Second Meeting of the Sub-Committee of CAC

NRCE 18.9.2014

Functions

- To compute the TTC of each Transmission Corridor in the Grid.
- To coordinate the protection of the Grid on an All-India basis.
- Any other matter related to Reliability of the Grid.

North American Electric Reliability Corporation (NERC)

- The North American Electric Reliability Corporation is a not-for-profit entity
- Mission is to ensure the reliability of the bulk power system in North America.

About NERC

- NERC's area of responsibility spans the continental United States, Canada and the northern portion of Baja California, Mexico.
- NERC is the electric reliability organization for North America, subject to oversight by the Federal Energy Regulatory Commission and governmental authorities in Canada.
- Entities under NERC's jurisdiction are the users, owners and operators of the bulk power system, which serves more than 334 million people.

Functions of NERC

- Develops and enforces Reliability Standards;
- Annually assesses seasonal and long-term reliability;
- Monitors the bulk power system through system awareness; and
- Educates, trains and certifies industry personnel.

Standards

NERC's **Standards** program ensures the reliability of the bulk power system by developing quality **reliability standards** in a timely manner that are effective, clear, consistent and technically sound.

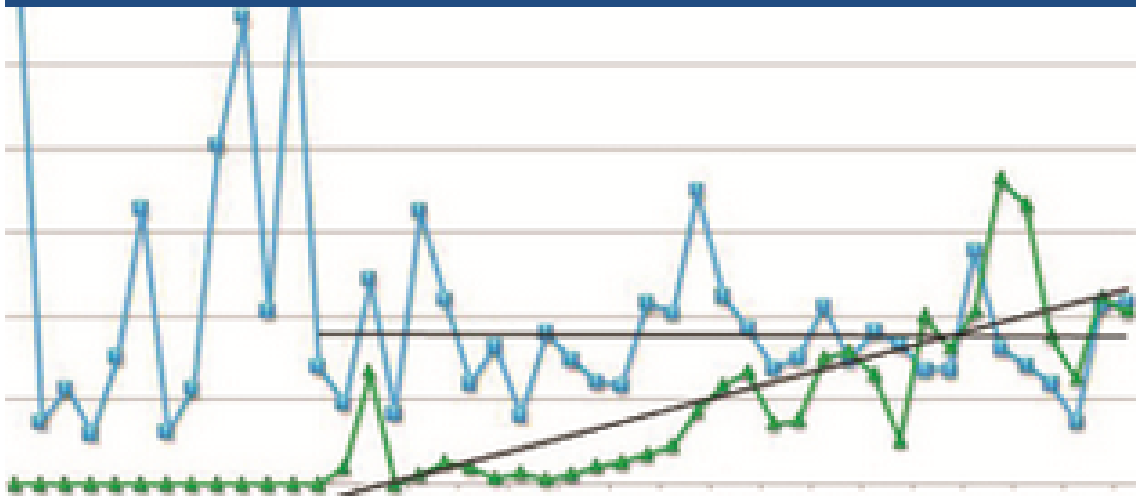
▸ **Standards**

Critical Infrastructure

Critical Infrastructure is designed to efficiently identify security threats, develop policies and procedures to address these threats, and bolster training activities for owners and operators.

▸ **ES-ISAC**

Reliability Assessment & Performance Analysis



The **Reliability Assessment and Performance Analysis** program assesses, measures and investigates historic trends and future projections to improve bulk power system reliability.

▸ **Reliability Assessment & Performance Analysis**

Reliability Risk Management

The **Reliability Risk Management** program's goals are to enhance reliability and serve as a learning initiative by providing timely lessons learned from system events, conditions, and trends.

▸ **Lessons Learned**

Compliance & Enforcement

The focus of NERC's **Compliance & Enforcement** program is to improve the reliability of the bulk power system in North America by fairly and consistently enforcing compliance with NERC standards.

▸ **Compliance & Enforcement**

System Operator Training & Certification

Training & Certification ensures personnel operating the bulk power system are well-trained and certified to operate the system reliably, and provides training for industry and staff on compliance programs and reliability standards.

▸ **System Operator Training & Certification**

Discussion of guidelines for determination of TTC, ATC and TRM in real time.

- **Permissible normal and emergency limits**
- Normal thermal ratings and normal voltage limits represent equipment limits that can be sustained on continuous basis.
- ***Emergency thermal ratings*** and emergency voltage limits represent equipment limits that can be tolerated for a relatively ***short time which may be one hour to two hour depending on design of the equipment***.
- The thermal loading limit of a line is determined by design parameters based on ***ambient temperature***, maximum permissible conductor temperature, ***wind speed***, ***solar radiation***, absorption coefficient, emissivity coefficient etc.

