CENTRAL ELECTRICITY REGULATORY COMMISSION

New Delhi

Coram

1. **Dr. Pramod Deo, Chairperson**
2. **Shri R. Krishnamoorthy, Member**
3. **Shri S.Jayaraman, Member**
4. **Shri V.S.Verma, Member**

Petition No. 66/2003

In the matter of

Free Governor mode of operation on all generating units installed at Ramagundam Super Thermal Power Station (Ramagundam STPS) of NTPC

And in the matter of

Southern Regional Load Despatch Centre, Bangalore …**Petitioner**

Vs.

Ramagundam STPS, NTPC Ltd, Ramagundam …**Respondent**

Petition No 4/2004

In the matter of

Exemption from participating in Free Governor mode of operation for the machines of different power stations of OHPC

And in the matter of

Orissa Hydro- power Corporation Ltd, Bhubaneswar ….**Petitioner**

Vs.

Eastern Regional Load Despatch Centre, Kolkata …**Respondent**

Petition No 12/2004

In the matter of

Exemption from participating in Free Governor mode of operation for NLC power stations.

And in the matter of

Neyveli Lignite Corporation Ltd, Chennai …**Petitioner**

Vs

1. Southern Regional Load Despatch Centre, Bangalore
2. Tamil Nadu Electricity Board, Chennai
3. Transmission Corporation of Andhra Pradesh, Hyderabad
4. Karnataka Power Transmission Corporation Ltd, Bangalore
5. Kerala State Electricity Board, Thiruvanthapuram
6. Pondichery Electricity Department, Poindichery
7. National Thermal Power Corporation Ltd, New Delhi …**Respondents**

Petition No 36/2004

In the matter of

Putting and continuing the free governor mode operation in the HTPS in the Korba (West) as per IEGC

And in the matter of

Hasdeo Thermal Power Station, CSEB Korba … **Petitioner**

Vs

1. Madhya Pradesh State Electricity Board, Jabalpur
2. Gujarat Electricity Board, Vadodara
3. Maharashtra State Electricity Board, Mumbai
4. TATA Power Co., Mumbai
5. BSES Ltd., Mumbai
6. National Thermal Power Corporation Ltd., New Delhi …**Respondents**

Petition No 93/2004

In the matter of

Exemption of certain power stations of NEEEPCO from participating free governor mode of operation.

And in the matter of

North Eastern Electric Corporation Ltd, Shillong …**Petitioner**

Vs.

North Eastern Regional Load Despatch Centre, Shillong
North Eastern Regional Electricity Board, Shillong …**Respondents**

The following were present

1. Shri. S. K Soonee, NLDC
2. Shri. R.K. Bansal, NLDC
3. Shri. S.S. Barpanda, NLDC
4. Shri. S.C. Saxena, NLDC
5. Ms. Minaxi Garg, PGCIL
6. Shri S.R. Narasimhan, NRLDC
7. Shri V.K Agrawal, NRLDC
8. Shri Sanjay Srivastava, CEA
9. Dr. L Hari, ERLDC
10. Shri S. Banerjee, ERLDC
11. Shri. C.S Srinivas, NTPC
12. Shri. K Selvaraju, NTPC
13. Shri. A.N. Sar, NTPC
14. Shri Murali Krishna, NTPC
15. Shri, V.K. Padha, NTPC
16. Shri A.R. Juneja, NTPC
17. Shri A Basu Roy, NTPC
18. Shri. S.K. Aggarwal, NTPC
19. Shri J Padha, OHPC
20. Shri. S.S. Bhai, OHPC
21. Shri R. Suresh, NLC
22. Shri P.K Borah, NEEPCO
23. Shri B Goswami, NEEPCO
24. Ms. Debjani Dey, NEEPCO
25. Shri. N. S. Namasivayam, TNEB
26. Shri Palanirajan, TNEB

ORDER
(**Date of Hearing 28.4.2009)**

In Petition No. 66/2003, the petitioner, Southern Regional Load Despatch Centre (SRLDC) had submitted that the respondent had failed to comply with the provisions of Indian Electricity Grid Code (IEGC), in particular, Clauses 1.6, 4.8 (c) and 4.8(d), 6.2(e) and 6.2(f) as also the Commission's order dated 30.10.1999 in Petition No.1/1999, so far as the operation of the generating units at Ramagundam STPS in Free Governor Mode was concerned. Accordingly, it had made the following prayers in the petition:

(a) To direct the respondent to faithfully follow the provisions of IEGC [(Clause 1.6, 4.8(c), 4.8(d), 6.2(e) & 6.2(f)] and relevant orders of the Commission

(b) To direct the respondent to put the Generating Units at Ramagundam Super Thermal Power Station in Free Governor Mode of Operation.

(c) To disallow a component of fixed charges as a deterrent for not participating in Free Governor Mode of Operation.

(d) To pass such further order or orders as may be deemed proper in the circumstances of the case.

