

Agenda for Special Meeting on “The performance of the primary frequency response of state generating units in Eastern Region” to be held on 31st August 2020

As per IEGC section 5.2 (f), All Coal/lignite based thermal generating units of 200 MW and above and all hydro units of 25 MW and above has to put their governors in Restricted governor mode of operation (RGMO) or Free governor mode of operation (FGMO) with manual intervention. List of state generating units (as per IEGC) where RGMO or FGMO with manual intervention are to be in operation is attached at **Annexure 1**. The performance of primary frequency response through governor operation for these generating units during any events with sudden frequency rise or dip are to be evaluated by SLDC/generating stations. A list of recent events for which these are required to be checked is provided in Table 1.

In addition to individual unit governor performance, Frequency Response Characteristics (FRC) of Individual state control areas also need to be calculated for evaluation by respective SLDC. Based on ERLDC SCADA data, the FRC of state control areas for the events shown in table 1 are also provided below as a percentage of the ideal response of the respective state control area. In these FRC calculations for the state, a 5% droop setting is considered for generating stations as per the common setting of droop observed at most of the plants in ISGS/IPP/SSGS/State-IPP. In these calculations, load response is also considered as 4% per Hz.

Table 1: FRC of various state control areas during events of sudden frequency change

Event No	Date	Time (Hrs.)	Frequency Change	Bihar FRC	Jharkhand FRC	DVC FRC	GRIDCO FRC	WB FRC
1	28 th May 2020	17:26:50.760	50.02 Hz to 49.55 Hz. Later stabilized at 49.65 Hz.	65%	19%	41%	3%	20%
2	11 th June 2020	11:59:28.840	50.06 Hz to 49.80 Hz. Later stabilized at 49.93 Hz.	-19%	-2%	9%	29%	2%
3	14 th July 2020	14:10:51.560	50.00 Hz to 49.90 Hz. Later stabilized at 49.96 Hz.	130%	179%	-31%	-13%	20%
4	16 th July 2020	16:27:21.480	49.99 Hz to 49.86 Hz. Later stabilized at 49.91 Hz.	-261%	-14%	29%	104%	44%
5	20 th July 2020	20:50:21.800	50.10 Hz to 49.97 Hz. Later stabilized at 50.02 Hz.	-50%	65%	-2%	78%	-13%
6	22 nd July 2020	12:49:18.800	50.03 Hz to 49.86 Hz. Later stabilized at 49.95 Hz.	99%	-76%	-31%	56%	11%
7	06 th Aug. 2020	13:50:17.640	50.07 Hz to 49.96 Hz. Later stabilized at 50.03 Hz.	-483%	47%	62%	144%	5%

Guidelines for the evaluation of primary frequency response performance of any generating unit are provided in **Annexure 2**. Relevant regulatory provisions as per IEGC and various state grid codes for primary frequency response of generating units are shown in **Annexure 3** for information and compliance purposes.

In order to discuss the performance evaluation, all State generating units may calculate their unit wise performance based on the annexure 2 and prepare in small presentation form indicating performance, action taken for better response, and proposed plan for improvement. All the SLDCs are hereby advised to coordinate with their respective generators and finalize the presentation and action plan. During the meeting, another aspect of governor response testing in line with CERC order and IEGC regulation will also be discussed.

Annexure 1: List of state generating units (as per IEGC) where RGMO or FGMO with manual intervention are to be in operation mode

