Stakeholder Consultation Workshop on

Detailed Procedures for

SCUC, USD, and SCED

[To be submitted for approval of Hon'ble CERC]

Grid Controller of India Limited (GRID-INDIA)
(formerly known as POSOCO)

Background

- CERC (Indian Electricity Grid Code) Regulations, 2023 i.e. IEGC-2023
  - Includes chapters on SCUC, Unit Shut Down (USD), and SCED
  - Regulations 46(4)(i), 47(2), 46(4)(j), 46(5)(a), 46(5)(b), 49(2)(a)(iv), 49(2)(a)(x), 49(2)(a)(xi) of IEGC-2023
- SCUC – Security Constrained Unit Commitment
- SCED – Security Constrained Economic Despatch

SCED Pilot Procedure - 2019 LINK

- USD – Unit Shut Down
- RSD – Reserve Shut Down {now obsolete, replaced by USD}

RSD Procedure - 2017 LINK

- Reserve estimation procedures for TRAS and SRAS

TRAS Reserve Requirement Procedure-2023 LINK

- This procedure supersedes the earlier procedures prepared for SCED, and RSD

Scope & Objectives

- **Regional entity thermal** generating stations or units
  - For which tariffs are determined under section 62 of the Act – mandated for SCUC/SCED
  - Other than Sec-62 thermal generating stations may opt to participate under SCUC/SCED
    - A thermal generating station which opts to participate in SCUC is mandated to participate in SCED
- **The objective of this procedure** is to lay down the roles of various entities and methodology for the operation of SCUC, USD, and SCED mechanisms
  - Achieve National Merit Order
- **The objective of SCUC** is **to commit** a generating station or unit thereof, for the maximisation of **reserves** in the interest of grid security.
- **The objective of SCED** is **to optimise generation despatch** and achieve National Merit Order after gate closure and RTM
  - Incrementing generation from the generating stations with cheaper charge
  - Decrementing commensurate generation from the generating station with higher charge
  - After considering the operational and technical constraints of generation and transmission facilities

Definitions

In line with definitions of IEGC-2023

- "**Cold Start**" in relation to steam turbine means start up after a shutdown period exceeding 72 hours (turbine metal temperatures below approximately 40% of their full load values)
- "**Hot Start**" in relation to steam turbine, means the start up after a shutdown period of less than 10 hours (turbine metal temperatures below approximately 80% of their full load values)
- "**Warm Start**" means the start up after a shutdown period between 10 hours and 72 hours (turbine metal temperatures between approximately 40% to 80% of their full load values) in relation to steam turbine.
- "**Minimum Up Time**" means the minimum time for which a unit shall be kept on bar, once committed under SCUC.
- "**Minimum Down Time**" means the minimum shutdown duration that would be provided between de-synchronization and synchronization of a generator under SCUC.
- **SCUC-Up** means the incremental generation scheduled under the head "SCUC" in the scheduling system, in order to bring the schedule up to minimum turndown level.
- **SCUC-Down** means the decremental generation scheduled under the head "SCUC" in the scheduling system, in order to balance the SCUC-Up scheduled in other generating stations.

Sample Scheduling System - illustration

Schedule » Net Schedule

Net Schedule

Details

Date: 13-09-2023 Region: WEST View: Seller

Seller: VSTPS V Revision No: 153 Show data

Created On: 13-09-2023 17:21:37 Remarks: ConsoleApplication

Time Block	Time Desc	ISGS	MTOA	STOA	LTA	DAM	GDAM	URS	AS	SCED	REMC	RTM	HPDAM	BUNDLE RE	Net Total	Grand Total
1	00:00-00:15	-463.750000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	-463.750000	-463.750000
2	00:15-00:30	-463.750000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	-463.750000	-463.750000
3	00:30-00:45	-463.750000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	-463.750000	-463.750000
4	00:45-01:00	-463.750000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	-463.750000	-463.750000
5	01:00-01:15	-463.750000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	-463.750000	-463.750000
6	01:15-01:30	-463.750000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	-463.750000	-463.750000
7	01:30-01:45	-463.750000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	-463.750000	-463.750000
8	01:45-02:00	-463.750000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	-463.750000	-463.750000
9	02:00-02:15	-463.750000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	-463.750000	-463.750000
10	02:15-02:30	-463.750000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	-463.750000	-463.750000
11	02:30-02:45	-463.750000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	-463.750000	-463.750000
12	02:45-03:00	-463.750000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	-463.750000	-463.750000
13	03:00-03:15	-463.750000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	-463.750000	-463.750000
14	03:15-03:30	-463.750000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	-463.750000	-463.750000
15	03:30-03:45	-463.750000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	-463.750000	-463.750000
16	03:45-04:00	-463.750000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	-463.750000	-463.750000
17	04:00-04:15	-463.750000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	-463.750000	-463.750000
18	04:15-04:30	-463.750000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	-463.750000	-463.750000

