ग्रिड-इंडिया
GRID-INDIA

ग्रिड कंट्रोलर ऑफ इंडिया लिमिटेड
(भारत सरकार का उद्यम)
GRID CONTROLLER OF INDIA LIMITED
(A Government of India Enterprise)
[formerly Power System Operation Corporation Limited (POSOCO)]
राष्ट्रीय भार प्रेषण केन्द्र / National Load Despatch Centre

कार्यालय : बी-9, प्रथम एवं द्वितीय तल, कुतुब इंस्टीट्यूशनल एरिया, कटवारिया सराय, नई दिल्ली - 110016
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संदर्भ: NLDC/SO/IEGC/Operating Procedure/

दिनांक: 11th Sep 2023

सेवा में,

All the Stakeholders

विषय: Stakeholder Workshop on Draft Procedure for **Resource Adequacy Assessment** – Reg.

संदर्भ: Central Electricity Regulatory Commission, Indian Electricity Grid Code, Regulations, 2023

महोदय/महोदया,

In compliance to the regulations 28 (3) of the Central Electricity Regulatory Commission (Indian Electricity Grid Code), Regulations 2023 published on 29th May 2023, NLDC in consultation with RLDCs has prepared a detailed Operating Procedure. **"Procedure for Resource Adequacy Assessment"** pursuant to Clause 5(3)(e) of the IEGC, is one of the important procedures to be included in the main Operating Procedure.

Accordingly, the draft procedure for **"Procedure for Resource Adequacy Assessment"** has been published on Grid-India website on **11th September 2023** and is available at: **https://posoco.in/nldc-procedures/.**

To familiarise the stakeholders about this procedure, an online workshop is being organized by Grid-India at **10:30 hrs** on **18th September 2023.**

All stakeholders are requested to join the workshop through the following link:

Stakeholder suggestions/feedback on this draft procedure are invited at operatingprocedure@grid-india.in by **20th September 2023.**

Microsoft Teams Meeting

Meeting ID: 438 833 079 494

Passcode: gbsBuw

सधन्यवाद,

भवदीय,

सुरजीत

(सुरजीत बनर्जी)

मुख्य महाप्रबंधक (प्रणाली प्रचालन, रा.भा.प्रे.के.)

Copy for kind information:

1. All RLDC/NLDC Heads

Annexure-I of Operating Procedure

Grid Controller of India Limited
(Formerly Power System Operation Corporation Limited)
National Load Dispatch Centre (NLDC)

Procedure for Resource Adequacy Assessment
(To be Part of NLDC Operating Procedure)

Prepared in Compliance

to

Central Electricity Regulatory Commission
IEGC Regulations, 2023

September 2023

Contents

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Procedure for Resource Adequacy Assessment

1. Background

1.1. As per clause 16.4 of the Electricity (Amendment) Rules, 2023 notified by Government of India, Ministry of Power.

"The National Load Dispatch Centre and the Regional Load Dispatch Centres shall carry out assessments of resource adequacy, for operational planning, at the national and regional levels, respectively, on an annual basis, in accordance with the guidelines issued by the Central Government."

1.2. This procedure is in accordance with clause 5.3 of the Indian Electricity Grid Code, 2023 notified by the Central Electricity Regulatory Commission.

"5.3. (d) …. each STU or such other agency as may be designated by the State Commission, on behalf of the distribution licensees in the State shall provide to NLDC every year, the details regarding demand forecasting, assessment of existing generation resources and such other details as may be required for carrying out a national level simulation for generation resource adequacy for States.

5.3. (e) …. NLDC shall carry out a simulation, to assist the States in drawing their optimal generation resource adequacy plan. While carrying out the simulation, NLDC shall also take into consideration the information related to demand estimation, generation planning and related matters as available with CEA…"

1.3. As per clause 31.1. (c) of the Indian Electricity Grid Code, 2023 notified by the Central Electricity Regulatory Commission.

