CENTRAL ELECTRICITY REGULATORY COMMISSION

NEW DELHI

No. L-1/265/2022/CERC

CORAM:

Shri Jishnu Barua, Chairperson
Shri I. S. Jha, Member
Shri Arun Goyal, Member
Shri P. K. Singh, Member

Date of Order: 28th September, 2023

In the matter of:

Approval of "Detailed Procedure for Assessment of Quantum of Secondary & Tertiary Reserve Capacity, along with Information Exchange and Timelines" under Central Electricity Regulatory Commission (Indian Electricity Grid Code) Regulations, 2023.

Order

The Central Electricity Regulatory Commission (Indian Electricity Grid Code) Regulations, 2023 (hereinafter called 'Grid Code') was published on 11.07.2023, in the Gazette of India Extraordinary (Part-III, Section-4, No. 488).

2. Regulation 30 (11)(k) of the Grid Code requires NLDC to prepare a detailed methodology for the assessment of secondary reserve capacity and submit the same for approval of the Commission. Further Regulation 30(11)(a) requires NLDC to assess tertiary reserve requirements for the regional control area and the State control area. Regulation 30(11)(q) and Regulation 30(12)(d) require that modalities

for information exchange and timelines in respect of secondary reserve and tertiary reserve, respectively, shall be as per the detailed procedure by NLDC.

3. Accordingly, NLDC vide its letter dated 20.09.2023 has submitted the “Detailed Procedure for Assessment of Quantum of Secondary & Tertiary Reserve Capacity, along with Information Exchange and Timelines”, after stakeholder consultation, for approval of the Commission.

4. The Commission has examined the Detailed Procedure along with formats submitted by NLDC and after incorporating suitable changes, the Commission hereby approves the “Detailed Procedure for Assessment of quantum of Secondary & Tertiary Reserve Capacity, along with Information Exchange and Timelines”. The approved Detailed Procedure is enclosed as Annexure to this order.

5. NLDC is directed to provide detailed feedback within one month after 6 months of the effective date of this procedure is completed, or earlier if required, to evaluate the operation of this procedure in practice.

Sd/	**Sd/**	**Sd/**	**Sd/**
(P. K. Singh)	**(Arun Goyal)**	**(I. S. Jha)**	**(Jishnu Barua)**
Member	**Member**	**Member**	**Chairperson**

Annexure

Detailed Procedure for Assessment of quantum of Secondary & Tertiary Reserve Capacity, along with Information Exchange and Timelines

1.0 Preamble

1.1 Every entity shall undertake all appropriate measures to maintain its drawal/injection as per schedule. Each control area has to follow certain Frequency Response Performance (FRP) criteria, as specified in Central Electricity Regulatory Commission (CERC) (Indian Electricity Grid Code) Regulations, 2023 hereinafter referred to as the Grid Code, in order to maintain frequency within the Grid Code stipulated band under normal operating conditions.

1.2 The objective of Ancillary Services in Indian power system is to maintain the grid frequency close to 50 Hz, restoration of the grid frequency within the allowable band as specified in the Grid Code and for relieving congestion in the transmission network, to ensure smooth operation of the power system, and safety and security of the grid.

1.3 Adequate reserves are required to be maintained in a distributed manner with both the regional entities at the regional level and at the State level for each state control area as per the Grid Code or the State Grid Code as the case may be.

1.4 As per Grid Code, assessment of reserves shall be carried out on year ahead basis, three day-ahead basis, day ahead basis and intra-day basis.

1.5 This procedure is prepared in accordance with Regulations 30(11) and 30(12) of the Grid Code [Covering Regulations 30(11)(k), 30(11)(q), 30(12)(d), 30(12)(l)]. This procedure supersedes the interim methodology for estimation of reserves prepared in accordance with Regulation 6(1) of the CERC (Ancillary Services) Regulations, 2022.

1.6 All the words and expressions used in the Procedure shall have the same meaning as assigned to them in various CERC Regulations.

2.0 Objective

2.1 The objective of this procedure is to lay down the roles of various entities and methodology for estimation of quantum of reserves for SRAS and TRAS to be followed by the Nodal Agency i.e. NLDC in coordination with RLDCs and SLDCs.

3.0 Scope

3.1 The procedure shall be applicable to all entities as provided in the Grid Code.

4.0 Definitions

4.1 **'Reference contingency'** means the maximum positive power deviation occurring instantaneously between generation and demand and considered for estimation of reserves.

5.0 Roles of NLDC (Nodal Agency), RLDCs and SLDCs

5.1 Nodal Agency i.e. NLDC shall, in coordination with RLDCs and SLDCs, estimate the quantum of requirement of SRAS & TRAS on year ahead basis, three day ahead basis, day ahead basis and real-time basis as per the methodology specified in subsequent sections.

5.2 SLDCs shall furnish data in the stipulated formats and timelines to the Nodal Agency for estimation of the quantum of requirement of SRAS & TRAS.

5.3 SLDC shall maintain reserves as allocated by Nodal Agency (after considering diversity benefit and reference contingency), in accordance with the Grid Code.

6.0 Reserves in Indian Power System

6.1 There shall be different types of reserves, as specified in the Grid Code and AS regulations, such as primary, secondary and tertiary for the purpose of frequency control and regulating Area Control Error. The reserves shall be deployed by each control area as per the Grid Code and the applicable AS regulations:

6.1.1 Provision for primary response shall be mandatory.

6.1.2 Secondary reserves shall be deployed through a regulated mechanism.

6.1.3 Tertiary reserves shall be procured through the market and deployed

6.2 The deployment of reserves is broadly distinguished on the basis of the time of initiation and duration of response as tabulated in Table-1 below:

Reserve	Start of activation	Full Availability/ deployment	Ability to sustain the full deployment
Primary Response	Immediately as soon as frequency crosses the dead band	Within 45 seconds	Up to 5 min
Secondary control Reserve	Within 30 seconds after the receipt of Automatic Generation Control (AGC) signal	within 15 Minutes	Up to 30 min or till replaced by Tertiary Reserves
Tertiary control Reserve	Within 15 minutes of dispatch instruction from NLDC/RLDC		Upto 60 minutes

Table 1: Reserves and their activation

7.0 Area Control Error (ACE)

7.1 "Area Control Error" or "ACE" means the instantaneous difference between a control area's net actual interchange and net scheduled interchange, taking into account the effects of frequency bias and correction of measurement errors.

7.2 The Area Control Error (ACE) for each control area would be calculated at all the load despatch centres based on telemetered values and external inputs as per the below formula:

ACE = (Ia - Is) - 10 * Bf * (Fa - Fs) + Offset

Ia = Actual net interchange in MW (positive value for export)

Is = Scheduled net interchange in MW (positive value for export)

Bf = Frequency Bias Coefficient in MW/0.1 Hz (negative value)

Fa = Actual system frequency in Hz

Fs = Schedule system frequency in Hz (default 50 Hz)

Offset = Provision for compensating errors such as measurement error

7.3 The detailed methodology to be followed by Nodal Agency for calculation and monitoring of Area Control Error (ACE) is attached at **Annexure I**. The ACE shall be worked out for each state and region. Post calculation of the ACE, the outliers would be removed using appropriate statistical techniques.

7.4 ACE is 'positive' means that the control area has surplus generation and the control area's internal generation has to be backed down. ACE is 'negative' means the control area is in deficit and the control area's internal generation has to be increased. All the frequency control interventions shall be in the direction to drive ACE towards zero.

