

**CENTRAL ELECTRICITY REGULATORY COMMISSION  
NEW DELHI**

**Petition No. 149/MP/2012**

**Coram:**

**Shri V.S.Verma, Member**

**Shri M. Deena Dayalan, Member**

**Date of Hearing: 04.07.2013**

**Date of Order : 02.12.2013**

**In the matter of**

Petition under Section 79 (1) (h) of the Electricity Act, 2003 read with Regulation 5.2 (f) of Central Electricity Regulatory Commission (Indian Electricity Grid Code) Regulation, 2010 regarding restricted governor mode of operation by hydro-electric generating stations and Chapter- V of the Central Electricity Regulatory Commission (Conduct of Business) Regulations, 1999 for exempting Purulia Pump Storage Project (PPSP) of West Bengal State Electricity Distribution Company Limited from Black Start mode and Restricted Governor mode of operation.

**And**

**In the matter of**

West Bengal State Electricity Distribution Company Limited  
Vidyut Bhawan, Block-DJ, Sector-II, Salt Lake City,  
Kolkatta-700 091

**...Petitioner**

**Vs**

Eastern Regional Load Despatch Centre, Kolkata  
14, Golf Club Road, Tollygunge  
Kolkatta-700 033

**....Respondent**

**Following was present:**

Shri Sakia Singh Choudhery, Advocate, WBSEDCL



## ORDER

This petition has been filed by the West Bengal State Electricity Distribution Company Limited for exemption of Purulia Pump Storage Project (PPSP) from Restricted Governor Mode of Operation and Black Start Mode under Regulation 5.2.(f) (i) and Regulation 5.8 (c) of the Central Electricity Regulatory Commission (Indian Electricity Grid Code) Regulations, 2010 (hereinafter referred to as "Grid Code").

### **Background**

2. Regulation 5.2 (f) of the Central Electricity Regulatory Commission (Indian Electricity Grid Code) Regulations, 2010 provides as under:

#### ***“Restricted Governor Mode***

*(i) Following Thermal and hydro (except those with up to three hours pondage) generating units shall be operated under restricted governor mode of operation with effect from the date given below:*

*(a) Thermal generating units of 200 MW and above,*

*(i) Software based Electro Hydraulic Governor (EHG) system : 1.8.2010*

*(2) Hardware based EHG system: 1.8.2010*

*(b) Hydro units of 10 MW and above: 1.8.2010*

*(ii) The restricted governor mode of operation shall essentially have the following features:*

*(a) There should not be any reduction in generation in case of improvement in grid frequency below 50.2 Hz. ( for example if grid frequency changes from 49.3 to 49.4 Hz. then there shall not be any reduction in generation). Whereas for any fall in grid frequency, generation from the unit should increase by 5% limited to 105 % of the MCR of the unit subject to machine capability.*

*(b) Ripple filter of +/- 0.03 Hz. shall be provided so that small changes in frequency are ignored for load correction, in order to prevent governor hunting.*

*(c) If any of these generating units is required to be operated without its governor in operation as specified above, the RLDC shall be immediately advised about the reason and duration of such operation. All governors shall have a droop setting of between 3% and 6%.*

*(d) After stabilisation of frequency around 50 Hz, the CERC may review the above provision regarding the restricted governor mode of operation and free governor mode of operation may be introduced.*

*(iii) All other generating units including the pondage up to 3 hours Gas turbine/Combined Cycle Power Plants, wind and solar generators and Nuclear Power Stations shall be exempted from Sections 5.2 (f), 5.2 (g), 5.2 (h) and ,5.2(i) till the Commission reviews the situation.”*

3. Regulation 5.8 (c) of the Grid Code further provides as under:

**Black Start Operation**

"(c) List of generating stations with black start facility, inter-State /interregional ties, synchronizing points and essential loads to be restored on priority, shall be prepared and be available with NLDC, RLDC and SLDC".

4. The petitioner has submitted that Purulia Pump Storage Project (PPSP) is a pure pumped storage project and it has been designed to utilize its function in various modes of operation such as Generation, Pumping, back to back operation and condenser mode operation. There is relation among modes of operation and sequence control for each operating mode. Considering the Grid frequency and status of the Grid system, selection of mode of operation is decided. One of the main objective for selection of mode of operation is the stabilization of grid frequency, such as when the grid frequency is at higher side its operation is selected in pumping mode for drawing power to stabilize the grid frequency and this operation in Automatic Power Factor Regulator (APFR) mode

helps to improve the power factor to balance capacitive load of the system by its inductive power drawl. On the other hand, during peak load when the load demand is higher, it runs in Auto Load Restriction (ALR) mode to keep up the lower frequency to higher by meeting the load demand. During synchronous condenser operation it improves power factor to the unity. All these operations are done as per instructions of System Operator i.e. Load Despatch Centre.

