jayaswals Neco Pvt. Ltd., Raipur

(f) M/s Vandana Vidhyut Limited, Raipur

(g) M/s Monnet Ispat & Energy Ltd., Mandir Hasaud, Raipur

(h) CSEB.

To hear the objectors in person, a public hearing was organized on 08.07.2008 in the Commission's office. Urla Industries Association, M/s Sarda Energy & Minerals Ltd. and M/s Jayaswals Neco Ltd. requested for another date for hearing due to their other engagements. They were separately heard on 30.07.2008. The study report of the consultant was made available for perusal of stakeholders in the office of the Commission.

During public hearings on 08.07.2008 and 30.07.2008, some of the CPPs raised the issue that the study was not carried out with CPP generators in isolation mode and hence was incomplete. It was informed by the consultant that the tests under isolation mode could not be done due to the selected CPPs' reluctance for tests in isolation mode. Urla Industries Association and some CPPs requested that the measurements with CPP generators in isolation mode may also be carried out, for which they agreed to give full cooperation.

07. STUDY PART-II:

In order to make the study more useful for the purpose of quantification of POC, the Commission decided that ERDA should carry out measurements in isolation mode also in only 4 CPPs out of 10 selected for study. Accordingly, ERDA carried out the measurements at following four CPPs:-

1. M/s Heera Ferro Alloys,
2. M/s Century Cement
3. M/s API Ispat & Powertech Ltd.
4. M/s Jayaswals Neco Ltd.

The measurements of various electrical parameters were taken under the following conditions:

(a) Grid isolated from load and generator; measure V_{thd} of the grid at point of common coupling.

(b) Grid and generator both feeding the load in parallel; measure all power system parameters simultaneously at the point of common coupling and at generator terminal.

(c) Generator isolated and grid feeding the load; repeat all above measurements at the point of common coupling.

(d) Grid isolated and generator feeding the load; measure all power system parameters at generator terminals.

08. ERDA'S REPORT, SECOND DISCUSSION PAPER AND COMMENTS:

ERDA submitted its report on the measurements carried out in the second part of the study and based on this, a second discussion paper was floated on 03.12.2008 by the Commission. This was sent to all the CPPs in State, Urla Industries Association and the CSEB for offering comments up to 20.12.2008. It was up-loaded on the web-site of the Commission. The Commission had also included the detailed calculation sheet of parallel operation charge for 10 sample industries. ERDA had worked out average parallel operation charge of Rs. 21.11 per KVA per month by the Base MVA method, as discussed later in para 11 infra. As proposed by the ERDA, effective charge on individual CPP was suggested as – Average rate of POC in Rs. per KVA per month x (Installed capacity of CPP in KVA – Contracted demand taken by CPP in KVA – Contracted export power by CPP to utility in KVA). Based on the whole study, ERDA in its report has come to the following conclusions:-

(1) The voltage THD (Total harmonic distortion) of CSEB grid is measured at point of common coupling in isolation mode. The voltage THD of CSEB grid is within the limit as per CBIP 251.

(2) The current THD at point of common couplings are high compared to permissible limit (IEEE 519).

(3) Percent negative phase sequence current at point of common couplings are much higher than the percent negative phase sequence current at generator output terminal.

(4) The magnitude of power factor at PCC are much less but the variation in power factor at PCC are high compared to at generator terminal.

(5) CPP generator operates at constant power mode when running in parallel with grid. Utility's grid takes care for the variation in the load demand of the CPP load.

(6) During the part –II measurements, the plant load factor has been measured both in parallel mode as well as in isolation mode. It is observed that the plant load factor of captive generator is improved when it operates in parallel with CSEB grid compared to when it operates without grid support.

(7) It was observed that the industries of a CPP draw starting power demand as also excess demand on account of its fluctuating load, beyond the contract demand, from the CSEB grid.

ERDA has further reported that the study carried out in the first and second part has not shown any difference in the pattern of various electrical parameters and concluded that CPPs in parallel with the grid take advantages listed elsewhere in this order.