8.0 Estimation of quantum of procurement of Reserves for SRAS and TRAS on an Year ahead and Three day ahead basis

8.1 For maintaining primary reserve, Grid Code provides that reference contingency shall consider quantum of generation outage based on outage of largest power plant, group of power plants, a generation complex, or a generation pooling station, or the actual generation outage occurred in an event during last two years, or a credible outage scenario. Similarly, reference contingency shall also consider outage of single largest load centre or actual outage of load occurred in an event during last two years . The reference contingency for maintaining primary reserve, presently considered in the Indian power system, is the outage of the largest power plant or a sudden load throw-off of 4500 MW, which shall be declared by the Nodal Agency from time to time on the NLDC website.

8.2 The data for assessment of the reserves capacity requirement for SRAS and TRAS shall be furnished to the Nodal Agency by respective SLDCs pertaining to their state control areas as per following timelines.

8.2.1 Year Ahead Basis – For reserve estimation for the next financial year (FY+1), the data for the previous calendar year shall be furnished by 15th January of the current financial year (FY) **(Format – RAS1).**

(Illustration: If the assessment is being carried out for FY 2024-25, the data for the period 1st Jan 2023 to 31st December 2023 has to be provided by 15th January, 2024)

8.2.2 The reserve capacity requirement as per the methodology in this document shall also be estimated by each RLDC and SLDC respectively

by 15th January every year for the next financial year and submitted to NLDC.

8.3 In case of non-availability of data from SLDCs as mentioned above, the data available at RLDCs/Nodal Agency shall be used to estimate the quantum of reserves requirement.

8.4 For estimation of reserve requirement on a three day ahead basis for D day on D-3 day, data for the last available 7 days (i.e., D-4 to D-10) shall be used.

Secondary Reserves

8.5 The estimation of secondary reserve capacity requirement, on regional basis and state basis (considering diversity benefit), shall be carried out by Nodal Agency as per the following methodology:

8.5.1 The positive (Up Reserve) and negative (Down Reserve) secondary reserve capacity requirement on regional basis would be computed as 99 percentile of negative and positive ACE respectively of that region for year ahead, quarter ahead and week ahead.

8.52 The 99 percentile of the positive and negative ACE of each state control shall be computed and aggregated at regional level. This shall be scaled using 99 percentiles of the regional ACE to factor diversity at regional level. The scaled values of 99 percentile of the state ACE shall be used to arrive at the reserve requirement at Inter-state and Intra-state levels.

8.5.3 The drawl by the respective state and its internal-generation at the time of peak demand during the period under consideration shall be used for apportionment of the reserve requirement. The intra state reserves shall be in proportion to the contribution of internal generation at the time peak demand. The Inter-state reserves shall be in proportion to the drawl from the grid at the time of peak demand.

8.5.4 The state level requirement shall be aggregated to arrive at the regional and all India reserve requirement.

8.5.5 If any state control area has net injection in the concerned period, then, entire reserve calculated for such State, is to be allocated within the state control area.

8.5.6 If any state control area has zero internal generation in the concerned period, then, the required reserve is to be allocated at the regional level.

8.6 The all-India total of positive (and negative) secondary reserves capacity requirement on regional basis shall be equal to the reference contingency or secondary reserve capacity requirement as computed above, whichever is higher. If the all-India reserve requirement, computed using 99 percentile of ACE, is less than the reference contingency such additional reserves shall be considered in the regional requirement.

Tertiary Reserves

8.7 The estimated quantum of tertiary reserve requirement at regional level would be considered equal to the secondary reserve requirement at regional level as computed above.

8.8 The estimated quantum of tertiary reserve requirement at state level would be considered equal to the sum of secondary reserve requirement at state level and 50 % of the largest unit size in the respective state control area.

9.0 Estimation of quantum of procurement of Reserves for SRAS and TRAS on Day ahead and Real time basis

9.1 AS Regulations provides that the reserves are to be procured from the market, considering the reserves likely to be available in real-time basis. Further the AS Regulations provides that all generating stations, whose tariff is determined by the Commission under Section 62 of the Act including those having URS power after declaration of the RTM results, shall be deemed to be available for use by the Nodal Agency for SRAS or TRAS or both, subject to technical constraints of such generating stations.

9.2 The all-India reserve requirement on day-ahead basis would be calculated by using the positive (Up Reserve) and negative (Down Reserve) reserve capacity requirement on regional basis, as 99 percentile of negative and positive ACE (10 second data), during the last 7 days respectively of that region for each time block. The up and down reserve requirement shall be aggregated on an all-India basis.

9.3 In any time block, the minimum up reserve requirement shall be equal to the reference contingency. The all-India credible contingency shall be continuously monitored using the SCADA MW data and the likely availability of the generating units. The quantum of reference contingency may vary across time blocks.

9.4 SLDCs shall intimate the quantum and location of the reserves for SRAS and TRAS to the Nodal Agency two days before the day of scheduling by 1100 hrs. The modalities for information exchange and timelines in this respect shall be as per **Format-RAS2**. ***(Illustration: The reserves booked in advance for Friday may be intimated in the NLDC web portal on Wednesday by 1100 hrs.)***

9.5 In case of non-submission of data by the SLDCs before 1100 hrs on 'D-2' basis, advance reserves with SLDC would be assumed as zero MW, for all the associated calculations.

9.6 As per the CERC (Ancillary Services) Regulations, 2022, only tertiary reserve procurement through TRAS day-ahead and real-time markets has been mandated. Hence the procedure covers reserve procurement in day-ahead and real-time segments of TRAS.

9.7 Similar procedure may be adopted in the future for secondary reserve procurement as and when such market segments are made operational by CERC.

9.8 In line with Grid Code Regulation 30(11)(t), 30(11)(u), 30(12)(h), shortfall of secondary and tertiary reserves would be flagged when availability of reserves is less than the requirement. Shortfall would be calculated using data from Format-RAS2 and Format-RAS5. NLDC, RLDC, and SLDC shall indicate the shortfall in secondary reserves, if any, and announce emergency alerts for such periods.

Day-Ahead Procurement of Reserves for TRAS and SRAS

9.9 Day-Ahead procurement of Reserves for TRAS and SRAS would be as per the methodology below:

(a) The total reserves likely to be available in section 62 power plants (including due to SCUC) would be estimated as the minimum of the total reserves available in last 7 days, for each time block.

(b) Reserves declared by SLDCs before 'D-2' shall be considered

(c) Reserves procured by RLDCs/NLDC in advance shall be considered

(d) The up and down reserves to be procured from the TRAS market (day-ahead plus real-time) shall be obtained as:

Total reserve requirement minus [Reserves available as per sub-clause (a) +(b)+(c) of this Clause].

(e) The up and down reserves to be procured, as calculated above, shall be apportioned between day-ahead and real-time AS market in a ratio as decided by the system operator. The ratio may be reviewed from time to time considering the quantum of sell bids received in DAM AS and RTM AS across all the power exchanges.

(f) The up and down quantum so obtained shall become the requirement for TRAS in the day-ahead market.

Real Time Procurement of Reserves for TRAS and SRAS

9.10 Real-Time procurement of Reserves for TRAS and SRAS would be as per the methodology below:

(a) the available up and down reserves in the section 62 thermal and gas generating stations scheduled by RLDCs shall be re-calculated using the latest available schedules.

(b) Reserves available with SLDCs, as declared before 'D-2'

(c) Reserves available with RLDCs/NLDC

(d) TRAS quantum procured in Day-ahead AS market

(e) The incremental up and down reserves to be procured from the real-time AS market shall be obtained as below:

Total reserve requirement minus [Reserves available as per sub-clause (a) +(b)+(c)+(d) of this Clause]

(g) The system operator may also choose to modify the reserve requirement considering factors such as real time system conditions, load/RE forecast, load generation balance, weather, contingencies, congestion etc, in line with the CERC approved procedure.