5. The petitioner has submitted that the project is a pump storage hydro generating station. According to the manufacturer, speed dead band is 0.1% instead of 1.1% as large load change is caused once frequency exceeds 1% if speed dead band setting is 1%. Otherwise, governor will not respond enough for frequency variation of 49.7 Hz to 50.20Hz. Speed droop is recommended by the manufacturer within 16% to 20%. If speed droop study is 10%, load change is 22%, i.e. 51 MW because frequency change is about 1 hertz per day. The above load change is too large. Therefore, 16% speed droop (corresponding to 28 MW, i.e. 12% load change) to 20% speed droop (corresponding to 22 MW, i.e. 9.5% load change) has been recommended by the manufacturer. Setting value lying between 3% and 6% may cause difficulty in operation of the unit installed in PPSP. In RGMO, secondary flow may occur which in turn may cause abnormal vibration as well as unstable operation. The project is operated in Auto Load Restriction (ALR) mode. However, speed droop function is not activated through ALR operation. M/s Mitsui & Co Ltd, supplier of the units, has recommended the values of speed droop at 15% to 20%.

6. According to the petitioner, same generator is used as motor for pumping operation by reversing its two phases. However, all the auxiliaries remain the same. The Governor which was set since commissioning of the units commonly utilized both for generation and pumping as per requirement. So during operation in generation mode, if setting of the Governor changes with frequency, then during pumping mode operation it will perform the same function with variation of frequency and discharge of water as well as Amperage will vary with variation of frequency which ultimately will affect the efficiency of the machine and may cause sever damage to the machine and if the discharge falls suddenly, which may happen anytime if the machine is kept on RGMO mode, suddenly flow may occur and cause pitting and even develop crack on the blades. At the time of pumping operation, all the auxiliary system may not be fully effective. Considering both generation and pumping by the same machine, it is not possible to disturb the setting which may disrupt its function.

7. With regard to black start operation, the petitioner has submitted that during the 14th Eastern Regional Power Committee (ERPC) meeting held on 10.6.2010, while deliberating on the running of all the hydro machines as start up power in case of total black out, ERLDC requested to make a programme for black start for the project. Accordingly, the petitioner explored the possibility of running the project in Black Start Mode. However, it appeared from the technical specifications of the plant (as indicated by the manufacturer M/s Mitsui & Co) it would not be prudent to run the project on black start mode which can result in damaging the equipment of the project. During charging of 200 km long 400 kV feeder of PPSP, the capacitive current during charging can be

as high as 4230 AMP at 16.5 kV side. The Mitsui & Co. Limited in its letter dated 18.7.2008 had informed that due to high capacitive current during line charging, it is highly risky to operate Generator Motor Circuit Breaker. M/s J-POWER WAPCOS JV, Consultant had also seconded the observations of Mitsui & Co. Limited and submitted that Generator Motor Circuit Breaker has no capability to operate during actual line charging due to capacitive current and it would be high risk due to line fault, over voltage trip, self excitation phenomenon and resonance of transmission line and it would create heavy damage to the equipment of PPSP. In view of the above, the petitioner has prayed as under:

(a) *The Project may be exempted from complying with the speed droop parameters specified in the IEGC for running under Restricted Governor Mode of Operation;*

(b) *The Project may be exempted from running in Black Start Mode for the reasons as indicated above; and*

(c) *Pass such other and further orders as may be deemed appropriate in the facts of the present case."*

8. Meanwhile, Eastern Regional Load Despatch Centre filed I.A. No. 51/2012 with a prayer to direct the petitioner to include ERLDC as necessary party to the petition. ERLDC in said IA has submitted that during the grid collapse on 31.7.2012, it was observed that the restoration of Eastern Region got delayed on account of failure of several hydro stations such as Teesta-V, Chukha HPS, Maithon and Upper Indravati to black-start their respective units. Under the circumstances, the time taken for extension of start-up power to major thermal station in the region and hence, attaining of normal mode of operation by the thermal generating station could have been

significantly reduced, had the black start support been available from PPSP. ERLDC has further submitted that considering the important role of PPSP, it has been repeatedly emphasizing the need for exploring the black start capability of the plant in ERPC forum. The matter was discussed in the 36th, 38th, 45th and 56th OCC meeting held on 24.3.2009, 15.5.2009, 18.12.2009 and 23.11.2010, respectively. However, WBSEDCL has demonstrated lukewarm response, perpetually deferred in attempting trial black start of PPSP units and made little sincere efforts in realizing the objective.