"….. RLDCs in consultation with NLDC shall issue procedures and formats for data collection to carry out: (i) Operational planning analysis……"

1.4. As per clause 3.2 of Section-3 of CEA Guidelines for Resource Adequacy.

"NLDC shall annually publish a one-year look-ahead Short-term National Resource

Adequacy Plan…."

Concurrent reading of the above provisions indicates that year ahead operation planning studies shall include studies for short term resource adequacy assessment for national level by NLDC.

2. Objective

2.1. The objective of this procedure is to describe the methodology adopted by NLDC for national level simulation for assessing generation resource adequacy and one year look ahead operational planning.

3. Definitions

3.1. Words and expressions used in this procedure are defined in the Act or any other regulations specified by the Central Commission, Central Electricity Authority or Guidelines for Resource Adequacy Planning Framework for India by Ministry of Power shall, unless the context otherwise requires, have the meanings assigned to them under the Act or other regulations specified by the Central Commission, as the case may be.

3.2. The description of various terms used in the data submission formats from RA-1 to RA-5 are enclosed in annexure I.

4. Roles of NLDC, RLDC and SLDCs

4.1. NLDC in consultation with RLDCs shall annually publish a one-year look-ahead Short-term National Resource Adequacy Plan (ST-NRAP) for the subsequent financial year to assist the States in drawing their optimal generation resource adequacy plan.

4.2. STUs/SLDCs, ISTS connected Bulk Consumers or such other agency as may be designated by the State Commission shall furnish data in the stipulated formats to the RLDC/NLDC for preparing the Short-term National Resource Adequacy Plan.

4.3. The STUs/SLDCs, ISTS connected Bulk Consumers or such other agency as may be designated by the State Commission shall submit the details of their contracted capacities to the respective RLDC for the ensuing year for meeting Resource Adequacy Requirement for national peak as assessed by NLDC.

4.4. The RLDCs shall aggregate the capacities assessed at the regional level and submit the information to the NLDC. NLDC shall aggregate the capacities at the national level and check compliance with ST-NRAP and identify shortfall for the ensuing financial year, if any.

5. Submission of Technical data

In line with IEGC regulation 5.3 (d), the concerned agencies shall furnish data to NLDC through respective RLDC every year for carrying out a national level generation resource adequacy for States. The data described in sub sections ahead shall be submitted by (i) STUs/SLDCs or such other agency as may be designated by the State Commission (ii) Inter-state Transmission Licensees (iii) Regional Entity Generating Stations or ISTS Connected Bulk Consumers, as applicable, by 30th April for the ensuing financial year.

(Illustration: For operational analysis for ensuing year, i.e. FY 2024-25, the responsible agency shall submit the specified data by 30th April 2023)

5.1. **Electricity Demand Data (as per format RA-1)**

5.1.1. Forecasted hourly demand (MW) for the ensuing year (as per IEGC 5 (2)).

5.1.2. Estimated month wise instantaneous peak demand (MW) for both solar & non-solar hours.

5.1.3. Monthly energy consumption (MU) of the control area for the ensuing year.

(Illustrations: If operational analysis is to be done for year 2024-25, then SLDCs have to submit data of load forecast for year 2024-25.)

If the forecast data is not furnished by concerned agencies, then RLDC in consultation with SLDC shall estimate the demand of states using historical data available at NLDC/RLDC and submit the data to implementing committee at NLDC.

5.2. **Reserve Requirement (as per format RA-2)**

Reserve requirement of each hour (in MW) for each state to be considered for the ensuing year.

5.3. **Tie Line Details (as per format RA-3)**

5.3.1. Existing interstate tie lines between states and external systems with the capacities.

5.3.2. Planned tie lines: The planned interstate tie lines between states and external systems anticipated to be commissioned in the in the ensuing year with design capacity.

5.3.3. Annual outage plan of the existing transmission lines for the ensuing year.

5.4. **Transfer Capability (as per RA-4)**

The available transfer capability of the respective states for each month of the ensuing year.