Discussion on TTC, ATC and TRM

Discussions in the second meeting of the sub-Group of the NRCE held on 10.6.2014

- How often should calculations of TTC, ATC and TRM be done.
- Presently it is done once or maximum twice, i.e. during peak and off-peak hours to arrive at the TTC, ATC and TRM for the month.
- If there is an outage of generator or line or other system element, then the same is calculated again.
- The power flow on inter-State transmission corridors keeps changing in the absence of Reserves and Automatic Generation Control.
- System Protection Schemes are put to increase the TTC, ATC and TRM.

Decisions taken in the second meeting of the sub-Group of the NRCE held on 10.6.2014

- (i) Awareness should be brought to all states in the OCC meetings on **the need for accurate data at all generation and demand nodes** of the power system in the State.
- (ii) System protection schemes have been put in place as contingency measures. All the RPCs would take this up as an agenda item in the OCC meetings **to ensure that the relays of these schemes are not bypassed**.
- (iii) In order to check the actual power flows vis-a-vis the ATC, it was decided that the **power flows in certain critical transmission corridors would be studied, like the S1 – S2 corridor and the corridor between Western and Northern Regions**.

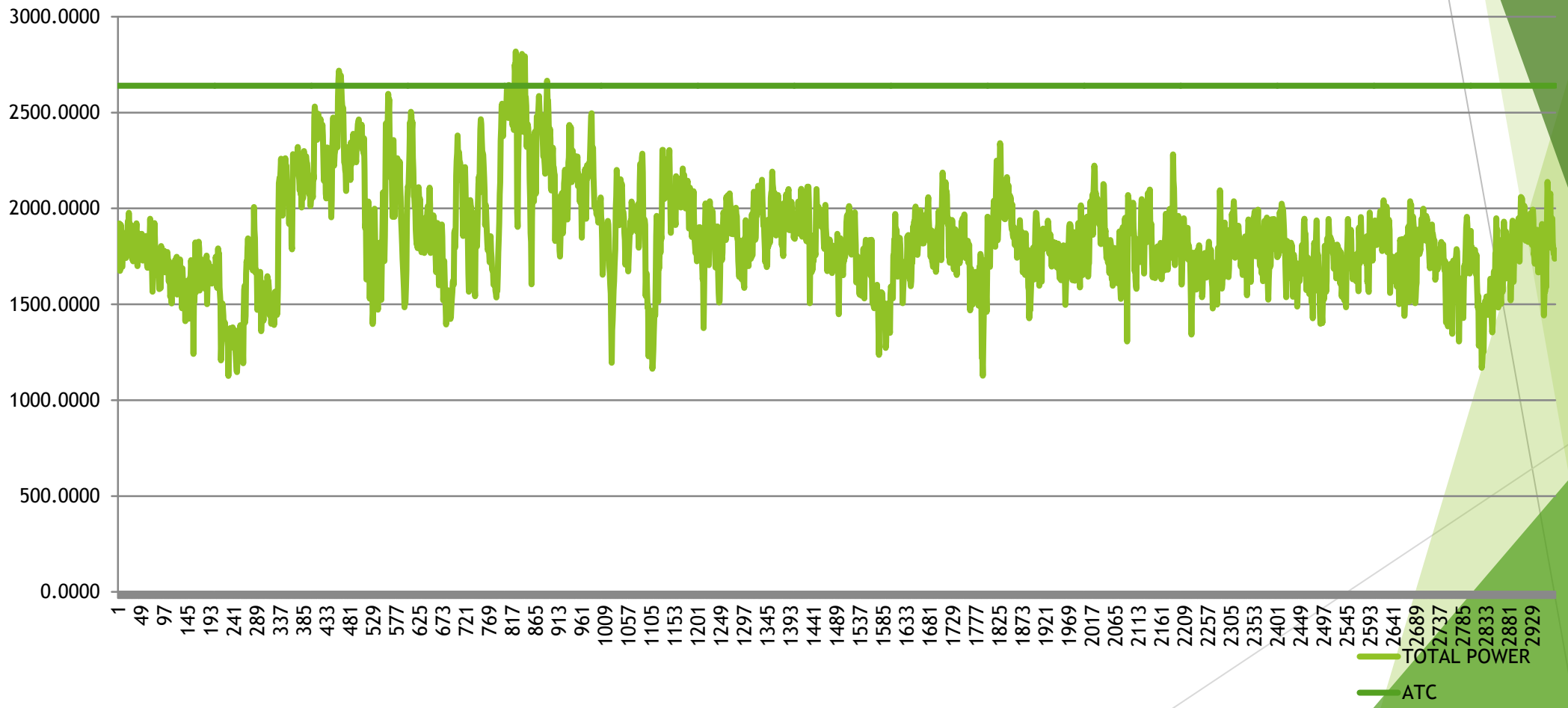
Power flows in S1 – S2 corridor

- Bangalore –Salem S/C 400 KV line
- Kolar –Hosur D/C 400 KV line
- Hosur-Salem S/C 400 kV line
- Kolar – Sriperumbudur (Chennai) S/C 400 KV line
- Nellore- Sriperumbudur (Chennai) S/C 400 KV line
- Chitoor- Sriperumbudur (Chennai) S/C 400 KV line
- Nellore-Almati S/C 400 KV line

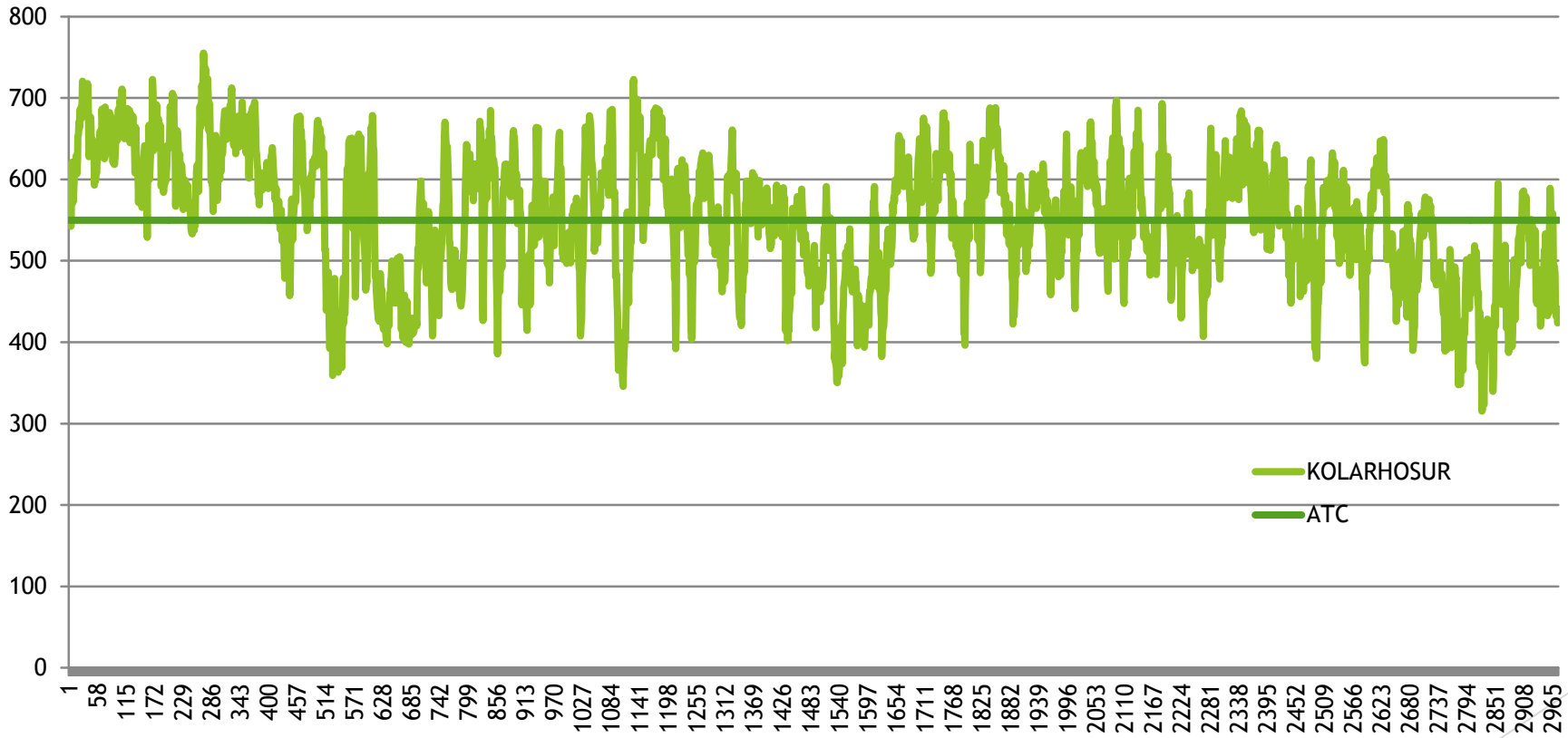
Critical lines in the S1-S2 corridor

- The main constraint are in the first two lines, i.e
  - **(i) Bangalore –Salem S/C 400 KV line and**
  - **(ii) Kolar –Hosur D/C 400 KV line**

Total Power flow on S1-S2 corridor (15 minute readings for May 2014)



Power flow on a single circuit of 400 kV D/C Kolar-Hosur line (15 minute readings for May 2014) (critical line in S1-S2)



Dynamic Line Rating (DLR).

