Ref: POSOCO/NLDC/AGC  

Dated: 09-10-2019

To,

As per distribution list

Subject: Minutes of meeting for implementation of Automatic Generation Control (AGC) dated 03rd October 2019.

Sir / Madam,

A meeting was held on 3rd October 2019 from 1100hrs to 1700hrs at NLDC for discussion on the requirements for AGC to be implemented at generator ends by the generators and activities to be undertaken by them for speedy implementation of AGC. Representatives from NTPC, NHPC, NLC, NSPCL, CGPL, THDC, BBMB, NEEPCO, Sasan, SJVNL and MPL participated in the meeting along with POSOCO. List of participants is attached as Annexe-I.

The minutes of meeting are attached for your kind reference.

Thanking You,

Yours Sincerely,

(N. Nallarasan)
Senior General Manager
NLDC, POSOCO.
Minutes of the Meeting held on 3rd October 2019 at National Load Despatch Centre (NLDC) regarding requirements for automatic generation control (AGC) connecting equipment at power plants as per CERC Order 319/RC/2018 dated 28th August 2019

1. NLDC vide communication dated 17th September 2019 notified the minimum requirements for AGC connecting equipment at power plants based on the experience of the AGC Pilot Project. The same is uploaded on the NLDC, POSOCO website at https://posoco.in/download/communication-to-power-plants-regarding-agc/?wpdmdl=24784

2. In this regard, a meeting (intimated through email dated 30th Sep’19) was organised at NLDC on 3rd October 2019 from 1100hrs to 1700hrs for discussion on the requirements for AGC to be implemented at generator ends by the generators and activities to be undertaken by them for speedy implementation of AGC.

3. Representatives from NTPC, NHPC, NLC, NSPCL, CGPL, THDC, BBMB, NEEPCO, Sasan, SJVNL and MPL participated in the meeting along with POSOCO. List of participants is attached as Annexes-I.

4. Executive Director, NLDC welcomed the participants and the importance of Automatic Generation Control (AGC) was briefly explained and informed that CERC Order 319/RC has to be implemented at the earliest. Senior GM (SO), NLDC explained about the experience with the AGC pilot project.

5. NLDC gave a presentation for driving the discussion covering the topics of experience with the AGC pilot project, CERC Order 319/RC on pan India implementation of AGC and action points for implementation of AGC at the identified power plants. A copy of the presentation is attached as Annexes-II. The presentation briefly covered:
   a. Background and past developments in AGC
   b. AGC pilot project architecture and design for the 5 plants under AGC
   c. CERC Order 319/RC proposed implementation plan
   d. Action items for power plants
   e. Accounting and settlement mechanism under AGC

6. Power plants have enquired regarding the input and output signals for AGC as given in the generic specifications uploaded on the POSOCO website. NLDC suggested to go for vendor agnostic solutions to meet the generic requirements.

7. NTPC shared their experience regarding AGC pilot project with five power plants, one in each region of Indian power system.

8. CGPL had a concern about optimizing their number of coal mills for various operating points. It was clarified by NLDC and NTPC that extra mills have to be brought into service.
only when the spinning reserves get exhausted. That is typically done by the power plants even without AGC to meet their normal schedules. It was requested to maintain a margin, if possible, depends upon the schedule.

9. NHPC enquired whether there will be a limit defined for maximum variation of AGC signal as presently being done at 50 MW, it was informed that initially though the band may be provided, but with the increase in participation by generators in AGC, such band will be removed. Besides, if any such operational limit is required at all, will be configured at NLDC end.

10. BBMB asked about the scenario of the AGC signal received when the plant runs at maximum schedule. NLDC clarified that AGC signal honours all the technical limits specified by the plants, therefore in case of zero margin in the plant no increment in the generation will be given under AGC. However, there may be the instruction for reduction in generation depending upon the Area Control Error (ACE) as automatic generation control works both ways (Up/Down).

11. NHPC informed that some of their Digital Control Systems (DCS) are capable of interfacing directly with the CTU/POWERGRID wide band communication node (via fibre optic cable) and no extra equipment may be needed. NLDC explained that if the DCS at NHPC stations can transfer and accept the desired input and output signals needed for AGC and can perform the desired calculations, equipment may be optimised to that extent with the firewall routers & communication redundancy at plant level.