5.5. **Generation Data (as per RA-5)**

5.5.1. Technical parameters of present conventional generation plants viz. Name of plant, location (State/Region), Maximum Continuous Rating (MW), Auxiliary Consumption (% of MCR), Maximum and Minimum Generation Limits (MW), Ramp Up and Ramp Down Rate (% of IC/min), Minimum up and down time, etc.

5.5.2. Fixed costs, variable costs, start up and shut down Cost of generators, etc.

5.5.3. Historical forced outage rates of generators/units for conventional stations

5.5.4. Planned maintenance rates of generators/units for conventional station

5.5.5. Hydro generation technical parameters viz. Capacity (MW), Efficiency, Upper and lower storage volume, or limits, pumping load (MW), Pumping Efficiency etc.

5.5.6. Capacities and hourly generation profile of renewable and hydro generation.

5.5.7. New generation capacity expected to be commissioned and generation capacity expected to retire by 30th September of the concerned year under study.

6. Methodology of Short-term National Resource Adequacy Plan (ST-NRAP)

6.1. The input data as mentioned in section 5 of this procedure shall be collated at the regional and national level. NLDC shall also take into consideration the information related to demand estimation, generation planning and related matters as available with CEA for carrying out simulations for resource adequacy assessment.

6.2. In case of non-availability of forecasted demand data, the historical hourly demand profile

for the states may considered by NLDC/RLDC to forecast the demand for the study period. The year ahead annual energy requirement and peak demand forecast by CEA shall be duly factored. Suitable assumptions shall be made for the study by NLDC in case of non-availability of input data from the respective agencies. These assumptions shall be mentioned in the report.

6.3. The forecasted hourly demand shall be used as input into the model. It shall be endeavoured that the resource adequacy model is capable of simulating all 8760 hours in a year.

6.4. After establishment of demand profile for the future year, the model would stack the available generation resources for meeting the forecasted demand and operating reserve requirement in all study periods.

6.5. This exercise shall be repeated for multiple scenarios so as to capture the uncertainty in demand forecast, RE Generation and forced outages of generating units. A suitable approach shall be adopted to generate probable demand profiles, RE profiles, and forced outage patterns, which would then be fed into the model.

6.6. Depending on the capability of the modelling tool available for simulations studies, the following constraints may be considered while modelling study:

6.6.1. **Portfolio balance constraints**: The portfolio balance constraints ensure that the total generation within a region/state and the import of power to the region/state is equal to the sum of the demand, the exports from the region/state, any energy not served and curtailment, for each hour. (insert equation) The nuclear, renewable and hydro plants shall be considered as must-run (at zero marginal cost). The profile of renewable and hydro plants shall be as per format RA-4.

6.6.2 **Transfer Capability:** The power flow between states or regions is limited by the available transfer capability of the respective states or regions.

6.6.3 **Generation constraints**:

6.6.3.1 The thermal resources are bound by constraints such maximum and minimum generation limits, ramp rates, spinning reserve offers and plant availability etc.

6.6.3.2 The hydro based resources are bound by the generation limits, storage capacity etc.

6.6.3.3 The dispatch (energy offer) plus the reserve offer (specified through regulations) for each generator is constrained to be within the maximum and minimum generation limits. Generation between two consecutive time blocks also must be within the ramping capabilities of the resources. Unit commitment decisions, such as start-up/shut-down, minimum up and down times, etc., require binary variables to implement and are to be included. Additionally, generation units will have periods of outages which will need to be captured by using an availability factor.

6.6.3.4 The capacity for each year needs to be tracked by a constraint which ensures that the capacity available on a particular day in a year is equal to the capacity available on same day last year plus any new capacity investment minus any capacity retirement.

