# Management of Ancillary Services Reserves in North Eastern Regional Grid of India

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## SYNOPSIS

In India, the Tertiary Frequency Control is realised in the form of Reserve Regulation Ancillary Services (RRAS) and Fast Response Ancillary Services (FRAS). Ancillary Services in India, is obtained from all generating stations that are regional entities and whose tariff is determined or adopted by the Commission for their full capacity [1]. The RRAS is a thin layer of centralized scheduling over the de-centralized scheduling model adopted in the country. Both the Ancillary Services have been very useful tool for the system operators at National Load Despatch Centre (NLDC) as well as at Regional Load Despatch Centres (RLDCs) to maintain the National Grid frequency within the IEGC band of 49.90-50.05 Hz, to handle high intermittency in Renewable Generation & to tackle any sudden contingencies in the grid. Availability of adequate and round-the-clock reserves for both types of Ancillary Services is highly essential. Experiences in maintenance of regional RRAS and FRAS reserves at North Eastern Regional Load Despatch Centre (NERLDC) have been presented in this paper. The challenges faced by the system operators at regional level in the maintenance of the reserves for both the ancillary services due to variation of availability in the reserves at different instances of a day and variation during high and lean hydro season has been incorporated in the paper. Probable solution to the challenges being faced for maintenance of adequate reserves for ancillary services in the form of "Market based Ancillary Services Mechanism" in line with Discussion Paper on "Re-designing Ancillary Services Mechanism in India" published by Central Electricity Regulatory Commission (CERC) on September, 2018, has also been discussed in brief.

## KEYWORDS

Tertiary Frequency Control, Ancillary Services, RRAS, FRAS and Reserve

## 1. INTRODUCTION

The target of installing 175 GW of Renewable Energy capacity by the year 2022 has been set by the Government of India. In view of integration of such a large amount of Renewable Energy, which is intermittent in nature, it has become very important to have adequate reserves in the Indian Grid. The system operators all over the world use various scheduling and control techniques in order to maintain the load-generation balance. However in an interconnected power system, due to sudden contingency events and intermittent nature of renewable energy sources, load and generation balance may get disturbed. Hence, the grid must have adequate reserves at all times to respond to such events and ensure quick restoration of the frequency.

The load – generation balance is generally maintained with three levels of frequency control namely, Primary frequency control, Secondary frequency control and Tertiary frequency control. The Primary Frequency Control is provided by the generator unit governor to a frequency deviation within a time frame of a few seconds. The Secondary frequency control is a centralised control directed by the operator, which utilizes the Automatic Generation Control (AGC) to bring the frequency of the grid back to its nominal value and keep the interchanges between the control areas to their scheduled values. This balancing service is deployed in minutes timeframe. The tertiary control is the balancing mechanism which is achieved with manual intervention of the system operator. The operator despatches the available reserves to handle current and future contingencies. The tertiary control is deployed within a timeframe varying from minutes to hours.

## 2. PRESENT PRACTICE OF ANCILLARY SERVICES IN INDIA

The RRAS has been implemented since 12th April, 2016 in accordance with the CERC Ancillary Services Operations Regulation, 2015 [1]. The RRAS is the ancillary services obtained from thermal generating stations. The pilot project for FRAS has also been implemented since 26th November, 2018 in accordance with CERC order in Petition No. 07/SM/2018 [2]. The FRAS is the ancillary services obtained from hydro generating stations.

### 2.1 Reserve Regulation Ancillary Services (RRAS)

The reserve for RRAS is obtained from Un-requisitioned Surplus (URS) of a particular generating station. The URS power is the reserve capacity in a generating station that has not been requisitioned and is available for despatch and is computed as the difference between the declared capacity of the generation station and its total schedule under long-term, medium-term and short-term transactions [3].

Depending upon the frequency pattern and present/ future grid contingencies, National Load Despatch Centre (NLDC) issues the RRAS-up/down despatch instruction in 15 min time block basis to the Regional Load Despatch Centres (RLDCs). Upon receiving the despatch

instruction from NLDC, the same is implemented in the net schedule of generating stations.