9. Considering the fact that ERLDC is the apex body for integrated operation of the power system in the region, the Commission, vide order dated 9.11.2012, impleaded ERLDC as respondent in the petition and directed ERLDC to file its reply accordingly.

10. Eastern Regional Load Despatch Centre in its reply dated 14.12.2012 has submitted that keeping the turbine governor in operation at all times is a very basic and mandatory requirement for a generator to remain connected with the grid, the petitioner need not adhere to the range of 3 to 6% and is at liberty to maintain a droop characteristic upto 10% for its generators at PPSP in terms of part-II of the Central Electricity Authority's "Technical Standard for Connectivity to Grid". ERLDC has submitted that the manufacturer of Purulia PSP units had initially recommended a droop setting of 10% based on short-term frequency fluctuation of +0.5 Hz (=1%) and long term frequency fluctuation of +1.5 Hz (+3%). However, considering actual short term system frequency fluctuation of -2.02% to -0.2% and actual long term fluctuation as -1.92% to -0.04%, manufacturer recommended a droop setting of 16% to 20%. In



this connection it may be noted from the frequency data for the month of November, 2012 that the short term fluctuations are generally within +/- 0.5 Hz (+/-1%) i.e. 49.5 Hz to 50.5 Hz. Therefore, under normal circumstances, the unit will not be subjected to frequencies beyond the limits specified by the manufacturer. Only rare contingencies such as complete generation loss of a large power plant, or unsuccessful SPS operation following Talcher HVDC bi-pole tripping or electrical separation of a sub-system from the main interconnection etc. may cause the generator bus frequency to change monotonically by 1 Hz (2%), provided the other eligible synchronized units do not participate in RGMO/FGMO. The fluctuations are expected to further reduce as the system inertia increases with synchronization of new generating units in the near future. Considering the integration of Southern Grid with NEW grid planned in the near future, all eligible generators are required to abide by FGMO/RGMO to minimize a large power flows across regions. With regards to petitioner's contention against putting its units in RGMO/FGMO on the ground that with a droop setting of 10%, 1 Hz change in system frequency shall cause the unit output to change by 51 MW (22%), which is too large. ERLDC has submitted that the change in a day are usually contained within +/-0.5 Hz (+/-1%) and a unidirectional 1 Hz change can only occur under rare occasions. Further, with a droop setting of 10%, the change in load due to 1 Hz change (2%) in frequency will be  $(100 \times 2) / 10 = 20\%$  which corresponds to  $(225 \times 20) / 100 = 45$  MW. Therefore, the statement made by the petitioner in the petition is incorrect. ERLDC clarified that 170 MW hydro units of Teesta-V HPS of NHPC are already operating successfully in RGMO with a droop setting within the IEGC specified range. Therefore the difficulty expressed by the petitioner cannot be accepted as justified. ERLDC has



submitted that difficulty in RGMO during motoring operation is well appreciated. However, since the periods of motoring operation and generation operation are distinct, governor action may be kept enabled only when the units are under operation as generator. Therefore, in the interest of smooth and secure operation of the integrated power system of the country, the petitioner may be directed to put the units of Purulia PSP on FGMO/RGMO in terms of Part-II (Technical Standards for Connectivity of the Distributed Generation Sources) of CEA Technical Standards for Connectivity to the Grid and Regulation 5.2 (f) of the Grid Code.

11. With regard to exemption from black start mode, ERLDC has submitted that hydro units, particularly those of large size, are normally expected to have black-start capability in terms of Sub-Regulation (14) of Part-II (Standards applicable to Generating Units) of CEA regulations on "Technical Standards for Connectivity to the Grid". Further, as per Sub-Regulation 32 (8) concerning operating capability of hydro generating units, in the "Technical Standards for Construction of Electric Plants and Electric Lines- Regulations, 2010, the hydro stations are required to be equipped with facilities for black start of generating unit in the event of grid black-out conditions. Therefore, Purulia PSP which is already equipped with 2 nos 415V, 750 KVA DG sets should have black-start facility. In terms of Chapter 4 of the CEA's "Best practices in design and engineering philosophy of hydro power projects" defines the line-charging capability of hydro machines as under:

"The under-excited rating of a hydro machines is also sometimes referred to as 'line charging capability'. It is maximum amount of reactive kVA which the machines can absorb when operating under-excited, at rated



frequency and voltage, without exceeding the rated temperature rise and becoming completely self-excited or unstable”.

$$\text{kVAR (under excited)} = 0.8 \times (\text{SCR}) \times (\text{maximum kVA}) / 1.15$$

where SCR= Short circuit Ratio of the machine.