09. OBJECTIONS AND SUGGESTIONS:

9.1 The following stakeholders have submitted comments on the first and second discussion papers:-

1. Urla Industries Association, Raipur
2. M/s Jindal Steel and Power Ltd., Raigarh (JSPL)
3. M/s Bharat Aluminium Co. Ltd., Korba (BALCO)
4. M/s ACC Ltd., Jamul
5. M/s Sarda Energy and Minerals Ltd., Raipur (SEML)
6. M/s Ultratech Cement Ltd., Hirmi
7. M/s Grasim Cement, Rawan
8. M/s Century Cement, Baikunth
9. Chhattisgarh State Electricity Board (CSEB)

9.2 The main objections / suggestions given and the Commission's comments thereon are given below:

(i) Most of the objectors have stated that no doubt their power plants take support of the grid, but they also support the grid. They get support from grid

for starting the large drives and for sustained running of their captive generators.

The studies conducted by the ERDA also shows the spikes on graph on account of heavy fluctuations on load and for starting of large motors, etc. This clearly indicates that the grid absorbs all short time peak demands and help in the captive generators not tripping.

(ii) Cement and aluminium industries have stated that their loads are generally of balanced type and hence there is no question of generation of negative phase sequence current.

The study was carried out for all types of industries. For the sample cement industry, the maximum and minimum percent negative phase sequence current recorded was 177.42% and 2.62% at the point of common coupling, which were much higher than at generator terminals. It indicates the support drawn by the CPP from the grid. Similar were the observations in measurements carried out at BALCO, although the difference between maximum and minimum negative phase sequence current was smaller.

(iii) JSPL and BALCO stated that their higher capacity generators support the grid.

As already stated, the CPPs also aid by way of feeding excess generation into the grid. This aspect has already been taken into consideration. The fault level contribution, and thus support, of grid is much higher as compared to that of a captive generator to the grid.

(iv) BALCO stated that the study was made on 132 KV system, but conditions are different on 220 KV system and also that they have installed harmonic filters in their plant.

As far as the study is concerned, there is no difference between 220 KV and 132 KV system. BALCO was included in the study and ERDA measured electrical parameters on 220 KV system. If BALCO has installed harmonic filter, the life of their generator and associated equipments shall enhance. However, the current THD at the point of common coupling in case of BALCO was measured above permitted values, indicating the support drawn from the grid.

(v) The generators also have capacity to absorb the reactive power. In case the reactive power consumption is recorded, the industry pays penalty on this account to the Board.

Every generator including that of the utility, has specified capacity of absorption of reactive power. The additional reactive power in an industry beyond the absorption capacity of captive generator when thrown onto the grid increases the line losses and affects the performance of a utility's generator and equipments. The grid also absorbs the instantaneous reactive power drawan by fluctuating captive load, which can not be recorded by the meter.

(vi) ACC has asserted that they had maintained good Plant Load Factor (PLF) even while running the generators in isolation mode.

The particular case of ACC can not be commented upon as this was not studied by ERDA and is a case of the past. The study carried out by ERDA clearly indicates improvement in PLF when captive generators get connected to grid because by parallel operation the CPP are able to operate at constant power mode of operation while the grid takes care for the fluctuations of the load. This results in additional unit generation by a captive plant and additional revenue earning. Some of the industries have infact agreed that the PLF of their generator increases when connected to grid.

(vii) Urla Industries Association and some others have stated that the Board has not created separate infrastructure for providing facility of parallel operation to CPPs. Secondly, the CPP pays to the Board the demand charges for the contracted demand. (CD)

When the CPP gets connected to the system of utility, it uses utility's infrastructure and all other facilities by way of technical aid and pollutions, disturbances and shocks of captive load of CPP is absorbed by the grid, while the CPP pays only for his contract demand with the utility and not for the disadvantages on account of captive load to the grid.

(viii) Fault level contributed by CPPs collectively in the State, is more than that of CSEB. Based on this, Urla Industries Association pleaded that the Board should pay charges to CPPs.