6.6.4 **Storage constraints**: Due to the intermittent nature of renewable generation, the need for resources which can store surplus energy and dispatch the stored energy during low RE periods becomes vital. Storage charge and discharge at any instant are constrained by the storage level or the state of charge (SoC) of the storage resource, and the maximum charge / discharge limit.

6.6.5 **Operating Reserve constraints:** Operating reserve constraints ensure that enough resources are in the system and kept online or on standby each hour to account for load forecast errors, intermittency of renewables or meeting contingencies in the real time.

6.6.6 **Renewable/Storage purchase obligation:** Fulfilment of Renewable/Storage purchase obligation should be considered as one of the constraints of Resource Adequacy studies.

6.7 The periods where the available All India generation is inadequate to meet the All India demand (including operating reserves) shall be identified along with the quantum of shortfall.

6.8 Based on the resource adequacy study outcome across different possible scenarios, the model shall compute the following parameters:

- Loss of Load Probability (LOLP)
- Loss of Load Expectation (LOLE)
- Expected Energy Not Served (EENS)
- Normalised Energy Not Served (NENS)

7. Compliance Monitoring

7.1. The SLDCs shall submit the details of the contracted capacities for the ensuing financial year for meeting Resource Adequacy Requirement (RAR) of the national peak to the respective RLDC by 15th February.

7.2. The RLDCs shall aggregate the capacities at the regional level and submit the information to the NLDC by 28th February.

7.3. NLDC shall aggregate the capacities at the national level and check compliance with ST-NRAP by 15th March and identify shortfall for the ensuing financial year, if any.

8. Information Dissemination

8.1. NLDC shall annually publish a one-year look-ahead Short-term National Resource Adequacy Plan (ST-NRAP) on its website by 31st July for the ensuing financial year.

8.2. NLDC shall publish the details of any short fall in capacities based on contracted capacities received from SLDCs on its website by 15th March.

9. Summary of Timeline

Timeline for the ST-NRAP implementation for year 2024 - 25 is shown as below:

- 30th April 23: Submission of data by STUs/SLDCs/Bulk Consumers or such other agency as may be designated by the State Commission in format RA-1, RA-2, RA-3, RA-4 & RA-5.
- 31st July 23: NLDC would publish a Short-term National Resource Adequacy Plan
- 15th February 24: SLDCs shall submit the details of the contracted capacities for meeting RAR of national peak to the respective RLDC

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- 28th February 24: RLDCs shall aggregate the capacities at the regional level and submit the information to the NLDC
- 15th March 24: NLDC shall publish the details of any short fall in capacities based on contracted capacities received from SLDCs

10. Revision of the Procedure

Notwithstanding anything contained in this Procedure, NLDC/RLDCs may take appropriate decisions in the interest of System Operation. Such decisions shall be taken under intimation to CERC and the procedure shall be modified/amended with the approval of the CERC, as necessary.

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Format RA-1

1. Load forecast during Horizon of analysis:

State	Year(2024-25)	Energy [GWh]	Peak [MW]
State A	April 2024	.....	.....
State A	May 2024	.....	.....
.....	.....	.....	.....

State	Date & Time	Load (MW)
State A	01-04-2024 00:00	.....
State A	01-04-2024 01:00	.....
State A	01-04-2024 02:00	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....
State A	31-03-2025 23:00	.....
State A	31-03-2025 24:00	.....

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Format RA-2

Spinning Reserve Requirement

State	Year (2024-25)	Reserve Name	Type [spinning, non-spinning]	Requirement (MW)

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Format RA-3

1. **Existing Tie Transmission Lines:**

State From	State To	Capacity (MW)	Voltage level [kV]	Resistance (pu)	Reactance (pu)	Thermal Loading Limit

2. **Tie Transmission Lines expected to be commissioned in the period under study**

State From	State To	Capacity (MW)	Voltage level [kV]	Resistance (pu)	Reactance (pu)	Commissioning Date

3. **Annual Outage Plan of existing transmission lines**

State From	State To	Outage Start Date	Outage end Date

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Format RA-4

Available Transfer Capability

State	Month	Import ATC (MW)	Export ATC (MW)

