EXPLANATORY MEMORANDUM ON

INTRODUCTION OF ANCILLARY SERVICES IN INDIA

I. BACKGROUND:

1.0 Ancillary services

1.1 Power systems require ancillary services to maintain reliability and support their primary function of delivering energy to customers. Ancillary services are principally real-power generator control capacity services the system operator uses over various time frames to maintain the required instantaneous and continuous balance between aggregate generations and load. Ancillary Services consist of services required for:

a) Maintaining load – generation balance (frequency control)

b) Maintaining voltage and reactive power support

c) Maintaining generation and transmission reserves

1.2 Ancillary Services are broadly classified as follows:

a) Frequency Control Ancillary Services: Three levels of Frequency Control are generally used to maintain the balance between generation and load i.e. Primary Frequency Control, Secondary Frequency Control, Tertiary Frequency Control. Three levels differ as per their time of response to a fluctuation and the methodology adopted to realize the fundamental operating philosophy of maintaining reliability and overall economy.

b) Network Control Ancillary Services (NCAS): This can be further subdivided into (i) Voltage Control Ancillary Service and (ii) Power Flow Control Ancillary Services,

c) System Restart Ancillary Services (SRAS): is used to restore the system after a full or partial blackout. Black start is a vital but inexpensive service. Its costs are primarily the capital cost of the equipment used to start the unit, the cost of the operators, the routine maintenance and testing of equipment and the cost of fuel when the service is required. At present this is a mandatory service. However, in future, this may be required to be introduced to incentivize generators to provide this service.

1.3 These Ancillary services are not new. Till now the functions have been provided by vertically integrated utilities. With restructuring it has become necessary to more carefully define, measure, and pay for these services. Ancillary services introduce an additional level of complexity and the potential for additional revenue for generation owners.

1.4 Section 5.2.3 of the National Electricity Policy (NEP) mandates that adequate reserves may be maintained to ensure secure grid operation (extract given below).

"5.2.3 In order to fully meet both energy and peak demand by 2012, there is a need to create adequate reserve capacity margin. In addition to enhancing the overall availability of installed capacity to 85%, a spinning reserve of at least 5%, at national level, would need to be created to ensure grid security and quality and reliability of power supply."

1.5 The CERC Power Market Regulations 2010 has made provisions for introduction of the Ancillary Services in the Indian Electricity Market in the future. Regulation 4(viii) defines Ancillary Services as follows:

"Ancillary Services Contracts – These contracts are for ancillary services. Ancillary Services in power system (or grid) operation are support services necessary to support the power system (or grid) operation for maintaining power quality, reliability and security of the grid, e.g. active power support for load following, reactive power support, black start, etc."

Further, Regulation 8 provides that the Ancillary Services Market would be introduced by CERC at a later date.

One of the objectives of the IEGC, as given in Regulation 1.2 is the "Facilitation for functioning of power markets and *ancillary services* by defining a common basis of operation of the ISTS, applicable to all the Users of the ISTS".

1.6 Ancillary services have been discussed for introduction in the Indian Power Sector as given below:

a) November 2010: NLDC petition (351/2010) filed for Frequency Support Ancillary Services (FSAS) before CERC

b) March 2012: Discussion in 16th Meeting of the Central Advisory Committee

c) June 2012: Workshop conducted by the Forum of Load Despatchers (FOLD)

d) July 2012: CERC directs Staff for draft Regulation on Ancillary Services

e) April 2013: CERC Staff paper on Ancillary Services

1.7 A number of issues pertaining to introduction of Ancillary Services Market were discussed during the above stakeholder consultations.

1.8 The NEW and SR Grid, which were connected asynchronously through HVDC links, have been synchronously connected in December 2013. The large interconnected power system of the country has facilitated economy interchange and cheaper power is replacing costlier power. Given the fact that a vibrant electricity market is functional, it is extremely essential to ensure secure grid operation and hence there is a need for introduction of ancillary services.