Dynamic line rating

(Reference: U.S. Department of Energy site)

- Dynamic line rating ***enable system operator to determine capacity and apply line ratings in real time, based on actual operating conditions***.
- In many power systems, ***static ratings are adjusted to account for significant differences in maximum ambient temperature***. Line ratings ***may be adjusted daily, hourly, or even more frequently to reflect the maximum ambient temperature predicted during a particular period of time***. The method of periodically adjusting a line's rating based on ambient air temperature is called ***ambient- adjusted rating***.

Dynamic line rating

(Reference: U.S. Department of Energy site)

- For example, in New York, transmission lines receive a summer seasonal line rating assuming an ambient temperature of 35 degrees Celsius. If the maximum ambient temperature predicted for the next 24 hours is only 25 degrees Celsius, the ambient- adjusted rating can be increased by approximately 10% for the next 24 hours.

Ambient adjusted rating (along with other parameters)

Operating Conditions	Change in Conditions	Impact on Capacity
Ambient temperature	2 °C decrease	+ 2%
	10 °C decrease	+ 11%
Solar radiation	Cloud shadowing	+/- a few percent
	Total eclipse	+ 18%
Wind	3 ft./s increase, 45° angle	+ 35%
	3 ft./s increase, 90° angle	+ 44%

Day and Night temperature at Hosur (Tamil Nadu State)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max of Min	18	21	23	25	25	23	22	19	20	19	17	16
Min of max temp during the day	26	28	29	34	27	28	25	26	27	28	27	26

Hosur, Tamil Nadu

Wednesday 3:00 pm

Mostly Cloudy

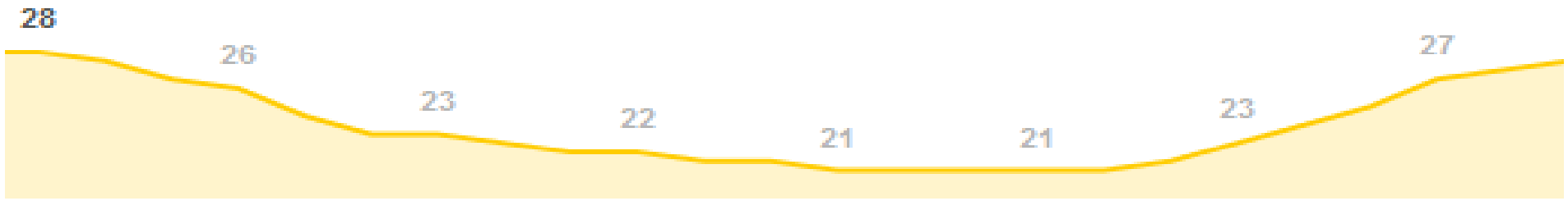
28 °C | °F

Precipitation: 9%

Humidity: 52%

Wind: 14 km/h

Temperature | **Precipitation** | **Wind**



4 pm | 7 pm | 10 pm | 1 am | 4 am | 7 am | 10 am | 1 pm

Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed
28° 21°	29° 20°	29° 20°	29° 20°	29° 19°	29° 19°	29° 19°	29° 19°