12. Tehri HEP has expressed concern that its Restricted Governor Mode of Operation works immediately after a frequency change and RGMO might have to be disabled for effective functioning of AGC which was agreed to. NLDC informed that during AGC operation Free Governor Mode of Operation may be enabled to take care of primary response.

13. SJVNL suggested that inclusion of Rampur hydro may be looked into. NLDC agreed for consideration.

14. Few power plants expressed the opinion that not all the signals required for AGC are readily available in their Digital Control Systems. NLDC suggested that along with the procurement and installation of AGC interfacing equipment, configuring these signals in the DCS is also an activity which power plants have to take up in parallel. In addition to that NLDC, informed that necessary firewall and routers along with communication redundancy at the plant level to be taken. Logics proposed shall also be taken care at plant level. NLDC informed that the signals suggested are only the minimum requirements and some review might be needed on case to case basis as there is no experience of AGC particularly with hydro and gas power plants. Regarding the expenditure to be incurred by the Generator, the following provision of the CERC order was mention:

"The expenditure as a result of compliance of the above directions may be claimed as per relevant regulations or provisions of the PPA."

It was also clarified that no work/service at NLDC end is envisaged to be included in the contract which are proposed to be awarded by generators. However, support of the
contractor will be required at the time of integration with the AGC software at NLDC. Accordingly, scope of the contract shall be defined clearly.

It was also clarified that the new AGC software is being procured by NLDC and the generators will be connected to the new AGC system. However, there is limited provision available in the existing set-up and it is possible to connect in the existing AGC system also in case the generators are ready to integrate.

15. NLDC informed that the signals mentioned in the RTU technical specification document are needed for effective functioning of AGC software apart from other one-time static data that will be collected later.

16. On a query to NHPC regarding possibility of communication through gateway, it was clarified that the same gateway could be used but since the communication need to be established with NLDC, gateway should be configured with a separate domain and IP address will be provided by NLDC at the time of configuration.

17. CGPL informed that they have a central control configuration and that minimization of number of RTUs needed is possible. NLDC informed that required input signals from the plant as per the document shall be adhered to.

18. It was also mentioned that sufficient protection regarding cyber security must be ensured at plant level while connecting with NLDC AGC server as the communication is proposed on IEC-104.

19. NHPC proposed for a pilot project for gaining experience of AGC implementation.

20. Some power plants expressed that only few spare fibre optic cores are available from the CTU/POWERGRID at some places. NLDC informed to flag the same to the respective POWERGRID/CTU stations and start the implementation with available cores. But, having spare cores is necessary. It was also mentioned that NLDC has already taken up with CTU for extending the fibre network to the nearest switchyard in case the network node is not available.

21. It was also highlighted in the presentation and later discussions that coordination between CTU/POWERGRID and the power plants is a must. The same also has been informed by NLDC to CTU vide meeting dated 27th September 2019. CTU has assured their full cooperation in this aspect.

22. Two nodal officers from each power plant and two nodal officers from each corporate office shall be nominated for coordinating the AGC implementation process. The contacts shall be forwarded to NLDC at the earliest.

23. NLDC and NTPC informed that coordination between various departments of the power plant is necessary for hassle free implementation. It was suggested to conduct regular orientation/progress update sessions to different departments and top management on AGC at the respective power plants.
24. NLDC requested to expedite the placement of LOA within one month of the meeting as the time available for implementation of AGC as per the CERC Order 319/RC is very short and the implementation has to be completed at the power plants latest by 31st January 2020. NLDC would need time to check the data of more than 75 power plants and integrate them into AGC by 1st April 2020.

25. It is proposed to have the next meeting for progress review around 22nd November 2019 and exact date would be intimated by NLDC.

26. NLDC as per the request from the power plants agreed to formally inform the top management of power plants for fast track implementation of AGC.

27. ED, NLDC and Sr.GM, NLDC thanked all the participants for their active participation and discussions.
<table>
<thead>
<tr>
<th>S. No.</th>
<th>Name</th>
<th>Designation</th>
<th>Organisation</th>
<th>E-mail ID</th>
<th>Contact Number</th>
<th>Signature</th>
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Automatic Generation Control Implementation in Indian Power System

3rd Oct 2019
NLDC, POSOCO, New Delhi
Frequency Profile over the years...

