

**MINUTES OF THE 15TH MEETING OF THE CENTRAL ADVISORY
COMMITTEE (CAC) HELD ON 07TH MARCH, 2011
AT NEW DELHI**

**VENUE : “MAGNOLIA” HALL, INDIA HABITAT CENTRE,
LODHI ROAD, NEW DELHI – 110 003.**

The meeting was chaired by Dr. Pramod Deo, Chairperson, CERC. A list of participants is **enclosed** at *Annexure-I*.

2.0 In his opening remarks, Chairperson, CERC mentioned that the Central Commission has made it clear that UI should not be used as a route for trading of electricity. The Commission has narrowed down the permissible frequency range for deviation and also substantially modified the UI charges. This objective is to drive the distribution utilities to go for planned procurement of electricity and create an environment for investors to set up new power plants. The utilities had over a period postponed setting up of power projects and relied on overdrawal from the grid for meeting consumer demand. This is not the correct approach, remarked Dr. Deo. The utilities should plan for procurement of power on long-term, medium-term and short-term basis. The Commission has also taken a strict view of the continued grid indiscipline by some state utilities and penalty has accordingly been imposed. Some of such orders are however under challenge. The need of the hour is for all stakeholders to appreciate the efforts being made by the Commission in larger interests of grid security and discipline. The question before the Commission at present is – to what extent should the permissible frequency range be further reduced for ensuring grid security. He requested the members of the committee to give their considered views and help the Commission take a final view in this regard.

3.0 A presentation was made by Shri Sushanta K. Chatterjee, Deputy Chief (Regulatory Affairs), CERC summarizing the issues and suggestions contained in the agenda note which was circulated for consideration in the meeting. A copy of the presentation is **enclosed** at *Annexure-II*. Shri S.K. Soonee, CEO, POSOCO thereafter made a presentation which is at *Annexure-III*. Shri Soonee highlighted how narrowing down of the frequency range has helped stabilize the grid operation and urged the Commission to bring the permissible range for deviation as close to nominal level as possible at the earliest. He also underscored the need for a separate regulation on Communications.

4.0 The following views were expressed by the members of the CAC on the issues contained in the agenda note:

4.1 Shri R.V. Shahi opined that the frequency band for Unscheduled Interchange (UI) should be reduced without any further delay. He stated that more and more generation capacities are being added. There is therefore a strong case for reduction of our dependence on UI. He emphasized that UI should not only be discouraged but also prevented. He recommended that an entity violating the IEGC and UI regulations and overdrawing beyond the permissible range for more than three times should be debarred from entitlement to unallocated share. He advised that CERC should give statutory advice to this effect to the Ministry of Power. Representatives of Adani, FICCI, JSW Power, PTC, and RIL also supported the proposal of reducing the permissible UI band.

4.2 Shri Anil Sardana, MD, Tata Power Company Limited felt that any decision on narrowing down the UI band should be taken, after due consideration of its impact on capability of distribution companies on load management. He argued that reduction of UI band might lead to increase in load shedding. He contended that there should be monitoring of load shedding at the distribution end and heavy penalty should be imposed for resorting to indiscriminate load shedding. He felt that it has been possible to tighten frequency band in the

developed countries because of adequacy of supply/spinning reserve and strict enforcement of performance standards. He also argued that renewables should be excluded from any move towards shrinkage of UI band.

4.3 Prof. S.C. Srivastava of IIT, Kanpur said that UI kinks should also be revisited. He underscored the need for a study on Peak Shortage vis-à-vis frequency deviation. He felt that tightening of UI frequency band should not be at the cost of load shedding. He also endorsed the proposal of NLDC for capacity building for better results.

4.4 MSEDCL representative said that shortage has been reducing with generation capacity additions. There is, therefore, a case for lower frequency band. He, however, felt that renewable, especially wind, should be given a special dispensation.

4.5 NTPC representative argued that Availability Based Tariff (ABT) should be implemented in all States immediately. With reduction of frequency band, flexibility of the generator gets limited. Further tightening of frequency band could lead to a situation where some generating companies might not participate.

4.6 Representative of APTRANSCO argued that ancillary services should be explored.

4.7 Shri V.S. Verma, Member, CERC argued that frequency variation impacts life of the plant and also life of the equipment. He said that in his opinion, if frequency band was reduced, this would encourage the distribution companies to contract power through organized markets. He also underscored the need for separate peak and off-peak tariff for generation.

5. On the other agenda item for discussion, i.e., need for a separate regulations on communications, there was a majority view that there exists adequate provisions in the existing regulations. There was a need for enforcement and implementation of those provisions. The system operator argued that the experience has proved that separate regulations (for instance on UI) has proved to be more effective.

6. **Consensus** :

- ❖ There was a general consensus that the UI frequency band should be reduced not only in the interest of grid security but also to encourage the distribution companies to procure power through contracts in the organized market.
- ❖ The concern that shrinkage of UI frequency band might lead to increase in instances of demand not being met was noted. However, there was a consensus that this could not be a valid argument for endangering grid security.
- ❖ As more and more generation capacities getting added, dependence on UI should reduce. In fact, the distribution companies should encourage contracting power through long term, medium term and short term market. The solution lies in contracting capacities in advance.
- ❖ As an alternative to UI, ancillary services should be brought in place.
- ❖ On the impact on renewable, there is a need for empirical study to assess as to how the existing wind generation capacity of about 13,000 MW has impacted the frequency and UI segment of short term transactions.

- ❖ There is also a need for estimation of investment requirements for implementing the proposal of the system operator for reduction of steps of UI vector (the system operator argued that the investment requirement was minimal).
- ❖ There is also a need for a study on peak shortage vis-à-vis frequency deviation.
- ❖ On the proposal for separate regulations on communications, it was agreed that adequate provisions are already there in the existing regulations. There was a need for enforcement and implementation of those provisions.

7. Shri R.V. Shahi made a statement at the end of the discussion on the agenda item that financial viability of the distribution companies is a major area of concern today in the power sector. The losses of the distribution companies are estimated to be in the range of Rs.55,000 crores. Lenders and investors are wary of financing/investment. He informed that a study has been conducted by IDFC Energy Advisory Group on the future course of action to be taken by different stakeholders like the Government, Regulators, Forum of Regulators (FOR) etc to address this issue. He expressed willingness to make a presentation before CERC and FOR and urged that CERC being a Central Regulator should take up such a issue for detailed deliberations and suitable recommendations to the Government of India.

The meeting ended with a vote of thanks to the Chair.

**LIST OF PARTICIPANTS ATTENDED THE FIFTEENTH MEETING OF
CENTRAL ADVISORY COMMITTEE (CAC)**

HELD AT INDIA HABITAT CENTRE, NEW DELHI

ON 07TH MARCH, 2011

S. No.	NAME	
01.	Dr. Pramod Deo Ex-Officio, Chairperson, CAC	Chairperson, CERC
02.	Shri S. Jayaraman Ex-Officio Member, CAC	Member, CERC
03.	Shri V.S. Verma ExOfficio Member, CAC	Member, CERC
04.	Shri R.V. Shahi	Former Secretary, MOP
05.	Shri Anil Sardana Managing Director	Tata Power Company Limited
06.	Shri R.K. Madan CEO (Power)	Adani Enterprises Limited
07.	Shri Satish Jindal Chief Operating Officer	JSW Power Trading Company Limited
08.	Prof. S.C. Srivastava	Indian Institute of Technology (IIT)
09.	Shri Bhasker U. Mete President, GEA	Maharashtra State Electricity Power Gen. Corpn. Limited
10.	Shri Kirti J. Amin President	Kisan Vikas Sangh
11.	Shri P. Srirama Rao Director (Grid Oprn.)	Representative of APTRANSCO
12.	Shri R.N. Nayak Director (Oprn.)	Representative of POWERGRID Limited
13.	Shri M.S. Babu Executive Director (Comml.)	Representative of NHPC Limited
14.	Shri M.K.V. Rama Rao Executive Director (Comml.)	Representative of NTPC Limited
15.	Shri Alok Roy Head (Transmission)	Representative of RIL
16.	Shri Vivek Pandit Director (E&D&A)	Representative of FICCI
17.	Shri P.B. Hote S.E. (Load Despatch), Kalwa	Representative of MSEDCL

18.	Shri M.L. Garg Chief Engr./SO&C	Representative of PSTCL
19.	Shri Rakesh Kumar Executive Vice-President	Representative of PTC
20.	Shri Sambit Basu	Representative of IDFC
21.	Shri Sanjay Kaul	Representative of Jindal Power Limited
22.	Shri Rajiv Bansal Secretary	CERC
	SPECIAL INVITEES	
23.	Shri S.K. Soonee CEO	POSOCO

Annexure II

15th Meeting of the Central Advisory Committee Presentation by CERC

7th March 2011

New Delhi

Agenda

- Grid Security
 - Need For Tightening of Frequency Band
 - Other Measures
- Any other Agenda
 - With the permission of Chairperson