The fault level is considered at different locations in the grid at the point of inter-connection with CPP. Consideration of total collective capacity of the CPPs is not correct. Fault level contribution of each individual CPP is much less than the fault level of the grid. The method of calculation by the Urla Industries Association by considering collective capacity of CPPs is not correct.

(ix) Some of the objectors including JSPL informed that they have been using SVC, harmonic filters, capacitors, etc. to take care of the harmonic and reactive power. Therefore, they should not additionally pay POC.

The study carried out by the ERDA is for all types of industries as selected by the Commission. The use of above devices shall improve the performance of industry and may assist in reduction of their energy bill, if the supply is contracted with the utility. The industry using such devices gets benefits / in terms of better operation and enhancing life of their equipments.

(x) Excess power demand from the grid is valid at times, but for that penal charges are payable. POC is an additional charge.

The concept of parallel operation charges and penal charges for excess demand are different. The study shows that peaks and spikes recorded during the study for very short time do not get registered in the meters and hence not always billed.

(xi) The report only speaks of the advantages to CPPs for parallel operation with the grid. It has ignored the practical aspects like plant outages due to grid faults, especially in the monsoon season. Variation in frequency and voltage in the grid also affects the generating plants.

The report has listed advantages and disadvantages to both the CPP and the utility. The plant and line outages due to bad weather are inevitable in an

electrical system. The running of captive generators 24 hours for all the 365 days continuously is also not practical. The Commission has set standards of operation and has been stressing hard for improvement in quality of supply.

(xii) The advantages to utility from CPPs such as, reduction in losses due to decentralized generation by CPPs connected to grid, availability of surplus stand-by power to the Board, contribution in bridging the gap between supply and demand, etc. have not been considered in commercial terms.

The Commission has considered the advantage offered by the CPPs by feeding power to the grid and therefore has reduced the power exported to the utility and contract demand of captive load with the grid from the total capacity of CPP for calculation of amount of effective parallel operation charges.

(xiii) 'No load losses' (iron loss) of transformers should not be added to the parallel operation charges based on the capacity of captive generators.

The transformer capacity required to be created is equivalent to the power handled in the system for 'step up' as well as 'step down' transformation. Hence 'no load losses' are inevitable in the system.

9.3 Suggestions of CSEB:

CSEB has stated that the study carried out by the ERDA, has only confirmed its plea that on account of parallel operation with the Board's grid, the CPP is able to enhance its PLF. Because of this enhanced generation, the CPP is able to supply power to the Board and others resulting in substantial financial benefit. The Board's grid bears the electrical pollutants like harmonics, reactive power, negative phase sequence current, etc. and the grid supports the CPP's system by way of offering much higher fault level and stability, which is further financial gain to the CPP, and prevents failure of equipments and also enhances their life. Currents for very high magnitude are drawn by CPP industries which can not be measured by meters and they inject other pollutants which reduce the life of Board's equipments. The Base MVA support method for evaluation of parallel operation charges also does not represent the complete evaluation for all the pollutants catered by the grid. Since the entire captive generating plant on bus bar is benefited, the parallel operation charges should be leviable on the entire generation capacity of CPP.

The Base MVA method as recommended by ERDA is more acceptable and correct method as compared to the other two methods stated in the report. Since the load is the element which pollute and create disturbances in the grid, only that portion of the captive load which pollutes and also avails the benefit from the grid for which it is not the Board's consumer, is considered liable for payment of parallel operation charges.

9.4 It may be mentioned that none of the CPPs had requested the Commission to permit inspection of the reports submitted by ERDA. It is also to be noted that none of the objectors had commented on the Base MVA Support method proposed to be adopted by the Commission for evaluation of parallel operation charges except Bhilai Steel Plant which considers this method as

logical. Similarly, on the quantum of the charges conveyed through second discussion paper, floated on 03.12.08 there was no comment. ERDA has worked out the average parallel operation charges of Rs. 21.11 per KVA per month.