1.9 Renewable energy generation is variable in nature (diurnal & seasonal) and implementation of ancillary services would facilitate integration of renewable energy generation in the country. Ancillary services will certainly help in controlling the variability of renewable generation, presently concentrated in certain parts of the country, however other suitable mechanisms like more frequent market clearing, new market products are required. Also, Grid scale Storage system e.g. Pumped Storage Plants are required for balancing renewable sources of energy.

II. Frequency Control in India

2.0 System frequency is a fundamental indicator of power system health. It can be observed everywhere on the power system and provides an immediate indication of the balance between generation and load. Frequency drops when load exceeds generation and rises when generation exceeds load. Large frequency deviations result in equipment damage and collapse the power system. Therefore, frequency is needed to be tightly controlled. Following controls are required that provide the system operator to maintain the instantaneous and continuous balance between generation and load and to manage transmission line flows.

2.1 Primary Control

Continuous load changes result in mismatch of generation and load leading to variation in frequency of interconnected power system. Keeping governors free to operate would enable smooth control of frequency fluctuations as well as security against grid disturbances. Time frame for primary governor control action is about a few seconds i.e. 2-5 seconds. However, in India in the past due to wide variation in frequency fluctuations, Free Governor Mode of Operation (FGMO)/ Restricted Governor Mode of Operation (RGMO) has faced difficulties in operation. Experience around the world is that primary frequency control by governors coupled with other controls are necessary to maintain frequency within strict limit.

All large generating plants i.e. 200 MW and above, as per IEGC-2010 must be on restricted governor mode of operation. Generating units in these plants must have working governors which respond to change in frequency by controlling steam and water to the turbine with a standard droop (between 3-6%). For primary control to work properly most of the generations have to be under governor control so that adequate primary reserve is available at all times.

2.2 Secondary Control

If the load generation imbalance caused by an outage of large generator or load causing sudden variation in frequency of interconnected power system, primary response through governor action described above would help arrest the change fall in frequency. However, the frequency has to be brought back to 50 Hz through corrective action taken by the Control Area within which the generation or load is affected. Supplementary corrective

action or secondary control has to be taken to bring frequency back to 50 Hz. For large interconnection system this automatic secondary control is known as Automatic Generation Control (AGC). Time line of secondary control action is a few minutes. Secondary control is absent by design in the Indian grid. Roadmap for introduction of secondary control in India needs to be devised at the earliest considering the 135 GW peak load system operating as a single grid. The implementation of secondary control requires that all generating units (above the required size) are under primary governor control. They should also be made ready to receive the control signal from the AGC software being run at the control centre to the governors through appropriate communication & control infrastructure for implementing AGC. Secondary control also requires that each area control centre (SLDC) must have the AGC software as well as the ability to send the control signal.

2.3 Tertiary Control

Loss of large generator (or load) may cause a large enough system excursion that cannot be handled by regulatory reserve alone. The above secondary control reserves also needs to be restored through tertiary reserves. Tertiary reserve provides significant insurance against wide spread outages. Tertiary reserve had been a luxury in our system that was perennially short of generation. Since generators reserve situation is getting better, it is proposed to use such surplus reserve by procuring and compensating tertiary reserve to start with.

2.3.1 It is proposed that to start with all Inter-State Generating Stations (ISGSs), including Ultra Mega Power Plants (UMPPs), operating on part load and have not received requisition and whose tariff is determined by the Central Commission, may be mandated to participate in the tertiary frequency control support services.

2.3.2 Presently, generation in some of the Inter-State Generating Stations is not getting dispatched as it is not getting requisitioned by the beneficiaries based on merit order considerations. Table – 1 below shows the reserves on account of un-requisitioned generation capacity that are typically available for dispatch.