Handling Imbalance in Indian Context

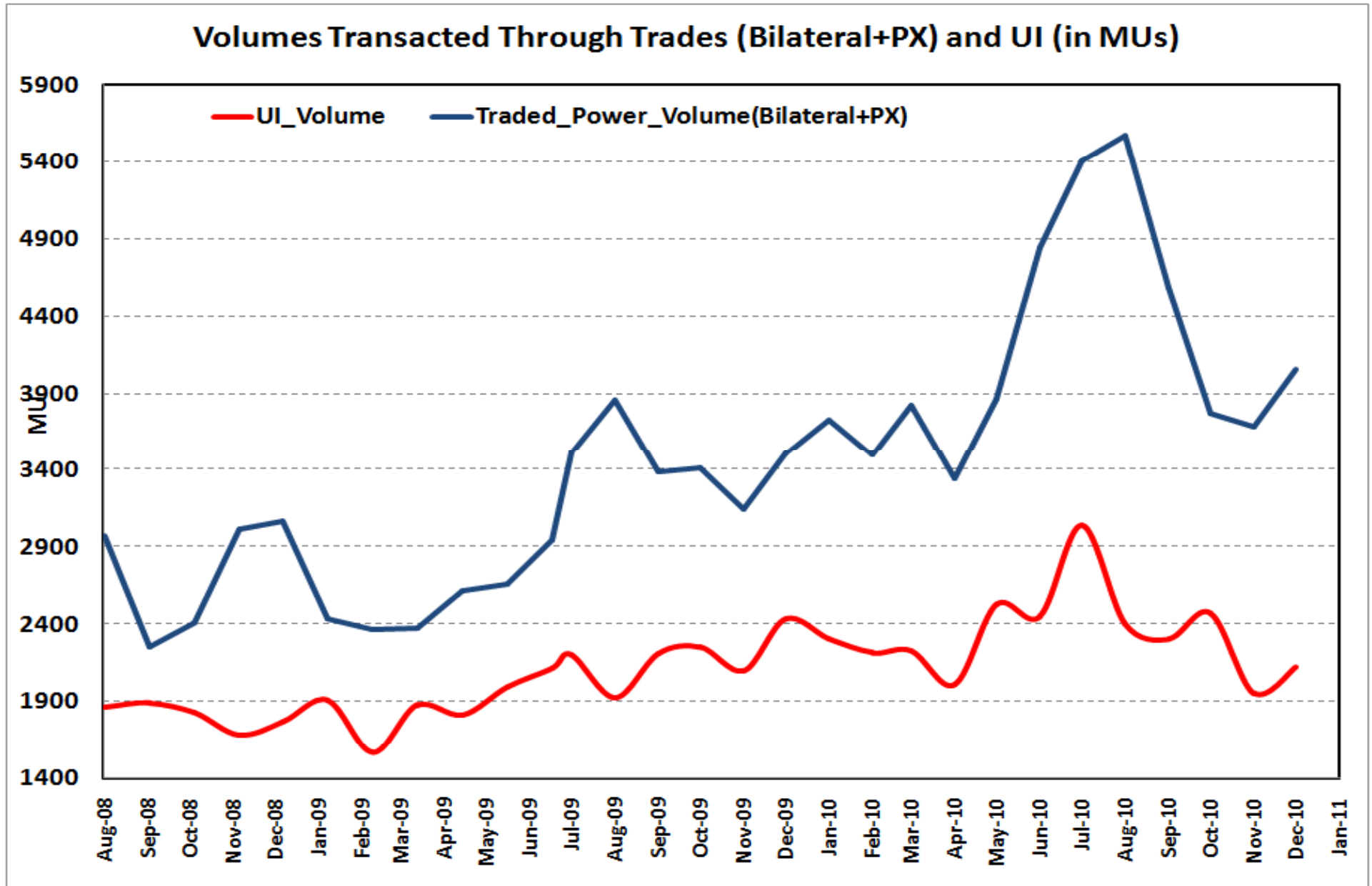
- Earlier

- Operational Frequency Band: 49.0 – 50.5 Hz
- *UI Vector a part of Terms & Conditions of Tariff*
- *A single Vector applicable for all*

Handling Imbalance...

- IEGC amendment: Tightening of Operational Frequency Band
 - From 49.0-50.5 Hz to 49.2-50.3 Hz and finally to 49.5-50.2
 - Objective
 - To improve quality of supply, ensure grid security
- Separate Regulations for UI charges
 - restructuring of UI regime to enforce grid discipline/discourage use of UI for trading
 - to rationalize the UI rates for the entities who abide by the specified grid operation parameters

Trade Volumes (Bilateral + PX)



Inference!

- Ratio of UI / (PX + Licensed trader) before and after UI regulation has reduced from 0.63 to 0.52.
- One can infer that incremental volume has moved at faster rate to (PX + trader market) than to UI .

Discussion in 4th Meeting of Coordination Forum

- Meeting held on 17th Aug 2009
- Extracts from MoM

...It was highlighted in the presentation that low frequency situations are also resulting in sub-standard grid voltages. After the discussion, it was generally felt that there was a need to further narrow down the permissible frequency range from 49.5 Hz to 50.3 Hz w.e.f. January 2010 and from 49.8 Hz to 50.2 Hz w.e.f. January 2011....

Issues for Discussion

- Tightening of operating frequency band is desirable
 - What should be next operating range for frequency?
 - Presently the operating range is 49.5 to 50.2 Hz with a Step Size of 0.02 Hz
 - **Suggested solution**
 - In year 2011: 49.7 to 50.2 Hz with a Step Size of 0.01 Hz
 - In year 2012: 49.8 to 50.1 Hz with a Step Size of 0.01 Hz
- Need for Separate Regulation on communication system

Thank You

Month	UI	PX+ Licensed Trader+ Bilateral	Short Trem including UI	Short Trem including UI/ generation	correlation UI and (PX + Licensed Trader+ Bilateral)	UI/ (PX+Licensed Trader +Bilateral)	AvgUI volume (8 months)	Avg PX+ Trader+B ilateral volume	Avg Ratio (UI/PX+Trad er+Bilateral)	Total generation	Ratio ui/ generation	ratio PX+bil/g eneratio n	Average UI / gen	Avg Px+bil / gen
Oct-09	2251	3411	5662	8.72%		0.6601				64896.26	3.47%	5.26%		
Nov-09	2098	3145	5244	8.83%	0.6750	0.6672	2259	3540	0.6382	59402.72	3.53%	5.29%		
Dec-09	2431	3504	5935	9.36%		0.6937				63417.34	3.83%	5.53%		
Jan-10	2308	3727	6035	9.31%		0.6191				64849.3	3.56%	5.75%		
Feb-10	2215	3493	5708	9.35%		0.6340				61076.19	3.63%	5.72%		
Mar-10	2230	3829	6059	8.64%		0.5823				70099.77	3.18%	5.46%		
Apr-10	2011	3343	5354	8.04%		0.6016				66572.47	3.02%	5.02%		
May-10	2530	3865	6395	9.41%		0.6545				67980.4	3.72%	5.69%	3.49%	5.46%
Jun-10	2450	4846	7296	11.19%	0.6621	0.5056	2408	4580	0.5258	65211.13	3.76%	7.43%		
Jul-10	3041	5411	8452	12.88%		0.5620				65632.15	4.63%	8.24%		
Aug-10	2399	5571	7970	11.86%		0.4306				67174.98	3.57%	8.29%		
Sep-10	2302	4583	6885	10.70%		0.5024				64315.24	3.58%	7.13%		
Oct-10	2470	3776	6246	8.85%		0.6541				70558.09	3.50%	5.35%		
Nov-10	1954	3687	5640	9.01%		0.5299				62583.8	3.12%	5.89%		
Dec-10	2121	4063	6184	9.22%		0.5222				67079.74	3.16%	6.06%		
Jan-11	2528	4702	7230	10.14%		0.5376				71282.05	3.55%	6.60%	3.61%	6.87%