<i>Sl No.</i>	<i>Station</i>	<i>Unit No</i>	<i>Source</i>	<i>Size (MW)</i>	<i>Owner</i>	<i>SLDC to analyse</i>
1	Barauni	8	Coal	250	BSPHCL	Bihar SLDC
2	Tenughat	1	Coal	210	TVNL	Jharkhand SLDC
		2	Coal	210	TVNL	
3	Subarnarekha	1	Hydro	65	JUVNL	
		2	Hydro	65	JUVNL	
4	Waria	4	Thermal	210	DVC	DVC SLDC
5	Mejia	1	Thermal	210	DVC	
		2	Thermal	210	DVC	
		3	Thermal	210	DVC	
		4	Thermal	210	DVC	
		5	Thermal	250	DVC	
		6	Thermal	250	DVC	
6	Mejia-B	7	Thermal	500	DVC	
		8	Thermal	500	DVC	
7	CTPS B	7	Thermal	250	DVC	
		8	Thermal	250	DVC	
8	Koderma TPS	1	Thermal	500	DVC	
		2	Thermal	500	DVC	
9	Bokaro B	3	Thermal	210	DVC	
10	Bokaro A	1	Thermal	500	DVC	
11	Raghunathpur	1	Thermal	600	DVC	
		2	Thermal	600	DVC	
12	Durgapur STPS	1	Thermal	500	DVC	
		2	Thermal	500	DVC	
13	Kolaghat	1	Thermal	210	WBPDC	
		2	Thermal	210	WBPDC	
		3	Thermal	210	WBPDC	
		4	Thermal	210	WBPDC	
		5	Thermal	210	WBPDC	
		6	Thermal	210	WBPDC	
14	Sagardighi	1	Thermal	300	WBPDC	
		2	Thermal	300	WBPDC	
		3	Thermal	500	WBPDC	
		4	Thermal	500	WBPDC	
15	Bakreswar	1	Thermal	210	WBPDC	
		2	Thermal	210	WBPDC	
		3	Thermal	210	WBPDC	
		4	Thermal	210	WBPDC	
		5	Thermal	210	WBPDC	
16	Santalidih	5	Thermal	250	WBPDC	
		6	Thermal	250	WBPDC	
17	Bandel	5	Thermal	210	WBPDC	

<i>Sl No.</i>	<i>Station</i>	<i>Unit No</i>	<i>Source</i>	<i>Size (MW)</i>	<i>Owner</i>	<i>SLDC to analyse</i>
18	PPSP*	1	Hydro	225	WBSEDCL	GRIDCO SLDC
		2	Hydro	225	WBSEDCL	
		3	Hydro	225	WBSEDCL	
		4	Hydro	225	WBSEDCL	
19	DPL	7	Thermal	300	WBPDCCL	
		8	Thermal	250	WBPDCCL	
20	HALDIA	1	Thermal	300	HEL	
		2	Thermal	300	HEL	
21	Budge-Budge	1	Thermal	250	CESC	
		2	Thermal	250	CESC	
		3	Thermal	250	CESC	
22	IBTPS Stage I	1	Thermal	210	OPGC	
		2	Thermal	210	OPGC	
23	IBTPS Stage II	1	Thermal	660	OPGC	
		2	Thermal	660	OPGC	
24	Balimela	1	Hydro	60	OHPC	
		2	Hydro	60	OHPC	
		3	Hydro	60	OHPC	
		4	Hydro	60	OHPC	
		5	Hydro	60	OHPC	
		6	Hydro	60	OHPC	
		7	Hydro	75	OHPC	
		8	Hydro	75	OHPC	
25	U-Kolab	1	Hydro	80	OHPC	
		2	Hydro	80	OHPC	
		3	Hydro	80	OHPC	
		4	Hydro	80	OHPC	
26	U-Indravati	1	Hydro	150	OHPC	
		2	Hydro	150	OHPC	
		3	Hydro	150	OHPC	
		4	Hydro	150	OHPC	
27	Rengali	1	Hydro	50	OHPC	
		2	Hydro	50	OHPC	
		3	Hydro	50	OHPC	
		4	Hydro	50	OHPC	
28	GMR	3	Thermal	350	GMR Infra	
29	Sterlite (CPP)	1	Thermal	600	Vedanta	
		2	Thermal	600	Vedanta	
		3	Thermal	600	Vedanta	
		4	Thermal	600	Vedanta	

Annexure 2: Guidelines for the performance evaluation of primary frequency response of a generating unit during sudden frequency change event.

Steps for analysis of the performance of primary frequency response:

- Unit output (MW) and frequency (Hz)/machine speed (RPM) recorded at generator data collection system (DCS) are to be collected for minimum 5 min duration (1 min prior to the frequency change and 4 min after the frequency change). The resolution of data should be not less than one data per second. Other unit parameter data e.g. RGMO influence, turbine pressure may be collected if required for analysis.
- Both unit output (MW) and frequency (Hz)/machine speed (RPM) are to be plotted with respect to time as shown in figure 1.