AVERAGE FREQUENCY PLOT

Slow Tertiary implemented from April, 2016
Maximum and Minimum Frequency patterns

MAXIMUM AND MINIMUM FREQUENCY PATTERNS

Hz

Date -->

MAXIMUM
MINIMUM
<table>
<thead>
<tr>
<th>S.No</th>
<th>Description</th>
<th>Values for</th>
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<td>1</td>
<td>Standard Deviation (Hz)</td>
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<td>2</td>
<td>Frequency Variation Index (FVI) in Hz</td>
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<tr>
<td>3</td>
<td>Instantaneous maximum frequency (Hz)</td>
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<td>4</td>
<td>Instantaneous minimum frequency (Hz)</td>
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<tr>
<td>5</td>
<td>15-minute maximum average frequency (Hz)</td>
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<td>6</td>
<td>15-minute minimum average frequency (Hz)</td>
<td>49.965</td>
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<tr>
<td>7</td>
<td>% of time frequency within 49.90-50.05 Hz</td>
<td>99.61</td>
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<tr>
<td>8</td>
<td>% of time frequency below 49.90 Hz</td>
<td>0.00</td>
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<tr>
<td>9</td>
<td>% of time frequency above 50.05 Hz</td>
<td>0.39</td>
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Frequency Control Continuum in India

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<tr>
<th>Response Attribute</th>
<th>Inertial</th>
<th>Primary</th>
<th>Secondary</th>
<th>Fast Tertiary</th>
<th>Slow Tertiary</th>
<th>Generation Rescheduling/Market</th>
<th>Unit Commitment</th>
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<tr>
<td>Time</td>
<td>First few sec</td>
<td>Few sec - 5 min</td>
<td>30 s – 15 min</td>
<td>5 - 30 min</td>
<td>&gt; 15 – 60 min</td>
<td>&gt; 60 min</td>
<td>Hours/day-ahead</td>
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<tr>
<td>Quantum</td>
<td>~ 10000 MW/Hz</td>
<td>~ 4000 MW</td>
<td>~ 4000 MW</td>
<td>~ 1000 MW</td>
<td>~ 8000-9000 MW</td>
<td>Load Generation Balance</td>
<td>Load Generation Balance</td>
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<tr>
<td>Local / LDC</td>
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<td>Local</td>
<td>NLDC / RLDC</td>
<td>NLDC</td>
<td>NLDC / SLDC</td>
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<td>Code / Order</td>
<td>IEGC / CEA Standard</td>
<td>IEGC / CEA Standard</td>
<td>Roadmap on Reserves</td>
<td>Ancillary Regulations</td>
<td>Ancillary Regulations</td>
<td>IEGC</td>
<td>IEGC</td>
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<td>Paid / Mandated</td>
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<td>Implementation</td>
<td>Existing</td>
<td>Partly Existing</td>
<td>Pilot</td>
<td>Pilot</td>
<td>Existing</td>
<td>Existing</td>
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System Frequency 50 Hz

Deviation from 50 Hz

Primary Control

- Activate
- 5-30s
- Take Over
- Free Reserves

Secondary Control

- Activate
- Take Over
- 30s – 5 min+
- Free Reserves

Tertiary Control

- Activate
- Take Over
- > 5 min +
- Free Reserves

- Primary (droop) control
  - Obligatory, Automatic response

- Secondary (AGC) control
  - Spinning reserve, NLDC/RLDC/SLDC controlled, Automatic Generation Control (AGC)

- Tertiary control
  - Tertiary Reserve and response from State, Manual
Immediate Frequency Response after an Event

- Rate of change of Frequency
- B. Nadir Frequency
- C. Quasi Steady State Frequency

- Importance of Inertia
- Load
- Frequency Nadir
- Quasi Steady State Frequency
All in a day’s play...Repeated again and again
### Timeline of Major Activities

<table>
<thead>
<tr>
<th>Oct’15</th>
<th>Roadmap to operationalise Reserves in the country</th>
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<tbody>
<tr>
<td>Mar’16</td>
<td>FOLD</td>
</tr>
<tr>
<td>Jan’17</td>
<td>LOA to M/s Siemens</td>
</tr>
<tr>
<td>Nov’17</td>
<td>Hon’ble CERC visit to NTPC Dadri</td>
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<tr>
<td>50 Hz</td>
<td>report Nov’17</td>
</tr>
<tr>
<td>Simhadri</td>
<td>stg-II Nov’18</td>
</tr>
<tr>
<td>Barh</td>
<td>stg-II Aug’19</td>
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<tr>
<td>Nov’18</td>
<td>Pan-India implementation of AGC by Apr’20</td>
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#### Jan’16
- Brainstorming session
- POSOCO visit to NTPC Dadri