Grid Security – Need For Tightening of Frequency Band & Other Measures

Meeting of the Central Advisory Committee

7th March 2011



FREQUENCY & FREQUENCY DURATION CURVE

DATE : 27/09/98 Sunday



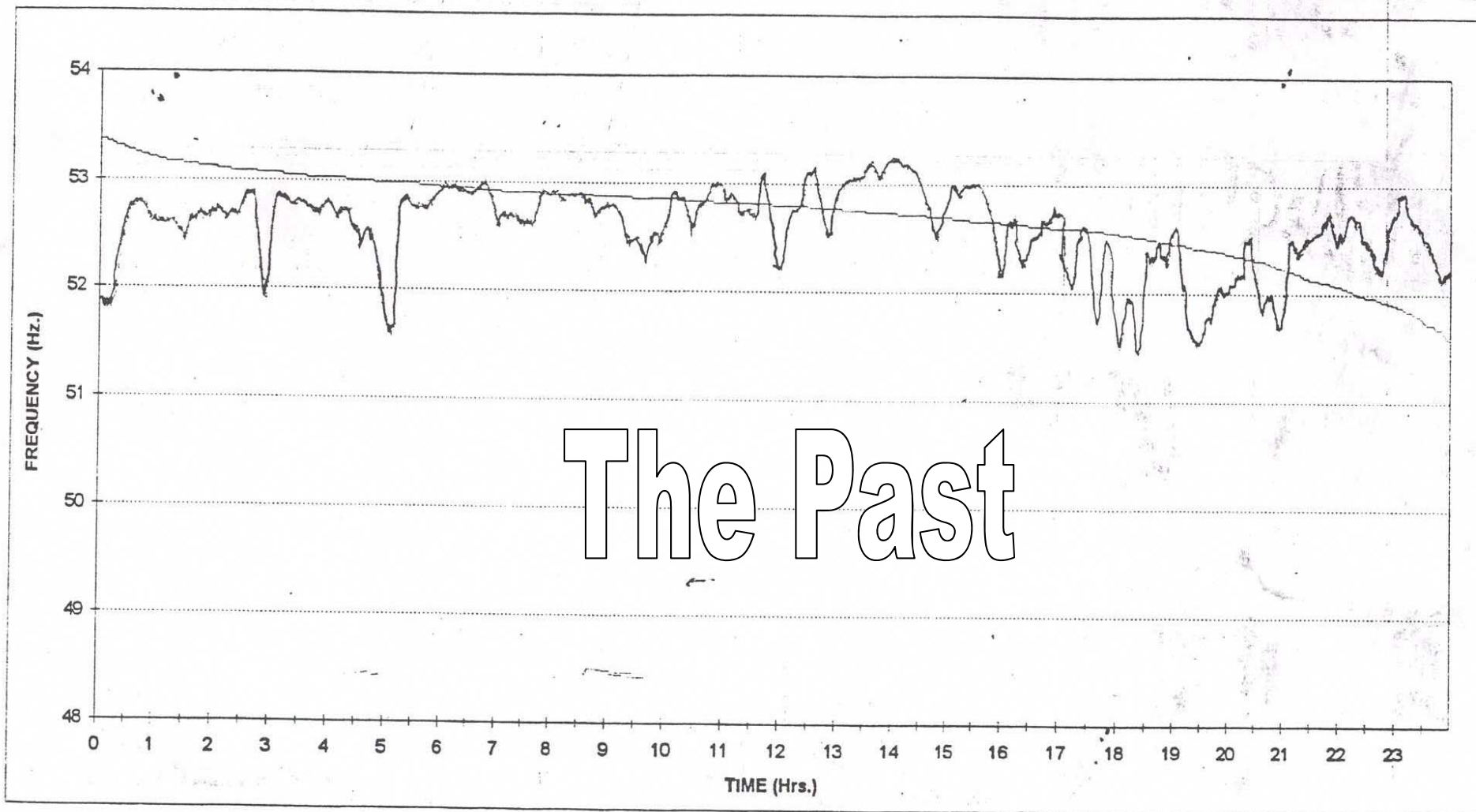
FVI : 68.38

STD : 0.3

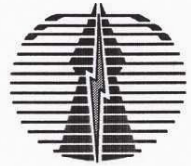
AVG. Freq : 52.6 Hz

Max. Freq : 53.3 Hz

Min Freq : 51.4 Hz



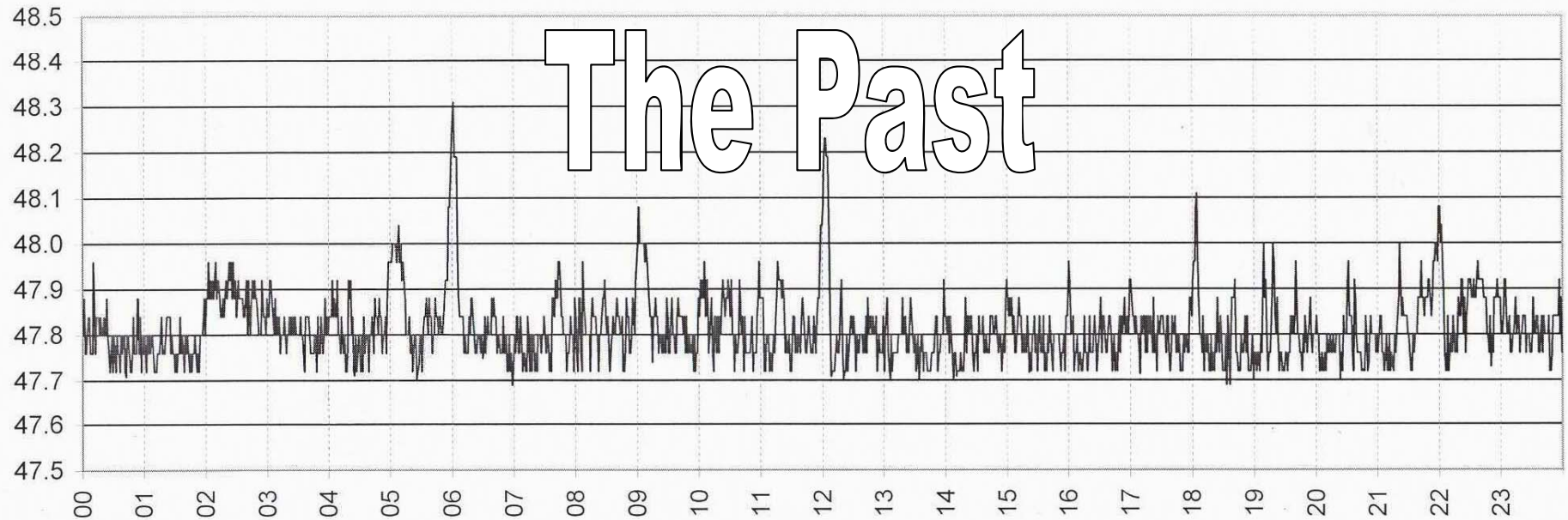
**POWER GRID CORPORATION OF INDIA LTD.
SOUTHERN REGIONAL LOAD DESPATCH CENTRE**



FREQUENCY ANALYSIS FOR

24-04-2002

Wednesday

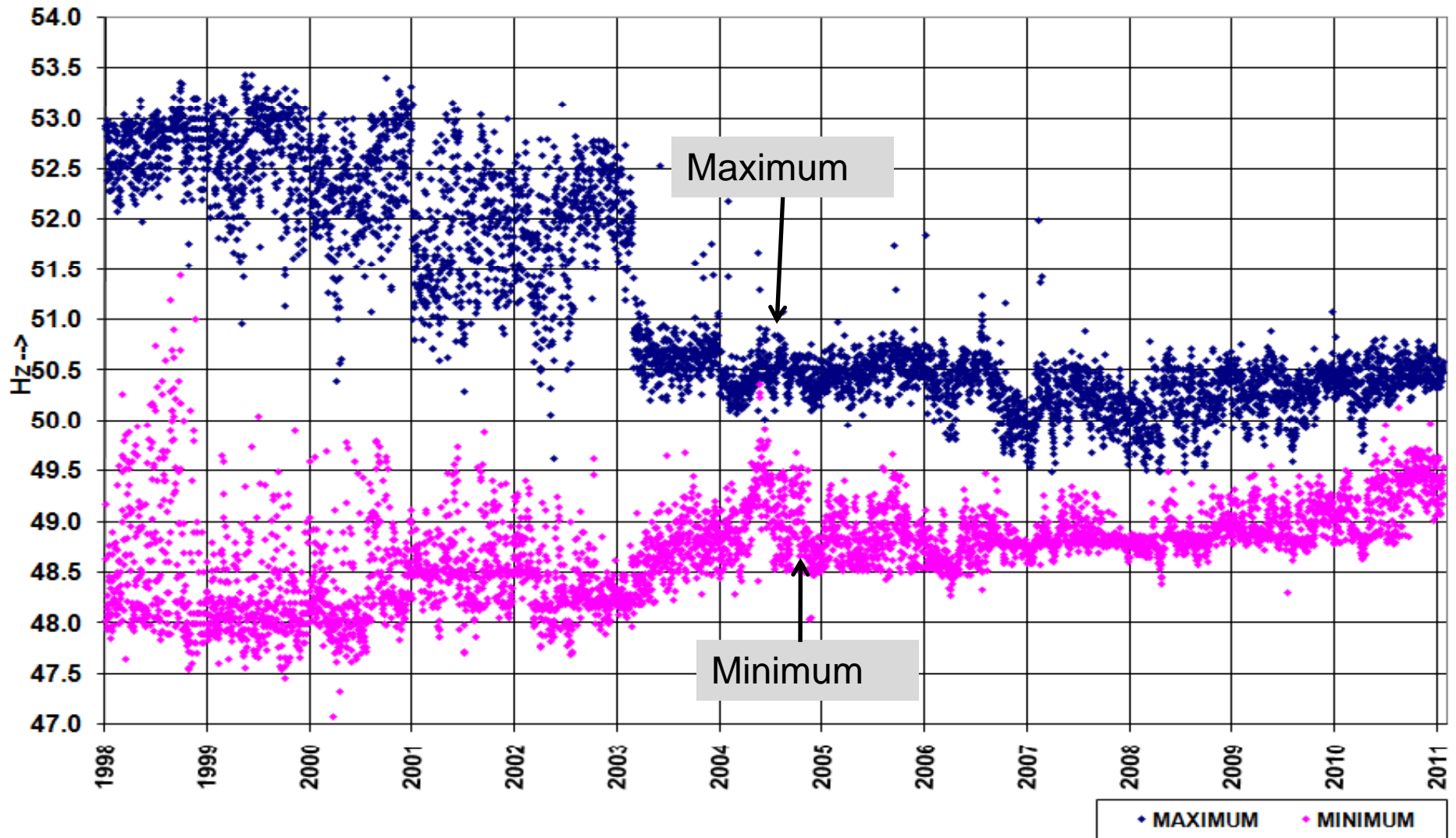


Frequency Variation based on data integrated over ONE minute interval

	<48.0	48.0 & <48.5	48.5 & <49	49 & <49.5	49.5 & <50	50 & <50.5	50.5 & Above	
Minutes	1396	44	0	0	0	0	0	
In %	96.9	3.1	0.0	0.0	0.0	0.0	0.0	
Average Frequency over the day:	47.82	Standard Deviation:	0.08	Frequency Variation Index :	47.70			
	Instantaneous					Quarter Hourly Average		
	Freq	Time				Freq	Time	
Max	48.31	06:01				Max	47.97	05:15
Min	47.69	18:36				Min	47.75	13:45

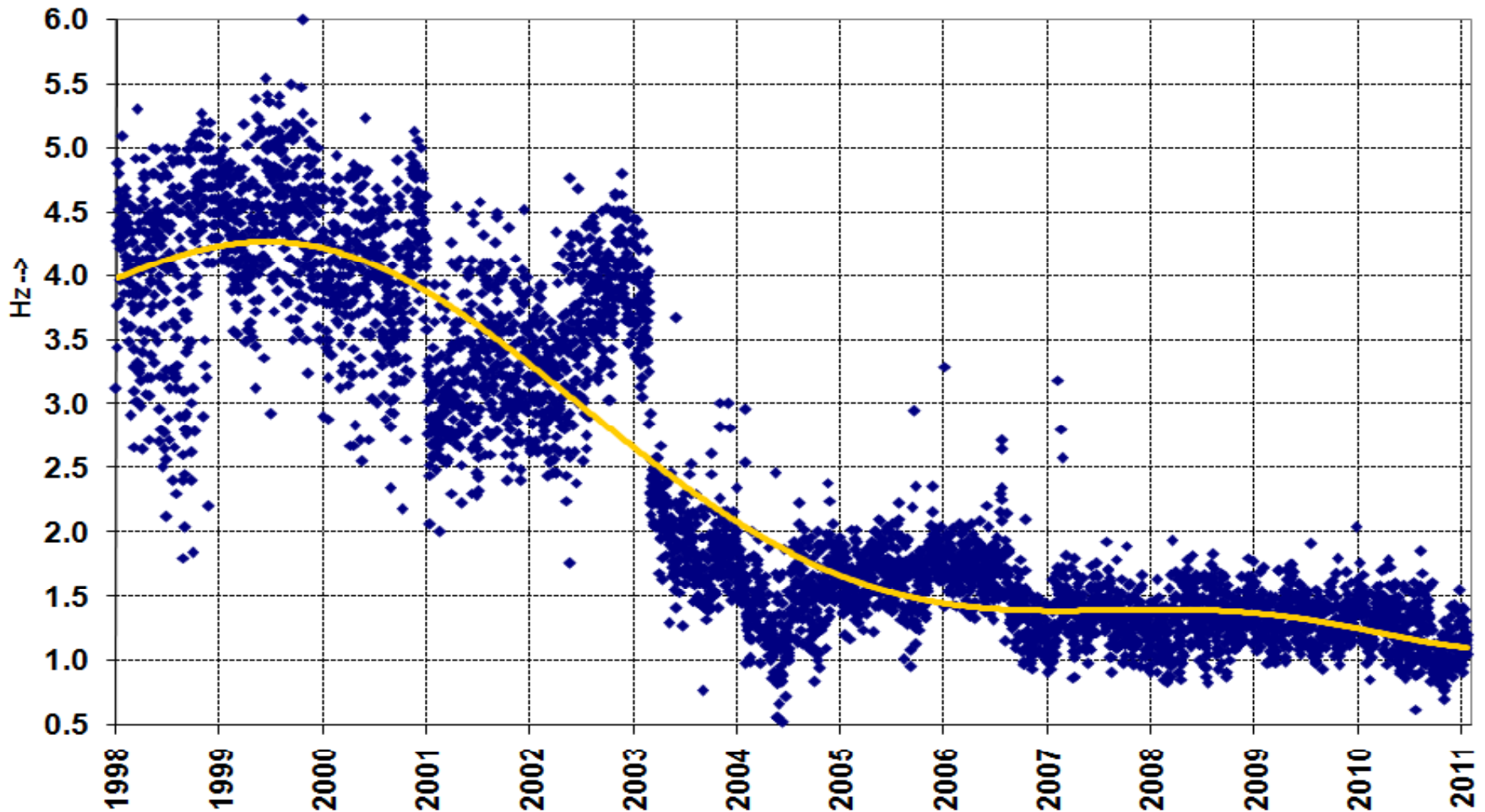
Daily Max & Min Frequency in NEW Grid (1998 onwards)