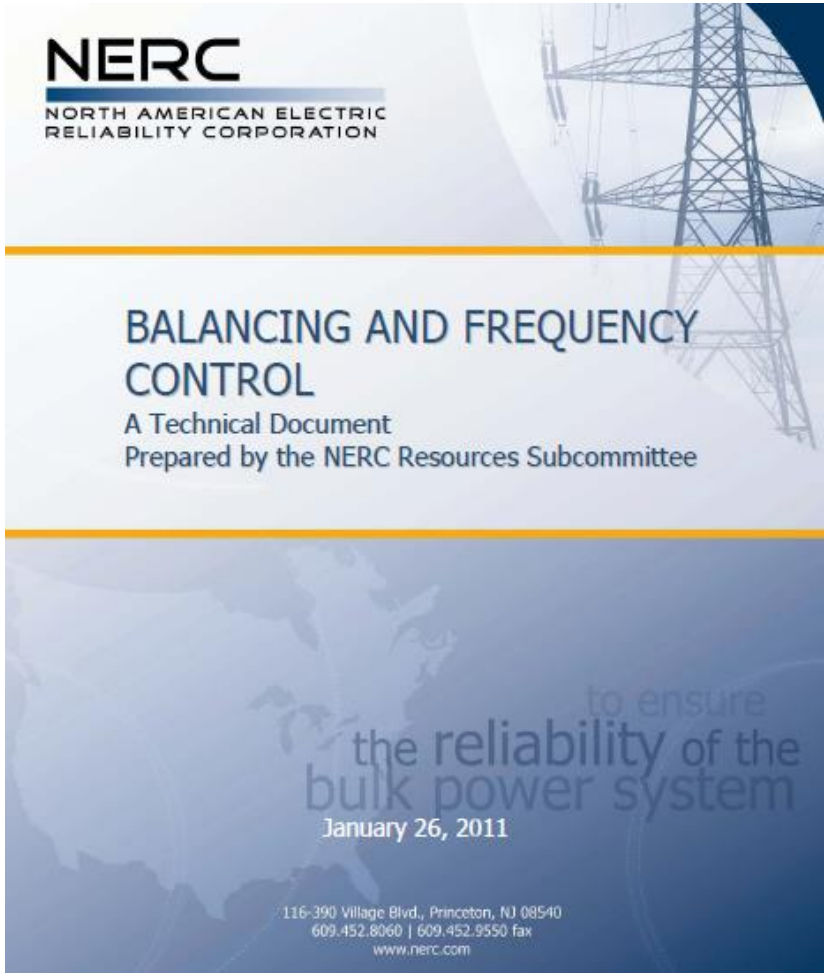
KOLAR

Now | Daily | **Hourly** | Morning | Afternoon | Evening | Overnight

	Wed 3pm	4pm	5pm	6pm	7pm	8pm	9pm	10pm
Forecast	Mostly Cloudy	Cloudy	Cloudy	Cloudy	Cloudy	Cloudy	Cloudy	Cloudy
Temp (°C)	28°	27°	25°	24°	23°	23°	22°	22°
RealFeel®	26°	24°	22°	21°	20°	20°	19°	19°
Humidity	48%	51%	56%	61%	71%	72%	75%	76%

Reserves and Automatic Generation Control (AGC).

NERC Technical Document



NERC Technical Document on **Balancing and Frequency Control**

- **Primary Control**
- Primary Control is more commonly known as Frequency Response. Frequency Response occurs within the ***first few seconds*** following a change in system frequency (disturbance) to stabilize the Interconnection. Frequency Response is provided by:
- 1. **Governor Action**. Governors on generators are similar to cruise control on your car. They sense a change in speed and adjust the energy input into the generators' prime mover.
- 2. **Load shedding**.

NERC Technical Document on **Balancing and Frequency Control**

- **Secondary Control**
- Secondary Control typically includes the balancing services deployed in the ***"minutes"*** time frame.
- Secondary Control ***also includes initial reserve deployment for disturbances***.
- In short, Secondary Control maintains the minute-to-minute balance throughout the day and is used to restore frequency to its scheduled value, usually 60 Hz, following a disturbance. Secondary Control is provided by both Spinning and Non-Spinning Reserves.

NERC Technical Document on **Balancing and Frequency Control**

- **The most common means of exercising secondary control is through Automatic Generation Control (AGC).**
- SCADA gathers information about an electric system, in particular system frequency, generator outputs, and actual interchange between the system and adjacent systems.
- **Using system frequency and net actual interchange, plus knowledge of net scheduled interchange,** it is possible to determine the system's energy balance with its interconnection in near-real-time.
- Most SCADA systems poll sequentially for electric system data, **with a typical periodicity of four seconds**.

NERC Technical Document on **Balancing and Frequency Control**

- AGC computes a Balancing Area's **Area Control Error (ACE)** from **interchange and frequency data**.
- ACE tells whether a system is in balance or needs to make adjustments to generation.
- **AGC software, while observing ACE, automatically determines the most economical output for generating resources while observing energy balance and frequency control,** usually by sending setpoints to generators.

Decisions taken in the third meeting of the NRCE

- (i) Ambient adjusted thermal rating would be used by POSOCO to calculate the TTC & ATC. Directions for the same would be issued by the NRCE to POSOCO.
- (ii) The proposal of reserves and AGC by each state would be put up in all the RPCs for discussions and approval.

Thank You