10.0 Information Dissemination

10.1 The reference contingency shall be declared by Nodal Agency by 25th January before the start of each financial year **(Format – RAS3)**. The review of reference contingency may be done by the Nodal Agency any time after the declaration. Accordingly, the figures of reference contingency would be revised and updated on the Nodal Agency website.

(Illustration: The reference contingency for financial year 2024-25 would be declared by 25th January, 2024)

10.2 The assessment of the reserve requirement for SRAS and TRAS on Year Ahead Basis would be declared by Nodal Agency by 25th January of the current year **(Format – RAS4)**

(Illustration: The reserve requirement for SRAS and TRAS in financial year 2024-25 would be declared by 25th January, 2024)

10.3 The assessment of the reserve capacity requirement for SRAS and TRAS on a three day-ahead basis would be declared by the Nodal Agency daily by 1100 hrs **(Format – RAS5)**

(Illustration: The reserve requirement for SRAS and TRAS for Friday would be declared by 1100 hrs on Tuesday)

10.4 The range of up and down quantum requirement for TRAS in the day-ahead market would be published on NLDC website. **(Format – RAS6).**

10.5 Before the commencement of bidding at Power Exchanges, NLDC shall communicate the range of Up and Down Reserves to be procured from DAM AS to the power exchanges.

10.6 The status of data received by the nodal agency from various sources and static data such as peak demand of the state, internal generation, frequency bias etc. shall also be published on the nodal agency website.

11.0 Revision of the procedures

The Procedure shall be amended from time to time, as necessary, with the approval of the CERC.

Format – RAS1: Data for Estimation of Year Ahead Reserves

Following Data is to be provided by each state control area

1. Assessment of reserves for the FY: 01.04.yyyy to 31.03.yyyy
2. Name of the state:
3. Data for the calendar: 01.01.yyyy to 31.12.yyyy
4. Data furnished (please tick the data submitted):
    a. Actual interchange of the State (10 seconds resolution), (Number of samples = 365*24*60*6 = 3153600 nos.) in excel format
    b. Frequency Response Characteristics of the State for the events posted on NLDC website (https://grid-india.in/frc/)
    c. Peak Demand met
    d. Intra-State Generation (other than ISGS) at the time of peak demand (*sample data filled up in Italics in the tables for understanding*)

Actual interchange of the State (10 seconds resolution) for calendar: 01.01.yyyy to 31.12.yyyy	
Date & Time (DD-MMM-YY HH:MM:SS)	Actual interchange of the State (MW)
01-jan-2021 00:00:10	*452*
01-jan-2021 00:00:20	*456*
01-jan-2021 00:00:30	*461*
…..	
…….	
31-Dec-2021 23:59:50	*498*

Frequency Response Characteristics of the State for calendar: 01.01.yyyy to 31.12.yyyy (In case State has difficulty in computation of FRC, it may seek assistance from respective RLDC)	
Event Details	Frequency Response Characteristics (MW/Hz)
Events 1:	*800*
Event 2:	*815*
Event 3:	*756*

Peak Demand and Intra-State Generation of the State for calendar: 01.01.yyyy to 31.12.yyyy		
State/UT	Peak Demand met (MW)	Intra-State Generation (other than ISGS) at the time of peak demand (MW)
……		

Format – RAS2: Information Exchange Format for intimation of Advance Procured Reserves before 1100 hrs on D-2 by SLDCs to NLDC

Note: Format in line with Regulations 30(11)(q), 30(12)(d) and 30(12)(l) of Grid Code

For date: DD/MM/YYYY

Submitted by: <Name of the State/RLDC>

S.no.	Region	State	Plant Name	From time block to time block	Method of dispatch (Secondary/Tertiary)	Earmarked Spinning Reserve as on D-2 (MW)
1	*WR*	*State-1*	*Station-A*	*1-96*	*Tertiary*	*30*
2	*WR*	*State-1*	*Station-B*	*1-96*	*Secondary*	*20*
3						
4						
5						
	Total					*50*

(*sample data filled up in Italics in the table for understanding*)

- The quantum and location of Reserves declared by SLDCs before D-2 and procured in advance by RLDCs would be intimated to the Nodal Agency two days before the day of scheduling.
- The information shall be submitted daily at 1100 hrs on a D-2 basis. For example, the reserves booked in advance for Friday may be intimated in the NLDC web portal on Wednesday by 1100 hrs.
- The information shall be submitted by the respective SLDCs/RLDCs on the web portal hosted by NLDC. URL and password for the secure web portal may be collected by SLDC from the respective RLDCs.

Summary of Intra-State Advance Reserves

Note: Format in line with Regulations 30(11)(t), 30(11)(u) and 30(12)(h) of Grid Code

S.no.	Region	State /Control Area	Tertiary Reserves Requirement Share intimated by NLDC on D-3	Tertiary Reserves Earmarked by SLDC/RLDC on D-2	Secondary Reserves Requirement Share intimated by NLDC on D-3	Secondary Reserves Earmarked by SLDC/RLDC on D-2	Shortfall in Tertiary Reserve Capacity (computed by NLDC on D-2)	Shortfall in Secondary Reserve Capacity (computed by NLDC on D-2)
1	NR	*State-1*	*100*	*85*	*50*	*30*	*20*	*15*
		State-2						

2	ER	*State-10*	*100*	*85*	*50*	*30*	*20*	*15*
		State-11						

3	WR	*State-16*	*100*	*75*	*50*	*35*	*25*	*25*
		State-17						

4	SR	*State-24*						
		State-25						

5	NER	*State-31*						

		State-37						
		Total	*200*	*160*	*100*	*65*	*40*	*45*

(*sample data filled up in Italics in the tables for understanding*)

Format – RAS3: Reference contingency for Indian Power System

Date: 25 January 2023	**Revision No.**	
Applicable for FY 2023-24		
Reference Contingency for generation loss (MW)	**4500**	
Reference Contingency for load loss (MW)	**4500**	

Format RAS4: SRAS and TRAS Reserve Requirement on an Annual Basis

Requirement of Reserve Quantum for Secondary Reserve Ancillary Service (SRAS) and Tertiary Reserve Ancillary Service (TRAS) for Year 2023-24																
State/ Union Territory (UT)	**Actual 99 Percentile Negative ACE (MW)**	**Actual 99 Percentile Positive ACE (MW)**	**Scaled 99 Percentile Negative ACE (MW) {a}**	**Scaled 99 Percentile Positive ACE (MW) {b}**	**Max. Demand met {c}**	**Internal Gen. at the time of max demand {d}**	**Drawl from ISTS {e=c-d}**	**State Internal Generation/ State Maximum Demand {f=d/c}**	**State drawl from ISTS/ State Maximum Demand {g=e/c}**	**Secondary Reserves in ISGS {h=a*g}**	**Secondary Reserves at Regional Level {sum of reserves in all states of the region as given in "h"}**	**Secondary Reserves within state {i=a*f}**	**Tertiary Reserves in ISGS (j = h)**	**Tertiary Reserves within state (k = i)**	**Largest Unit Size of internal generation (l)**	**Total Tertiary Reserves within state {m=k + 0.5*l}**
UT of Chandigarh																
Delhi																
Haryana																
Himachal Pradesh																
UT of Jammu and Kashmir and UT of Ladakh*																
Punjab																
Rajasthan																
Uttar Pradesh																
Uttarakhand																
NR state Sum																
Northern Region (NR)																
Chhattisgarh																
UT Daman and Diu#																
UT Dadra and Nagar Haveli#																
Gujarat																
Goa																
Madhya Pradesh																
Maharashtra																
WR States Sum																
Western Region (WR)																
Andhra Pradesh																
Karnataka																
Kerala																
UT of Puducherry																
Tamil Nadu																
Telangana																
SR State Sum																
Southern Region (SR)																
Bihar																
Damodar Valley Corporation																
Jharkhand																
Odisha																
Sikkim																
West Bengal																
ER state Sum																
Eastern Region (ER)																
Arunanchal Pradesh																
Assam																
Manipur																
Meghalaya																
Mizoram																
Nagaland																
Tripura																
NER State Sum																
North-Eastern Region (NER)																
All India																
											Total Tertiary Reserves Requirement in India					
	Note: * UT of Jammu and Kashmir and UT of Ladakh have been considered as single entity inline with data availability at NLDC. # UT Daman and Diu & UT Dadra and Nagar Haveli have been considered as separate entities inline with data shared with NLDC.															