ER / NEW GRID MAXIMUM AND MINIMUM FREQUENCY JANUARY '98 ONWARDS



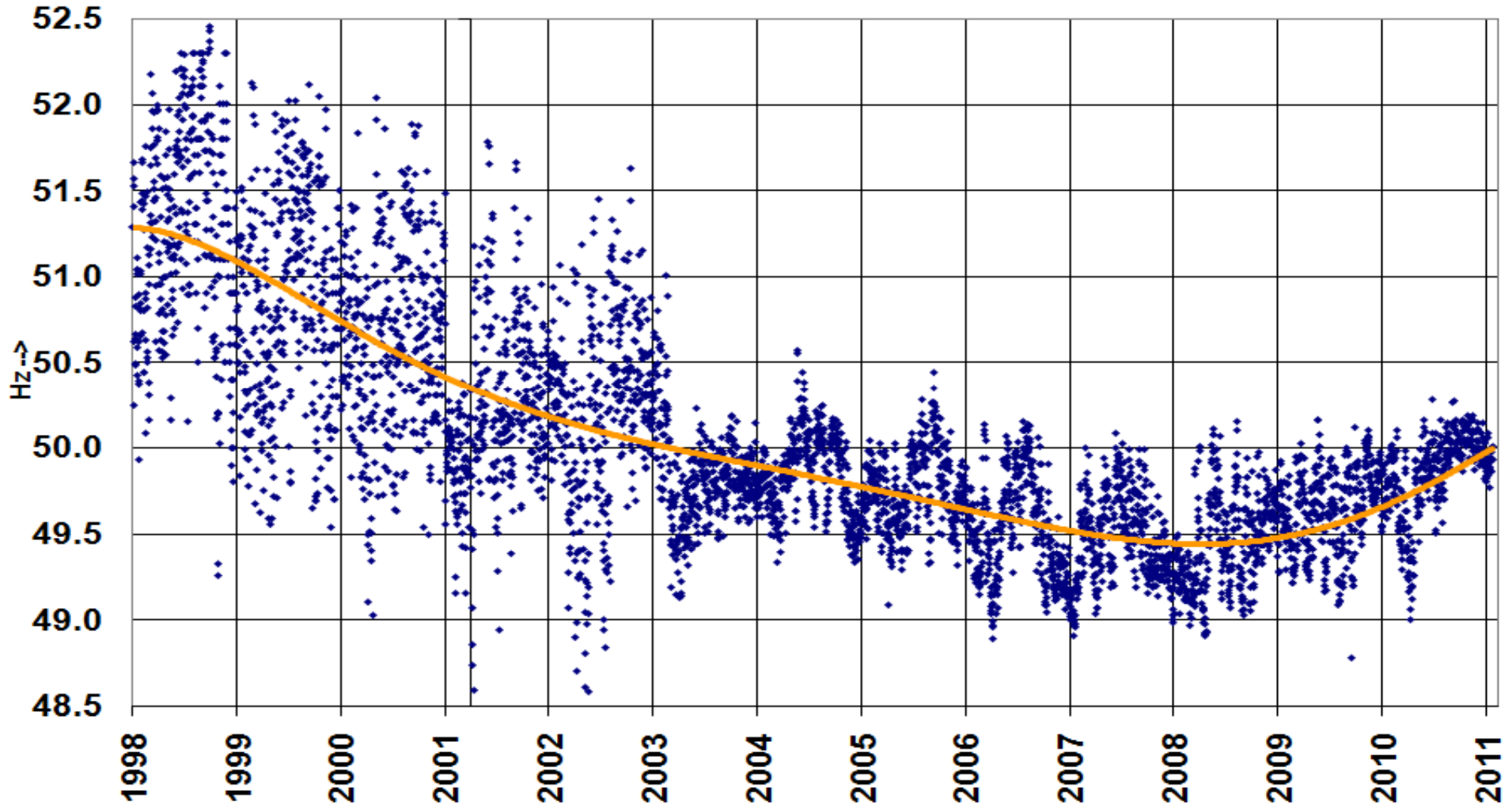
Daily Frequency Fluctuations in ER/NEW Grid (1998 onwards)

ER/NEW GRID FREQUENCY FLUCTUATIONS (MAXIMUM-MINIMUM) JANUARY '98 ONWARDS



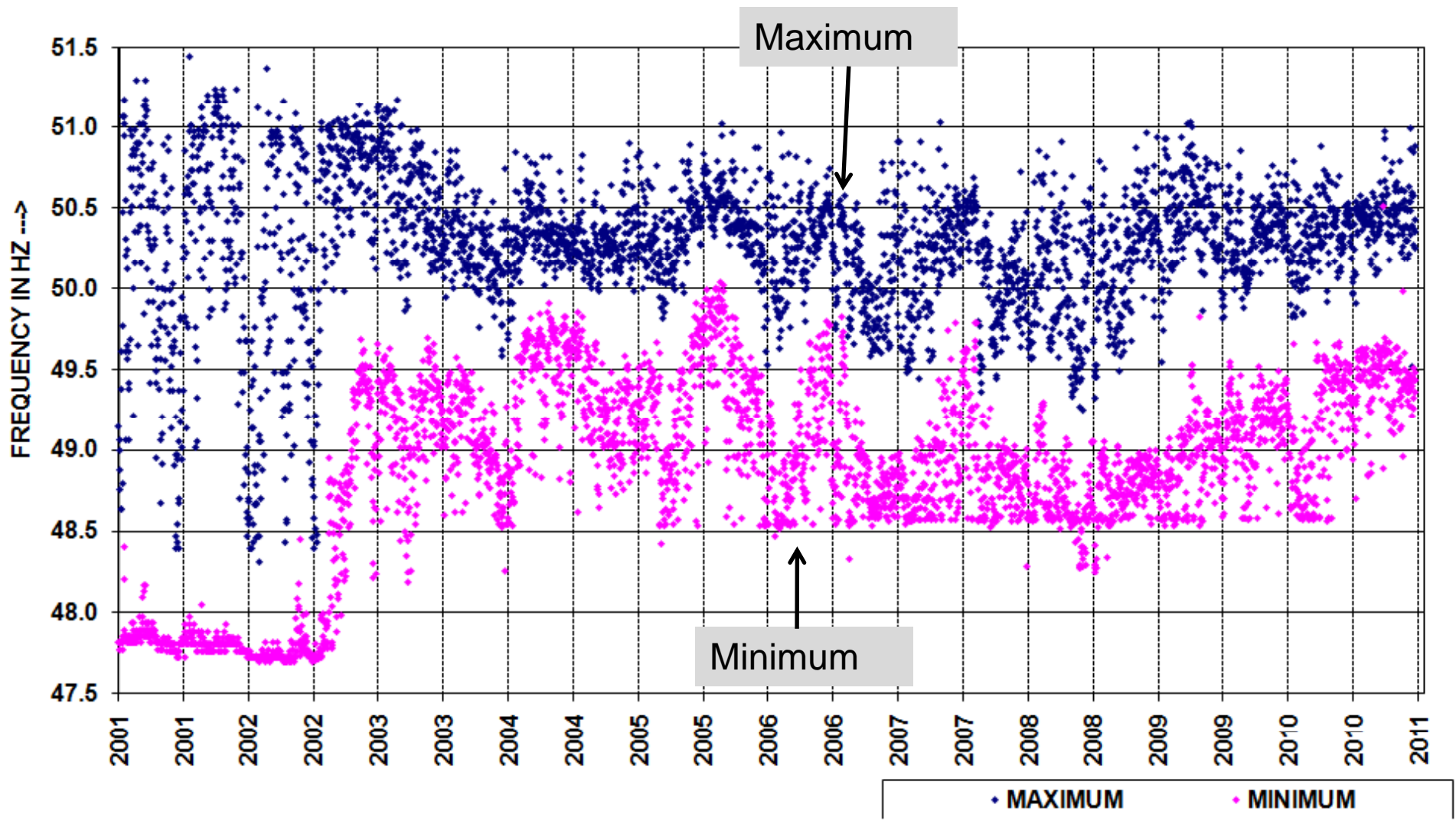
Daily Average Frequency in NEW Grid (1998 onwards)

EASTERN REGION / NEW GRID AVERAGE FREQUENCY SCATTER PLOT JANUARY '98
ONWARDS

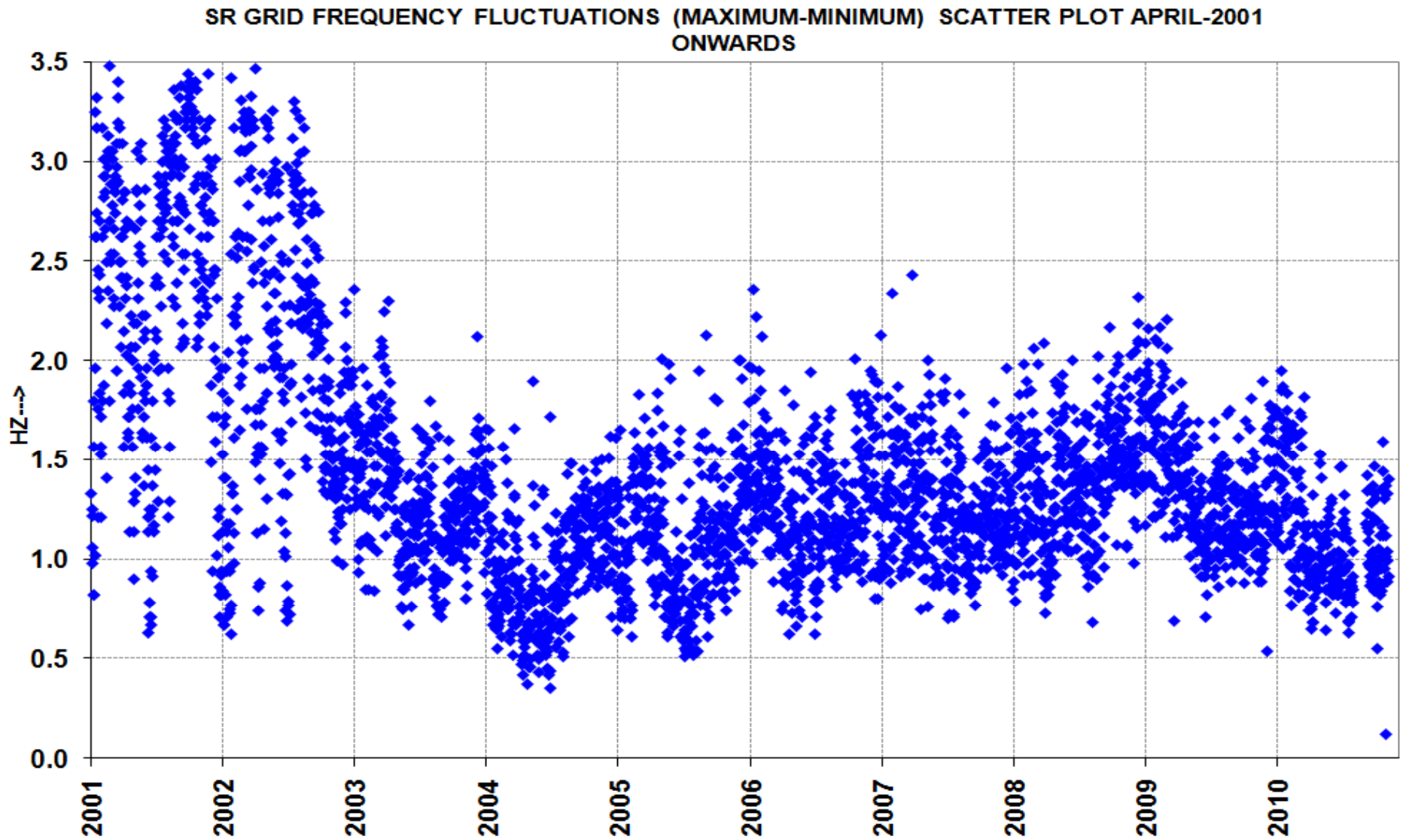


Daily Max & Min Frequency in SR Grid (2001 onwards)