Key Roles & Responsibilities

- NLDC shall be the nodal agency for coordinating and overseeing SCUC, and SCED processes
- RLDC shall be the nodal agency for overseeing USD process in consultation with NLDC
- Generating stations shall provide necessary data and information to RLDCs and NLDC for scheduling and dispatch
- Beneficiaries shall facilitate NLDC, RLDCs and Generating stations to ensure proper implementation of SCUC, and SCED processes
- RPCs shall prepare Energy and Deviation Accounts of the SCUC and SCED participants based on variable charge or compensation charge, as the case may be, as per IEGC
- NOAR shall be the single point entry and the master repository for submitting variable charge/compensation charge applicable for SRAS, TRAS, SCUC, and SCED
  - Same variable charge/compensation charge shall be used for dispatch under all the mechanisms and/applications

In line with Regulation 49 of IEGC-2023

Scheduling Timelines - selected

0600 hrs of D-1	DC/Pmax, Ramp rate, turndown level/Pmin for the next day
0700 hrs of D-1	RLDCs prepare the entitlements and share of each beneficiary
0800 hrs of D-1	Beneficiaries shall submit their requisitions/schedules from ISGS
0945 hrs of D-1	RLDCs shall prepare the injection and drawl schedules
1300 hrs of D-1	DAM-Energy cleared and Power Exchanges would convey DAM results to NLDC
1400 hrs of D-1	Information by NLDC about plants with Sch < TM
1400-1430 hrs D-1	Slot for revision by beneficiaries to maintain turndown level
1430 hrs of D-1	Bids for Tertiary Reserve Ancillary Services TRAS-DAM-Up/Down cleared by NLDC
1430 hrs of D-1	Injection and drawal schedules with NLDC
1500 hrs of D-1	SCUC run and information dissemination

TRAS Reserve Requirement Procedure LINK

SCUC Requirement Assessment

- In case of shortage of reserves despite efforts made to procure by stakeholders
- Dovetailed with TRAS procurement/assessment procedure
  - TRAS-DAM-Up-Cleared quantum shall be say “X” MW.
  - Block wise TRAS-RTM-Up reserves expected to be available (say “Y” MW)
    - Shall be considered as the minimum of the last 7 days data
- If the Total TRAS Reserve Requirement say “Z” MW is more than the total cleared MW in TRAS-DAM and TRAS-RTM (i.e., X+Y MW),
  - System would need additional reserves for such duration.
  - While calculating the TRAS Reserve Requirement “Z”, factor
    - Reserves created due to action of SCUC in the previous 7 days
    - Reserves anticipated to be available in Section 62 plants
    - Advance reserves procured, and reserve position intimated by the states

Sources of SCUC Reserves

- Additional Up reserve required (R=Z-X-Y) MW committed from
  - **Cat#1: Units that are likely to go below their minimum turndown level**
  - **Cat#2: Units under Unit Shut Down**
- By 1400 hrs of D-1, NLDC/RLDCs publish a tentative list of generating stations likely to be scheduled below the minimum turndown level. **Format-1.**
- Beneficiaries of such stations, shall be permitted to revise their requisitions by 1430 Hrs of D-1
- After 1430 hrs of D-1 day, further reduction in drawal schedule shall not be allowed
- NLDC may schedule incremental power from the generating units by 1500 hrs of D-1. **Format-2.**
  - Bringing these units to technical minimum would create extra Up reserves
  - Scheduled as per merit order, lowest energy charge to the highest energy charge
  - Changes in drawal schedule shall not be considered between 1430 hrs to 1500 hrs

Formats for SCUC Cat#1 units

Format-1: Tentative list of generating stations, scheduled below the minimum turndown level

Time: 1400 hrs Date <published on D-1 basis>: DD/MMM/YYYY

For Date "D": DD/MMM/YYYY

Sno	Name of generator (Multiple entries allowed)	From time block	To time block	Schedule (MW)	Turndown level (MW)	ECR (Paise/kWh)
1	Gen-A	10	20	225	275	330
2	Gen-A	25	35	180	275	330
3	Gen-B	5	96	200	275	375

Increase generation up to Minimum Turndown Level

Format-2: List of generating stations with incremental power scheduled to achieve minimum turndown level