#### Mar’16
- Mock Test 29th Jun’17

#### May’16
- CERC Order 6th Dec’17

#### Apr’20
- Dadri stg-II 4th Jan’18

#### Oct’19
- Mauda stg-II Mar’19

#### Aug’19
- Barh stg-II Oct’19

#### Nov’18
- Simhadri stg-II

#### Dec’17
- 50 Hz report Nov’17

#### Jan’18
- CERC Order 6th Dec’17

#### Dec’17
- 50 Hz report Nov’17

#### Jan’17
- Mock Test 29th Jun’17

#### Jan’17
- Hon’ble CERC visit to NTPC Dadri

#### May’16
- LOA to M/s Siemens
Region considered as an Area for secondary control

\[ \text{ACE} = (I_a - I_s) + 10 \times B_f \times (F_a - 50) \]

- \( I_a \) = Actual net interchange, negative for NR meaning import by NR
- \( I_s \) = Scheduled net interchange, negative for NR meaning import by NR
- \( B_f \) = Frequency Bias Coefficient in MW/0.1 Hz, positive value
- \( F_a \) = Actual System Frequency
- ACE positive means NR is surplus and NR internal generation has to back down
- ACE negative means NR is deficit and NR internal generation has to increase

- Tie line bias mode and Frequency bias only mode both possible
Data Flow in AGC Project

NLDC SCADA

AGC on/Off
AGC Set Point
Scaled ACE

ICCP

NR-IR Schedule
NR-IR Actual Frequency

AGC System at NLDC

AGC Set Point

IEC 104 Protocol

AGC RTU at Plant

AGC Local/Remote
Unit Load Set Point
Actual Generation
Circuit Breaker Status

AGC console at Plant

Factor

DeltaP

Plant DCS
Performance Monitoring Display

AGC PILOT PROJECT: FUNCTIONAL BLOCK DIAGRAM

DADRI IFS STATUS: UP
NLDC AGC
UP ICCP STATUS

DADRI UI

NTPC DADRI STAGE-2
UNIT 5 ON BAR: ON
UNIT 6 ON BAR: ON
UNIT 5 L/R: REMOTE
UNIT 6 L/R: REMOTE
ULSP1/ULSP2: 325/270
TOTAL ULSP: 595

NTPC SIMAHADRI STG-2
UNIT 3 ON BAR: ON
UNIT 4 ON BAR: ON
UNIT 3 L/R: REMOTE
UNIT 4 L/R: REMOTE
ULSP1/ULSP2: 294/291
TOTAL ULSP: 586

PLANT DELTA P:
UNIT 3 DELTA P1: 25
UNIT 4 DELTA P2: 25
UNIT 3 GEN: 322
UNIT 4 GEN: 330
TOTAL GEN: 653
Variation of AGC regulation signal over a typical day
Input vs Output

Response of Plant Output wrt Input Command from AGC

Input (x) Vs output (y)
\[ y = 0.8849x \]
\[ R^2 = 0.8324 \]

"Skid" of around 15 MW

"Skid" of around 25 MW

95000 samples over 3 months
16\(^{th}\) Nov – 31\(^{st}\) Jan 2019
Ramp rate of the plant AGC set point

Plant ramp rate in MW/min during the mock test on 29th June 2017

Ramp rate limited to +/- 10 MW/min
All thermal ISGS stations with installed capacity of 200 MW and above

All hydro stations having capacity exceeding 25 MW excluding the Run-of-River Hydro Projects

Whose tariff is determined or adopted by CERC

Directed to install equipment at the unit control rooms

Required data for AGC as per the requirement to be notified by NLDC.

- [https://posoco.in/download/communication-to-power-plants-regarding-agc/?wpdmdl=24784](https://posoco.in/download/communication-to-power-plants-regarding-agc/?wpdmdl=24784)

Shall have communication from the nearest wide band node to the RTU in the unit control room

- Fibre optic cable might have to be laid
- Dual cable and Path redundancy
- Armoured cable against rodents/damage

Central Transmission Utility (CTU) is directed to have communication availability from NLDC/ RLDCs to the nearest wide band node/ switchyard for the generating stations in a redundant and alternate path ensuring route diversity and dual communication