SR GRID MAXIMUM, MINIMUM FREQUENCY PLOT FROM APRIL-2001 ONWARDS

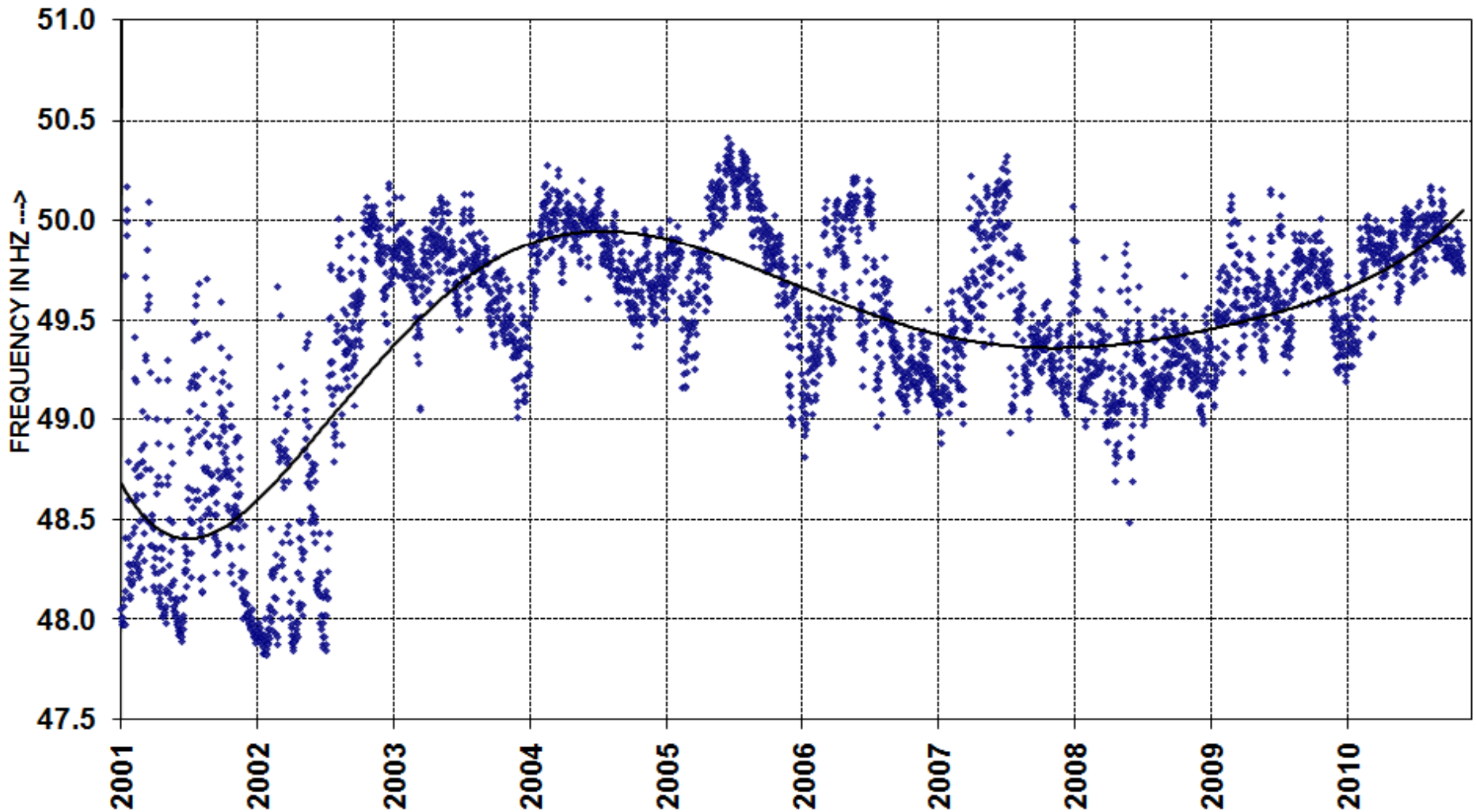


Daily Frequency Fluctuations in SR (2001 onwards)



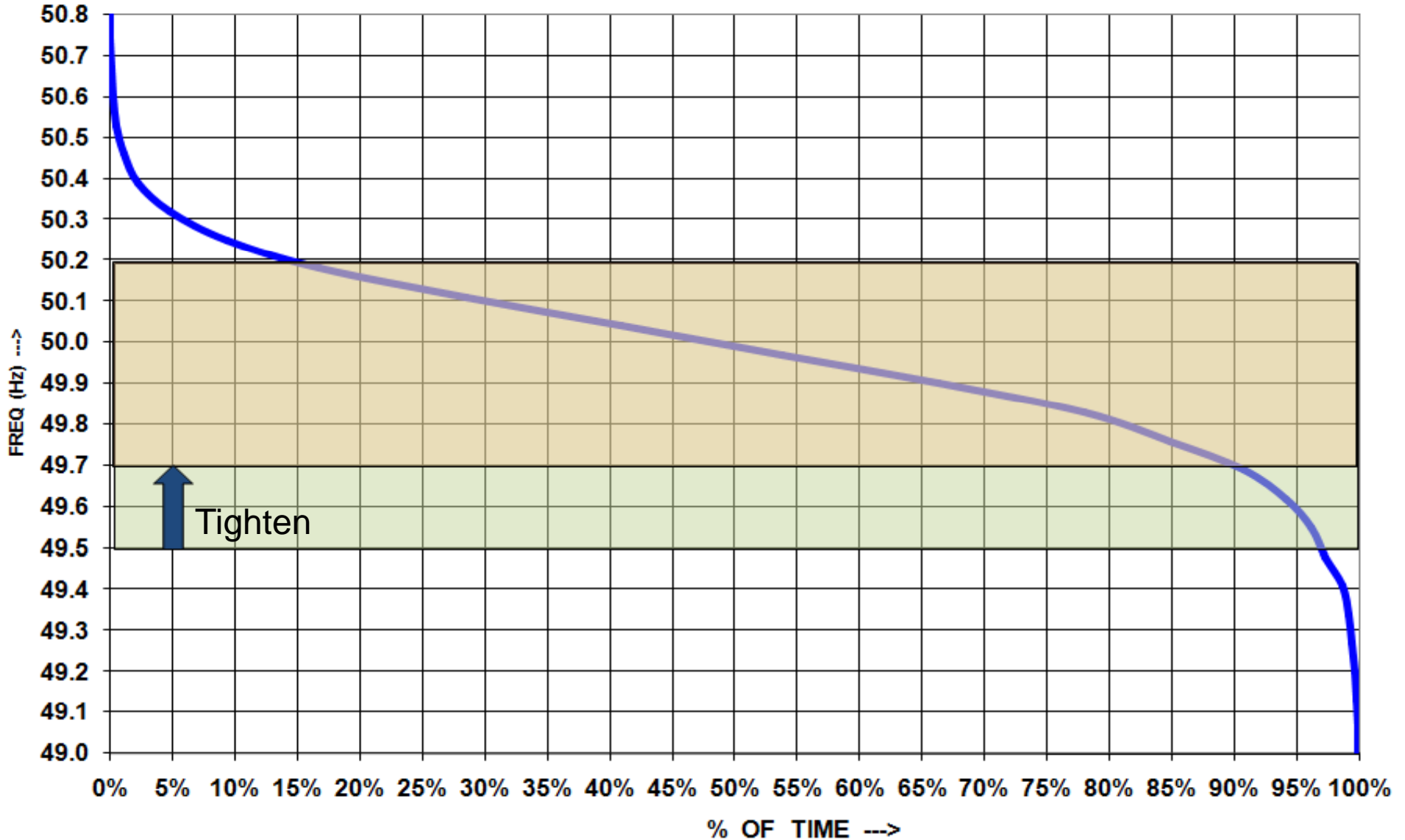
Daily Average Frequency in SR Grid (2001 onwards)

SR GRID AVERAGE FREQUENCY PLOT FROM APRIL-2001 ONWARDS



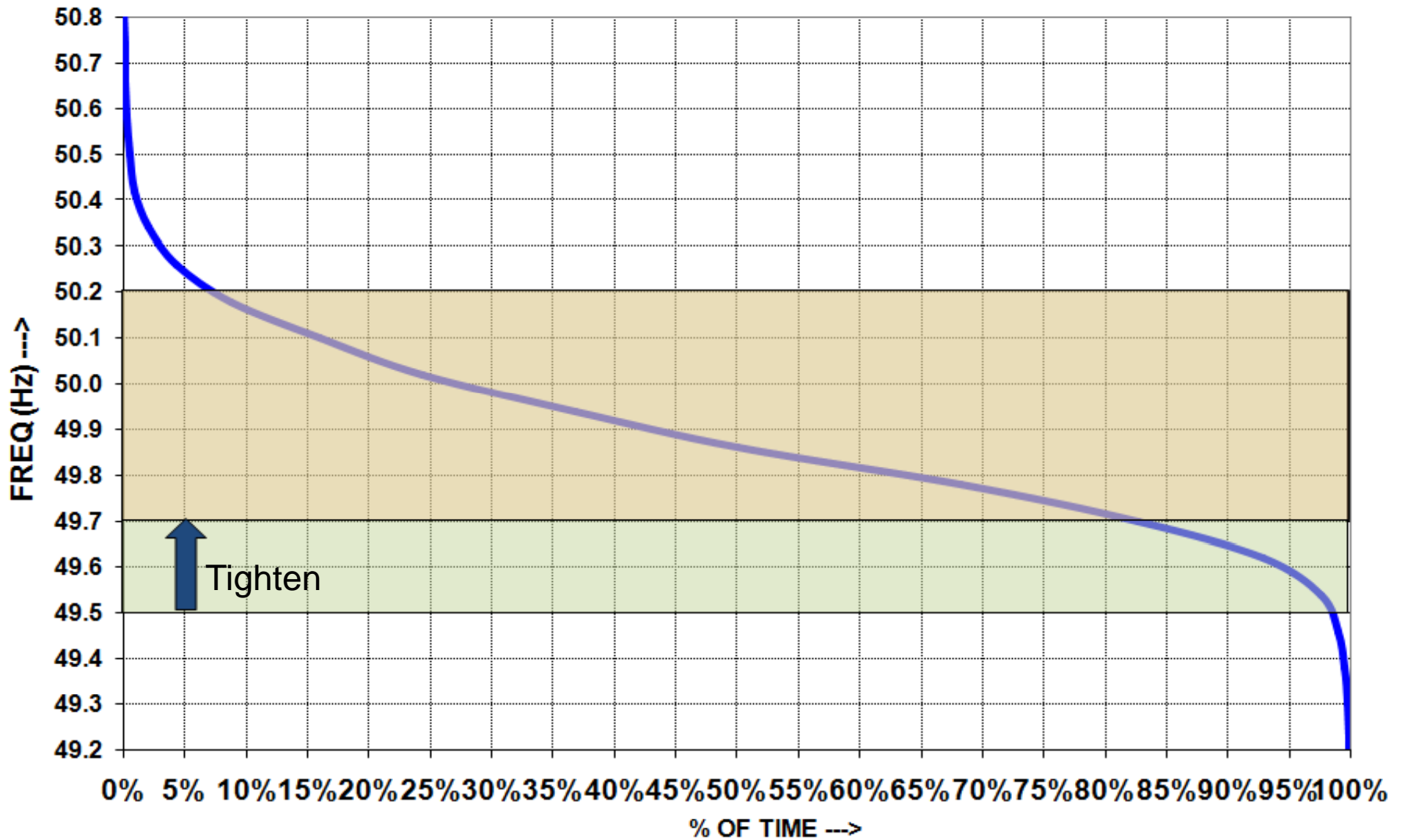
NEW Grid Frequency Duration Curve *(July 2010 – Jan 2011)*