2. The Commission in its order dated 30.10.1999 in Petition No.1/1999 on the draft of the IEGC submitted by the Central Transmission Utility (CTU) had directed as follows:

> ***"5.13*** *The question of operating each generating unit with turbine speed governor was considered by us with the support of our technical experts. A number of suggestions have been made by various respondents like (a) free governor shall be "normally in operation" in place of "always in operation"; (b) it may not be possible in existing units; (c) special treatment to nuclear units; and (d) exclusion of units embedded in the intra-State transmission system.* ***We are convinced that provision for free governor action in generating units is desirable for overall grid control.*** *Though frequency control in the present conditions of the power system operation may not be possible with governor action alone and other means like load shedding, manual intervention etc. may also be necessary, yet the necessity of invoking the free governor action cannot be undermined. We also understand that governor is always an integral part of the turbine supplied to the generating unit. The problem really is that these governors have not been put to use by generating units. It is also understood that the problem of such discontinuation of use will be more pronounced in turbines of older vintage. Hence, activating existing governors in turbines of older vintage is a task for which suitable time may have to be allowed. We also understand that there should be no difficulty in activating the governor function on units of recent vintage. It is understood from CEA's publication of compendium of power generation plants - July 99 that the plants which are 200 MW size and above constitute about 46% of the total installed capacity. Most of these units have been installed in 1980s and later and shall have no problem in activating governors for frequency control.* ***Accordingly we direct that to begin with the stipulation regarding free governor shall apply to thermal units with a capacity of 200 MW and above, with immediate effect. This condition will also apply to all reservoirs based hydro stations. For N.E. region, this condition will apply to units of 10 MW capacities and above. Keeping in view the time required to activate free governors, CTU may separately announce the time limit by which all other units should put free governors in action.***

We also grant liberty to any particular unit to approach the Commission to get exempted from the provisions regarding free governor for valid reasons. As regards the plea of Nuclear Power Corporation to provide a separate dispensation in view of safety considerations and special characteristics of Nuclear Plants, we have considered the matter and it is appropriate that Nuclear Units be permitted to continue operating in `turbine follow reactor' mode. Since Nuclear capacity is small compared to regional capacity, such special dispensation will not make any significant difference. ***CTU is directed to accordingly modify clause 4.8.c so that (a) thermal generating units of 200 MW and above (10 MW and above for N.E. region) and reservoir based hydro stations need only to be covered by this clause immediately; (b) for all other units CTU may separately announce time limits for putting free governor in action. As regards suggestion of substituting the words "always in operation" by the words "normally in operation", keeping in view the purpose of this provision and to get the advantage of governor action for frequency control, the words `always' is more appropriate than the words `normally in operation.'***

5.14 *Clause 4.8 (d) stipulates that each generating unit must be capable of instantaneously increasing the output by 5% for a minimum of 5 minutes when the frequency falls and when operating at any loading up to 105 % MCR, limiting to 105 % MCR. NLC has suggested that the words `whenever possible' be included in this clause. We consider that there is no need for change, as any constraints in delivering full output may be mentioned by the generator during operation. As regards separate treatment for nuclear power stations in this connection, the contention of Nuclear Power Corporation was considered. According to it since the Nuclear Power Stations are basically base load stations, due to complexity of nuclear fuel plant design, instantaneous increase of output by 5 % for a minimum of 5 minutes will not be possible. It may adversely affect the performance of nuclear fuel and reactor components due to undesired transients. Keeping in view the special characteristics of nuclear plants, we accept the suggestion of Nuclear Power Corporation. Accordingly, CTU shall modify clause 4.8(d) to provide for exception to nuclear plants.*

6.6 *Considerable discussion took place on Clause 6.2(g) which stipulates that all generating units operating at/up to 100 % of their MCR shall normally be capable of (and shall not in any way be prevented from), instantaneously picking up 5 % extra load for at least 5 minutes or within manufacturer's technical limits when frequency falls due to a system contingency. Those units operating above 100 % shall also be capable as above when frequency falls suddenly. Any Unit not complying with the above shall operate only after obtaining the permission of RLDC. GRIDCO suggested exclusion of IPPs embedded in the intra State system from this stipulation. MPEB suggested the deletion of `permission of RLDC'. NHPC has stated that this should be subject to design limitations of the generator/constituent. TNEB has stated that this is possible only after the implementation of availability tariff. WBSEB has stated that compliance of this stipulation shall depend on the capability of the Units. We have considered all the views in this connection. We observe that this*

clause has already been cautiously worded to stipulate that the Units operating upto 100 % shall normally be capable of picking up 5 % extra load; whereas, units operating above 100 % shall be capable of going at least up to 105 %. Secondly, for the extra load in case of first category of units, there is a further limitation of manufacturers' technical limits. Hence, given the operational flexibility, in the interest of better grid operations, the above minimum requirements have to be met. We however are inclined to consider the plea of NPC for exemption in view of the safety requirements for such stations. The above observations also apply to clause 6.2(h) as well which deals with the rate for changing the governor setting. The exemption from these clauses shall apply to Nuclear Units and the proposal of NPC for adoption of turbine follow reactor mode is accepted. The clauses shall be amended accordingly."

3. Subsequently, the Commission vide its order dated 21.12.1999 in Review Petition on order dated 30.10.1999 in Petition No.1/1999 had directed as follows:

"The Commission, vide its order dated October 30, 1999 has directed that the IEGC shall come into force w.e.f. 1.1.2000. The Commission has also directed constitution of a review panel to study the working of the IEGC and make appropriate recommendations for updating the IEGC. In accordance with the directions of the Commission, the CTU is to submit the reviewed code to the Commission by 1.5.2000. It is in this context that the CTU has sought the extension of time upto May, 2000 for compliance of directions contained in paras 5.7 (preparation of agreement and its approval by the Commission), 5.13 (provisions for putting free governors in action), 6.12 (incorporating appropriate clause to ensure compliance with operating procedures), 7.7 (incorporation of details of metering scheme, etc.) and 7.17 (revised provisions regarding operation of pool account and VAR charges). ***The Commission on careful consideration of the matter allows extension of time up to May 2000 or the date when the Commercial Mechanism i.e. the ABT system will be made effective whichever is earlier.*** *It is directed that while submitting the reviewed code in compliance with the directions contained in para 8.7 of the order dated 30.10.1999, the CTU shall also report compliance with the directions contained in above referred paras, for which the extension of time has been sought and has been allowed by the Commission.*