10. ADVANTAGES AND DISADVANTAGES OF PARALLEL OPERATION:

In its report ERDA has enumerated following advantages and disadvantages to the CPP as well as utility:

10.1 Advantages to CPPs:

(1) The fluctuations in the load is absorbed by the utility grid in the parallel operation mode. This will reduce the stresses on the captive generator and equipments. The bulk consumer can operate his generating units at constant power generation mode irrespective of his load cycle.

(2) Fluctuating loads of the industries connected in parallel with the grid inject harmonics into the grid. The current harmonics absorbed by the utility grid is much more than that by CPP generator. These harmonics flowing in the grid system are harmful to the equipments and are also responsible for polluting the power quality of the system.

(3) Negative phase sequence current is generated by unbalance loads. The magnitude of negative phase sequence current is much higher at the point of common coupling than at generator output terminal. This unbalance current normally creates problem of overheating of the generators and other equipments of CPP, if not running in parallel with grid. When they are connected to the grid, the negative phase sequence current flows into the grid and reduces stress on the captive generator.

(4) Captive power plants have higher fault level support when they are running in parallel with the grid supply. Because of the higher fault level, the voltage drop at load terminal is less when connected with the grid.

(5) On account of increase in plant load factor of captive generator, additional revenues can be generated by the CPPs by sale of surplus power to the utility.

(6) In addition to the above, CPPs enjoy the following advantages also:

   (i) In case of fault in a CPP generating unit or other equipment, bulk consumers can draw the required power from the grid and can save their production loss.

   (ii) The grid provides stability to the plant to start heavy loads like HT motors.

   (iii) The variation in the voltage and frequency at the time of starting large motors and heavy loads, is minimized in the industry, as the grid supply acts as an infinite bus. The active and reactive power demand due to sudden and fluctuating load is not recorded in the meter.

   (iv) The impact created by sudden load throw off and consequent tripping of CPP generator on over speeding is avoided with the grid taking care of the impact.

(v) The transient surges reduce the life of equipment of the CPP. In some cases, the equipment fails if transient is beyond a limit. If the system is connected to the grid, it absorbs the transient load. Hence, grid enhances the life of CPP equipments.

In short, the gains to the CPPs is quite substantial in case there is grid support.

10.2 Disadvantage of Parallel Operation to CPPs:

(1) The CPP-holder is required to pay for minimum contract demand even if connection is floating to take care of emergency.

(2) The CPP-holder is required to install higher rating switchgear depending on grid fault level.

10.3 Advantages of Parallel Operation to Utility:

(1) The power generated by captive power plants partially bridges the gap between demand and supply because there is a gap between generation and demand in most of the States in the country.

(2) Fault level of both the grid and CPP improves due to parallel operation of captive power plant connected with the grid. However, the fault level contribution by CPP unit is much less as compared to the contribution of grid.

(3) Normally, the CPP takes power from the grid at very low load factor with respect to its contract demand, which results in high diversity. The demand charge is recovered from the consumers irrespective of diversity and also results in lower per MVA investment cost. Due to higher diversity, the utility is required to have surplus stand-by power which can be used as spinning reserve.

(4) Addition of generation capacity at centralized station may not be the most economical solution to the power sector utilities. Decentralized generation capacities of other generators like CPPs at different locations results in lesser T & D loss and is a better solution.

(5) The service lines are lightly loaded due less power flow to the CPPs. The capacity of service line is very much higher than the contract demand. Hence, it reduces the line losses to some extent.

10.4 Disadvantage of Parallel Operation to Utility:

(1) Load fluctuations of captive consumer are passed on to the utility's system thereby the efficiency of utility's system may be affected, which may also impact on utility's other consumers.

(2) In case of an ungrounded (or grounded through resistance) system supply, fault on interconnecting line (consumer's side) results in interruption of system. For single phase to ground fault which are 80 to 85% of the short circuit fault level, the grounding of the system is achieved through the neutral or step down transformer of the utility, when the generator runs in parallel with the utility's grid. This supply is likely to cause damage to the terminal equipments at utility's sub-stations and line insulators, as voltage on the other two healthy phases rise beyond the limit, under such conditions.