Frequency Duration Curve for NEW Grid



SR Grid Frequency Duration Curve *(July 2010 – Jan 2011)*

Frequency Duration Curve for SR Grid



Frequency & Reactive Power

■ Correlation between frequency and Reactive power

- Studied using real time SCADA data in NR
- Case Studies Considered
 - Generator
 - Radial Load
 - SVC

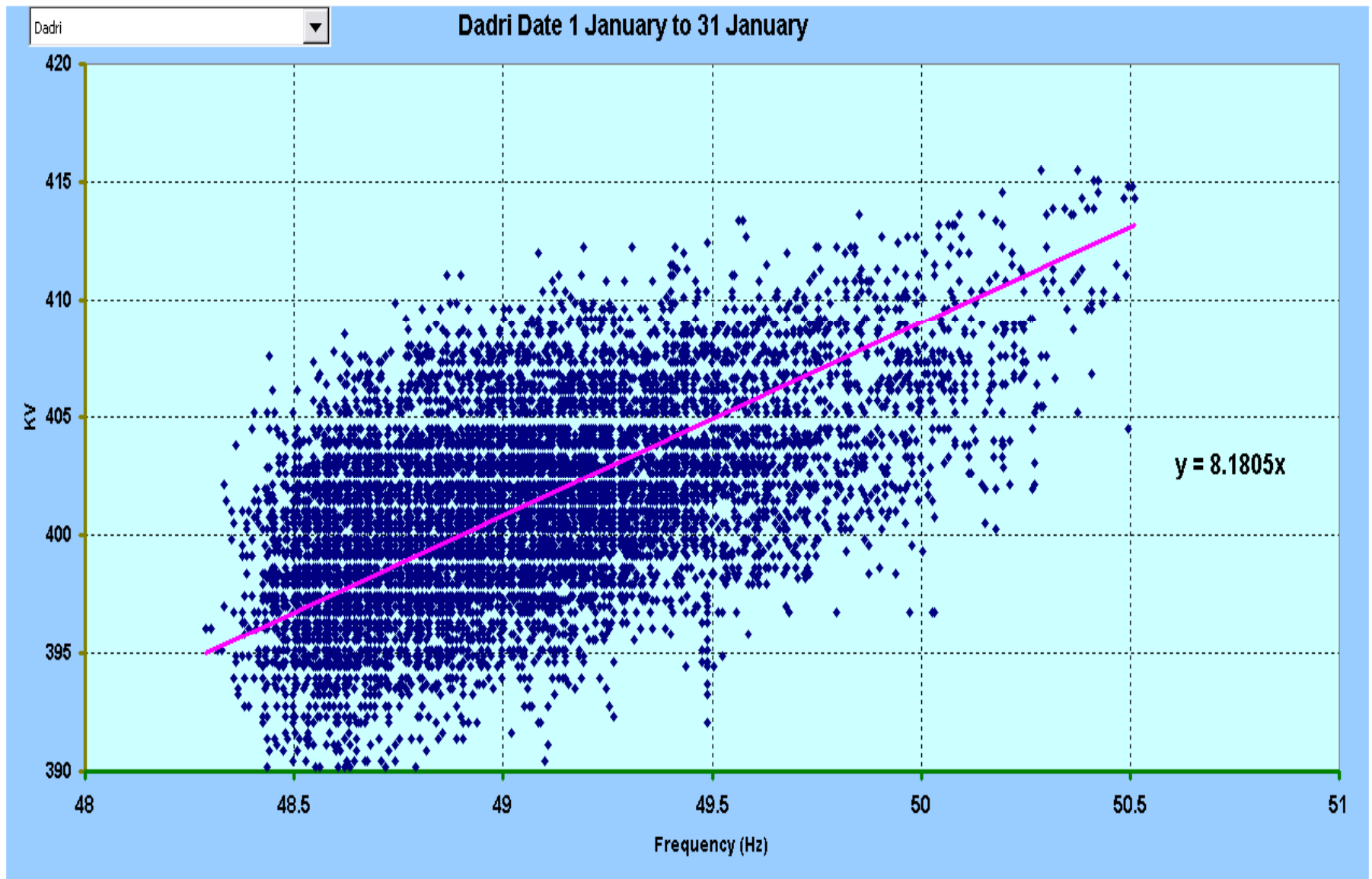
■ Summary of Results

- 1% fall in frequency results in 6% to 12% increase in reactive power
- One Hz change in frequency translates into 8000 to 10000 MVAR, considering an All India reactive power requirement of approx 60000 MVAR

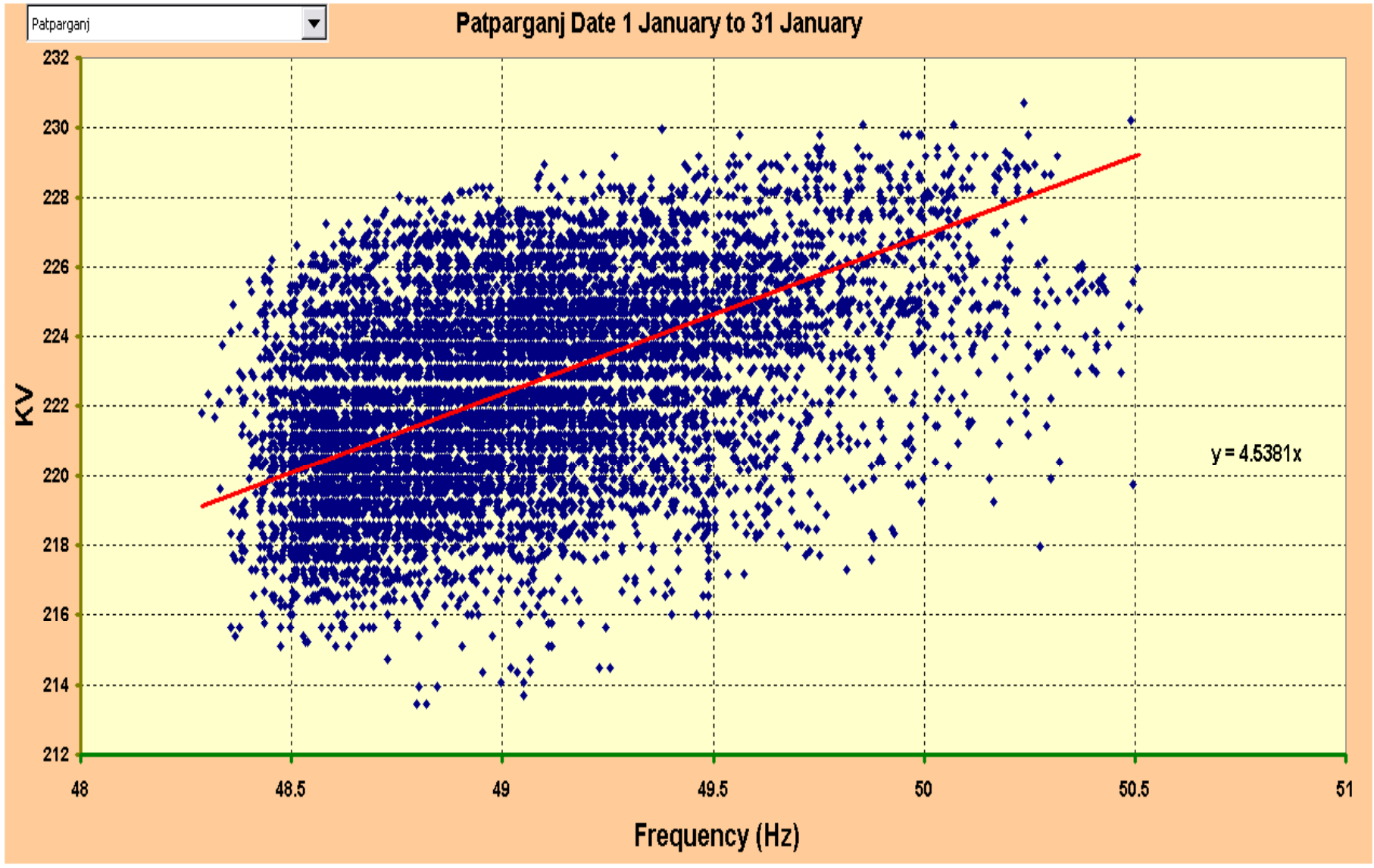
Source: Reactive Power and System Frequency Relationship: A Case Study