Sample illustration for Format RAS4

Year-Ahead SRAS and TRAS Reserve requirement for Year 2023-24 (Scaled for reference contigency of 4500 MW)																
State/UT	**Actual 99 Percentile Negative ACE (MW)**	**Actual 99 Percentile Positive ACE (MW)**	**Scaled 99 Percentile Negative ACE (MW) {a}**	**Scaled 99 Percentile Positive ACE (MW) {b}**	**Max. Demand met {c}**	**Internal Gen. at the time of max demand {d}**	**Drawl from ISTS {e=c-d}**	**State Internal Generation/ State Maximum Demand {f=d/c}**	**State drawl from ISTS/ State Maximum Demand {g=e/c}**	**Secondary Reserves in ISGS {h=a*g}**	**Secondary Reserves at Regional Level {sum of reserves in all states of the region as given in "h"}**	**Secondary Reserves within state {i=a*f}**	**Tertiary Reserves in ISGS (j = h)**	**Tertiary Reserves within state (k = i)**	**Largest Unit Size of internal generation (l)**	**Total Tertiary Reserves within state {m=k + 0.5*l}**
UT Chandigarh	52	74	15	23	409	0	409	0.00	1.00	15		0	15	0	0	0
Delhi	266	343	77	108	7800	952	6848	0.12	0.88	67		9	67	9	216	117
Haryana	483	491	139	154	12642	3178	9464	0.25	0.75	104		35	104	35	660	365
Himachal Pradesh	206	173	59	54	2135	555	1580	0.26	0.74	44		15	44	15	100	65
UT Jammu & Kashmir	405	490	117	154	4495	1856	2639	0.41	0.59	69	615	48	69	48	150	123
Punjab	372	509	107	160	14286	5424	8862	0.38	0.62	67		41	67	41	700	391
Rajasthan	699	813	202	255	16918	10498	6420	0.62	0.38	77		125	77	125	660	455
Uttar Pradesh	770	873	222	274	26462	12390	14072	0.47	0.53	118		104	118	104	660	434
Uttarakhand	243	271	70	85	2606	584	2022	0.22	0.78	54		16	54	16	76	54
NR state Sum	3495	4037	1009	1266												2005
Northern Region	2247	2981	1009	1266												
Chhattisgarh	249	267	111	93	5403	2203	3200	0.41	0.59	66		45	66	45	500	295
UT Daman Diu	57	38	26	13	378	0	378	0.00	1.00	26		0	26	0	0	0
UT Dadra Nagar Haveli	100	98	45	34	1043	0	1043	0.00	1.00	45		0	45	0	0	0
Gujarat	851	909	380	316	21558	12835	8723	0.60	0.40	154	589	226	154	226	800	626
Goa	63	54	28	19	607	0	607	0.00	1.00	28		0	28	0	0	0
Madhya Pradesh	586	758	262	264	17091	7006	10085	0.41	0.59	154		107	154	107	660	437
Maharashtra	999	852	446	297	31929	23586	8343	0.74	0.26	117		329	117	329	660	659
WR States Sum	2906	2976	1297	1036												2018
Western Region	2891	2438	1297	1036												
Andhra Pradesh	729	632	296	276	12294	6549	5745	0.53	0.47	138		158	138	158	800	558
Karnataka	660	639	268	279	14859	9137	5722	0.61	0.39	103		165	103	165	800	565
Kerala	170	191	69	83	4522	1630	2892	0.36	0.64	44	639	25	44	25	130	90
UT Puducherry	58	81	24	35	492	0	492	0.00	1.00	24		0	24	0	0	0
Tamil Nadu	753	858	306	374	17636	5676	11960	0.32	0.68	207		98	207	98	600	398
Telangana	587	523	238	228	14128	6828	7300	0.48	0.52	123		115	123	115	800	515
SR State Sum	2956	2924	1200	1276												2126
Southern Region	2673	3004	1200	1276												
Bihar	340	387	157	160	6778	475	6303	0.07	0.93	146		11	146	11	250	136
DVC	426	359	197	149	4052	5111	-1059	1.26	-0.26	0		197	0	197	600	497
Jharkhand	207	236	95	98	1812	332	1480	0.18	0.82	78		17	78	17	210	122
Orissa	419	412	194	171	6652	3584	3068	0.54	0.46	89	411	104	89	104	600	404
Sikkim	42	38	19	16	128	0	128	0.00	1.00	19		0	19	0	0	0
West Bengal	369	371	170	154	9735	5270	4465	0.54	0.46	78		92	78	92	500	342
ER state Sum	1802	1805	833	747												1502
Eastern Region	1856	1759	833	747												
Arunanchal Pradesh	40	57	17	22	213	0	213	0.00	1.00	17		0	17	0	0	0
Assam	135	189	59	74	2375	323	2052	0.14	0.86	51		8	51	8	50	33
Manipur	29	32	13	12	258	0	258	0.00	1.00	13		0	13	0	0	0
Meghalaya	53	47	23	18	425	0	425	0.00	1.00	23	141	0	23	0	42	21
Mizoram	19	30	8	12	166	0	166	0.00	1.00	8		0	8	0	6	3
Nagaland	28	32	12	13	172	0	172	0.00	1.00	12		0	12	0	8	4
Tripura	66	63	29	24	387	155	232	0.40	0.60	17		12	17	12	21	22
NER State Sum	371	450	161	175												83
North-Eastern Region	358	412	161	175												
All India	10026	10594	4500	4500							2396	2104	2396	2104		7734
										Total Tertiary Reserves Requirement in India				10130		
4500 is the largest contigency considered																