Table - 1: Typical Reserve Available on Account of Un-requisitioned Generation

Capacity					
	Installed Capacity	2014-15 (upto Jan - 2015)			Average
		Availability (%)	PLF (%)	Difference (%)	Reserve
	(MW)	-1	-2	(1-2)	MW
Northern Region					
ANTA GPS	419	94.82	48.41	46.41	194
AURAIYA GPS	663	88.19	28.66	59.53	395
DADRI GPS	830	95.18	35.74	59.44	493
DADRI NCTPS-I & II	1820	98.71	85.86	12.85	234
APCPL Jhajjar	1500	80.52	56.56	23.96	359
RIHAND STPS	3000	83.47	80.05	3.42	103
UNCHAHAR TPS	1050	93.64	87.37	6.27	66
TOTAL					**1844**
Eastern Region					
Farakka STPS	2100	83.13	77.99	5.14	108
Kahalgaon STPS	2340	87.93	76.81	11.12	260
TOTAL					**368**
Western Region					
VSTPS	4260	85.21	78.71	6.5	277
KAWAS	656	92.71	31.78	60.93	400
GANDHAR	657	90.69	30.97	59.72	392
SIPAT-II	2980	88.44	82.76	5.68	169
Mundra UMPP	4000	78.44	75.58	2.86	114
Mauda	1000	79.73	28.33	51.4	514
RGPPL	2220	35.48	0	35.48	788
TOTAL					**2654**
Southern Region					
NTPC,RAMAGUNDAM	2600	91.32	88.97	2.35	61
NTPC, SIMHADRI-II	1000	86.15	81.48	4.67	47
TOTAL					**108**
All India					**4974**

Source: As per REA (Prov.) issued by respective RPCs for Jan – 2015.

2.3.3 As per Central Electricity Regulatory Commission (CERC) orders, the despatch of such un-requisitioned surplus can be done if one of the other beneficiaries requisitions the power. Alternatively, the generator can sell the un-requisitioned power to others through Short Term open Access. However, there are issues regarding proper load forecasting, duration for

requisitioning power and timely information dissemination. The NLDC website is presently displaying the total quantum of un-requisitioned surplus on station wise basis for the current day. Hence, in addition to the existing mechanism of dispatching the un-requisitioned surplus, it is proposed to utilize this under Ancillary Services also. Such Ancillary Services may be known as Reserves Regulation Ancillary Services (RRAS).

2.3.4 Analysis of international experiences reveal that the Ancillary Service products (viz. Primary Response / Regulating Reserve; Spinning / Operating Reserve; Demand Response; Voltage Control; Black Start etc.) are chiefly market driven. In such markets, generally, there are assured commitment charges payable to the Ancillary Service providers as they are committing their capacity for such services. In some countries the system operator anticipates Ancillary Services in advance, and factors in the commitment charges towards Ancillary Services in their Annual Revenue Requirement (ARR) / Rate Base. Thus, the liability towards the commitment charges is socialized while the energy charge component of Ancillary Services is passed on to the specific entities responsible for causing the requisition of Ancillary Services.

2.3.5 The Commission has noted these practices and feels that while the international experience calls for Ancillary Services to be purely market based instrument, it would be desirable to move in a calibrated way in so far as introduction of Ancillary Services in India is concerned. This is primarily due to the fact that the cost of socialization of availing Ancillary Services is a major issue, in India, unlike the same in developed electricity markets. It is, therefore, proposed to start by way of utilizing un-requisitioned surplus (URS) of inter-state generating stations (ISGSs) as Ancillary Services to support grid operation. The proposed framework is outlined in subsequent sections.

III. PROPOSED FRAMEWORK FOR ANCILLARY SERVICES IN INDIA

3.0 Objectives of proposed Ancillary Services

Objective of proposed Reserves Regulation Ancillary Services (RRAS) is to restore the frequency level at desired level and to relieve the congestion in the transmission network. The RRAS shall support both regulation up and regulation down service. Provision for the regulation down service is being made with the objective of facilitating pumping/motoring operation of the pumped storage plants and integration of renewable sources.