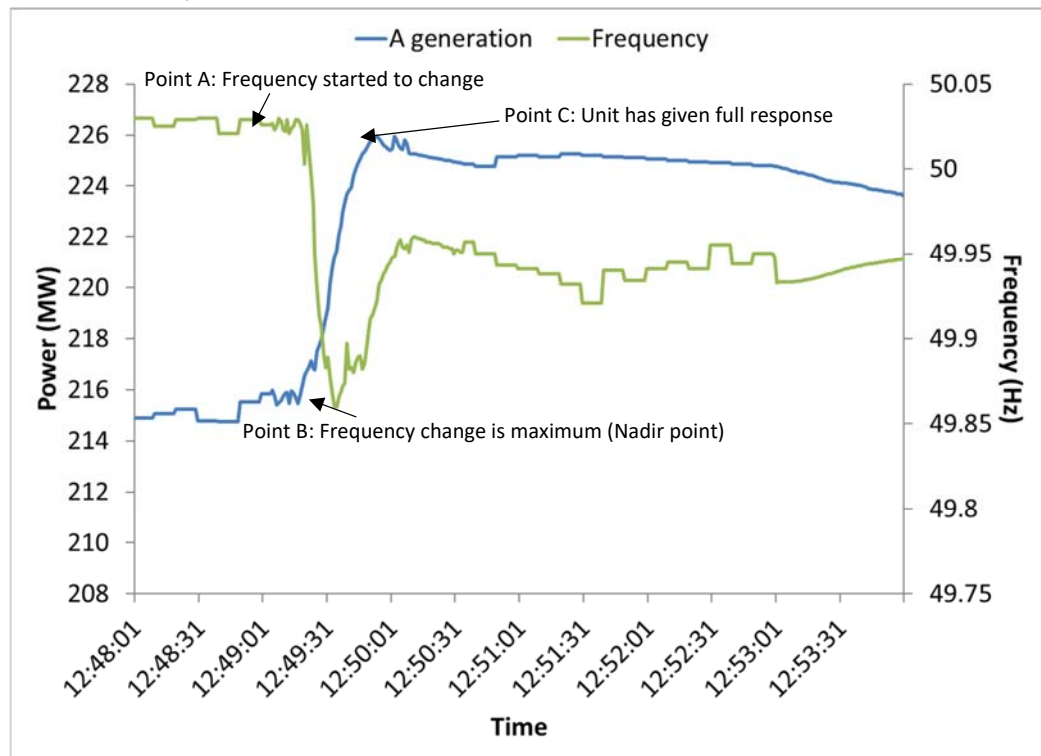


Figure 1: Primary frequency response provided by a generating unit

Analysis of the response of generating unit:

After plotting the response of a generating units, following parameter may be compiled for each generating unit

- **Frequency change during the event (F)** = Frequency at point B – Frequency at point A.
- **Ideal response (P_{ID})** = (Frequency change during the event (F)/2.5) * Installed Capacity limited to 5% of generation
- **Response observed (P)** = Unit output at Point C – Unit output at Point A
- **Time to reach full response (T)** = Time at point C – Time at point A
- **Duration of the response:** Time duration between Point C and the instant when withdrawal of governor response started

Response of any unit will be considered non-satisfactory (as per IEGC) in case of

- Response of any unit < 80% of ideal response (P_{ID})

- Response of any unit is oscillatory in nature
- Response of any unit is withdrawn (after providing response) at ramp rate more than 1% of installed capacity per minute

Governor may be tuned for any unit in case of

- Time to reach full response (T) > 30 seconds
- Duration of the response < 3 min

Analysis of the response shown in figure 1

- Unit capacity = 250 MW.
- Frequency change during the event (F) = (50.02 – 49.86) = 0.16 Hz
- Ideal response (P_{ID}) = Minimum of $\{(0.16/2.5) * 250, 215 * 0.05\} = 10.75$ MW
- Response observed (P) = (225.75 – 215.45) = 10.3 MW
- Time to reach full response (T) = Around 30 seconds
- Duration of the response: More than 3 min
- Response of this unit was satisfactory (as per IEGC) as
 - Response of this unit (10.3/10.75) = 96% of ideal response
 - Response of this unit is stable and non-oscillatory
 - Response of this unit was withdrawn at rate of less than 1% of installed capacity per min i.e. 2.5 MW/min