4. As regards the prayers made by SRLDC, the Commission in its order dated 21.5.2004 held as follows:

"9. When we heard the matter on 13.4.2004, Shri Chandan Roy, Director (Operations), NTPC gave an undertaking on behalf of NTPC that the directions of the Commission and the provisions of IEGC would be strictly complied with and that in future all its machines would be kept on FGMO. The respondent shall be bound by the undertaking given. ***In view of this undertaking, no further directions on prayers extracted at para 1 (a) and***

(b) are called for. On the question of levy of penalty for the past non-compliance of the provisions of IEGC, we note that the Commission will be observing for some more time the conduct of the respondent in view of the undertaking given on its behalf in the matter. *A serious view will be taken in case of any default in compliance of the undertaking given.*

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18. The main commercial concerns of the generators with regard to FGMO have been adequately addressed in the terms and conditions of tariff notified by the Commission on 26.3.2004, applicable from 1.4.2004. Now only a few technical problems need to be taken care of. We consider the technical aspects of the problems projected by the respondent need to be studied by CEA, as a technical expert. The respondent is, therefore, directed to approach CEA with all the necessary technical details and the problems faced and render all necessary assistance to CEA for an in depth study. CEA may submit its report to the Commission latest by 15.8.2004. ***However, in the meantime, the existing system of FGMO shall continue to be followed and the respondent shall implement the scheme envisaged in the IEGC in view of the undertaking given on its behalf at the hearing.***

19. The respondent in this petition has filed an application for impleadment of certain state/central power utilities as also the private ones. At this stage, we do not consider it necessary to specifically implead them as prayed for by the respondent. The progress of implementation of FGMO will be monitored through the CTU and if on consideration of report(s) of the CTU, it becomes necessary to call any one defaulting in the process of implementation of FGMO, the Commission will in no way be handicapped to take appropriate steps, including coercive ones, if necessary. Therefore, the application filed by the respondent is dismissed."

Petition No.4/2004

20. The petitioner (Orissa Hydro Power Corporation) has submitted that it too had technical problems in running the units on FGMO under particular operating conditions at around 70% loading. It is submitted that it is unsafe to operate the units in this critical zone and has sought exemption of its units from FGMO in this critical zone. We do not propose to go into the merits of the issue raised by the petitioner in view of our decision to refer the study of all technical aspects of the problem to CEA. Accordingly, the petitioner may also approach CEA with its technical problems, for study by CEA who will advise the Commission on the issues raised by the petitioner.

Petition No.12/2004

21. NLC, the petitioner submitted that all the units of the stations were put on FGMO. However, these units being very old, operation beyond 215 MW was not possible. It is submitted that it is unsafe to operate the machines beyond this under FGMO. The petitioner in this case also seeks exemption

from FGMO. We direct that the petitioner may bring its difficulties and problems to the notice of CEA, along with complete details for latter's study and report as aforesaid. ***However, in the meanwhile no exemption from FGMO could be considered and the petitioner shall be liable to implement the provisions made in IEGC.***

General

22. The present order is made based on the petitions filed before the Commission. Maybe, other generators also face similar kinds of technical difficulties in regard to putting their machines on FGMO. Therefore, Member Secretary, REBs are directed to bring the contents of this order to the notice of the constituents of the respective REB so that if any one of them has any technical difficulties, it may also approach CEA for study of its problems and difficulties in the light of aforesaid directions."

5. On the same line, the Commission vide its order dated 7.6.2004 in Petition No. 36/2004, directed CSEB to approach Central Electricity Authority (CEA) for study of the technical and operational issues listed by it in implementation of Free Governor Mode Operation (FGMO) so that CEA would advise the Commission on these issues, like in other cases referred earlier.

6. NEEPCO had filed Petition No. 93/2004 seeking exemption for Assam Gas Based Power Plant units from FGMO. It had also approached CEA citing the Commission's earlier order dated 21.5.2004 with a comprehensive note highlighting the details of the difficulties encountered during the test operation regime on FGMO.

7. Significantly, even after updating IEGC effective from 1.4.2006, para 1.6 relating to the implementation of FGMO still provides as follows:

"1.6 Free Governor Action

i) ***All thermal and hydro (except those with zero pondage) generating units: with effect from the date to be separately notified by the Commission.***

ii) Any exemption from the above may be granted only by CERC for which the concerned constituent/ agency shall file a petition in advance.

iii) The Gas turbine/Combined Cycle Power Plants and Nuclear Power Stations shall be exempted from Sections 4.8 (c), 4.8 (d), 5.2 (e), 5.2 (f), 5.2 (g) and 5.2 (h) till the *Commission reviews the situation."*

8. As such, the first requirement for the implementation of FGMO is issue of notification by the Commission on a suitable date in this regard.

9. Other relevant provisions of the IEGC prior to 1.4.2006 were as follows:

"4.8 Generating Units and Power Stations

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c) Each Generating Unit shall be fitted with a turbine speed governor having an overall droop characteristic within the range of 3% to 6% which shall always be in service.

d) Each Generating Unit shall be capable of instantaneously increasing output by 5% for a minimum of 5 minutes, when the frequency falls and when operating at any loading up to 105% MCR, limited to 105% MCR.