3.1 Nodal Agency

3.1.1 System operator, namely National Load Despatch Centre (NLDC) through the Regional Load Despatch Centres (RLDCs) shall be the nodal agency for implementation of the ancillary services at the inter-state level. At the intra state level, the State Load Despatch Centre (SLDC) would be the nodal agency as and when such services are introduced by the SERCs.

3.2 Ancillary Market Participants

3.2.1 All Inter-State Generating Stations whose tariff is determined or adopted by the Commission and are operating on part load and have not received full requisition shall be eligible to participate in the Reserves Regulation Ancillary Services Market.

3.2.2 The RRAS provider should submit on monthly basis, details of fixed charge, variable charge and any other statutory charges as per the CERC Regulations, to the Regional Power Committees who in turn shall intimate the same to the Nodal Agency for merit order dispatch. The Regional Power Committee (RPC) would use these figures for preparation of deviation Accounts also with ancillary service schedule indicated separately.

3.3 Role of Nodal Agency

3.3.1 NLDC, the Nodal Agency, shall prepare merit order stack of un-requisitioned surplus of ISGSs willing to participate in this mechanism, based on the variable cost of generation, Declared Capacity and take despatch decision. The stack would be made region-wise / bid area-wise to factor in transmission constraints on any inter-regional or area boundary.

3.4 Kick in by NLDC based on contingency

3.4.1 Nodal agency shall stack un-requisitioned surplus capacities available from ISGS based on lower generation Cost to higher generation cost in each time block.

3.4.2 Nodal agency shall direct the selected RRAS providers for regulation up and regulation down, as and when requirement arises in the system. The requirement may arise on account of any of the following events (indicative list only) as may be decided by the Nodal Agency:

i. Extreme weather forecasts and/or special day;
ii. Multiple generating unit or transmission line outages;
iii. Trend of load met;
iv. trends of frequency;
v. Intimation of any abnormal event such as outage of hydro generating; units due to silt, coal supply blockade etc.;
vi. Excessive loop flows leading to congestion; and
vii. Such other events.

3.5 Dispatch of proposed service

3.5.1 Once the time period specified by the Nodal Agency starts, ancillary service will be deemed to have been triggered.

3.5.2 RRAS provider will inject or back down the generation as per quantum and time specified by the Nodal Agency.

3.5.3 The schedules of the RRAS providers would be considered as revised by the quantum specified by the nodal agency. The deviations beyond this revised schedule would be treated as per CERC DSM Regulations.

3.6 Withdrawal of Ancillary service

3.6.1 The Nodal Agency, on being satisfied that the circumstances leading to triggering of RRAS, no longer exist, shall direct the RRAS provider to withdraw from the time block specified in the detailed procedure. For this, the Nodal Agency shall monitor the frequency during continuous low frequency period, contingency period, loading on tie line etc.

3.7 Energy Accounting

3.7.1 Energy Accounting shall be done by the respective RPC on weekly basis along with UI or DSM statement on the basis of SEM data and schedule.

3.7.2 The RPC shall issue an Ancillary Services Statement along with DSM deviation statement account.

3.8 Settlement

3.8.1 The settlement shall be done by the RLDC similar to that of UI account under additional head of Ancillary Services.

3.9 Scheduling of RRAS

3.9.1 The quantum of generation dispatched shall be directly incorporated in the schedule of respective RRAS providers. For up-regulation, power would be scheduled from the generator to the pseudo-entity "pool" by the RLDC concerned. Similarly, for down-regulation, power would be scheduled from the "pool" to the generator, so that effective scheduled injection of the generator comes down.

3.9.2 Separate statement shall be maintained within the Regional DSM Pool Account for RRAS.

3.9.3 The payment to RRAS provider would be from the Regional DSM Pool Account.

3.9.4 Payment to the generators under RRAS would be on the basis of the scheduled quantum and any deviation would be handled through DSM Regulations. Sustained failure to provide the Regulation Reserves by any generator (barring unit tripping) would lead to stringent penalties on account of gaming.