- Meeting held with CTU dated 27th Sep’19 for discussing way-ahead
- Mutual coordination of CTU and Power Plants is also necessary
• Plants shall be AGC-enabled within six months of this order
  • NLDC is directed to monitor implementation of the above directions
    • Target date 1st April 2020
• All new power plants shall be AGC enabled
• NLDC/RLDCs are allowed to operate the AGC system for enabling the signals to the power plants at the earliest.
• The framework regarding compensation for AGC support and deviation charges as stipulated in the Commission’s Order in Petition no. 79/RC/2017 dated 06.12.2017 shall apply to the five pilot projects as also to other ISGS as and when they are AGC enabled.
  • This arrangement shall remain in place till the relevant regulations inter-alia on compensation for AGC services are framed by the Commission.
  • Generating company corporate offices shall have a 2-3 member team for following up metering, accounting and settlement with power plants.
  • Detailed procedure and formats for metering and accounting will be uploaded on POSOCO website shortly.
  • Weekly accounting by RPCs based on data sent by RLDCs/NLDC
Action items for power plants

• Provide the infrastructure for AGC connecting equipment
  o Generic requirements uploaded on website
  o Vendor agnostic
  o Communication over IEC-104

• Arranging the communication from the existing nearest wideband communication node to the unit control room
  o Through redundant and alternate paths
  o Where remote terminal unit would be located
  o Through redundant fibre optic cables
  o In coordination with Central Transmission Utility (CTU)

• Basic signal list

• Simple logics might have to be configured/re-designed
  o First time experience in India
  o Ensure necessary training at power plants
  o Large pool of experts at power plants
WRPC MUMBAI  
D. Payments to the AGC Service Provider from the DSM Pool for the week 22-04-2019 to 28-04-2019

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>AGC Provider Name</th>
<th>Total AGC UP and Down regulation (MWh) (based on 5-Min schedule)</th>
<th>Markup at the rate of 50p/unit for both positive and negative AGC from the DSM Pool (Mwh) (Rs) (A+1000*0.5)</th>
<th>Total Net AGC (MWh) (based on 15-Min schedule)</th>
<th>AGC Energy Charges (Rs) (C+Variable Cost)</th>
<th>Total Charges [(Payable to Pool/ Receivable from Pool) (Rs) (B+D)]</th>
<th>Payable to Pool/ Receivable</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mouza STPP Stage-II NTPC Ltd</td>
<td>6058.516</td>
<td>3,029,258.000</td>
<td>515.256</td>
<td>1,453,021.074</td>
<td>4,482,279.074</td>
<td>Receivable</td>
</tr>
</tbody>
</table>

Note: Above calculations are based on the direction of Hon'ble CERC in order dated 06.12.2017 in petition No:79/RC/2017
AGC Compensation Mechanism

• 5-Minute MWh accounting for incentive calculation
• 15-Minute MWh account for net energy calculation
• For Up regulation there would be Payment from the pool and incentive from DSM pool
• For Down regulation there would be payment to the pool and incentive from DSM pool
• Reconcile data from Digital Control System / RTU installed
• Accounts be sent by power plants corporate to NLDC/RLDCs for verification by Tuesday
• Corporate teams to compile and coordinate the accounts
• NLDC/RLDCs to prepare final account and submit to RPCs
• Weekly Accounting by RPCs
• Detailed procedure would be uploaded on POSOCO website
Following values archived at NLDC as well as at Power Plant

1. Offline scheduling software: Pshdl (15 minute average MW)
2. Offline metering system: PACT (15 minute MWh)
3. NLDC AGC Server (2 sec instantaneous MW):
   i. P set point
   ii. ULSP #5
   iii. ULSP#6
   iv. ΔP#5, ΔP#6
   v. RGMO-1, RGMO-2

Values used for settlement

i. Energy Charge: Pshdl/4 MWh
ii. AGC shdl = (Σ_{t=0}^{15} \min \frac{ΔP}{1800}) \text{ MWh} - NAC
iii. DSM = P Act - Pshdl/4 - AGC Shdl - NAC
iv. Mark up for AGC = (Σ_{t=0}^{5} \min \frac{ΔP}{1800}) \text{ MWh}
v. Performance: Track ΔP Vs
   Pgen1 + Pgen2 – ULSP1 – ULSP2 – RGMO1-RGMO2
Future Ready AGC for 175 GW of RE by 2022

- Forecasting of Load & RE
- Use of Pumped Storage Plants
- Automatic controls
AGC on other Plants