Sample Illustration for Summary of Format RAS4

	Year-Ahead (2023-24)								
	Secondary Reserves			Tertiary Reserves			Total Reserves (Secondary + Tertiary)		
State/ Union Territory UT	Within in ISGS	Within state	Total	Within in ISGS	Within state	Total	Within in ISGS	Within state	Total
UT of Chandigarh	15	0	15	15	0	15	30	0	30
Delhi	67	9	77	67	117	185	135	127	262
Haryana	104	35	139	104	365	469	208	400	608
Himachal Pradesh	44	15	59	44	65	109	88	81	169
UT of Jammu and Kashmir and UT of Ladakh*	69	48	117	69	123	192	137	171	309
Punjab	67	41	107	67	391	457	133	431	565
Rajasthan	77	125	202	77	455	532	153	580	733
Uttar Pradesh	118	104	222	118	434	552	236	538	775
Uttarakhand	54	16	70	54	54	108	109	69	178
Chhattisgarh	66	45	111	66	295	361	132	341	472
UT Daman and Diu ,	26	0	26	26	0	26	51	0	51
UT Dadra and Nagar Haveli#	45	0	45	45	0	45	89	0	89
Gujarat	154	226	380	154	626	780	308	853	1160
Goa	28	0	28	28	0	28	57	0	57
Madhya Pradesh	154	107	262	154	437	592	309	545	853
Maharashtra	117	329	446	117	659	776	233	989	1222
Andhra Pradesh	138	158	296	138	558	696	276	715	991
Karnataka	103	165	268	103	565	668	206	729	935
Kerala	44	25	69	44	90	134	88	115	203
UT of Puducherry	24	0	24	24	0	24	47	0	47
Tamil Nadu	207	98	306	207	398	606	414	497	911
Telangana	123	115	238	123	515	638	246	630	876
Bihar	146	11	157	146	136	282	292	147	439
Damodar Valley Corporation	0	197	197	0	497	497	0	694	694
Jharkhand	78	17	95	78	122	200	156	140	296
Odisha	89	104	194	89	404	494	179	509	688
Sikkim	19	0	19	19	0	19	38	0	38
West Bengal	78	92	170	78	342	420	156	435	591
Arunanchal Pradesh	17	0	17	17	0	17	35	0	35
Assam	51	8	59	51	33	84	101	41	142
Manipur	13	0	13	13	0	13	25	0	25
Meghalaya	23	0	23	23	21	44	46	21	67
Mizoram	8	0	8	8	3	11	17	3	20
Nagaland	12	0	12	12	4	16	24	4	28
Tripura	17	12	29	17	22	39	34	34	68
Region-wise and All-India									
Northern Region	615	394	1009	615	2005	2620	1230	2399	3628
Western Region	589	708	1297	589	2018	2607	1178	2727	3905
Southern Region	639	561	1200	639	2126	2765	1279	2686	3965
Eastern Region	411	422	833	411	1502	1913	822	1925	2746
North-Eastern Region	141	19	161	141	83	224	283	102	385
All India	2396	2104	4500	2396	7734	10130	4791	9838	14630

Note:
* UT of Jammu and Kashmir and UT of Ladakh have been considered as single entity inline with data availability at NLDC.
# UT Daman and Diu & UT Dadra and Nagar Haveli have been considered as single entity inline with data availability with NLDC.

Format RAS5: Assessment of the reserve capacity requirement for SRAS and TRAS on a three day-ahead basis

State/ Union Territory (UT)	Actual 99 Percentile Negative ACE (MW)	Actual 99 Percentile Positive ACE (MW)	Scaled 99 Percentile Negative ACE (MW) {a}	Scaled 99 Percentile Positive ACE (MW) {b}	Max. Demand met {c}	Internal Gen. at the time of max demand {d}	Drawl from ISTS {e=c-d}	State Internal Generation/ State Maximum Demand {f=d/c}	State drawl from ISTS/ State Maximum Demand {g=e/c}	Secondary Reserves in ISGS {h=a*g}	Secondary Reserves at Regional Level {sum of reserves in all states of the region as given in "h"}	Secondary Reserves within state {i=a*f}	Tertiary Reserves in ISGS (j = h)	Tertiary Reserves within state (k = i)	Largest Unit Size of internal generation (l)	Total Tertiary Reserves within state {m=k + 0.5*l}
UT of Chandigarh																
Delhi																
Haryana																
Himachal Pradesh																
UT of Jammu and Kashmir and UT of Ladakh*																
Punjab																
Rajasthan																
Uttar Pradesh																
Uttarakhand																
NR state Sum																
Northern Region (NR)																
Chhattisgarh																
UT Daman and Diu#																
UT Dadra and Nagar Haveli#																
Gujarat																
Goa																
Madhya Pradesh																
Maharashtra																
WR States Sum																
Western Region (WR)																
Andhra Pradesh																
Karnataka																
Kerala																
UT of Puducherry																
Tamil Nadu																
Telangana																
SR State Sum																
Southern Region (SR)																
Bihar																
Damodar Valley Corporation																
Jharkhand																
Odisha																
Sikkim																
West Bengal																
ER state Sum																
Eastern Region (ER)																
Arunanchal Pradesh																
Assam																
Manipur																
Meghalaya																
Mizoram																
Nagaland																
Tripura																
NER State Sum																
North-Eastern Region (NER)																
All India																
											Total Tertiary Reserves Requirement in India					
	Note: * UT of Jammu and Kashmir and UT of Ladakh have been considered as single entity inline with data availability at NLDC. # UT Daman and Diu & UT Dadra and Nagar Haveli have been considered as separate entities inline with data shared with NLDC.															