Time: 1500 hrs Date <published on D-1 basis>: DD/MMM/YYYY

For Date "D": DD/MMM/YYYY

Sno	Name of generator (Multiple entries allowed)	Time block	Schedule (MW) @1430 hrs	Revised Schedule (MW) @ 1500 hrs	Pmax (MW)	ECR (Paise/kWh)
1	Gen-A	10-20	225	275	500	330
2	Gen-A	25-35	180	275	500	330
3	Gen-B	5-96	200	275	500	375

Time Block	Total Up Reserves from Cat#1 units (MW)
1	0
2	0
....	
10	450
....	.....
25	450

Hot, Warm, Cold Start timings – for algorithm

Start Type	Time (in hrs)
Hot	4
Warm	8
Cold	12
Cold + revive from wet preservation	18
Cold + all units under s/d	18

Type	Time (in hrs)
Minimum Up time: Coal	12
Minimum Up time: Gas	3
Minimum Down time	4

The total time available for the revival of the unit would be the duration between the time of instruction by NLDC/RLDCs and the target time for synchronization of the unit --- typically greater than the default timings

- State Regulations surveyed
- CERC Approved Procedure for RRAS – 2016 LINK
- Generators can submit a lower time limit than specified

SCUC from Cat#2 units

In line with Regulation 46 of IEGC-2023

- If the entire incremental reserve (R=Z-X-Y) requirement is not fulfilled by Cat#1 units
  - ➢ New units have to be committed from Cat#2 units
- Three-day ahead block-wise inter-state generation requirement forecasted shall be considered including Up and Down reserves
- The system security constraints and power plant constraints would be considered
- Units under USD may be selected by the NLDC algorithm to come on bar under hot, warm and cold starts
- The list of units for the next day would be broadcasted in the NLDC website every day at 1500 hrs. **Format-3(a).**
- Units with longer startup would be informed in advance on a D-2 basis at 1000 hrs. **Format-3(b).**
- Advance intimation units would be factored while preparing the additional list

SCUC Broad Algorithm

MILP based optimization program

Heat rate neglected

Objective function

Minimize the 3 day-ahead power plant variable operation cost. The operation costs comprise of energy cost and startup cost.

Constraints

1. Meeting the 3 day ahead forecasted demand (requisition)
2. Maintaining the required spinning reserve
3. Honouring transmission constraints
4. Must RUN/ Must OFF units
5. Capacity and Ramp constraints
6. Minimum Up Time and Minimum Down Time
7. Crew constraint

New Inputs from WBES

Blockwise Unit Availability considering planned/forced outages

Suitable assumptions to be made for data

Outputs [by 1500 hrs]:

1. List of units to be brought on bar (SCUC-Up flag)
2. Units scheduled to at least 55%
3. Earmark reserves in each station where unit brought on bar under SCUC to the scheduling system
4. SCUC Up/Down MW

Formats of SCUC Cat#2 units

Units required on next day

Inform @1500 hrs on 14th Sep 2023 to bring units on 15th Sep 2023

D-1

Format-3(a): List of units that are required to come on bar on the next day

Time: 1500 hrs Date <published on D-1 basis>: DD/MMM/YYYY

For Date "D": DD/MMM/YYYY

Sno	<Station Name>#<unit number>	Unit synchronization time	Unit synchronization date
1	Gen-A#1	0000 hrs	D
2	Gen-A#2	0800 hrs	D
3	Gen-A#3	1300 hrs	D
4	Gen-B#1	1600 hrs	D

Intra-day forecasts not considered for SCUC at present

9 hrs lead time

Information passed on

D-2

Format-3(b): Advance intimation of the list of units that are required to come on bar on the next two days

Time: 1000 hrs Date <published on D-2 basis>: DD/MMM/YYYY

For Date "D": DD/MMM/YYYY

Sno	<Station Name>#<unit number>	Unit synchronization time	Unit synchronization date
1	Gen-A#1	1500 hrs	D-1
2	Gen-A#2	1600 hrs	D-1
3	Gen-A#3	0100 hrs	D
4	Gen-B#1	0200 hrs	D

Units given advance intimation

Inform @1000 hrs on 14th Sep 2023 to bring units on 15th Sep 2023 and 16th Sep 2023.