Annexure 3: Relevant regulatory provisions for primary frequency response of generating units

Indian Electricity Grid Code:

- **IEGC 5.2.f:** All Coal/lignite based thermal generating units of 200 MW and above, Open Cycle Gas Turbine/Combined Cycle generating stations having gas turbines of capacity more than 50 MW each and all hydro units of 25 MW and above shall be operated under restricted governor mode of operation.
- **IEGC 5.2.g:** 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 and no dead bands and/or time delays shall be deliberately introduced. Provided that periodic checkups by third party should be conducted at regular interval once in two years through independent agencies selected by RLDCs or SLDCs as the case may be. The cost of such tests shall be recovered by the RLDCs or SLDCs from the Generators. If deemed necessary by RLDCs/SLDCs, the test may be conducted more than once in two years.
- **IEGC 5.2.i :** 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 49.8 Hz, all partly loaded generating units shall pick up additional load at a faster rate, according to their capability

Bihar Electricity Grid Code:

- **Section 6.3.6:** All generating units of 200 MW and above in case of thermal and 10 MW and above in case of hydro which are synchronized with the grid irrespective of their ownership shall have their governors in normal operation at all times. If any generating unit of over 50 MW size is required to be operated without its governor in normal operation, the ERLDC through SLDC shall be immediately intimated about the reason and duration of such operation. The exemption from free governor mode operation in respect of run of river hydro stations without any pondage, steam turbine of thermal and gas based power stations not having free governor mode facility shall be obtained from CERC under clause 1.6 of IEGC.
- **Section 6.3.7:** Facilities available with / in Load limiter, Automatic Turbine Run-up System (ATRS), Turbine Supervisory Coordinated Control System etc., shall not be used to bypass the normal governor action in any manner. No dead bands and time delays shall be deliberately introduced.
- **Section 6.3.8:** All generating units operating in Free Governor Mode Operation (FGMO) at or up to 100% of their maximum continuous rating shall normally be capable of (and shall not be prevented from) picking up 5% extra load, more than the declared maximum continuous rating, for at least five minutes or within the technical limits specified by the manufacturers, when the frequency falls due to a system contingency. In case any generating unit of 50 MW and above size does not meet this requirement for any period, the generating company should intimate the same to SLDC along with reasons thereof. Any generating unit not capable of complying with above provisions either due to not having requisite facilities or otherwise shall seek exemption from Central Electricity Regulatory Commission (CERC) under clause 1.6 of IEGC.

Jharkhand State Electricity Regulatory Commission (State Grid Code) Regulations, 2009

- **Section 22.8:** Each In-State Generating Unit shall be fitted with a turbine speed governor having an overall droop characteristic within the range of 3% to 6% and such turbine speed governor shall always be in service:

Provided that if any in-State generating unit of over fifty (50) MW size is required to be operated without its governor in normal operation, the State Load Despatch Centre shall be immediately advised about the reason and duration of such operation.

- **Section 22.9:** Facilities available with/in load limiters, Automatic Turbine Run-up System, 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.
- **Section 22.10:** Each in-State Generating Unit shall be capable of instantaneously increasing output by 5%, when the frequency falls, subject to limit of 105% of Maximum Continuous Rating. Ramping back to the previous generation level, in case the increased output level cannot be sustained, shall not be faster than 1% per minute:

Provided that any in-State generating unit of over Fifty (50) MW size not complying with the above requirements, shall be kept in operation (synchronized with the State Grid) only after obtaining the permission of State Load Despatch Centre:

Provided also that User can make up the corresponding short fall in spinning reserve by maintaining an extra spinning reserve on the other generating units of the User

- **Section 22.11:** 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.