Note: To be published every day by 1100 hrs

Sample Illustration for Format RAS5

State/UT	Actual 99 Percentile Negative ACE (MW)	Actual 99 Percentile Positive ACE (MW)	Scaled 99 Percentile Negative ACE (MW) {a}	Scaled 99 Percentile Positive ACE (MW) {b}	Max. Demand met {c}	Internal Gen. at the time of max demand {d}	Drawl from ISTS {e=c-d}	State Internal Generation/ State Maximum Demand {f=d/c}	State drawl from ISTS/ State Maximum Demand {g=e/c}	Secondary Reserves in ISGS {h=a*g}	Secondary Reserves at Regional Level {sum of reserves in all states of the region as given in "h"}	Secondary Reserves within state {i=a*f}	Tertiary Reserves in ISGS (j = h)	Tertiary Reserves within state (k = i)	Largest Unit Size of internal generation (l)	Total Tertiary Reserves within state {m=k + 0.5*l}
UT of Chandigarh	44	46	16	17	283	0	283	0.00	1.00	16		0	16	0	0	0
Delhi	236	266	83	95	4965	366	4600	0.07	0.93	77		6	77	6	216	114
Haryana	378	418	134	149	8698	2238	6460	0.26	0.74	99		34	99	34	660	364
Himachal Pradesh	138	131	49	47	2033	426	1606	0.21	0.79	38		10	38	10	100	60
UT of Jammu and Kashmir and UT of Ladakh*	359	309	127	110	2971	202	2769	0.07	0.93	118	688	9	118	9	150	84
Punjab	332	423	117	151	11466	3751	7715	0.33	0.67	79		38	79	38	700	388
Rajasthan	606	618	214	221	16918	10498	6420	0.62	0.38	81		133	81	133	660	463
Uttar Pradesh	718	836	253	299	22510	11431	11078	0.51	0.49	125		129	125	129	660	459
Uttarakhand	219	206	77	74	2326	670	1656	0.29	0.71	55		22	55	22	76	60
NR state Sum	3030	3254	1069	1163												1992
Northern Region (NR)	1960	2472	1069	1163												
Chhattisgarh	205	236	107	99	4917	2373	2544	0.48	0.52	56		52	56	52	500	302
UT Daman and Diu , UT Dadra and Nagar Haveli#	74	55	39	23	1409	0	1409	0	1	39		0	39	0	0	0
Gujarat	727	778	382	327	20350	8611	11740	0.42	0.58	220	623	162	220	162	800	562
Goa	50	49	26	20	594	0	594	0.00	1.00	26		0	26	0	0	0
Madhya Pradesh	507	700	267	294	17091	7006	10085	0.41	0.59	157		109	157	109	660	439
Maharashtra	783	754	411	317	27002	18840	8162	0.70	0.30	124		287	124	287	660	617
WR States Sum	2346	2572	1232	1080												1920
Western Region (WR)	2259	2295	1232	1080												
Andhra Pradesh	522	498	273	250	10278	5834	4444	0.57	0.43	118		155	118	155	800	555
Karnataka	573	569	300	285	13093	7916	5177	0.60	0.40	118		181	118	181	800	581
Kerala	156	156	82	78	4006	1426	2580	0.36	0.64	53	612	29	53	29	130	94
UT of Puducherry	67	92	35	46	430	0	430	0.00	1.00	35		0	35	0	0	0
Tamil Nadu	615	690	322	346	15645	9364	6280	0.60	0.40	129		192	129	192	600	492
Telangana	564	506	295	254	14013	6456	7557	0.46	0.54	159		136	159	136	800	536
SR State Sum	2498	2512	1306	1258												2259
Southern Region (SR)	2394	2674	1306	1258												
Bihar	237	348	115	169	6600	425	6175	0.06	0.94	108		7	108	7	250	132
Damodar Valley Corporation	377	379	184	184	3486	5000	-1514	1.43	-0.43	0		184	0	184	600	484
Jharkhand	229	226	112	110	1779	482	1297	0.27	0.73	81	307	30	81	30	210	135
Odisha	371	417	180	203	6119	3959	2160	0.65	0.35	64		117	64	117	600	417
Sikkim	43	27	21	13	128	0	128	0.00	1.00	21		0	21	0	0	0
West Bengal	255	341	124	166	9086	6656	2430	0.73	0.27	33		91	33	91	500	341
ER state Sum	1513	1739	736	846												1509
Eastern Region (ER)	1350	1797	736	846												
Arunanchal Pradesh	32	55	16	23	155	0	155	0.00	1.00	16		0	16	0	0	0
Assam	114	138	57	58	2274	296	1978	0.13	0.87	50		7	50	7	50	32
Manipur	27	28	14	12	247	0	247	0.00	1.00	14		0	14	0	0	0
Meghalaya	40	37	20	16	425	0	425	0.00	1.00	20	135	0	20	0	42	21
Mizoram	18	28	9	12	146	0	146	0.00	1.00	9		0	9	0	6	3
Nagaland	27	24	14	10	166	0	166	0.00	1.00	14		0	14	0	8	4
Tripura	54	52	27	22	320	165	155	0.52	0.48	13		14	13	14	21	24
NER State Sum	311	362	156	153												85
North-Eastern Region (NER)	286	325	156	153												
All India	8250	9563	4500	4500							2365	2135	2365	2135		7765
											Total Tertiary Reserves Requirement in India		10130			

Note: * UT of Jammu and Kashmir and UT of Ladakh have been considered as single entity inline with data availability at NLDC.
UT Daman and Diu & UT Dadra and Nagar Haveli have been considered as single entity inline with data availability with NLDC.

4500 is the largest contigency considered

Note: To be published every day by 1100 hrs

Sample Illustration for Summary of Format RAS5

State/ Union Territory UT	Secondary Reserves			Tertiary Reserves			Total Reserves (Secondary + Tertiary)		
	Within in ISGS	Within state	Total	Within in ISGS	Within state	Total	Within in ISGS	Within state	Total
UT of Chandigarh	16	0	16	16	0	16	31	0	31
Delhi	77	6	83	77	114	191	154	120	274
Haryana	99	34	134	99	364	464	198	399	597
Himachal Pradesh	38	10	49	38	60	99	77	70	147
UT of Jammu and Kashmir and UT of Ladakh*	118	9	127	118	84	202	236	92	328
Punjab	79	38	117	79	388	467	158	427	584
Rajasthan	81	133	214	81	463	544	162	595	758
Uttar Pradesh	125	129	253	125	459	583	249	587	837
Uttarakhand	55	22	77	55	60	115	110	82	193
Chhattisgarh	56	52	107	56	302	357	111	354	465
UT Daman and Diu , UT Dadra and Nagar Haveli#	39	0	39	39	0	39	78	0	78
Gujarat	220	162	382	220	562	782	441	723	1164
Goa	26	0	26	26	0	26	52	0	52
Madhya Pradesh	157	109	267	157	439	597	315	549	863
Maharashtra	124	287	411	124	617	741	249	904	1152
Andhra Pradesh	118	155	273	118	555	673	236	710	946
Karnataka	118	181	300	118	581	700	237	762	999
Kerala	53	29	82	53	94	147	105	123	228
UT of Puducherry	35	0	35	35	0	35	70	0	70
Tamil Nadu	129	192	322	129	492	622	258	685	943
Telangana	159	136	295	159	536	695	318	672	990
Bihar	108	7	115	108	132	240	216	140	355
Damodar Valley Corporation	0	184	184	0	484	484	0	668	668
Jharkhand	81	30	112	81	135	217	163	166	328
Odisha	64	117	180	64	417	480	127	534	661
Sikkim	21	0	21	21	0	21	42	0	42
West Bengal	33	91	124	33	341	374	66	432	498
Arunanchal Pradesh	16	0	16	16	0	16	32	0	32
Assam	50	7	57	50	32	82	99	40	139
Manipur	14	0	14	14	0	14	28	0	28
Meghalaya	20	0	20	20	21	41	40	21	61
Mizoram	9	0	9	9	3	12	18	3	21
Nagaland	14	0	14	14	4	18	27	4	31
Tripura	13	14	27	13	24	37	26	38	64
Region-wise and All-India									
Northern Region	688	381	1069	688	1992	2680	1376	2373	3749
Western Region	623	610	1232	623	1920	2542	1245	2529	3775
Southern Region	612	694	1306	612	2259	2871	1224	2952	4177
Eastern Region	307	429	736	307	1509	1816	614	1938	2553
North-Eastern Region	135	21	156	135	85	220	270	106	376
All India	2365	2135	4500	2365	7765	10130	4730	9900	14630

Note:
* UT of Jammu and Kashmir and UT of Ladakh have been considered as single entity inline with data availability at NLDC.
# UT Daman and Diu & UT Dadra and Nagar Haveli have been considered as single entity inline with data availability with NLDC.

Format RAS6: Range of Reserve Requirement from the Day-ahead AS Market

Note: Format to be published on NLDC website everyday by 1100 hrs

Date	TRAS Regulation Up	TRAS Regulation Down
02-June-2023	0 to 3800 MW	0 MW
03-June-2023	0 to 4000 MW	0 to 2500 MW
04-June-2023	0 to 4500 MW	0 to 2500 MW
05-June-2023	0 to 4500 MW	0 MW

(*sample data filled up in in the table for understanding*)

Annexure I: Guideline for Calculation and Monitoring of Area Control Error

This document provides the detailed guidelines to be uniformly adopted by the NLDC, RLDCs, SLDCs, and REMCs for measurement, calculation, monitoring, and archival of Frequency, Tie-Line Flows, Frequency Bias, Metering Errors, and Area Control Error (ACE). ACE is an important parameter which depicts the health of the power system. This document enables uniform notation for ACE, thereby allowing all the load despatch control rooms pan India to pass on information about this grid security aspect with one another.

Table of the Contents

1. Formula of Area Control Error (ACE)

The Area Control Error (ACE) for each control area[1] would be calculated at all the load despatch centres based on telemetered values and external inputs as per the below formula.