3.9.5 No commitment charges would be payable to the RRAS providers for making themselves available in the RRAS market.

3.9.6 The energy despatched under RRAS would be deemed to be delivered at the Regional periphery. Under/over injection by the RRAS provider to be treated as per the CERC Unscheduled Interchange / Deviation Settlement Regulations.

3.9.7 Any deviation by the RRAS provider would be accounted for through the imbalance handling mechanism.

3.10 Detailed Procedure

3.10.1 The nodal agency shall after obtaining prior approval of the Commission, issue the detailed procedure to operationalise Ancillary Services at inter-state level and on any residual matter not covered under these regulations.

3.11 Commercial mechanism

3.11.1 The RRAS provider shall be paid at their fixed and variable charges, with a mark up as decided by the Commission through a separate order from time to time, in case of regulation up services for the quantum of RRAS scheduled. However, the RRAS provider shall refund back the fixed charges to the original beneficiaries in proportion to the quantum surrendered from the generating station.

3.11.2 The RRAS provider shall pay variable charges to pool in case of regulation down of the generation.

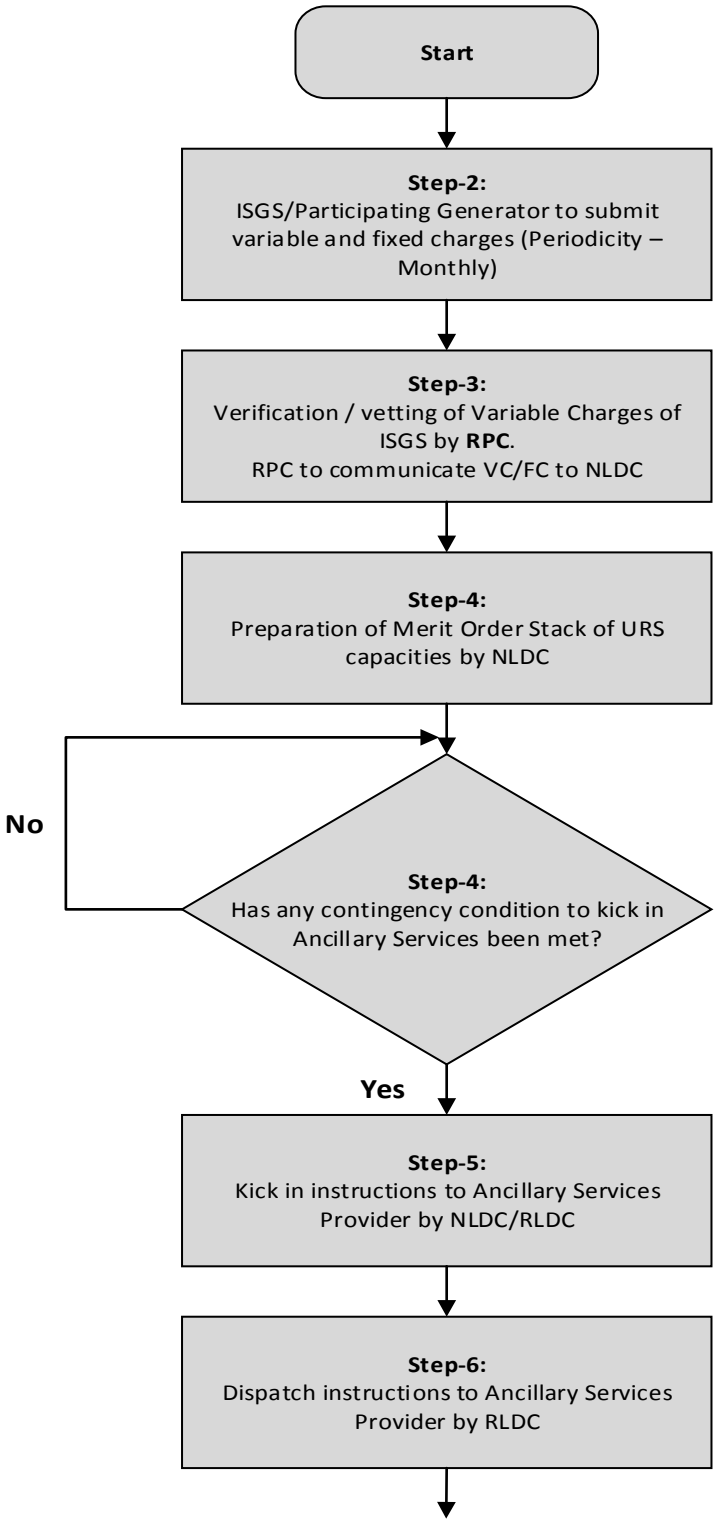
3.11.3 A Flowchart for Operationalization of Ancillary Services Framework alongwith stepwise description of each activity is placed at Annexure – I.