### 2.2 Fast Response Ancillary Services (FRAS)

Hydro generators have quick ramping capability and thus can provide faster response than the thermal generators. Hence for FRAS the hydro generators are used to provide ancillary services to handle sharp frequency variations due to sudden variations in demand, fluctuations in RE generations, etc. But, hydro generators are energy limited resources, so, they are used less frequently than RRAS.

The generation schedule of Hydro plants is maintained by RLDCs such that some percentage of the available capacity in the plant is kept as reserve at all times for FRAS. The FRAS reserve is being monitored and despatch instructions are given to generating stations as well as RLDCs by NLDC. Constraints declared by the hydro station honoured and the total energy delivered over the day is maintained as declared by the hydro station. The total energy dispatched under FRAS is proposed to be squared off by the end of the day. The plants upon receiving of such despatch instructions change and maintain their generations as per the instruction. RLDCs incorporate the FRAS instructions in the net schedule of the plants. 05-minute- Scheduling, Metering, Accounting and Settlement being used in FRAS.

## 3. EXPERIENCE OF ANCILLARY SERVICES IN NORTH EASTERN REGIONAL GRID OF INDIA

The North Eastern Regional Grid of India is one of the 5 operational regions of the Indian Grid. North Eastern Load Despatch Centre (NERLDC) is the apex body to ensure integrate operation of the North Eastern Regional Grid of India as mandated by the Electricity Act, 2003. NERLDC supervises the activities of seven state control areas and eleven ISGSs [4]. The net installed capacity of the region is 3912 MW out of which 2623 MW is the installed capacity of ISGSs. The thermal generating stations which are providing RRAS have a net installed capacity of 926 MW. The hydro generating stations which are providing the FRAS have a net installed capacity of 455 MW.

### 3.1 Experience of RRAS

There has been considerable increment in the net installed capacity in the last few years in the North Eastern Grid of India which in turn has led to increase in the availability of power in the RRAS reserve. The growth of the RRAS reserve of NER Grid over the period of last 3 years is shown in the Figure-1. The growth of the RRAS available is around 41.18 % from the year 2017 to the year 2018 and 48.61 % from the year 2018 to the year 2019.