5.2 System Security Aspects:

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(e) All generating units, which are synchronised with the grid, irrespective of their ownership, type and size, shall have their governors in normal operation at all times. If any generating unit of over fifty (50) MW size (10 MW for North Eastern Region) is required to be operated without its governor in normal operation, the RLDC shall be immediately advised about the reason and duration of such operation. All governors shall have a droop of between 3% and 6%.

(f) Facilities available with/in load limiters, Automatic Turbine Run up System (ATRS), Turbine supervisory control, coordinated control system, etc. shall not be used to suppress the normal governor action in any manner. No dead bands and/or time delays shall be deliberately introduced.

(g) All Generating Units, operating at/up to 100% of their Maximum Continuous Rating (MCR) shall normally be capable of (and shall not in any way be prevented from) instantaneously picking up five per cent (5%) extra load for at least five (5) minutes or within technical limits prescribed by the manufacturer when frequency falls due to a system contingency. The generating units operating at above 100% of their MCR shall be capable of (and shall not be prevented from) going at least up to 105% of their MCR when frequency falls suddenly. Any generating unit of over fifty (50) MW size (10 MW for NER) not complying with the above requirement, shall be kept in operation (synchronised with the Regional grid) only after obtaining the permission of RLDC. However, the constituent can make up the

corresponding short fall in spinning reserve by maintaining an extra spinning reserve on the other generating units of the constituent.

(h) The recommended rate for changing the governor setting, i.e. supplementary control for increasing or decreasing the output) (generation level) for all generating .units, irrespective of their type and size, would be one (1.0) per cent per minute or as per manufacturer's limits. However, if frequency falls below 49.5 Hz, all partly loaded generating units shall pick up additional load at a faster rate, according to their capability".

10. The above provisions are also existing in the IEGC presently in force, with some modifications. In the above background of the statutory provisions, the Commission heard the petitions yet again on 28.4.2009 to take a view in the matter of implementation of FGMO and its form. The various issues involved in this regard are discussed in subsequent paragraphs.

Recommendation of CEA

11. In pursuance of the Commission's order dated 21.5.2004, a "Report on the Issues of Operation of Hydro Generating Units in Free Governor Mode (FGMO)" has been received by the Commission from Secretary, CEA, under his letter No. 103/18/2004-HPA-III/338 dated 8/11.10.2004. The concluding part of this report is as follows:

"5.0 <u>Recommendations</u>

12. From the discussions with the generators and ERLDC, it is observed that the hydro machines are operating satisfactorily in FGMO. For the operation of hydro generating units in FGMO, it is recommended as below:

(i) Every power station should participate in FGMO to reduce frequency fluctuations in the grid and share the load by all the machines.

(ii) Monitoring of the power stations operating in FGMO is to be strengthened. The problems, if any, in implementation of FGMO should

be discussed in the REB meetings and solutions to be found for improving operation in FGMO.

(iii) The operation of machines should be avoided in the critical zone as recommended by manufacturers or as determined from the experience of generators to safe guard machines against excessive pitting and vibration.

(iv) The power stations linked to irrigation and other requirements should be operated in such a way that the scheduled requirement of irrigation and drinking water are met.

(v) Spilling of water from hydro power stations is to be minimized by maintaining normal grid frequency."

12. We are generally in agreement with the recommendations at (i) to (iv) above, and accept the same in respect of all Hydro electric generating stations. As for the recommendation at (v) above is concerned, it is inferred that according to CEA, the governor in a hydroelectric generating station should not be allowed to reduce generation when this would cause spilling of water, which basically amounts to wasting free energy. This implies that the frequency may not be allowed to go beyond 50 Hz, which would result in reduction of generation of a hydroelectric generating station when its reservoir is full thereby causing spilling of water. It may be mentioned that maintaining normal grid frequency is a result of the joint effort of all generators and loads, acting in tandem and in accordance with the instructions of the Regional Load Despatch Centres. Apparently, maintenance of grid frequency is not the exclusive responsibility of the hydro generator.

13. The **"Report on the Issues of Free Governor Mode of Operation in Thermal Units"** has also been received in the Commission under Secretary, CEA's letter No. CEA/5-41(17)/2004/Secy/331 dated 5/8.11.2004. This report is the result of a very detailed exercise by a Committee under the chairmanship of Member (Thermal), CEA, after necessary field studies at Dadri TPS, WRLDC, EREB, BHEL Simulator, BHEL Haridwar, Simhadri TPS and Nasik TPS in 2004 and elaborate

discussions at senior levels. Specific recommendations have been made in this report, in consultation with BHEL, for implementation of FGMO on KWU and LMW/LMZ type turbines of 200 MW and above under the prevailing conditions in India.

14. CEA has observed that the frequency profiles of Power System in India has improved significantly after implementation of ABT and the same now generally remains within 49.0 to 50.50 Hz against pre-ABT levels of 47.5 to 52.5 Hz. The response of the governors as first line frequency control mechanism is practiced internationally. However, there are two differences between the conditions prevailing in India and in other countries. Firstly, installed capacity far exceeds the demand in those countries. Secondly, the deviation from the target frequency of 50 Hz is as low as +/-0.1 or +/-0.2. Thus, in India, requirement of implementing FGMO in a scenario of frequency variation of 49.0 to 50.5 Hz is unique. This obviously demands a unique solution rather than stereotype copy.