ACE = (Ia - Is) - 10 * Bf * (Fa - Fs) + Offset

Ia = Actual net interchange in MW (positive value for export)

Is = Scheduled net interchange in MW (positive value for export)

Bf = Frequency Bias Coefficient in MW/0.1 Hz (negative value)

Fa = Actual system frequency in Hz

Fs = Schedule system frequency in Hz

Offset = Provision for compensating errors such as measurement error

In the above formula, ACE has three components as below.

1. Interchange deviation component **(Ia-Is)**
2. Frequency deviation component -**10*Bf*(Fa-Fs)**
3. Offset or Metering Error

Sign convention adopted for interchange MW values is, positive value for export and negative value for import. Bf is a negative value. System Frequency (Fa) is a positive value, close to the National Reference Frequency of 50 Hz.

ACE is positive means that the control area has surplus generation and the control area's internal generation has to be backed down. ACE is negative means the control area is in deficit and the control area's internal generation has to be increased. ACE has to be driven towards zero for better frequency control and grid security.

2. Measurement of Frequency

System frequency is an important input for calculating ACE. Typically, ACE is used for taking generation increase/decrease actions using the below applications

[1] *Control Area means an electrical system bounded by interconnections (tie lines), metering and telemetry which controls its generation and/or load to maintain its interchange schedule with other control areas and contributes to regulation of frequency as specified;*

a. Secondary frequency control through AGC
b. Tertiary frequency control through TRAS
c. Monitoring and manual generation rescheduling

All the above three applications operate in the time frame of a few seconds to several minutes. Hence it should suffice that the system frequency signal is captured using a sampling time of a few seconds for calculation of ACE.

Suggested sampling time for frequency: 4 seconds, i.e., take a fresh frequency data point every four seconds.

2.1. Choosing the master list of redundant frequency sources

The frequency signal taken should be free from noise. To ensure the same, the signals from such stations shall be selected as the frequency sources, whose historical data is proven to be at least 99.9% noise-free in the past three months. To identify noise, the frequency data of different stations shall be plotted in a time series graph. The graph should be free from spikes. Choose 10 such stations to act as redundant frequency sources in ACE calculation. This list may be reviewed quarterly.

2.2. Location of redundant frequency sources and host server

For the applications a, b, and c, mentioned above, frequency source from any geographic location should serve the purpose as the time range of interest is in seconds. Typically, in time frame of a few seconds, all the electromagnetic transients and most of the electromechanical transients usually get damped and settled[2]. Hence, stations from different geographic locations can be chosen as redundant frequency sources. Having a mix of at least 10 redundant frequency sources from SCADA and URTDSM (PMU) is advised. Frequency data from URTDSM server are generally imported into SCADA3 for the purpose of ACE calculation.

2.3. Algorithm for selecting the Primary Frequency Source

The ACE calculation program can look at the quality tags of all the redundant signals and choose one of the signals as the primary source. The update of the quality tags happens along with the sampling of the data in the EMS system, as a general practice. In case the quality of the primary frequency source becomes 'suspect', then the next signal with 'good quality tag' shall be selected as the primary frequency source automatically. This logic may be developed into the calculation program gradually, if not immediately.

Algorithm outline:
Initialize Primary Freq= 50 Hz

Initialize K=1

Initialize J=1

Initialize Flag = Good

Call Subroutine-A

Subroutine-A ()

Select the Kth frequency signal in the list as 'primary' and read its quality tag.

If the quality tag is good, set J=1, exit Subroutine-A and GOTO Subroutine-B.

If, J=11, Primary Freq = 50 Hz, exit Subroutine-A and GOTO Subroutine-B.

Else, K=K+1, J=J+1 and Call Subroutine-A.

End Subroutine-A ()

Subroutine-B ()

While Flag = Good

Read the quality tag of the Kth signal at time t

If the quality tag is good, t=t0+4s, Flag=Good

Else Flag = Bad

End While

GOTO Subroutine-A

End Subroutine-B

3. Measurement of Tie-Line Flows

3.1. Actual Tie-Line Flows

Actual tie-line flows shall be sampled every 4 seconds similar to frequency and shall be used in the ACE calculation. The update of the quality tags happens along with the sampling of the data in the EMS system, as a general practice. Say, the data is acquired only every 12s by the SCADA because of delays, the ACE calculation program shall repeat the data thrice in those 12s. Some Tie-Line flows have the problem of becoming suspect often. Such data should be identified and rectified immediately by following up with site/substation. Efforts shall be made by respective utilities that the clock synchronization across all the stations taken into consideration by the respective LDC and its calibration shall be done once every

year in order to ensure the synchronicity of time stamping of the collected data. Every tie-line flow can be obtained from 3 different sources viz.,

i. Primary Side (choose the Metering End as per Grid Code)
ii. Secondary Side (side other than the Metering End as per Grid Code)
iii. State Estimator output

Primary side data shall be normally used for ACE calculation. In case the quality of the primary side becomes 'suspect', then let the ACE calculation program automatically choose the secondary side. If flow at both the ends goes suspect, use the state estimator output. If the state estimator is not running, replace the suspect data manually with 'last good value', rather than retaining garbage value. Information of manual interventions shall be monitored, carried forward and updated frequently in every shift. Sign convention adopted for interchange MW values is, positive value for export and negative value for import.

Note that all the tie-lines should be accounted for, while calculating the Net Actual Tie-Line Flow (Ia), i.e., algebraic sum of the flows. If any of the tie-lines is non-observable, the data of the same can be replaced with a fixed value as informed by site/substation telephonically to the control room.

3.2. Scheduled Tie-Line Flows

The Net Scheduled Tie-Line Flow (*Is*) of a control area should generally be the output of a scheduling software program, from which the data is imported into SCADA for all the 96-time blocks. ACE is calculated using the net tie-line flow, and path-wise scheduled flows are algebraically added based on direction.

Net Scheduled Tie-Line Flow of the control area can be calculated every time block by adding the algebraic sum of scheduled MW export contracts (from the control area to all the other control areas; positive values) and the scheduled MW import contracts (to the control area from all the other control areas; negative values) and the MW sum of resultant of such entities. In line with the tie-line flow convention, sign convention for TRAS Up regulation is positive, TRAS Down is negative. For ACE calculation, net control area values are important and not the path-wise values.

For example, if a particular control area imports 2000 MW from the other control areas through tie-lines, exports 500 MW to the other control areas through tie-lines, TRAS Up of 200 MW is dispatched and SCED Down of 100 MW is dispatched. Then Is = -2000+500+200-100 = -1400 MW for that time block.

The Net Scheduled Tie-Line Flow value should be less than the Export Available Transfer Capability (ATC) and greater than the Import ATC value. While calculating ACE, this 15-minute data has to be updated/refreshed every 4 seconds.

4. Assessment of Frequency Bias

The 2017 IEEE Task Force Report on "Measurement, Monitoring, and Reliability Issues Related to Primary Governing Frequency Response," recommends using Frequency Response Characteristic (FRC) calculated after the power and frequency transients have settled, for the Frequency Bias Coefficient (Bf) used in the ACE equation. A sample size of twenty (20) FRC events may be adequate for estimating the frequency response characteristic to minimise error.

FRC computation procedure is provided in Grid Code. A sample template for FRC assessment is enclosed as Annexure-I.I. FRC shall be computed for every control area for all events involving a sudden 1000 MW or more load/generation loss or a step change in frequency by 0.10 Hz. All these FRC values shall be archived along with date, time and reasons of the event.