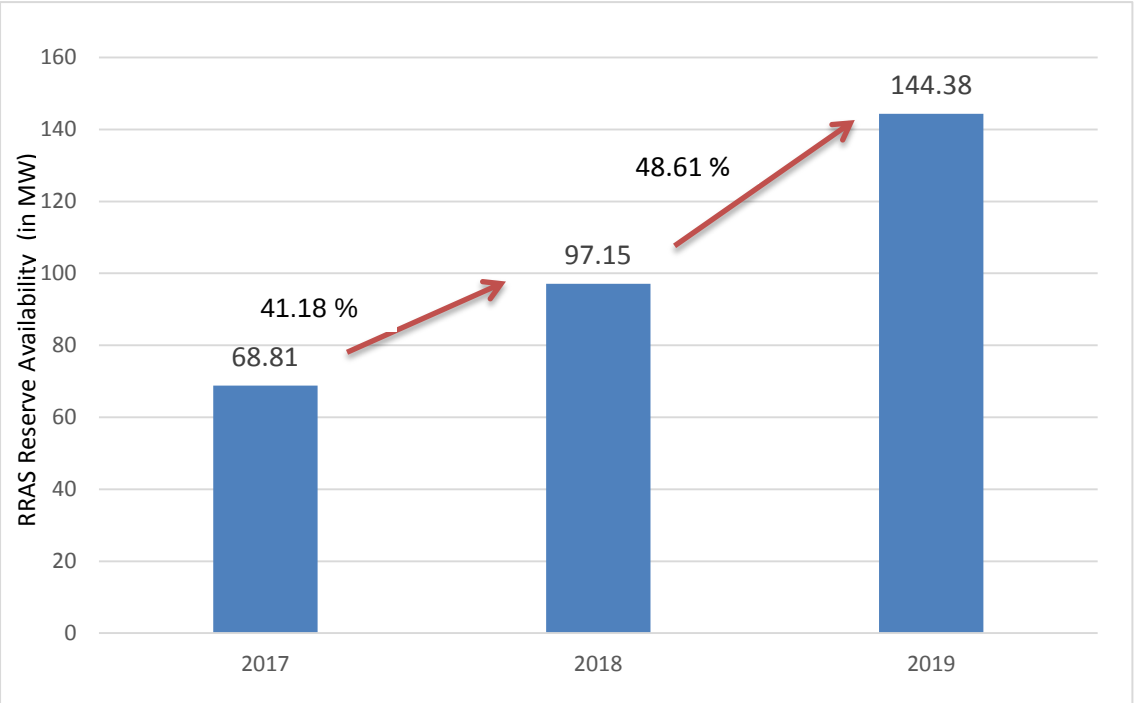


Figure 1: Average RRAS availability of NER Grid for a typical day in the month of January for the last 3 years

As discussed in section 2.1, the RRAS reserve depends upon the URS power in thermal ISGSs when a beneficiary of a thermal ISGS does not requisition its allocated share. On the basis of the load forecast of beneficiaries of North Eastern Region, the quantum of their power requisition is estimated by them from each generating station. The amount of share to be surrendered from the ISGS also depends on the energy charge rates of the ISGS. The reserve available for RRAS thus depends directly upon the drawal pattern of the beneficiaries or States of the North Eastern Region. The drawal pattern changes in daily, monthly and yearly basis.

### 3.1.1 Reduction of the available RRAS reserve in the Peak Hours

In the timeline of a day, in general, the drawal pattern of the North Eastern States changes such that the drawal is mostly higher in the peak hours of the day ( 18:00 Hrs to 22: 00 Hrs). In order to meet the peak demand, the states take their full shares from all ISGSs. This leads to less availability in the RRAS reserve. If any contingency arises in the North Eastern Grid in these hours and the system operator feels the need to despatch RRAS, enough quantum of power will not be available in the reserve. Also, during the peak hours, the trend of frequency is such that it tends to remain low and even go below the lower limit of 49.90 Hz specified in Indian Electricity Grid Code (IEGC) mostly due to the drawal by the States more than their respective drawal schedule. During such low frequency, to maintain the grid frequency within the IEGC band of 49.90 Hz - 50.05 Hz, the system operator needs adequate quantum of power available in the RRAS Reserve. But during peak hours, low surrender of power by the States leads to low RRAS reserve. As RRAS reserve varies with the varying of requisition of

power by States, the reserve available varies at all time.

A plot showing falling net availability of RRAS reserve of NER Grid in a typical day is shown in the Figure -2. The low availability of RRAS reserve can be seen in the plot. The RRAS reserve availability begins to decrease in the peak hours and falls to around 50 MW at around 20:30 Hrs.