(3) The utility has to sustain the impact of highly fluctuating peak loads like that of arc furnace, rolling mill, etc. for which it does not get any return on the capital invested to create system reserve.

(4) The variation in reactive power requirement increases the system losses and lowering of the voltage profile. Utility has to bear the cost of such effects.

(5) The lower voltage profile and fluctuations affect the service to the neighboring consumers due to deterioration in quality of supply, thus resulting in revenue loss to the utility.

(6) Non-recording of high fluctuating / sudden active and reactive demand by the meter results in financial losses. .

11. METHODS OF EVALUATION OF POC:

11.1 The technical study which is perhaps the first of its kind in the country, by an eminent research organization in the field, has only confirmed that CPPs do derive substantial benefit from operating in parallel with the grid. In fact, the advantages of parallel operation with the grid, which accrue to the CPPs and the disadvantages to the utility together far outweigh the small advantages that the CPPs may offer to the utility and the disadvantages which might accrue to them from the grid. Thus the study has gone only to confirm the observations of the Hon'ble ATE in their judgement aforementioned. However, establishing a co-relationship between the advantages of parallel operation with the grid to the CPPs, in financial terms, is a difficult task. No direct nexus as such between the two in financial terms is practically possible with some degree of exactness. However, ERDA has evaluated and suggested three methods for possible quantification of parallel operation charges in financial terms and has recommended one method as the most appropriate. ERDA has suggested the following three alternative methods for working out the parallel operation charges:

(a) BASE MVA SUPPORT

(b) POWER QUALITY PARAMETERS

(c) INTERCONNECTING TRANSFORMERS OF THE CPP

11.2 **Base MVA Support Method**: - In this method, base MVA support is calculated on the basis of fault level. The CPP in parallel gets fault level support from the grid and also provides fault level support to the grid to a smaller extent depending on its generation capacity. Since grid has much higher fault level, it provides much higher support to the CPP. The parallel operation charges are calculated considering the base MVA support provided by the utility to the CPP, base MVA support provided by the CPP to the utility grid and 'no load losses' of power transformers in financial terms. For finding out the average POC, the parameters of all the 10 selected CPPs have been proposed to be considered. For calculation of the quantum of parallel operation charges to be levied on an individual CPP, due weightage has been proposed in respect of contract demand with the utility and also the contracted sale of power to the utility in order to consider effect of support of CPPs to the grid.

11.3 Power Quality Parameters Method: This method assumes percent distortion based on type of load as either 10% or 25%. Industrial load can have distortion varying from CPP to CPP, both in terms of quality and quantity. Power quality parameters method considers the lumpsum charges as 10% and 25% depending on the quantum of pollution. Variation from CPP to CPP feeding similar type of load may be high in this method. Also the quantum of pollution may vary from time to time depending on the fluctuation of loads. This method does not take into account the advantage gained by the grid due to parallel operation.

11.4 Interconnecting transformer method: In this method, uniform applicability of parallel operation charges on all the CPPs connected to the grid can not be adopted as the highest capacity motor of individual CPPs and its impact in terms of voltage dip, special torque requirement, frequency dip will be altogether different and also it will not be judiciously applicable on all CPP consumers. Also, like power quality method, this method does not take into account the advantages gained by the grid due to parallel operation, unlike the Base MVA method.

11.5 Advantages of Base MVA Support Method:

Considering the strength and weakness of the various methods enumerated above ERDA has recommended the Base MVA support method based on following advantages:-

(i) This method takes into consideration the Base MVA support taken from the grid by a CPP as well as Base MVA support given to the grid by it. This method considers the advantages of parallel operation to both the captive power plant and to the utility. Thus, this method does justice technically to both the utility as well as CPP.

(ii) This method is based on the fault level support available at point of common coupling i.e. the point at which the CPP is connected with the grid. Basically the fault level has the significance of service provided by utility to captive power plants in terms of voltage regulation, stability, reliability and absorbing the load variation / fluctuation, etc. Most of the ancillary services are thus provided by the utility to the CPP through better fault level.