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Format RA-5

1. Existing and Planned conventional generators Parameters:

Production													
State	Plant Name	Unit No	Max Capacity (MW)	Aux consumption (% of IC)	Min Stable Level (MW) - min level for continuous operation	Heat Rate (kcal/kWh)	Fuel Type (e.g. coal, oil, gas, nuclear, biomass etc.)	Variable Charge (Rs/ MWh)	Fixed Charge (Rs/MW/year)	Max Ramp Up Rate (% of IC/min)	Max Ramp Down Rate (% of IC/min)	Run Up Rate [MW/ min]	Run Down Rate [MW/ min]

Production								Expansion		
Start Cost/ Shut down cost (Rs) (for Hot, Warm and Cold Start)	Min Up time (hrs)	Min Down time (hrs)	Planned Maintenance rate [%]	Forced Outage Rate [%]	Mean Time to Repair (hrs)	Details of GT and ST Combinations (for gas based units)	Dispatchable/Non-Dispatchable	Commissioning Date (planned)	Decommissioning Date (for both existing unit and planned unit)	Fixed Charge (Rs/kW/year) (If applicable)

***Units under outage due to reserve shutdown & coal outages at the time of carrying out of study shall not be considered under planned or forced outages.**

2. Existing and Planned Hydro (DAM, Run of river, and Pump Storage) Generator Parameters

Production													
State	Station Name	Unit No	Type [Storage/RUN OF RIVER/PUMP STORAGE]	Upper Reservoir Name	Lower Reservoir Name (For Pump Storage only)	Max Capacity (MW)	Efficiency	Upper Reservoir Max Volume (GWh)	Lower Reservoir Max Volume (GWh) (For Pump storage only)	Upper Reservoir Min Volume (GWh)	Lower Reservoir Min Volume (GWh) (For Pump storage only)	Pump load (MW) (For Pump storage only)	Pump Efficiency (For Pump storage only)

Production			Expansion		
Variable Charge (Rs/MWh)	Dispatchable/ Non-Dispatchable	Energy Limits (Yearly, Monthly, Weekly, Daily – as applicable)	Fixed Charge (Rs/MW/year) (If applicable)	Commissioning Date	Decommissioning Date (for both existing unit and planned unit)

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Historic Generation Profile of Hydro Plants for last 5 years

Plant Name	Date & Time	Generation (MW)
Plant B	01-04-2018 00:00	.....
Plant B	01-04-2018 01:00	.....
Plant B	01-04-2018 02:00	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....
Plant B	31-03-2023 22:00	.....
Plant B	31-03-2023 23:00	.....

3. Existing and Planned Renewable Plants:

Production					Expansion	
State	Renewable Plant Name	Type [PV/Wind/Hybrid]	Max Capacity (MW)	Fixed Charge (Rs/MW/year) (If applicable)	Commissioning Date	Decommissioning Date (for both existing unit and planned unit)

ddd

Renewable historic generation profiles for last five years

Name	Datetime	Available Capacity (MW)	PV/ Wind Generation profile (MW)	Curtailed quantum (MW)
	01-01-2018 00:00			
	01-01-2018 01:00			
	01-01-2018 02:00			
	01-01-2018 03:00			
	.....			
	.....			
	31-03-2023 23:00			
	31-03-2023 24:00			

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Annexure - I

The properties description of different attributes mentioned in RA-5 format for thermal and renewable data are given below:

Category	Property	Unit	Definition	Example
Production	Max Capacity	MW	Maximum generating capacity of each unit	This value determines the generator's Installed Capacity
Production	Min Stable Level	MW	Min Stable Level is the minimum stable generation level of each generating unit	
Production	Heat Rate	kcal/kWh	Average heat rate (total fuel divided by total generation)	To calculate generators fuel offtake and the Short Run Marginal Cost for the Economic dispatch
Production	Fuel Type		Fuel used for Generation, e.g. coal, oil, gas etc.	
Production	Variable Charge or Energy Charge Rate	Rs/MWh	Variable operation	Component of the incremental cost of generation (per megawatt hour), and it is used to recover maintenance costs that are a direct function of generation e.g. wear and tear and other regular equipment replacement and servicing costs. This is a component of a units short-run marginal cost
Production	Percentage Auxiliary Consumption (Aux Incr.)	%	Auxiliary loss per megawatt of generation. Input between 0 and 100.	Auxiliary Use = Aux Incr. x Generation
Production	Max Ramp Up	%IC/min	Maximum ramp up rate	It sets a limit on the amount that generation can increase and is expressed as the maximum ramp up rate in %IC per minute.
Production	Max Ramp Down	%IC/min	Maximum ramp down rate	It sets a limit on the amount that generation can decrease and is expressed as the maximum ramp down rate in %IC per minute.

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Category	Property	Unit	Definition	Example
Production	Run Up Rate	%IC/min	Ramp rate that applies while running the unit up from zero to Min Stable Level.	By default, generating units are assumed to run up instantaneously. It is used to represent the startup profile of the generator.
Production	Run Down Rate	%IC/min	Ramp rate that applies while running the unit down from Min Stable Level to zero.	By default, generating units are assumed to run down instantaneously. It is used to represent the shutdown profile of the generator.
Production	Start Cost	Rs	Cost of starting a unit	It is the operations and maintenance cost associated with start-up of a unit.
Production	Shutdown Cost	Rs	Cost of shutting down a unit	It is the operations and maintenance cost associated with shut down of a unit.
Production	Min Up Time	hr	Minimum number of hours a unit must be run after being started	It is the minimum number of hours the unit must be 'on' in any commitment cycle. For Example: Min Up Time: 3 hrs = The unit can't be turned off during this period, but after this period it is subject to economical dispatch to decide if will be turned off.
Production	Min Down Time	hr	Minimum number of hours a unit must be off after being shut down	It is the minimum number of hours the unit must be 'off' in any commitment cycle. For Example: Min Down Time: 3 hrs = The unit can't be turned on during this period, but after this period it is subject to economical dispatch to decide if will be turned on.
Production	Maintenance Schedule (Historical)		Planned maintenance	Planned Maintenance for historical years
Production	Forced Outage Events		Forced Outage Events	Forced Outage for historical years.
Production	Maintenance Schedule (Future)		Planned maintenance	Planned maintenance for planning year

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Category	Property	Unit	Definition	Example
Production	Maintenance Rate	%	Maintenance rate	It is the fraction of time annually that the units are expected to be out-of-service (OOS) due to scheduled maintenance events. Maintenance Rate MR= [Maintenance hours/ (Total hours per year)].
Production	Forced Outage Rate	%	Forced outage rate	It is the fraction of time annually that the units are expected to be out-of-service (OOS) due to forced outage events. By Default, the following formula is considered, Forced Outage Rate FOR= [Forced outage hours/ (Total hours per year)].
Production	Mean Time to Repair	hr	Mean time to repair	Average number of hours the unit will be recover from a maintenance or Forced outage event. For Example: Mean time to Repair: 24 hrs = On average the unit will be available after 24 hrs from the time it was shut down.
Expansion	Commission Date		Start Date of operation of Planned Unit	Applicable for new units that are currently under construction or ready to start operating or started operations in planning year.
Expansion	Decommission Date		End Date of operation of Existing Unit	Applicable for Units to be retired or were retired in planning year.
Production	Fixed Charge	Rs/MW/yr.	Annual fixed operation and maintenance charge	is the fixed operations and maintenance charge, and forms part of the unit annual fixed cost charge. * For Short Term will be only for reporting * For Long Term, it is part of the fixed costs of new generation projects and it will be included in the formulation to minimise system cost

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