15. For 200/210/250/500 MW coal/lignite fired generating units with KWU turbines of BHEL make, the Committee has recommended adoption of a control logic in which “reference frequency” would be allowed to float and track the actual frequency. In the 37 units of more recent vintage with Procontrol/Max DNA type control systems, incorporation of this logic would be possible through software modification, for which BHEL has quoted a price of Rs.7.6 lakhs per unit (excluding taxes and duties). The other 81 units in this category have ISKAMATIC based controls, and they would require both hardware and software changes, for which BHEL has quoted Rs.15.2 lakhs per unit (excluding taxes and duties).

16. In addition, CEA has stated that revamping of boiler controls is recommended wherever they are presently not on ‘auto’. This would involve further cost and time, and may have to be a part of the larger R&M exercise. The timeframe recommended by the Committee is:

(a)	Software based EHG system:	One to three months
(b)	Hardware based EHG system Where boiler controls are in “auto”:	Three to six months

(c) Hardware based EHG system where Boiler controls are to be put in “auto”: Nine months

17. CEA has further proposed the following moderated form of FGMO in the current scenario:

> “Load change is proposed to be limited to +/-5% of MCR in the frequency range of 49 Hz & 50.5 Hz and sustained for about 5 minutes before ramping back to original load automatically. Small changes up to +/- 0.03Hz are ignored for load corrections. For frequency below 49 Hz and above 50.5 Hz, 5% droop of the governor would be effective with load change limited to +5% of MCR for frequency below 49 Hz and -10% of MCR above 50.5 Hz.”

18. CEA has stated that since as per the revised EHG control logic, contribution of each unit has been limited to +/-5% of MCR (except for frequencies above 50.5 Hz.), the units after implementation of revised EHG logic can be put on FGMO, one by one, irrespective of whether other units are in FGMO or not. Apprehensions expressed by generators earlier that unless all the units should be put on FGMO, the burden of frequency control on their units would be too high, has been adequately addressed with revised EHG logic.

19. For the 200/210 MW units with LMZ turbines (of which there are 67 in the country), the Committee has recommended adoption of the scheme introduced by MSEB at Nasik, where the reserve steam in the boiler was used for increased generation for about 4-5 minutes. The details of the Scheme are given in Annexure-I. CEA has recommended a time period of three months for implementation of the scheme adopted at Nasik station of MSEB. Recognizing this, the Committee has recommended further improvement of putting the boiler controls in auto mode through adoption of the same scheme as recommended for the KWU machines. However, this would call for a major R&M, both on turbine and boiler side, which may not be justified at this juncture for these fairly old generating units. No proposal has been put forward by BHEL either.

20. Action to modify scheme for non BHEL turbines was proposed to be taken on similar lines with the help of OEM or any other agency.

21. The subject report also states that the recommendations regarding FGMO for gas based generating stations shall be given subsequently.

22. It can be seen that even after the above modifications, CEA has proposed a moderated form of free governor operation in the current scenario.

23. During the course of above exercises, it was noticed that stipulation regarding FGMO at para 5.2 (g) of the IEGC as it stood then, had caused some apprehension. In order to enable FGMO even on generating units which do not have automatic boiler controls in operation, the Commission had moderated this provision in the revised version of IEGC in force since 1.4.2006 as follows:

> *"(g) All Generating Units, operating at/up to 100% of their Maximum Continuous Rating (MCR) shall normally be capable of (and shall not in any way be prevented from) instantaneously picking up five per cent (5%) extra load for at least five (5) minutes or within technical limits prescribed by the manufacturer when frequency falls due to a system contingency. The generating units operating at above 100% of their MCR shall be capable of (and shall not be prevented from) going at least up to 105% of their MCR when frequency falls suddenly.* ***After an increase in generation as above, a generating unit may ramp back to the original level at a rate of about one percent (1%) per minute, in case continued operation at the increased level is not sustainable.*** *Any generating unit of over fifty (50) MW size (10 MW for NER) not complying with the above requirement, shall be kept in operation (synchronised with the Regional grid) only after obtaining the permission of RLDC. However, the constituent can make up the corresponding short fall in spinning reserve by maintaining an extra spinning reserve on the other generating units of the constituent."*

24. The modification of the above clauses amounts to moderation of total free governor operation so as to let the generation increase to the extent of 5% only when frequency declines. Clause 1.6 also therefore needs to be modified accordingly, by using the term "free governor operation as specified by the Commission", which can be done now, through review of the relevant provisions of the IEGC.

25. Taking CEA reports as the base, further exercises were carried out by the Commission to see whether it was possible to achieve the moderated FGMO response in a simpler, quicker and more cost-effective manner. A moderated FGMO trial operation in Southern Regional grid was also conducted on 9.2.2008.

26. Based on this exercise, the experiments conducted at Nasik, Simhadri, Dadri and Farakka in 2004, the discussions with engineers of MSEB, NTPC and BHEL, and the submission of the stake holders, the following conclusions emerge regarding free governor operation :

(a) Total free governor operation causes changes in generating unit MW from zero generation to full generation at a rate depending on the governor droop setting. In thermal units, because of inherent inertia, the above MW changes lead to fluctuations in steam parameters, even if feed-forward signals are given for fuel firing, because of transient mismatches between steam production in boiler and steam consumption by turbine. It has to be ensured that the steam parameter fluctuations remain within permissible limits.