4.1. Bf value assessment

In the calculation of ACE, the value of Frequency Bias Coefficient in MW/0.1 Hz (negative value) shall be based on median Frequency Response Characteristic. Median value of the past 20 events shall be used for updating the FRC. The occurrence of these 20 events is actually expected to cover the entire previous year, thereby subsuming the seasonality aspect of load and generation. The all-India, region-wise and state-wise Bf value, used in the reserve estimation computation, shall be provided on the Nodal Agency website as per ***Format RAS7***. Bf value shall be reviewed by the Nodal Agency.

4.2. Bf update timing

The Bias (Bf) value may be reviewed in the ACE calculations at the LDCs, once in every quarter on the 24th day of the month after the completion of the previous quarter. For example, Bias (Bf) value shall be updated on 24th July, after the completion of the quarter April – June. The updated Bf value in SCADA shall also be shared continuously through ICCP bottoms up, from SLDCs to RLDCs, and from RLDCs to NLDC for all the relevant control areas. An offline all India compilation in Excel/DB may be maintained by NLDC for all the control areas. While calculating ACE, this quarterly data has to be updated/refreshed every 4 seconds.

5. Measurement of Metering Errors – OFFSET

Typically, the accuracy level of the SCADA Remote Terminal Unit (RTU) is 0.5%. Also, there is a chance of error in the instrumentation and communication. Inherent latency and non-simultaneous reporting of SCADA might also cause metering error. Hence, while calculating ACE using the RTU metered tie-line flows, there is a probability of metering errors corrupting the actual value. OFFSET shall be used if such a metering error has been established using long-term data/statistical analysis.

In case of un-observable tie-line flows, where it is not feasible to replace the actual tie line flow data manually, OFFSET can be used to substitute the tie-line flow with correct sign convention. Information of manual interventions shall be monitored, carried forward and updated frequently in every shift. Sign convention adopted for interchange MW values is, positive value for export and negative value for import. While calculating ACE, OFFSET data has to be updated/refreshed every 4 seconds.

6. Calculation of ACE

Scheduled Interchange (Is), Actual Interchange (Ia), Actual Frequency (Fa), Scheduled Frequency (Fs), Frequency Bias (Bf) and Offset shall be updated/refreshed every 4 seconds in the calculation.

7. Archival of different parameters

It is important to archive the individual parts of the ACE into a database every 4 seconds. That means, apart from the calculated ACE, Interchange deviation (Ia-Is), Frequency deviation (Fa-Fs), Frequency Bias (Bf) and Offset shall also be separately archived in the database every 4 seconds. This is necessary to build and calculate what-if scenarios for reserve estimation, forecasting, etc.

8. Monitoring of ACE and Suggested Corrective Actions

All the control rooms of the control areas shall prominently monitor ACE, apart from the tie-line deviation and frequency deviation.

ACE is positive means that the control area has surplus generation and the control area's internal generation has to be backed down. ACE is negative means the control area is in deficit and the control area's internal generation has to be increased. All the frequency control interventions shall be in the direction to drive ACE towards zero. ACE remaining in the same direction for several minutes without crossing zero is a strong indicator that the frequency control interventions have to be kicked in.

9. Calculating ACE for Regional Entity Control Area

Each Regional entity generating station is a control area by itself. ACE for such entity shall be worked out separately for the purpose of monitoring. The bias would depend on the number of units on bar (40% of capacity on bar per Hz assuming 5% droop plus a small load response from the unit auxiliaries).

Annexure-I.I: Sample Template for Frequency Response Characteristic Calculation

Frequency Response Characteristic Calculation for All India based on NLDC SCADA Data

EVENT: As reported at 16:02 Hrs on 11th June 2021, 220 kV Akal-Bhu -1&2 tripped due to snapping of B-phase jumper which resulted into 1200MW wind generation loss and 300MW solar generation loss in Northern region. At the same time, 400kV Barmer-Jaisalmer-1&2 also tripped due to over voltage after tripping of wind and solar generation.It appears that two events happen in quick succesSsion, total generation loss of around 1500 MW as per reported region has been considered for FRC calculation.

S No	Particulars	Dimension	NR	ER	WR	NER	SR	Nepal	Bhutan	#Bangladesh	Combined cross border	All India
1	Actual Net Interchange before the Event (16:02:30)	MW	11313	-5678	-8306	21.2	1850	109	1241	1039	2390	164388
2	Actual Net Interchange after the Event (16:03:50)	MW	12241	-6128	-9200	-21.5	1469	105	1241	1038	2384	164088
3	Change in Net Interchange (2 - 1)	MW	928	-451	-895	-42.7	-381	-4	-1	-1	-6	-300
4	Generation Loss (+) / Load Throw off (-) during the Event	MW	1500	0	0	0	0	0	0	0	0	1500
5	Control Area Response (3 - 4)	MW	-572	-451	-895	-43	-381	-4	-1	-1	-6	-1800
6	Frequency before the Event	HZ	50.09	50.09	50.09	50.09	50.09	50.09	50.09	50.09	50.09	50.09
7	Frequency after the Event	HZ	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
8	Change in Frequency (7 - 6)	HZ	-0.090	-0.090	-0.090	-0.090	-0.090	-0.090	-0.090	-0.090	-0.090	-0.090
9	Frequency Response Characteristic (5 / 8)	MW/Hz	6353	5007	9939	475	4233	47	6	11	64	20000
10	Net System Demand met before the Event	MW	57737	18219	47210	2249	38974	--	--	--	--	--
11	Internal Generation before the Event (10 - 1)	MW	46424	23897	55516	2228	37124	--	--	--	--	--
12	Ideal load response assuming 4% per Hz (0.04*Row 10)	MW/Hz	2309	729	1888	90	1559	--	--	--	--	--
13	Ideal generator response assuming 5% droop.....40% per Hz (40% of Row 11)	MW/Hz	18570	9559	22206	891	14849	--	--	--	--	--
14	Composite ideal response (12 + 13)	MW/Hz	20879	10287	24095	981	16408	--	--	--	--	--
15	Percentage ideal response	%	30.4%	48.7%	41.2%	48.4%	25.8%	--	--	--	--	--

(*) - Data may be constant/suspected during the event
Note: +ve exchange=> import ; (-)ve exchange => export

Flow of 132kv Surjamani-comilla D/c is included in Bangladesh interchange,

Total Generation All India

Total Change in (MW)	1500
FRC for NEWS GRID (dp/df) MW/Hz	**16667**
Power Number (net change in MW/maximum change in frequency)	**8824**

Source Wise Generation (MW)	GAS	HYDRO	NUCLEAR	Thermal	WIND	SOLAR
	4834	22342	5088	98676	20669	12686

Percentage of non responsive generation(nuclear+ wind+ solar as a percentage of total generation)	23.40%

Format RAS7

All-India, Region-wise and State-wise Frequency Bias Coefficient

State/Region/All India	Frequency Bias Coefficient (value in MW/0.1 Hz)
Punjab	
Haryana	
Rajasthan	
Delhi	
Uttar Pradesh	
Uttarakhand	
UT Chandigarh	
Himachal Pradesh	
UT Jammu & Kashmir	
West Bengal	
Bihar	
Odisha	
Jharkhand	
DVC	
Sikkim	
Maharashtra	
Gujarat	
Madhya Pradesh	
Chhattisgarh	
UT Dadra Nagar Haveli	
UT Daman Diu	
Goa	
Andhra Pradesh	
Tamil Nadu	
Karnataka	
Kerala	
UT Puducherry	
Telangana	
Assam	
Meghalaya	
Tripura	
Manipur	
Mizoram	
Nagaland	
Arunachal Pradesh	
ER	
NR	
NER	
SR	
WR	
All-India	

Updated as on: dd/mmm/yyyy