- CBIP 7th International R&D Conference, Feb 2009

Frequency & Voltage at 400 KV



Frequency & Voltage at 220 KV

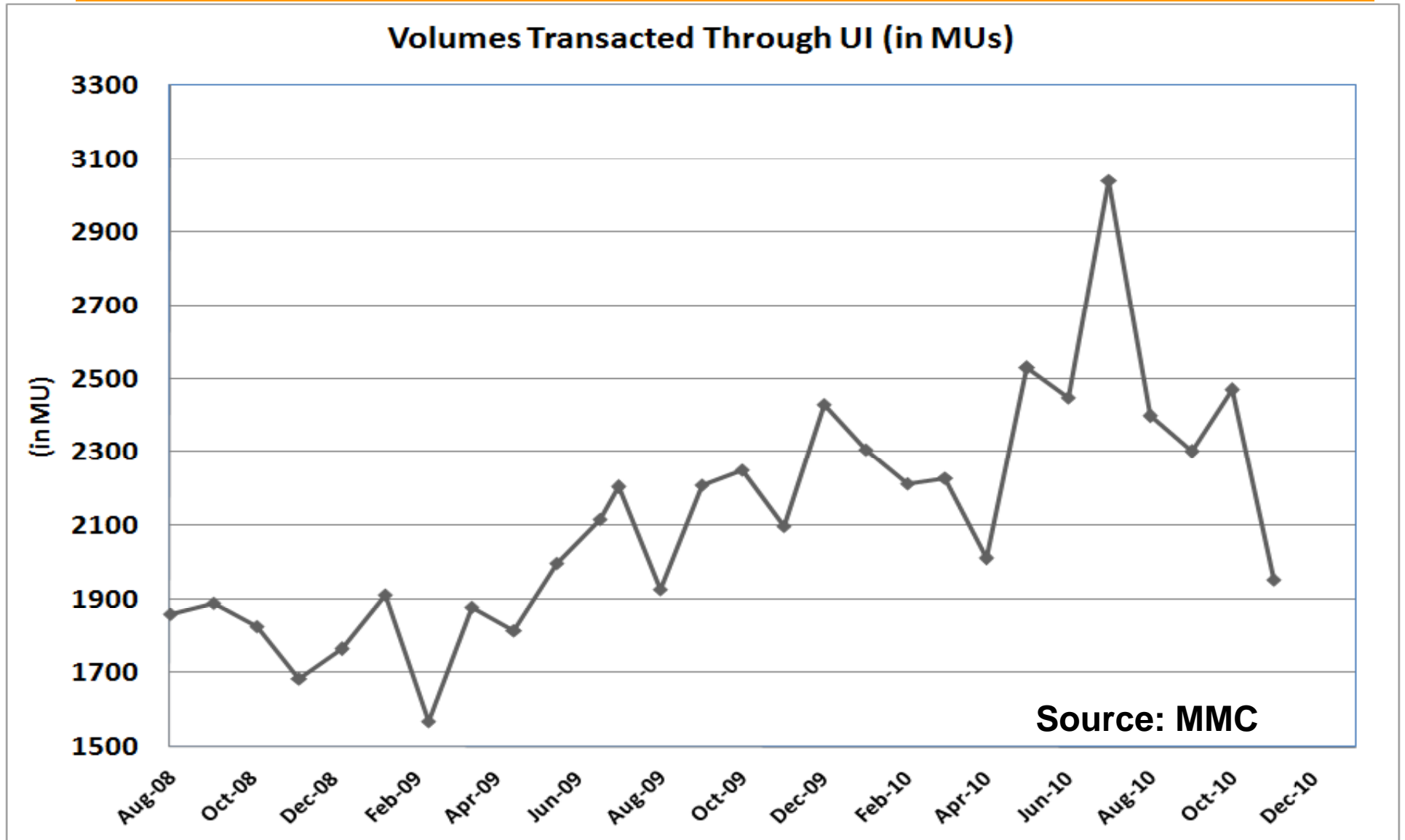


Frequency Response Characteristics

- **Study conducted using real time SCADA data in NR and SR Grids**
- **Summary**
 - SR Grid: ~1020 MW/Hz
 - NEW Grid: ~ 1800 MW/Hz
 - All India (Combined) ~ 3000 MW/Hz
- **1 Hz change in frequency implies 3% change in demand**
- **Tightening of frequency band by 0.1 Hz translates into approx. 180 MW in NEW Grid and approx. 102 MW in SR Grid**

Source: Frequency Response Characteristics of an Interconnected Power System – A Case Study of Regional Grids in India - CBIP 6th International R&D Conference, Feb 2007

Shift from UI to SI – Declining Volumes in UI



Present Power Supply Position

Power supply Position 2010-11(JANUARY,11)*

Region	Energy(MU)	Deficit%	Peak	Deficit%
	Requirement		Demand(MW)	
Northern	22,815	-7.2	35,848	-12.1
Western	24,493	-12.7	39,825	-16.7
Southern	19,960	-2.9	31,593	-5.3
Eastern	7,718	-4.7	13,537	-6.0
North Eastern	850	-5.3	1,667	-7.2
All India	75,836	-7.6	122,470	-11.1

* PROVISIONAL

Source: CEA

Projected Power Supply Position by 2012

Period	Peak Demand (MW)	Peak Met (MW)	Deficit / Surplus (MW)	Deficit / Surplus (%)
2011-12	152746	142765	-9981	-6.5

Period	Energy Req (MU)	Energy Avail (MU)	Deficit / Surplus (MU)	Deficit / Surplus (%)
2011-12	968659	948836	-19823	-2%

Demand as per 17th EPS

Source: Power Scenario at a Glance, January 2011, CEA

CERC Order on ABT Dated 4th Jan 2000

***“5.9.8 Another point for consideration is whether charges for overdrawal should be the same at 49.0 Hz and even below 49.0 Hz. It should be noted that the declared frequency in India is 50 Hz. An integrated power system should operate with a grid frequency hovering around 50 Hz. In practice however, the frequency range in India has been 48.5 Hz to 50.00 Hz. This is not desirable for achieving interconnected/integrated operation of the grid. With the additions to generation capacities, it is hoped that there may not be a drop below 49 Hz.
..... In fact the attempt should be to further narrow down the range with more generating capacities coming up and redundancy created.”***

Discussion in 4th Meeting of Coordination Forum

- Meeting held on 17th Aug 2009

- Extracts from MoM

...It was highlighted in the presentation that low frequency situations are also resulting in sub-standard grid voltages. After the discussion, it was generally felt that there was a need to further narrow down the permissible frequency range from 49.5 Hz to 50.3 Hz w.e.f. January 2010 and from 49.8 Hz to 50.2 Hz w.e.f. January 2011....

Need for Tightening the Freq Band (1)

■ Operation of very large grid

□ Reliable & Secure operation

- Disturbances in one area can propagate

□ Enhance grid security

■ Influence of frequency on

□ Voltage

- One Hz change results in about 8 KV change at 400 KV level

□ Reactive power

- 1% decrease in frequency causes 6% to 12% increase in MVAR

□ Line loadings

- One Hz change may result in line flow variations of the order of 1000 MW across regions
- May lead to congestion

□ Overfluxing of Transformers

- Low frequency and high voltage combination

Need for Tightening the Freq Band (2)

■ Defense Mechanism

- ❑ Presently first stage at 48.8 Hz
- ❑ Frequent excursions below 49 Hz & operation of UFRs
 - UFRs bypassed, security compromised
- ❑ Operation in a tightened frequency band and planned load shedding would ensure relief through UFRs is always available, enhancing grid security

■ Primary Response

- ❑ Chicken and egg situation
- ❑ Large frequency variations making implementation of FGMO difficult
- ❑ Tightened frequency band to facilitate implementation of FGMO

■ Secondary Response

- ❑ Absent by design
-

Indian Electricity Grid Code, 2010

■ IEGC Clause 6.4.7

- *“Provided that the States, through their SLDCs, shall always endeavour to restrict their net drawal from the grid to within their respective drawal schedules, whenever the system frequency is below 49.5 Hz”*
- Encourage demand side management, “Negawatts”

■ Encourage implementation of IEGC Clause 6.4.8

- *“The SLDCs/STUs shall regularly carry out the necessary exercises regarding short-term demand estimation for their respective States, to enable them to plan in advance as to how they would meet their consumers’ load without overdrawing from the grid”*
- Encourage balanced portfolios

■ IEGC Clause 6.4.11

- *“When the frequency falls below 49.5 Hz, the generation at all ISGS (except those on peaking duty) shall be maximized, at least upto the level which can be sustained, without waiting for an advise from RLDC.”*
- Encourage voluntary despatch of costly stations below 49.5 Hz

IEC Standards

PERMISSIBLE FREQUENCY RANGES FOR OPERATION OF VARIOUS MAKES OF STEAM TURBINES			
S.NO.	TURBINE	FREQUENCY(HZ.)	TIME FOR OPERATION
1	100 MW,200 MW,210 MW of Russian Design	49.0 to 50.5	Continuous unrestricted operation
		50.5 to 51.0	3 minutes at a stretch and 500 minutes in whole life
		48.0 to 49.0	3 minutes at a stretch and 500 minutes in whole life
		47.0 to 48.0	1 minute at a stretch and 180 minutes in whole life
		46.0 to 47.0	10 seconds at a stretch and 30 minutes in whole life
2	210 MW , 500 MW of KWU design	47.5 to 51.5	Continuous unrestricted operation
		Below 47.5	2 hours in whole life
		Above 51.5	2 hours in whole life
3	200 MW of GE (ANSALDO) design	48.5 to 50.5	Continuous unrestricted operation
		50.5 to 51.0	90 minutes in whole life
		48.0 to 48.5	90 minutes in whole life
		51.0 to 51.5	15 minutes in whole life
		47.5 to 48.0	15 minutes in whole life
		51.5 to 52.0	1 minute in whole life
4	RAPS/NAPS 2x220 MW English Electric	48.5-Operating Frequency	Summation in lifetime $t \leq 3$ minutes where 't' is the operating time for incidents of frequency excursion below 48.5 Hz.
		>51.5	Not recommended
5	110 MW of Skoda Design	49.0 - 51.0	Continuous unrestricted operation
		48.0 - 49.0	2 hours at a stretch and 30 hours in a year
		47.0 - 48.0	30 minutes at a stretch and 2 hours in a year
<p>Source : Extracts from the report of "Task Force on Frequency Control" NREB,1992</p>			

Credible Contingencies

■ Entire station trip

- ❑ A credible contingency
- ❑ Past incidences bear testimony

■ Increasing size of Generating Units

- ❑ 600 MW / 660 MW / 1000 MW

■ Increasing Population of Large Generation Complexes

- ❑ Upto 2000 MW
- ❑ 2000 MW – 4000 MW
- ❑ 4000 MW – and above

Defense Mechanism

Flat Under Frequency Relays			
Region	Stage-I	Stage-II	Stage-III
Northern Region	48.8 Hz	48.6 Hz	48.2 Hz
Western Region	48.8 Hz	48.6 Hz	48.2 Hz
Eastern Region	48.5 Hz	48.2 Hz	48.0 Hz
Southern Region	48.8 Hz	48.2 Hz	48.0 Hz
North-eastern region	48.4 Hz	-	-

Rate of Change of Frequency Relays			
	Stage-I	Stage-II	Stage-III
df/dt	49.9 / 0.1 Hz/sec	49.9 / 0.2 Hz/sec	49.9 / 0.2 Hz/sec

No operation of the Under Frequency or Rate of Change Relays in the recent past

Significant New Developments

- **High rate of growth of the Power Sector**
- **Interconnections of the Regional Grids**
 - Four Regions connected synchronously
 - SR to be connected synchronously in near future
- **Integration of Renewables**
 - Variable generation source
 - A threat to grid security
 - Need for secure operation of the Grid with better frequency profile
- **Power Quality**
 - Increasing need & awareness
 - Traction Supply

International Interconnections

■ Nepal

- Synchronous Interconnection
- Under implementation

■ Bangladesh

- HVDC Link
- Under implementation

■ Sri – Lanka

- HVDC Link
- Under consideration

■ Future

- SAARC Grid

Operational Frequency Band – SAARC Countries

Nominal Frequency in all Countries: 50.0 Hz

Country	Permissible Frequency Band (Hz)	Permissible Deviation (%)
Bangladesh	49.0 – 51.0 Hz	(+/- 2 %)
Bhutan	49.2 - 50.3 Hz	(+/- 2 %)
India	49.5 – 50.2 Hz	(-1 % / +0.4 %)
Maldives	49.5 - 50.5 Hz	(+/- 1%)
Nepal	49.5 – 50.5 Hz	(+/- 1 %)
Pakistan	49.5 – 50.5 Hz	(+/- 1 %)
Sri Lanka	49.5 – 50.5 Hz	(+/- 1 %)