Typical values of SCR for large hydro generators are as follows:

<b>Power Factor</b>	<b>SCR</b>
1.00	1.250
0.95	1.175
0.90	1.100
0.85	1.050
0.80	1.000

In line with the above guidelines, the line charging capacity of Purulia PSP can therefore be estimated as:

Line charging capability =  $0.8 \times 1.1 \times 250 / 1.15$  MVAR = 191.3 MVAR which corresponds to a current of 6694A at 16.5 kV.

It has been stated vide Annexure P/2 of the petition that the capacitive current during charging a 200 km line can be of the order of 4230 A on 16.5 kV side, which is abnormally high considering the switching capability of the generator-motor CB. Comparing with the line charging capability as estimated above, it is observed that this current is much below the expected capability of the machines. Moreover, if the terminal voltage of the machine is maintained at around 12.4 kV (instead of the rated value of 16.5kV) by reducing the field excitation by approximately 25%, the charging current at machine terminal will get reduced to around 3030 A. Additionally, if the 50 MVAR bus reactor at Arambagh is used as line reactor, the charging current in GT primary side will further reduce to 1840 A approximately.

12. ERLDC has submitted that in the event of overvoltage tripping of the charged line, 400 kV side CB should operate to electrically isolate the unit from the grid, rather than the generator CB. The charging current to be interrupted at 400 kV would be 76A only (125A without line reactor). Therefore, the concern of the manufacturer and the petitioner is not clear. The idle-charging of line at reduced voltage, while extending start-up power from hydro stations is a common practice and has been successfully tested during the black-start exercise of Indira Sagar HPS in M.P. In the present case, 125 MW U#5 of the plant was started on 22.5.2011 with a reduced terminal voltage (4 kV against the rated voltage of 11 kV) and 400 kV Indira Sagar-Indore-II (161 km) Twin Moose line was idle charged along with 50 MVAR line reactor at Indore (remote) end . In another incidence, 205 km Tehri-Koteshwar-Merrut 400 kV Quad Moose section was successfully idle charged on 12.5.2011 by 250 MW Tehri hydro U#3, by maintaining the voltage to 85% of rated at Tehri end along with 50 MVAR line reactor at Meerut. It may also be appreciated that by charging the outgoing line at reduced voltage, the chance of its tripping on overvoltage protection gets reduced manifold, and therefore, the circuit breaker will not be required to perform the duty of interrupting capacitive current at all. As an additional precaution, the setting of the overvoltage relays at PPSP, Arambag and Bidhannagar can be relaxed so as to eliminate the probability of overvoltage tripping almost completely. In the event of occurrence of a line fault, after the line is charged, the current to be interrupted will be largely inductive in nature, which is quite natural for all circuit breakers to successfully perform. The manufacturer themselves have endorsed the capability of the generator-motor circuit breaker to interrupt any reactive fault current up to 8000 A at 16.5 kV. However, as in the case of over-voltage,



in case of line fault also, the 400 kV line circuit breaker is expected to clear the fault, rather than the generator-motor circuit breaker.

13. ERLDC has requested to direct the petitioner to put its units in RGMO/FGMO while operating as generator in terms of provisions of Part-II (Grid Connectivity Standards applicable to the Generating Units) of CEA Technical Standards for Connectivity to the grid and Regulation 5.2 (f) of the Grid Code and make sincere efforts for black-starting its unit, charging an outgoing line and building up a small island after finalizing a suitable scheme.

14. We have considered the submissions of the petitioner and respondent. We directed the petitioner to file its rejoinder to the reply of ERLDC. In response, the petitioner has filed its rejoinder to the reply of ERLDC only on 8.11.2013. However, the petitioner vide its reply to the impleadment application has submitted that ERLDC is not a qualified body/institution under the Electricity Act, 2003 to examine the issue of whether the operational parameters of the PPSP station are compatible with the RGMO mode of operation and for black start operation and therefore, ERLDC should not be allowed to intervene in the present proceedings. In this regard, it is clarified that the Commission vide its order dated 9.11.2012 had allowed ERLDC to be impleaded as respondent in the present petition. Therefore, the petitioner's assertion goes on to show and makes us to believe that the petitioner is deliberately trying to avoid RGMO and black start operation at PPSP.