Odisha Grid Code Regulations, 2015

- **Section 5.2.6:** 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 shall have their governors in normal operation at all times. Such generating units (except those with upto three hours pondage) shall be operated under restricted governor mode of operation. 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 50.05 Hz. (for example if grid frequency changes from 49.90 to 49.95 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.
- **Section 5.2.7:** All other generating units including the pondage upto 3 hours, Gas turbine/Combined Cycle Power Plants, wind and solar generators and Nuclear Power Stations shall be exempted from Sections 5.2(6), 5.2 (9), 5.2 (10) and 5.2 (11) till review of the situation by appropriate Commission. Provided that if a generating unit cannot be operated under restricted governor mode operation, then it shall be operated in free governor mode operation with manual intervention to operate in the manner required under restricted governor mode operation.
- **Section 5.2.8:** If any Generating Unit of 200 MW and above and all hydro units of 10 MW and above, is required to be operated without its governor in normal operation, the SLDC shall be immediately advised about the reason and duration of such operation. All governors shall have a droop of between 3% and 6%.
- **Section 5.2.9:** 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.

- **Section 5.2.10:** All Generating Units of 200 MW and above and all hydro units of 10 MW and above, 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 to 105% and 110% of their MCR, respectively, 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 not complying with the above requirements shall be kept in operation (synchronized with the State grid) only after obtaining the permission of SLDC. However, SLDC can make up the corresponding short fall in spinning reserve by maintaining an extra spinning reserve on the other Generating Units of the State.
- **Section 5.2.11:** 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 & size would be 1% per minute or as per manufacturer's limits.

West Bengal Electricity Regulatory Commission (State Electricity Grid Code) Regulations, 2007

- **Section 4.2.5:** All generating units, which are synchronized with the grid, irrespective of their ownership, type and size, shall have their governors in normal operation at all times. If any generator of over 50 MW rating is required to be operated without its governor in normal operation, the SLDC shall be immediately advised about the reason and duration of such operation. All governors shall have a droop between 3% and 6%.
- **Section 4.2.6:** Facilities available with 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. No dead bands and / or time delays shall be deliberately introduced.
- **Section 4.2.7:** All generating units, operating at or up to 100% at their MCR shall normally be capable of (and shall not in any way be prevented from) instantaneously picking up five percent (5%) extra load as soon as possible but preferably within five (5) minutes when frequency falls due to a system contingency. However, for existing generating units (generating units of COD up to 31.12.2005), these should be within the technical limits stipulated by the manufacturer. The generating units operating at above 100% of their effective MCR shall not be prevented from going at least up to 105% of their effective MCR when frequency falls suddenly. After an increase in generation as above, a generating unit may slide back to the original level at a rate of about 1% per minute, in case continued operation at the increased level is not sustainable. Any generating unit (synchronized with the State grid) of over fifty (50) MW size, not complying with the above requirement, shall be kept in operation only after obtaining the permission of the SLDC. However, the entity can make up the corresponding shortfall in spinning reserve by maintaining an extra spinning reserve on the other generating units of the entity.
- **Section 4.2.8:** The recommended rate for changing the governor setting, i.e. supplementary control for increasing or decreasing the generation sent out for all generating units, irrespective of their types and sizes, would be 1% 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 respective capability

CERC order in 84/MP/2015 dated 31st July 2017:

- Para 23 (a) of the order state that “the Commission, starting from the month of September, 2017 shall be closely watching the primary response of ISGSs as reported by POSOCO/NLDCs. At the State level, SLDCs shall report the frequency response of intra-State generators to the concerned SERCs.”

Para 23 (c) of the order state that “All ISGSs are directed to provide primary response compulsorily in terms of Regulation 5.2 (f), (g), (h) and (i) of the Grid Code failing which we would not hesitate in initiating action under Section 142 of Electricity Act, 2003 for not providing desired RGMO/FGMO response without any valid reasons.”

CERC Terms and conditions of Tariff regulation 2019:

- **Regulation 30(2)-(i):** In case of a new project, the rate of return on equity shall be reduced by 1.00% for such period as may be decided by the Commission, if the generating station or transmission system is found to be declared under commercial operation without commissioning of any of the Restricted Governor Mode Operation (RGMO) or Free Governor Mode Operation (FGMO), data telemetry, communication system up to load dispatch centre or protection system based on the report submitted by the respective RLDC; Regulation 30(2)-(ii): in case of existing generating station, as and when any of the requirements under (i) above of this Regulation are found lacking based on the report submitted by the concerned RLDC, rate of return on equity shall be reduced by 1.00% for the period for which the deficiency continues;

Decision taken in OCC meeting:

As per decision taken in 145th OCC meeting, generating station is to send 1 sec or higher resolution data to ERLDC/SLDC as the case may be.