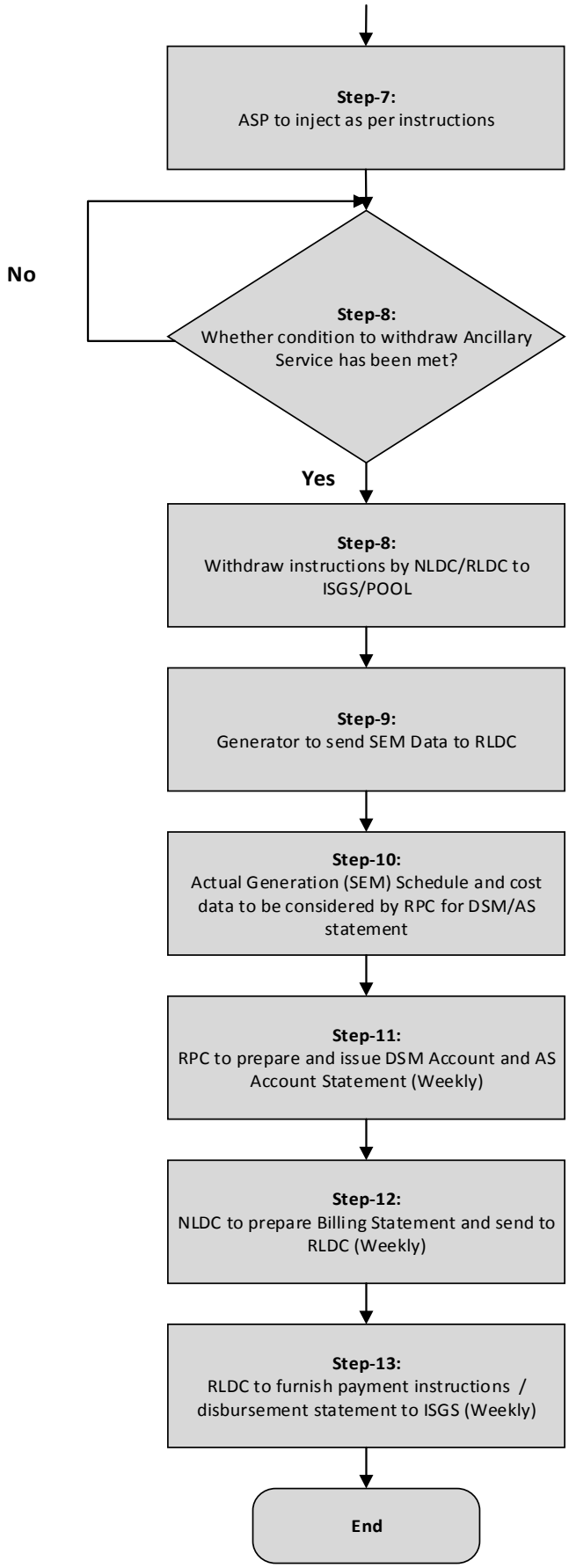
IV. Simulation Studies

4.0 Sample Simulation studies to assess the impact of despatch of Ancillary Services were done. The findings are placed at Annexure – II.