15. We are of the view that the requirement of primary response by the generating units is an absolute necessity in the larger interest of grid. As per the Regulation 5.2 (f) of the Grid Code, all thermal generating units of 200 MW and above and all hydro units of 10 MW and above which are synchronized with the Grid, irrespective of their ownership, are required to have their governors in operation at all time in accordance with the provisions of sub-clauses (i) to (iii) of the Grid Code. Generators on the pretext of technical constraints cannot be allowed to avoid the said provisions of Grid Code.

16. With regard to the petitioner's prayer for exemption from implementation of RGMO, we are of the view that operation of PPSP in RGMO with droop setting of 10% will not cause large load change, as being apprehended by the petitioner. Especially in view of the fact that with increasing number of generators participating in RGMO/FGMO, the system stiffness will increase manifold and the frequency fluctuation is not expected to go beyond the permissible frequency band of 49.7 Hz to 50.2 Hz. Accordingly, we direct the petitioner to ensure that the plant is put on RGMO with droop setting of 10% or in FGMO with manual intervention as per proviso to Regulation 5.2 (f) (iii) of the Grid Code as amended from time to time.

17. With regard to black start facility, it is noted that mock black start exercises are required to ensure preparedness of hydro stations to extend supply in case of black out. It may be seen that there are more hydro generating units in the Northern Region and most of the hydro stations are situated at far end. They have to feed charging current of

long transmission lines. Mock exercise is being conducted in the Northern Region at regular intervals. We have considered one such mock exercise of Uri HPS, situated in J&K, which was presented in the 72<sup>nd</sup> OCC meeting on 14.2.2012 at NRPC, New Delhi. Uri station has four units of 120 MW each having Francis turbines with gross head of about 252 meter. During black start operation, one unit was synchronized with Grid with approximately 35 MW load, in steps of 5 MW each, at Zenakoat Load Centre sub-station. On perusing the black start exercise, it is found that the unit was synchronized with certain pre-determined load at load centre and charging the 400 kV bus bar at 380 kV. Such arrangement stabilizes the machine and small island can be formed. During grid disturbances, such island can be synchronized with bigger islands or can be used in extending the start up power to other plants. ERLDC has suggested similar process of charging at lower voltage to reduce the amount of charging current. Purulia pump storage project with proper load management, in consultation with WBSEDCL, can conduct black start mock exercise by following the above methodology. Further, in this regard minutes of 82<sup>nd</sup> OCC meeting of NRPC reads as under:

"14. Status of mock black-Start Exercise (Agenda by NRLDC).

Representative of NRLDC stated that the schedule for Mock self-start exercise for power stations was approved in 80th OCC meeting of NRPC. The status of mock-exercise till now is as follows:

Hydro Power Station:

<b>Date</b>	<b>Name of stations</b>	<b>Status of mock-exercise</b>
5.11.2012	Delhi GT	Black start done successfully (Exercise Co-ordinated by Delhi SLDC)
16.11.2012	Koteshwar HEP	Black start exercise done successfully

19.11.2012	Chamera-3 HEP	Black start exercise done successfully
21.11.2012	Jhakri HEP	Black start exercise done successfully
30.11.2012	Dhauliganga HEP	Black start Exercise not successful Date to be given by NHPC for carrying out exercise again
6.12.2012	AD hydro	Black start exercise done successfully

18. It may be noted from the above that hydro stations of Northern Region are providing black start facility and are also participating in the mock exercises being conducted by NRPC. It is also observed from the minutes of various OCC meetings of the ERPC that number of hydro stations of Eastern Region are also providing black start facility and are also participating in the mock exercises being conducted by NRPC.

19. In view of the above, we hold that ERLDC by way of its submissions and calculations based on CEA's publication "Best Practices in Design and Engineering Philosophy of Hydro Power Projects" has brought out that the petitioner's apprehensions with regard to line charging capability are misplaced and petitioner has not filed its reply to the same within specified time. Accordingly, we direct the petitioner to provide black-start facility after finalizing a suitable scheme in consultation with ERLDC through WBSEDCL.

20. The petition No. 149/MP/2012 is disposed of in terms of the above.

Sd/-  
**(M. Deena Dayalan)**  
**Member**

sd/-  
**(V. S. Verma)**  
**Member**