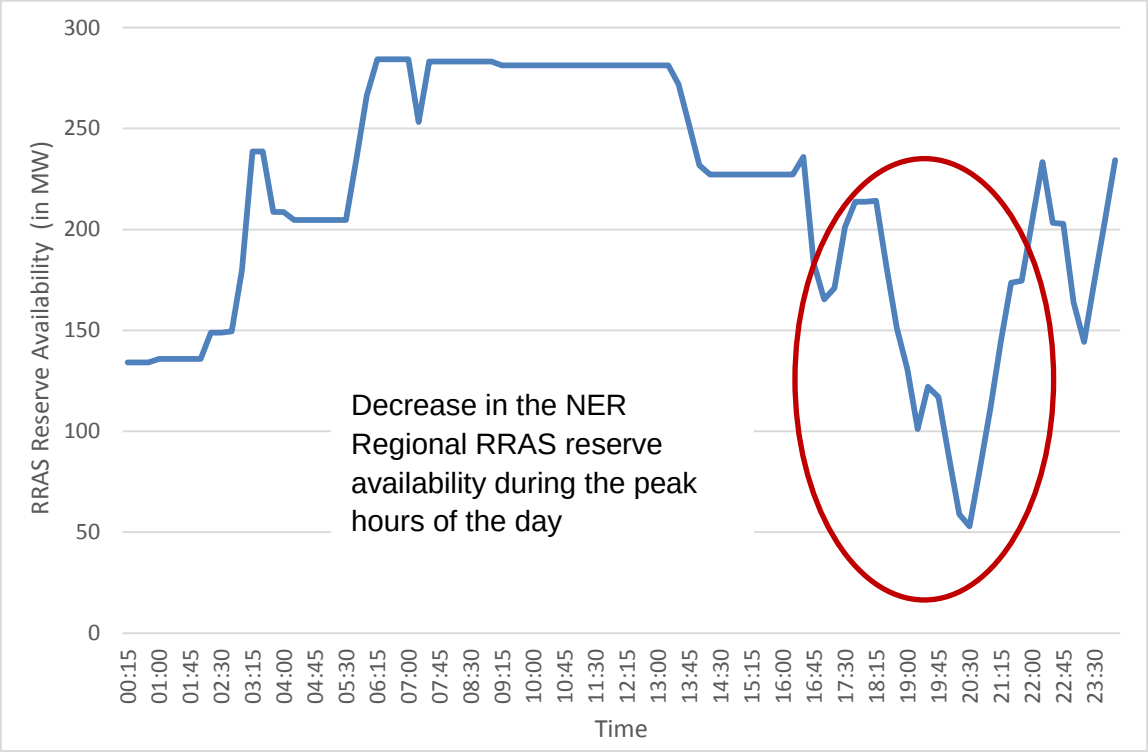


Figure 2: Net availability of RRAS reserve of NER Grid in a typical day

### 3.1.2 Dependency of RRAS reserve on High and Lean Hydro Season

The North Eastern Region is bestowed with a good amount of hydro resources with the regional installed capacity of 1584 MW being obtained from Hydro Generating Stations of the Region. During the months of May to October (High Hydro Season), the water and thus energy availability of the hydro generations is maximum, and they generate upto their declared capacity (DC) at most of the times during the day. During the other months of the year i.e. the Lean Hydro Season, the water/ energy availability of the Hydro Generating Stations is very less. Thus, in the time of lean hydro season, the system operator (NERLDC) schedules the hydro ISGSs in such a manner that they help in meeting the peak demand of the region.

As the Hydro ISGS are scheduled near to their declared capacity throughout the day during the high hydro season, the constituent States that have shares from these hydro ISGSs are entitled to get power with respect to their full shares throughout the day. The high power availability from hydro ISGS helps in meeting the full demand of the State in the whole day including the peak demand of the States. Also, the States like Meghalaya, Assam, etc. who

have their own intra State hydro generations, have the tendency to surrender their share from the ISGSs. The states surrender their share from the ISGS having higher energy charges and as the Hydro ISGSs have lower energy charges than the thermal ISGSs, the States are reluctant to take the power from thermal ISGSs. Thus, during the high hydro season, the states surrender their shares from Thermal ISGSs and the power available in RRAS reserve is very high.

The effect of Lean Hydro season on RRAS reserve availability is just opposite to what has been observed during the High Hydro season. As the water/energy availability in both Hydro ISGS and the State owned Hydro Generating Stations is less, the states depend largely on the power available from Thermal ISGSs, and thus their requisition from the Thermal ISGSs is equal to their full share in most of the time of the day. This in turn leads to low availability of power in the RRAS reserve and the system operator becomes helpless if any contingency arises in the Grid or if the Grid frequency drops to a very low value as enough power is unavailable in the RRAS reserve during the lean hydro season.

A comparison between the average RRAS reserve availability of NER Grid for a typical day in the high hydro and lean hydro season of the year 2018 has been shown in the Figure – 3. The RRAS reserve falls from 211.90 MW in the high hydro season to 97.15 MW in the lean hydro season. The decrease of around 54 % can be clearly observed in the RRAS reserve availability in the lean hydro season due to full requisition of power by almost all States.