Annexure-I

Flowchart for Operationalization of Ancillary Services Framework




Step-7:
ASP to inject as per instructions
No
Step-8:
Whether condition to withdraw Ancillary Service has been met?
Yes
Step-8:
Withdraw instructions by NLDC/RLDC to ISGS/POOL
Step-9:
Generator to send SEM Data to RLDC
Step-10:
Actual Generation (SEM) Schedule and cost data to be considered by RPC for DSM/AS statement
Step-11:
RPC to prepare and issue DSM Account and AS Account Statement (Weekly)
Step-12:
NLDC to prepare Billing Statement and send to RLDC (Weekly)
Step-13:
RLDC to furnish payment instructions / disbursement statement to ISGS (Weekly)
End

Annexure – II

Simulation studies to assess impact of despatch of Ancillary Services

Introduction

A sample case study to understand the implications of introduction Regulation Reserve Services ("Ancillary Services") was carried. It was decided to carry out mock study for ancillary service in Northern Region for the week 16-22 June, 2014 to improve system frequency and relieve the system constraints due to loss of generation at Napth Jhakri as mentioned below:

- Karcham Wangtoo (900 MW), Nathpa Jhakri (1600 MW) and Rampur (206 MW) HEPs were taken out of service in 6 time blocks i.e. from 1030 hrs to 1200 hrs on 18.06.2014 in Northern Region due to high silt level with a total generation loss of about 3000 MW;
- Consequently, the frequency dipped from around 50.1 Hz to 49.7 Hz which constrained to do load shedding in the state of Uttar Pradesh, Haryana and other constituents;
- The inter-regional drawal of Northern Region increased by 1500 MW in this period with drawal from ER increasing by around 300 MW and drawal from WR increasing by 1200 MW.

Ancillary Service

The following aspects have been considered for the study:

- Un-requisitioned Surplus (URS) power of 691 MW of Auraiya RLNG and Dadri RLNG was kicked in on 18th June 2014 during time blocks from 56(1345-1400) to 59(1430-1445) [total one hour];
- URS of 691 MW was scheduled to the dummy entity in Northern Region;
- The frequency in each block was increased by 0.18 HZ on the basis of Power Number (3%);
- The drawal of each state was increased by 0.54% (0.18x3%) of demand being met considering the improvement in system frequency;

- The impact on the unscheduled interchange charges payable by the NR beneficiaries vis-à-vis actual cost of power kicked into the system has been worked out through the weekly UI computation.

Implication:

- The variable cost and fixed cost of RLNG power are considered as Rs 6 and Re 1 respectively. The total cost of power pumped into the system has been worked out as 48.37 Lakhs.
- The pool balance has been reduced by 47 Lakhs (Annexure II(a), II(b) and II(c)).
- DSM charges payable by the beneficiaries has reduced by 87 Lakhs (including UI charges and additional UI charges).
- Amount payable to WR and ER DSM Pools has gone down due to dispatch of additional power in NR.

Inferences

The system security has been attained by way of increase in system frequency as well as reduction in power flow through WR-NR, for which URS of 691 MW at a cost of 48 lakhs has been utilized . At the same time, the liabilities of beneficiaries on account of deviation mechanism have reduced by 87 Lakhs due to increase in frequency. The generating stations will be benefited by getting dispatch and with improved operational parameters. The beneficiaries will be benefited through reduction of deviation charges. The study indicates that the generating companies as well as beneficiaries will be equally benefited.