(iii) Due to higher fault level of the grid at the point of common coupling, the flow of pollutants like harmonics, negative phase sequence current, etc. are absorbed by the grid due to low impedance path of the grid as compared to that of CPP generator.

(iv) As the fault level of grid is higher, it results in better voltage regulation to CPP load.

(v) Stability of a system is defined as $P = E \times V \sin \delta / X$. Lower the X-impedance, higher will be the stability. Since grid is more stable, it provides stability to CPP.

12. RATE OF PARALLEL OPERATION CHARGES:

ERDA has given the detailed procedure of calculation of parallel operation charges through Base MVA Support Method in the first discussion paper. The transmission related fixed cost has been worked out as Rs. 27.33 per KVA per month (i.e. ratio of total transmission related cost and total generation capacity in KVA connected to grid). The fault level contributed by the grid to CPP and by CPP to grid (Installed capacity / transient reactance) is worked out. Total support required in financial terms to the CPP is worked out on the basis of minimum support required multiplied by the above charges. In the net base MVA support in financial terms, the 'no load loss' of power transformers has been added, which works out to Rs. 0.74 per KVA per month.

$$\text{Rate of parallel operation charge (Rs. per KVA / month)} = \frac{\text{Charges for net support received by CPP in Rs.}}{\text{Installed capacity of CPP (KVA)}} + \text{No load charge (Rs. per KVA)}$$

This rate has been worked out for individual ten sample CPPs included in the study. Due weightage to the contracted demand of CPP with the utility and the contracted power for sale to CPP to the utility has been given in view of the advantages gained by the utility by way of support received from the CPP in to the grid.

Total POC for individual CPP = Rate of POC in Rs. per KVA per month X (Installed capacity of CPP in KVA – Contracted demand taken by CPP from utility in KVA – Contracted export power by CPP to utility in KVA)

The ERDA has worked out rate of parallel operation charges in Rs. per KVA per month for the CPPs included in the study and averaged this charge at Rs. 21.11 per KVA per month. The calculation sheet of working out of above average charge is given in the second discussion paper.

13. CONCLUSION AND ORDER OF THE COMMISSION:

In the light of the above discussion the Commission agrees with the recommendation of ERDA and comes to the conclusion that the rates of parallel operation charges should be as derived on the basis of Base MVA Support method i.e. Rs. 21 per KVA. However, instead of levy of parallel operation charges on the installed capacity of the CPP, as being done at present, we consider that the demand towards auxiliary consumption of CPP (which shall not be more than 10% of the capacity of the plant), contract demand of the CPP agreemented with the utility, the power supplied by the CPP to CSEB or sold inside/outside the State through open access, should be excluded from the installed capacity for the purpose of calculation of POC. It is because, parallel operation charges are not leviable on industrial consumers of the Board. The intra-State supply either to the Board or to any consumer under open access and inter-State transactions and demand of auxiliary consumption of CPP are not the captive load and parallel operation charges has to do with the captive load of the CPP (i.e. the load of the captive consumer) and not the total capacity of the captive power plant as such. This also takes care of the main objection of the CPPs, raised repeatedly before this Commission that the charges should not be levied on the basis of their installed capacity. Calculated on

the above basis, the rate of parallel operation charges determined in this order will vary from CPP to CPP depending on the above factors.

As far as this Commission is aware, this is the first time that such a technical study has been carried out regarding CPPs operating in parallel with the grid and the consequences thereof. ERDA has spared no effort to go into the matter in detail and conducted studies and measurements, not once but twice, so that the study is accurate to the extent possible. The Commission records its deep sense of appreciation of the efforts put in by the ERDA in this pioneering study. Their report and voluminous data generated by the study is now available in this Commission for the use of any power utility and any State Regulatory Commission in the country. Commission also acknowledges and appreciates the help and cooperation extended by the industries and CSEB carrying out this task.

The billing of parallel operation charges is ordered as above and it shall be effective from Ist January, 2009, and shall remain in effect till it is revised by the Commission.

Sd/- **Sd/-**
Member **Chairman**

True Copy

(N.K. Rupwani)
Secretary