(b) A majority of thermal units in the country are not having their boiler controls in a satisfactory state. Most boilers are operating on fixed firing, manually adjusted when a need arises. They are not amenable to automatic control and/or feed-forward signal without a major R&M effort and cost, which in turn may not be justified on older units.

(c) Experiments have shown that there is enough thermal inertia in most generating units to obtain a frequency response for a few minutes, without steam parameter going beyond permissible limits, even if fuel firing is not varied, i.e. without putting the boiler controls into auto mode. It is however most crucial that the generating unit, after the initial frequency response through FGMO, gradually returns to the previous MW which matches with fuel firing. This should happen automatically, i.e., without any operator intervention.

(d) The above approach was tried out successfully at Nasik TPS in November 2004 after modification in the control scheme. CEA has recommended a timeframe of three months for this modification. Taking a time period of three months for processing and placement of order, we may give a timeframe of six months for operationalization of the modified scheme. Similarly, three months may be added to the timeframe recommended by CEA for operationalizing the Hardware based EHG system.

(e) Since the IEGC presently in force does not envisage increasing generation beyond 5% (considering only shortage conditions, since reduction of 5% is not mentioned in the IEGC), there may not be any need to put boiler controls in auto since that would be a major R&M exercise. That would also expedite the generating units being put into the moderated form of free governor operation as envisaged in the IEGC.

(f) Most of the hydroelectric generating units already said to have their governors in free governor mode of operation. However, here also only 5% increase of generation in case of fall of frequency is stipulated in the IEGC, to be restored to original generation in 5 minutes. This should continue, since free governor operation and UI charges should not act at cross purposes. Also, water in a storage type reservoir is to be used judiciously during the year, so that generation from hydro units is done as per plan.

(g) As already decided, Nuclear and gas turbine/combined cycle power plants should be exempted from FGMO for the present.

27. The main concerns of the generator with regard to FGMO can be summarized as follows :-

(a) There is no control over load i.e. drawl by beneficiaries for controlling frequency. As a result, the responsibility of frequency control has been left exclusively to the generators.

(b) In case of frequency improvement when the frequency is below 50 Hz., say for example, if frequency improves from 49.5 Hz. to 49.7 Hz., free

governor operation would decrease the generation of a 200 MW generator from 200 MW to 184 MW with a 5% droop setting, in the process forcing them to incur UI charges in addition to losing generation. Under these circumstances, the free governor operation would work at cross purposes with the regulations on UI charges.

(c) FGMO may subject the machines to undue thermal and reversal of stresses leading to fatigue failures and would cause undue hunting of control valves

(d) FGMO is required to be implemented simultaneously in all generating units to avoid undue stressing of some of the units.

28. World over, the deviations in grid frequency is in the order of ±0.1 Hz to ±0.2 Hz. On the other hand, grid frequency in India varies widely between 50.5 to 49 Hz and occasionally goes even above 50.5 Hz or below 49 Hz. Further, world over, maintenance of the grid frequency is done through procurement of generation reserves or through interruptible loads, where some consumers are in a position to shed load, which entitle the consumer to a lower tariff, through contracts by the system operator. Therefore, load generation balance to maintain frequency is either done through supply side management or through demand side management, or both.

29. In surplus scenario countries, there is a system of differential tariff for interruptible loads, i.e. loads which pay a lower tariff for allowing themselves to be interrupted when the grid requires it against non-interruptible loads, which pay a higher tariff for more reliable supply. It is felt, in view of the advancement in information technology that this country has achieved resulting in drastic reduction of costs, the time has come for introducing state-of-the-art technology in demand side management using Advanced Metering Infrastructure (AMI), which is how it is done in some advanced countries. Alternatively, the States could implement a microprocessor-based rotational load-shedding scheme, as was existing in Delhi before privatization of distribution, where, if frequency dipped below a benchmark

frequency, load-shedding would be carried out automatically in different areas at pre-programmed times for say, a week. This would ensure that persons in the area always know at what time the load shedding would occur in their area, if at all, and thus could plan their day with confidence. The programming can be done in such a way that the time of load-shedding would also keep on changing on a weekly basis as per the programme, so that the same area does not always suffer during the same time period. Therefore, load-shedding would get roastered in such a way that load-shedding in all areas is carried out in a pre-programmed way and in an equitable manner. The only difference would be that the load-shedding will not be dependent on the frequency alone but also on the net drawal of the State. The APDRP Phase-II also provides vast amounts of funds for information technology in the field of sub-transmission and distribution fields.

30. It may be seen from the following extract that the objective of free governor control is to prevent frequency excursions, as given in the Commission's order dated 30.10.1999 on Free Governor Control:

> *"Though frequency control in the present conditions of the power system operation may not be possible with governor action alone and other means like load shedding, manual intervention etc. may also be necessary, yet the necessity of invoking the free governor action cannot be undermined."*

31. In the Commission's order on ABT dated 4.1.2000, one of the objectives of ABT, particularly the UI charges was also to control frequency excursions, as may be seen from the following:

> *"5.9.1 The ECC Study team has elaborately dealt with the need for UI charges in order to stabilise the frequency in the regional grids and to minimise extreme deviations in the frequency. A special task force constituted by the study team has observed that "while inadvertent UI could be accepted and tolerated as a necessary feature of pooled operation, the deliberate UI should be discouraged. Therefore, there appears to be a need to apply a mandatory pricing scheme to scheduled inter changes in India".*

32. In the Indian context, therefore frequency control is presently achieved to some extent through the commercial mechanism of Unscheduled Interchanges (UI), which is voluntary in nature, in the sense that generator or beneficiaries are

prompted through the UI commercial mechanism to modify their generation and/or load as the case may be.