Annexure II(a)

Computation without Regulation Reserve Service

Revision-II

Northern Regional Power Committee

Deviation Settlement Account For The Week 16/06/2014 To 22/06/2014

ABSTRACT OF UTILITY WISE DEVIATION CHARGES

(All Figs. in Rs. Lakh)

Utilities	Amount Payable		Utilities	Amount Receivable
HIMACHAL PRADESH	901.84416	:	WR-NR	1874.58838
PUNJAB	863.25585	:	ER-NR	718.30947
UTTAR PRADESH	672.75207	:	DELHI	60.89456
HARYANA	653.53175	:	NHPC	122.68993
CHANDIGARH	444.23685	:	SCL	12.61754
JAMMU AND KASHMIR	386.05094	:	THDC	6.96827
RAJASTHAN	339.00474	:	LANCO	4.05983
UTTARAKHAND	228.34367	:	EPPL	0.80430
RAILWAYS	147.48923	:	POOL BALANCE (CAP)	1021.57820
NTPC	477.81188	:	POOL BALANCE (Add DEVI)	1860.78311
JPVL	401.82001	:		
APCPL	118.52248	:		
SJVN	35.34092	:		
ADHPL	13.28904	:		
Total	**5683.29359**	:	**Total**	**5683.29359**

NOTE :-

1. Deviation Settlement of central sector and Inter-regional sources have been determined with reference to their schedule at the point of injection but those of BUYERs with reference to their ex-periphery schedule

2. Deviation over I.R. links retained without adjustment.

Annexure II(b)

Computation with Regulation Reserve Service

Northern Regional Power Committee

Mock for Ancilliary Services

Deviation Settlement Account For The Week 16/06/2014 To 22/06/2014

ABSTRACT OF UTILITY WISE DEVIATION CHARGES

(All Figs. in Rs. Lakh)

Utilities	Amount Payable		Utilities	Amount Receivable
HIMACHAL PRADESH	882.70123	:	WR-NR	1854.35292
PUNJAB	866.72451	:	ER-NR	703.47195
UTTAR PRADESH	660.79745	:	DELHI	62.67801
HARYANA	649.47465	:	NHPC	121.02067
CHANDIGARH	435.79117	:	SCL	12.44356
JAMMU AND KASHMIR	379.22354	:	THDC	6.80273
RAJASTHAN	331.68230	:	LANCO	4.03350
UTTARAKHAND	227.72562	:	EPPL	0.80001
RAILWAYS	147.27161	:	POOL BALANCE (CAP)	1018.65968
NTPC	463.39128	:	POOL BALANCE (Add DEVI)	1816.32568
JPVL	391.92742	:		
APCPL	118.27130	:		
SJVN	32.28931	:		
ADHPL	13.31732	:		
Total	**5600.58871**	:	**Total**	**5600.58871**

NOTE :-

1. Deviation Settlement of central sector and Inter-regional sources have been determined with reference to their schedule at the point of injection but those of BUYERs with reference to their ex-periphery schedule

2. Deviation over I.R. links retained without adjustment.

Annexure II(c)

Impact on UI Charges

Northern Regional Power Committee

DIFFERENTIAL AMOUNT OF DEVIATION CHARGES PAYABLE/ RECEIVABLE DUE TO REVISION OF THE DEVIATION SETTLEMENT ACCOUNT FOR THE WEEK 16-06-2014 - 22-06-2014- Revision - 3

Constituents	Payable		Constituents	Receivable
WR-NR	20.23546	:	HIMACHAL PRADESH	19.14293
ER-NR	14.83752	:	NTPC	14.42060
PUNJAB	3.46866	:	UTTAR PRADESH	11.95462
NHPC	1.66926	:	JPVL	9.89259
SCL	0.17398	:	CHANDIGARH	8.44568
THDC	0.16554	:	RAJASTHAN	7.32244
ADHPL	0.02828	:	JAMMU AND KASHMIR	6.82740
LANCO	0.02633	:	HARYANA	4.05710
EPPL	0.00429	:	SJVN	3.05161
POOL BALANCE (CAP)	2.91852	:	DELHI	1.78345
POOL BALANCE (ADD DEVI)	44.45743	:	UTTARAKHAND	0.61805
		:	APCPL	0.25118
		:	RAILWAYS	0.21762
Total	**87.98527**		**Total**	**87.98527**