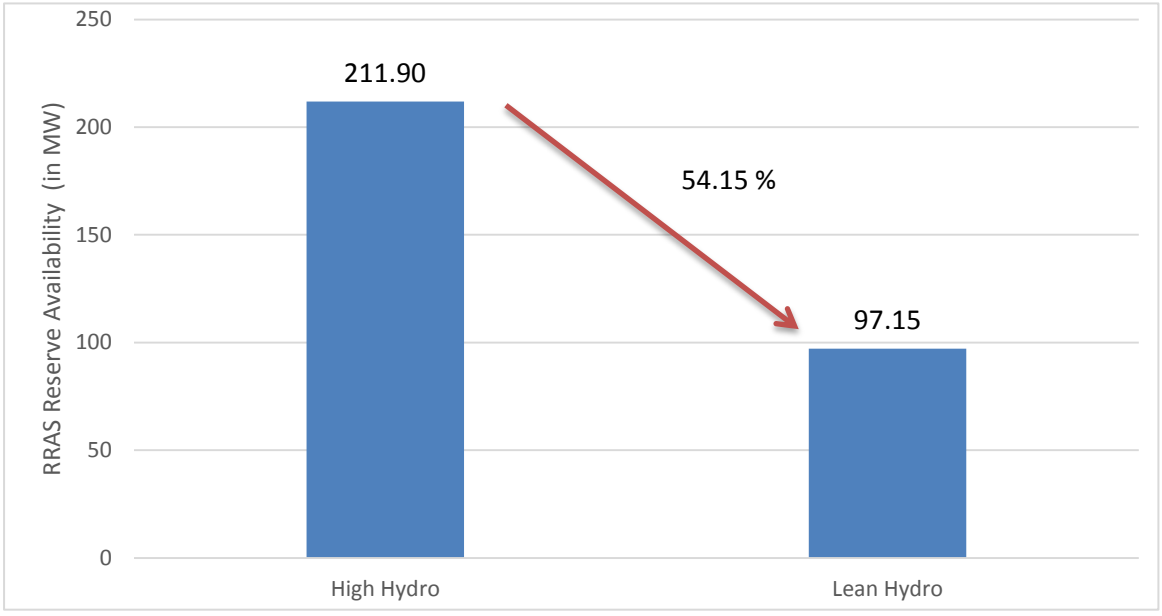


Figure 3: Average RRAS reserve availability of NER Grid for a typical day in the high hydro and lean hydro season of the year 2018

### 3.2 Experience of FRAS

FRAS has been implemented in India since 26th November, 2018 on a pilot basis. As discussed in section 3.1.2, NER Region is rich in hydro resources. The all India net installed capacity of storage type Hydro ISGSs is 3.7 GW and pondage type Hydro ISGSs is 5.6 GW.

Thus, all over India around Installed Capacity of 9.3 GW Hydro ISGSs are providing the FRAS [5]. In NER Region, net Installed capacity of Hydro ISGSs which provide FRAS is 455 MW.

The FRAS reserve is maintained by RLDCs by scheduling the designated FRAS providers in such a way that there is almost equal margin for FRAS up instruction and FRAS down instruction. A comparison of FRAS up and down margin of each storage type hydro ISGS along with net FRAS up and down margin of the NER region for a typical day in lean Hydro season is presented in the Figure – 4 and Figure – 5 respectively. The average net FRAS up margin generated of the region for a typical day in lean hydro season is 15.66 MW and the same for FRAS down is 22.15 MW. However, the average up and down margin is expected to increase in high hydro season.