33. The IEGC states that a generating unit shall be capable of instantaneously increasing output by 5% when frequency falls limited to 105% of MCR. If the unit is already running at 100% of MCR, then it has to pick up by 5%. However, in the prevailing shortage scenario, it is seen that all generating stations are already running at 100% of MCR. Some Central Sector Stations are running at above 100%, say 103%, since it is allowed under the Central Electricity Regulatory Commission (Unscheduled Interchange charges and related matters) Regulations, 2009 (UI Regulations) to generate up to 105% of the declared capacity in any time block of 15 minutes and 101% over the day and be entitled to UI charges for such excess generation above the scheduled generation. The generator may like to help the grid in times of low frequency and claim UI charges accordingly. Significantly, UI charges act as a real time market in India and are unique since they do not exist anywhere else in the world. Under such a condition, there would be limited or no scope for the governor of a generator, to act when the frequency falls. The relevant paras from IEGC and the UI Regulations are reproduced below.

"IEGC

4.8(d) Each Generating Unit shall be capable of instantaneously increasing output by 5% when the frequency falls limited to 105% MCR. Ramping back to the previous MW level (in case the increased output level cannot be sustained) shall not be faster than 1% per minute.

5.2(g) All Generating Units, operating at or up to 100% of their Maximum Continuous Rating (MCR) shall normally be capable of (and shall not in any way be prevented from) instantaneously picking up five per cent (5%) extra load when frequency falls due to a system contingency. The generating units operating at above 100% of their MCR shall be capable of (and shall not be prevented from) going at least up to 105% of their MCR when frequency falls suddenly. After an increase in generation as above, a generating unit may ramp back to the original level at a rate of about one percent (1%) per minute, in case continued operation at the increased level is not sustainable…….

UI Regulations

6(3) Any generation from the generating stations other than hydro generating stations up to 105% of the declared capacity in any time block of 15 minutes

and averaging up to 101% of the average declared capacity over a day shall not be considered as gaming, and the generating station shall be entitled to UI charges for such excess generation above the scheduled generation.

34. In a power deficit scenario such as that in India, where the frequency remains below 50 Hz. for about 90% of the time, all available generation capacity is expected to be harnessed at its full capacity, with no or negligible reserves remaining. In all such conditions where frequency remains below 50 Hz. the grid would need every MW of power. Therefore, there would almost be no power available for moderating the frequency. CEA's Report on free governor operation also mentions that :

"The response of the governors as first line frequency control mechanism is practiced internationally but with a difference that in such countries installed capacity far exceeds the demand and target frequency of 50 Hz with in a band as low+/-0.1 or +/-0.2. Thus requirement of implementing FGMO in a scenario of frequency variation of 49.0 to 50.5 Hz is unique to our country and requires a unique solution."

35. In such a deficit scenario, we feel that although the governor must be operational for conditions when frequency is around 50 Hz. what must be mandated always whenever frequency is below 50 Hz. is demand side management by the loads, i.e. the States. All generators and loads connected to the grid are jointly responsible for maintaining the frequency of the integrated grid. Since all the loads are within the purview of the States, demand side management is to be ensured by them.

36. Para 5.4 of the IEGC already contains provisions for demand side management, in the form of Manual Demand Disconnection. The clause stipulates that load-shedding shall be carried out when frequency falls below 49.2 Hz. We feel that this clause should be modified to provide that demand disconnection may be compulsorily done by the States automatically, sensitive to both frequency and net drawal, even before the contingency measures of under-frequency load-shedding become operational at lower frequencies.

37. We feel that the State Electricity Boards or the distribution licensees, as the case may be, shall prepare a scheme for automatic demand side management, according to the principles proposed to be specified in IEGC.

38. We also take note of the fact that relying on the governor operation for maintaining frequency may even be counter-productive. When we are using the limited reserves available in the generation overload capacity, if any, then in case the frequency falls and all connected generators with the limited reserves respond through governor control to improve the frequency for 5 minutes to the limited extent, and the frequency still keeps falling due to increasing load, the governors, which had tried to arrest the frequency by increasing generation, would, by restoring back to original position in 5 minutes, make the frequency fall even more. At this time it would be the combined effect of falling frequency due to increasing load in the system as well as restoration of governor position after 5 minutes. The effect on the grid would be even worse, unless demand side management is done.

39. In the present scenario of deficit, it is not desirable to have any frequency response from generators by reducing generation when frequency is rising towards 50 HZ from a lower level. Reduction of generation would be necessary when frequency is already above 50 Hz and tends to rise further. Therefore, suitable control logic would have to be developed to limit the governor response to situations when frequency is rising and the grid frequency is below 50 Hz. Such a situation could be called a restricted governor mode operation and not total FGMO. However, this does not exempt the generators from getting the free governor mode into operational state for use when required.

40. For storage type hydroelectric generating stations of 10 MW and above, with governors not in free governor mode, this should be done in line with the logic given above for thermal generating stations. The other requirements as recommended by CEA in its Report of not allowing the generators to operate in the critical zone as recommended by manufacturers or as determined from experience and taking into account the scheduled requirement of irrigation and drinking water also have to be built into the logic while implementing the restricted free governor mode of operation.