- Karnataka Power Transmission Corporation Limited (KPTCL)
  - Varahi, Sharavati @ 3rd August 2017 workshop
- NP Kunta Solar power project
  - Under Greening the Grid (GtG)-RISE project, MoP
  - Workshop by USAID and NLDC on 15th May 2018 at Andhra Pradesh SLDC, Vijayawada
- Agenda on AGC sent for discussion in RPCs, several RPC meetings conducted
  - National Power Committee (NPC) meeting held at Indore on 8th Sep 2017
- Workshop at NCTPS on 28th Dec 2018
- Visit of Telangana, Kerala and TN officers to Simhadri on 24th Jan 2019
- Dadri stg-II in continuous operation from January 2018
- Simhadri stg-II in continuous operation from November 2018
- Mauda stg-II operationalised from March 2019
- Barh stg-II operationalised from Aug 2019, Bongaigaon in advanced phases
- Contracting issues
- NLDC SCADA upgradation by mid 2020
  - Target to have AGC on several phase-I plants by 2020
Coordinated action items for RPCs

• Ensuring accurate load forecasting and Renewable Energy (RE) forecasting.
• Proper scheduling by each state including indication of reserves
• Evaluate Area Control Error (ACE) of each control area
• The SLDCs must also monitor the primary response from the generating units within the state
• Periodic monitoring of the data quality needs to be done at the RPC forums
• Fibre optic communication from Regional Entity power plant to nearest CTU node and there on to RLDCs/NLDC
• Ensure adequate reserves for secondary control
• Renewable Energy (RE) resources under AGC
Pathway to Pan-India AGC Rollout

5 Generation Plant

5.3 GW
Generation plants under pilot

~₹ 2.5 Crore
Project Cost

5000
Highly Skilled Manhours

Several km
Existing Communication path

6 km
Optical Fibre

100+ Generation Plants

65 GW+
By 2021

₹ 150 Crore+
Pan-India roll out

25000+
Highly Skilled Manhours

1000s km
Existing Communication path

140 km+
Optical Fibre
Useful Links

• CERC Order for implementation of AGC Pan-India – Aug 2019

• Requirements for Automatic Generation Control (AGC) Connecting Equipment at Power Plants – Sep 2019
  • [https://posoco.in/download/communication-to-power-plants-regarding-agc/?wpdmdl=24784](https://posoco.in/download/communication-to-power-plants-regarding-agc/?wpdmdl=24784)

• 50 Hz report of the Expert Group – Nov 2018

• CERC Order on AGC pilot – Dec 2018

• Modus Operandi on AGC submitted to CERC – Jul 2017
  • [https://posoco.in/download/detailed-modus-operandi-on-operationalization-of-spinning-reserves/?wpdmdl=13461](https://posoco.in/download/detailed-modus-operandi-on-operationalization-of-spinning-reserves/?wpdmdl=13461)

• Sample AGC accounts by RPCs - 2019
  • [http://wrpc.gov.in/htm/may19/rrasmay5.10.pdf](http://wrpc.gov.in/htm/may19/rrasmay5.10.pdf)
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- Reserve Regulation Ancillary Services (RRAS) Implementation in Indian Grid - Half Year Analysis and Feedback by POSOCO, November, 2016. [online] https://posoco.in/download/half-year-feedback-to-cerc/?wpdmdl=8916


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• ENTSOE, Supporting Document for the Network Code on Load-Frequency Control and Reserves, 2013
• Frequency data of Continental Europe available at RTE France website
• ENTSOE P1 – Policy 1: Load-Frequency Control and Performance [C], 2009
• NERC Standard BAL-001-2 – Real Power Balancing Control Performance
• NERC WECC Standard BAL-002-WECC-2 — Contingency Reserve
  (http://www.nerc.com/files/BAL-002-WECC-2.pdf)
• NERC standard BAL-001-TRE-1 — Primary Frequency Response in the ERCOT Region
• Glossary of Terms Used in NERC Reliability Standards
• NERC BALANCING AND FREQUENCY CONTROL: A Technical Document Prepared by the NERC Resources Subcommittee
  (http://www.nerc.com/docs/oc/rs/NERC%20Balancing%20and%20Frequency%20Control%2004052011.pdf)
• Draft European Union regulation on establishing a guideline on electricity transmission system operation, 2016
• Essential Reliability Services and the Evolving Bulk-Power System— Primary Frequency Response, Issued November 17, 2016
• FERC report – John Undrill
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