36 hrs lead time

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Day-ahead SCED/SCUC

LP based optimization program

- To maintain load generation balance with SCUC, and create a feasible schedule factoring requisitions
- A 96 time block multi-period day-ahead SCED run at NLDC, starting 1500 hrs
- Where SCUC stations have to be scheduled SCUC-Up, commensurate reduction shall be done as SCUC-Down
  - Subject to technical constraints, following merit order
  - Separate head in the scheduling system, "SCUC"
- If "SCUC-Up flag" is set, downward requisition blocked from 1500 hrs
- The total MW reserves after SCUC+Multi-period SCED > greater than the Reserve Requirement --- soft constraint
- $\sum_{i=1}^{n} SCUC = 0$
- Run @ 1500 hrs, 2315 hrs
- Real time SCED takes over…

Key Inputs:

1. Unit commitment status
2. Earmarked Reserves
3. Changes in requisitions

Outputs:

1. SCUC Up/Down MW
2. Look-ahead feasible schedule

SCUC Support summary

- SCUC support will ensure the below from 1500 hrs of D-1
  - Schedule generator up to technical minimum (55%*Normative IC)
  - Reserves earmarked and blocked from sale/requisition
  - Downward revision restricted up to TM
  - Upward revision allowed upto DConbar-reserves earmarked
- SCUC units would be intimated twice daily to come on bar - @1000 hrs & @1500 hrs
  - 1000 hrs list is for advance intimation based on 1500 hrs of D-2 data
  - 1500 hrs list would be based on D-1 data, and would factor the 1000 hrs list
- Day-ahead multi-period SCUC/SCED will provide look-ahead schedules for the next day

Unit Shut Down (USD)

- T-GNA exigency buy-sell
- RTM buy-sell

- Units not brought on bar under SCUC
  - Operate at a level below the minimum turn down level or
  - Go under Unit Shut Down (USD)
- In case a generating station opts to go under unit shut down (USD) --- "arrange supply"
  - Obligation to supply its beneficiaries who had made requisition before 1530 hrs
  - by entering into a contract(s); or by arranging supply from any other generating station or unit thereof owned by such generating company; or
  - **rely on SCED** for arranging the schedule 30 minutes before dispatch
- The power scheduled from alternate supplier shall be reduced from the schedule of the generating station.
- In case of emergency conditions, for reasons of grid security, units under USD may be directed by NLDC/RLDCs to come on bar **Format-3(a) or Format-3(b).**
- Reserve quantum earmarked in units brought on bar under SCUC shall be used only by NLDC
  - Shall not be available for requisition by beneficiaries or sale by generating station

Security Constrained Economic Despatch (SCED)

- SCED shall run after RTM, 30 minutes before the actual dispatch period
  - Block by block SCED run every 15 minutes
  - After gate closure and RTM energy market clearing
  - SCUC-Up and SCUC-Down shall be evaluated/re-adjusted for every generator
    - Factoring the up revision by the beneficiaries, and
    - Any market sale transactions by the generator
- Generators to declare the energy charge, or the SCED Compensation Charge
- The objective function and the constraints for SCED similar to pilot project
- USD plants to submit standing consent to NLDC before gate closure for arranging supply
  - Pmax = Schedule.
  - Pmin=0
- NLDC shall accommodate USD under SCED subject to
  - Availability of reserves
  - Only If the energy charge or SCED Compensation Charge, is higher than that of the marginal generating station of SCED
  - To encourage generator to use market avenues, interlock to be designed in WBES
- No guarantee that SCED can provide the incremental schedule

Some Probable Scenarios for SCUC/SCED

Sno	Scenario	Requisition by Beneficiary	Obligation met from alternate source	SCUC	SCED
1	Low Requisition – Plant given SCUC-Up	• Yes – obligation met • Reserve locked • Down revision locked • Up revision allowed	• No	✓	✓
2	Previously under USD-Plant given SCUC-Up	• Yes-obligation met • Reserve locked • Down revision locked • Up revision allowed	• No	✓	✓
3	Low Requisition – Plant goes under USD Off bar DC	• No –obligation not met • Down revision allowed • Up revision allowed (up to 1530 hrs D-1)	• Yes • Match requisition from alternate source	X	✓
4	Unit Tripping DC not zero	• Yes- obligation not met • No revision allowed	• Yes • Block change in requisition	X	X
5	Unit Tripping DC = 0	• No revision allowed • No requisition, no schedule	• No	X	X

Accounting and Settlement

- SCUC - Deviation and Ancillary Services Pool Account.
  - Scheduling head “SCUC” would be used
  - Pay to the pool or receive from the pool @ energy charge
- SCED - SCED Pool Account
- As per the IEGC-2016 (fourth amendment) provisions [retained in IEGC-2023]
  - Startup cost settlement
  - Compensation due to Part Load Operation to be paid for SCUC and SCED
- SCED benefits sharing mechanism 50 (Beneficiaries) : 50(Sellers)
  - ẋ 7 paise/kWh cap removed – for generator
  - ẋ 60:40 split for SCED Up/Down removed – for generator

Thank You

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