41. Based on the above and having specific regard to the prevailing condition of shortage, we direct the implementation of only restricted governor operation in various types of thermal and hydro units as per the following schedule:

(a) KWU & LMZ turbines for thermal sets of 200 MW and above:

(i) Software based EHG system: 1.3.2010

(ii) Hardware based EHG system where boiler controls are in "auto": 1.6.2010

(b) Hydro units of 10 MW and above 1.3.2010

42. All the generating companies are directed to place before the Commission, within a month, their action plan in line with the above schedule and furnish monthly progress reports to the Commission in this regard.

43. The Staff shall initiate suitable amendment to para 1.6 of IEGC and submit the same for the Commission's approval within a month.

Sd/-	Sd/-	Sd/-	Sd/-
[V. S. VERMA]	**[S. JAYARAMAN]**	**[R. KRISHNAMOORTHY]**	**[DR. PRAMOD DEO]**
MEMBER	**MEMBER**	**MEMBER**	**CHAIRPERSON**

New Delhi, dated 20th August 2009

ANNEXURE-1

CONTROL LOGIC SUGGESTED FOR ENABLING FGMO ON THERMAL UNITS WITHOUT AUTOMATIC FUEL FIRING CONTROL

BACKGROUND

Unit-4 of NASIK TPS in Maharashtra is a fairly old, conventional 210 MW coal-fired generating unit, with LMZ (Russian) type turbine. Its C&I system has however undergone extensive R&M recently, and the generating unit now has a modern DDC control. This unique combination, and the readily available cooperation of MSEB engineers enabled a very useful exercise on FGMO in November 2004. Although the unit is now capable of fully automatic control, it was decided to operate it on fixed firing mode, to simulate the conditions on a similar unit but with old C&I. There are many such SEB units in operation, and they are presently being operated on “constant pressure” mode, as described herein.

Because of the non-operative boiler controls, most of the older thermal units are today being operated with their fuel firing set at a fixed level. In this mode, the steam production in the boiler remains constant except for variations on account of fluctuations in calorific value of coal being fired. The turbine is set to operate at a constant inlet pressure. In this mode, the throttle valve opening automatically reduces if inlet pressure falls below the set point, and increases if inlet pressure rises above the set point. In effect it means that throttle valve opening (and therefore the MW generated by the unit) perpetually corresponds to the steam production in the boiler.

In the above basic mechanism, if a turbine is released to operate on free-governor mode, a change in MW consequent to a grid frequency change would result in an immediate mismatch between the boiler steam production and turbine steam consumption. This would lead to a rise or fall of turbine inlet pressure, and an automatic action on throttle valve to increase or decrease its opening and thus quickly move it back to original opening. The unit MW would also return to the earlier level within a very short time, effectively nullifying the initial frequency response.

THE NEW CONTROL LOGIC

The approach tried out on NASIK-4 in November 2004 was basically to slow down the return of turbine inlet pressure to the set value. Instead of giving a sustained raise or lower command to the speeder gear when steam inlet pressure deviates from the set point by more than plus or minus one kg/cm^2 (as generally adopted in many power stations), an intermittent command is being given to the speeder gear (for one second every sixteen seconds) when turbine inlet pressure is rising or falling at a rate exceeding 0.2 kg/cm^2 per minute.

As a back up to the above, a sustained raise/lower command is given to the speeder gear when turbine inlet pressure deviates from the set point by more than 2 kg/cm^2. It has been seen that the above described simple logic has enabled stable operation of the generating unit while giving a good primary response through FGMO. The modern DDC has enabled the relevant parameters to be precisely recorded and plotted. NASIK-4 has been satisfactorily operating on the above logic (please see block diagram in figure-1) since 22.11.2004, without any operator intervention. One feature, however, is required to be added: in case the frequency exceeds 50.5 Hz, the speeder gear should not be given any command for increasing the governor setting.

TYPICAL SEQUENCE OF OPERATION

Suppose a 210 MW thermal unit is operating steadily at a load of 200 MW, the main steam pressure is at the target value of 125 kg/cm^2, and the grid frequency is 49.8 Hz. Now suppose there is a load throw off in the grid, and frequency rises to 49.9 Hz (a step change). The governor on the unit's turbine would sense the consequent rise in turbine speed (2988 rpm to 2994 rpm), and act on the main steam control valves to reduce the T-G output by about 8.4 MW (from 200 MW to 191.6 MW), in case the governor has a droop of 5%. Since the fuel firing in the boiler would be continuing at the previous level (corresponding to 200 MW load), the main steam pressure would start rising immediately.

For a load change as above, it is expected that the rate of change of main steam pressure (before turbine control valves) would be more than 0.2 kg/cm^2 per

minute. Sensing this, the control system would send an intermittent pulse to the speeder gear motor for raising the governor setting. While a one-second pulse every sixteen seconds has been presently implemented on Nasik-4, the pulsing rate has to be set so as to increase the unit load at about two (2) MW per minute, as long as the main stream pressure is rising at a rate more than 0.2 kg/cm^2 per minute. Thus, in 4-5 minutes from the step change in frequency, the unit load would return to about 200 MW, and turbine steam consumption would again match the steam production in boiler. The main steam pressure would then stop rising and would stabilize, may be at 127 kg/cm^2 or so.

The operator may then bring down the steam pressure to the target value of 125 kg/cm^2, by manually trimming the fuel firing, or by adjustment of speeder gear setting. There is also a back up in the control logic. In case the main steam pressure deviates from the target level by more than 2-3 kg/cm^2, a continuous command is given to the speeder gear motor, to bring the pressure back within the desired band. It is expected that this back up action would be very infrequent when most generating units are on FGMO and frequency is more stable.