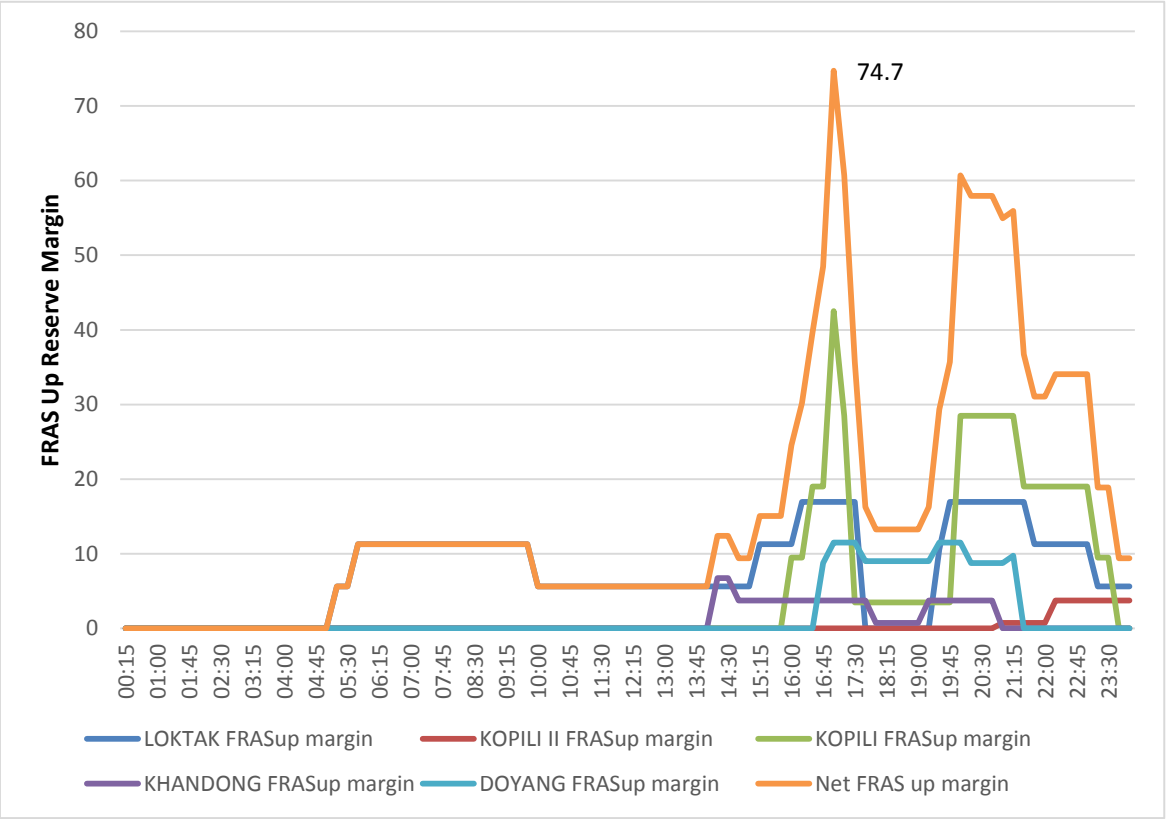


Figure 4: FRAS up reserve margin for a typical day in lean hydro season

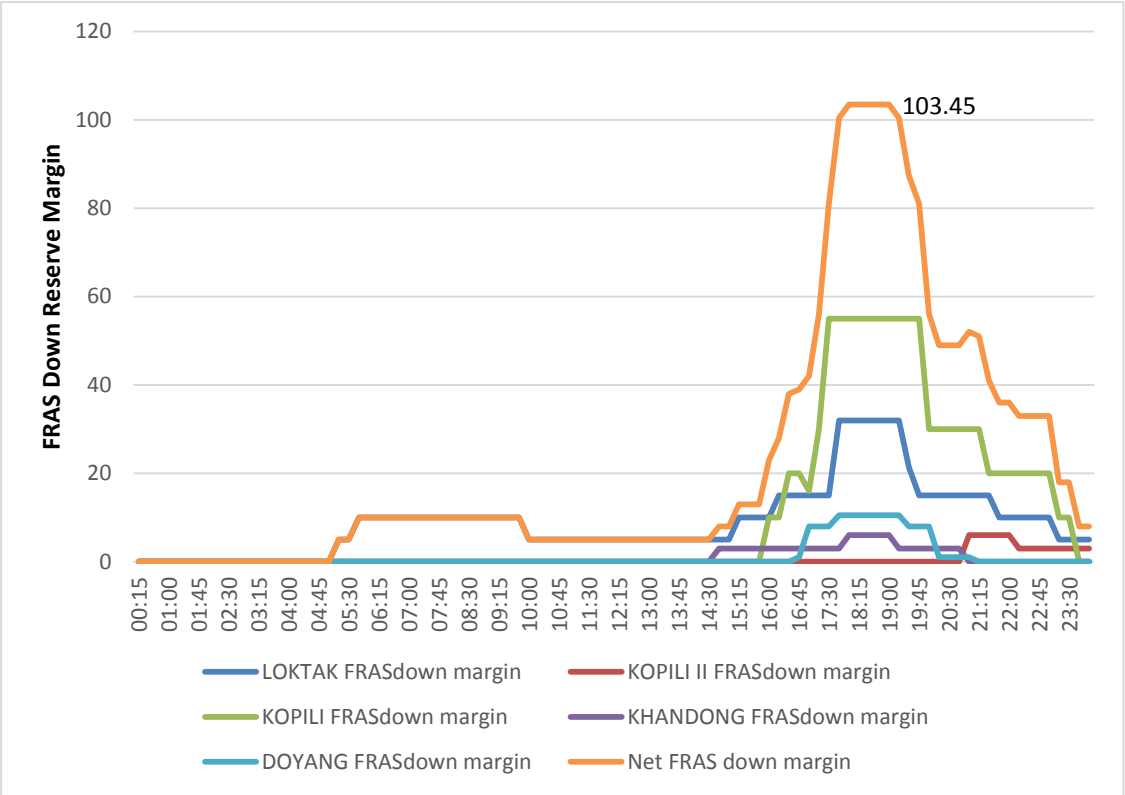


Figure 5: FRAS down reserve margin for a typical day in lean hydro season

## 4. INTRODUCTION TO MARKET BASED ANCILLARY SERVICES

In a discussion paper published by Hon'ble CERC, the day-ahead/ real time market based Ancillary Services has been envisaged for Indian power system [6]. In the paper day ahead as well as real time Ancillary Services Market has been proposed where all the resources i.e. ISGSs/State Owned as well as RE can participate for providing the services. The demand curve for ancillary service shall be put forth by the NLDC/RLDCs for day ahead market as well as real time market. The generating station whose quantum is cleared, must respond accordingly. This new concept shall ensure the availability of resources on firm basis unlike the prevailing practice where available reserves vary with the varying of requisition. In the present scenario the generating stations which are providing ancillary services are only limited to the ISGSs whose tariff is being determined or adopted by the Commission. But with the market based Ancillary Services, the ambit of ancillary services shall be extended to merchant plants, state owned generating stations and RE generators which shall increase the overall availability of reserves for Ancillary Services.

## 5. CONCLUSION

It is very important to have adequate and round-the-clock reserves available for tertiary frequency control in Indian Power System. Although, the FRAS is a newly introduced

tertiary control, we have almost 3 years of experience in using RRAS in the form of slow tertiary control and managing the reserves availability for RRAS. As presently the RRAS reserves are generated through the un-requisitioned quantum remaining in the ISGSs, the availability of RRAS reserve hugely depends on the demand pattern of the beneficiaries which naturally varies with time. The variation in RRAS reserve observed at different time of the day and during different season of the year has been described in detail. The tertiary reserve is very low in NER during the lean hydro season. Brief description on the experience in maintenance of FRAS reserve has also been described. The probable solution to variation in Ancillary Reserve could be found by introducing Market Based Ancillary Services in Indian Power System. A fixed percentage of Declared Capacity of generators may also be kept on reserve for Ancillary Services. But whatever be the approach, adequate reserve has to be made available to ensure reliable operation of the Grid. Any other regulatory changes may be thought of which may help in maintenance of adequate reserves at all times and at all seasons.

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