Source: SAARC Task Force on Grid Interconnections amongst SAARC members

Operational Frequency Band in Europe / Americas

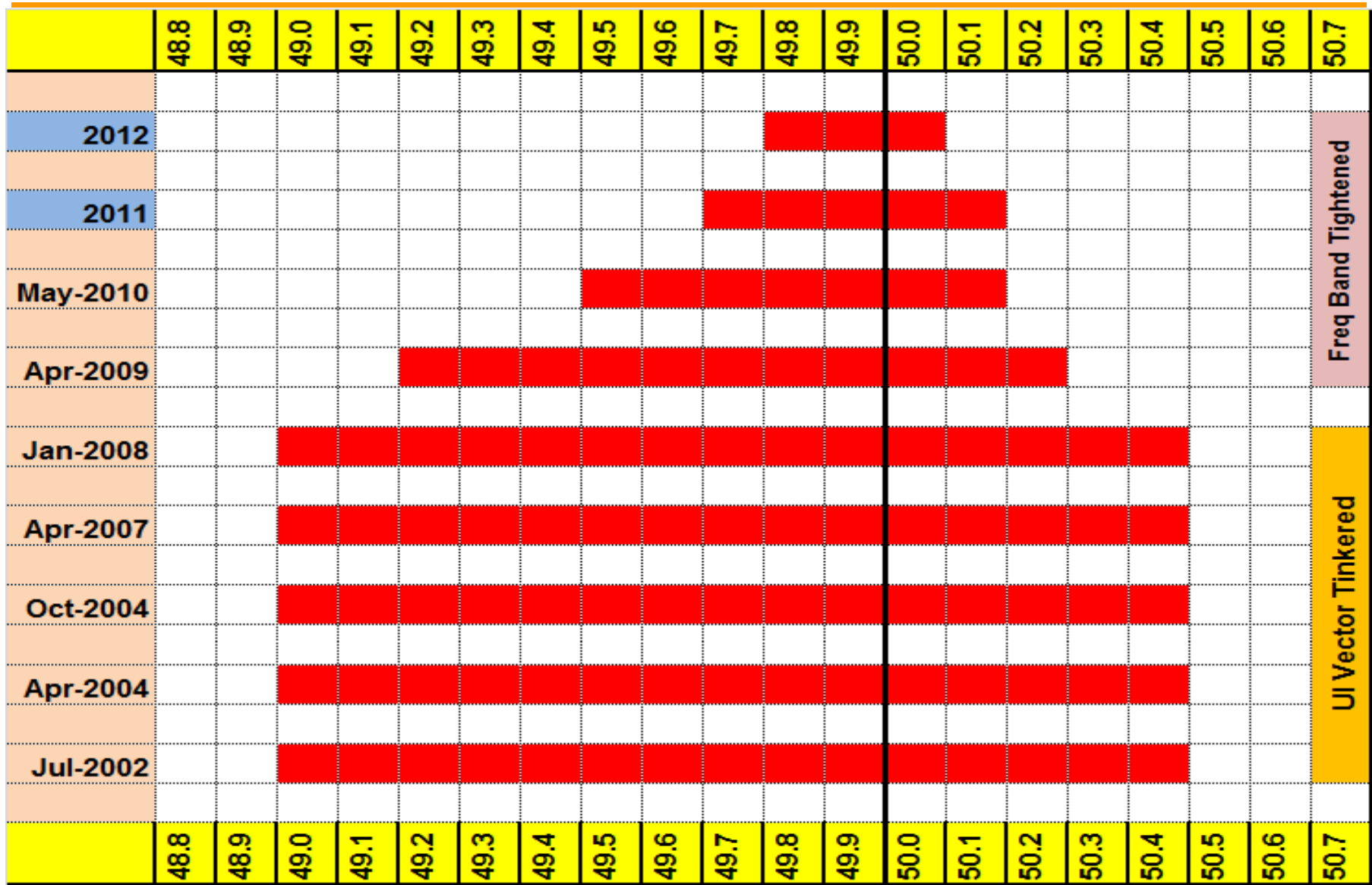
- **Nordic Area: 49.9 to 50.1 Hz**

- **UCTE Europe Continental: 49.8 to 50.2 Hz**

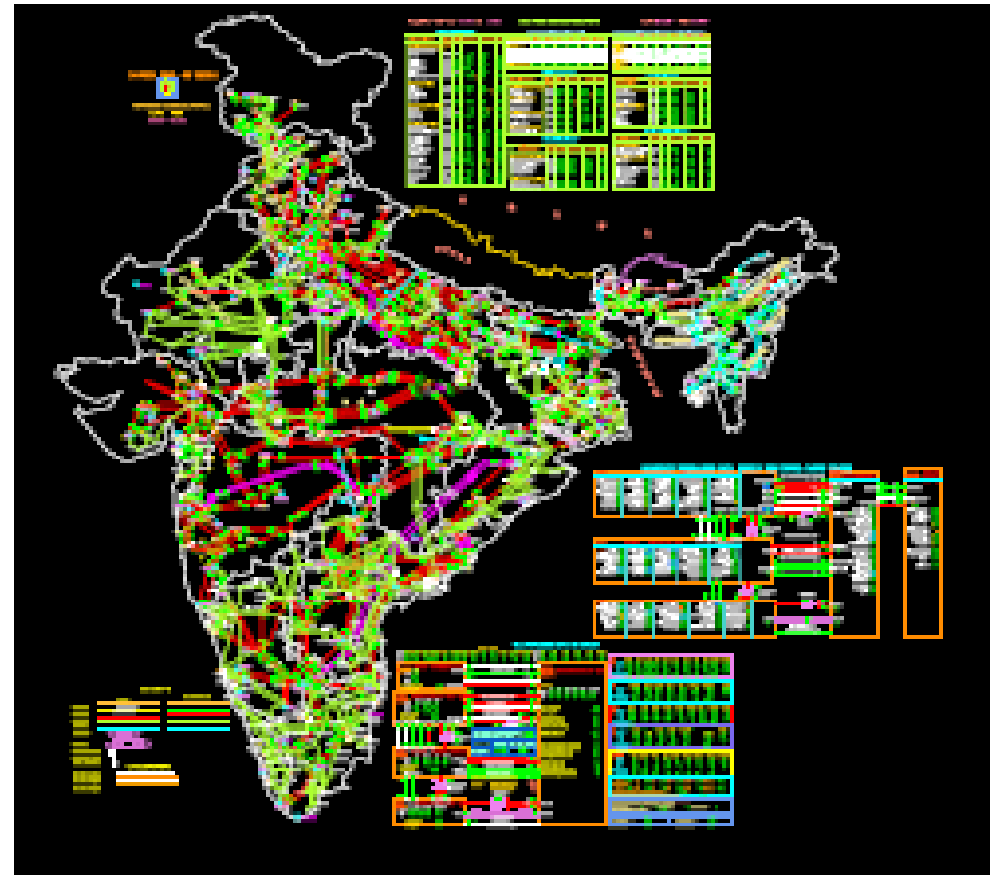
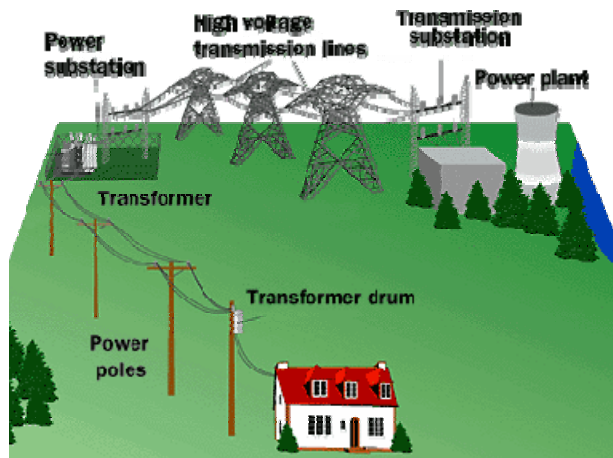
- **US:**
 - Eastern Interconnection:
 - 59.95 to 60.05 Hz

 - Western Interconnection:
 - 59.856 to 60.144 Hz

Evolution of the Operational Frequency Band



Secure Operation of Very Large Grid



Larger the footprint.....

..... More the complexities involved

Changing the Step Size

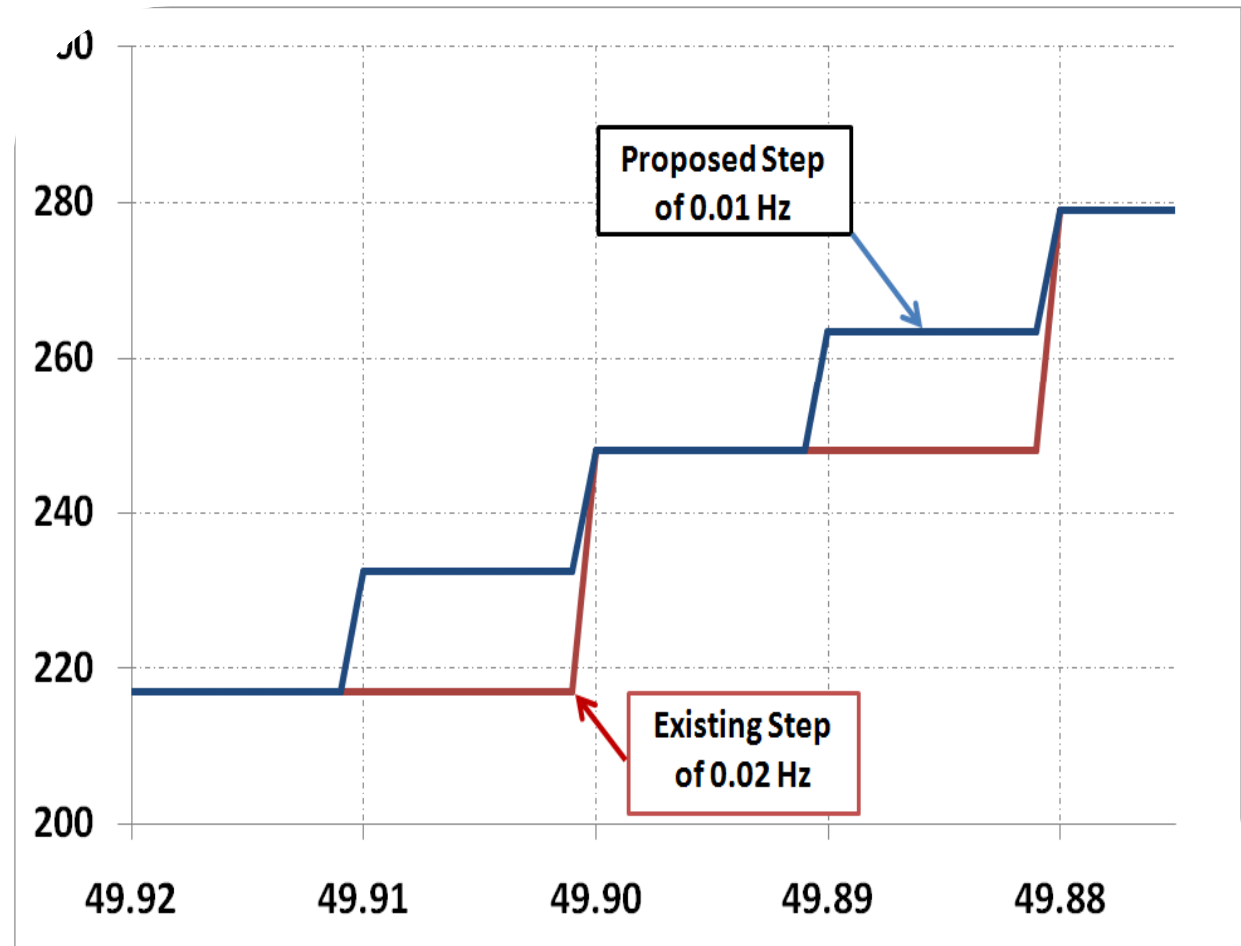
- Present Step Size

 - 0.02 Hz

- Proposed Step

 - 0.01 Hz

- Need for revised specifications for the SEMs



Proposed Road Map

■ Present

- 49.5 to 50.2 Hz with a Step Size of 0.02 Hz

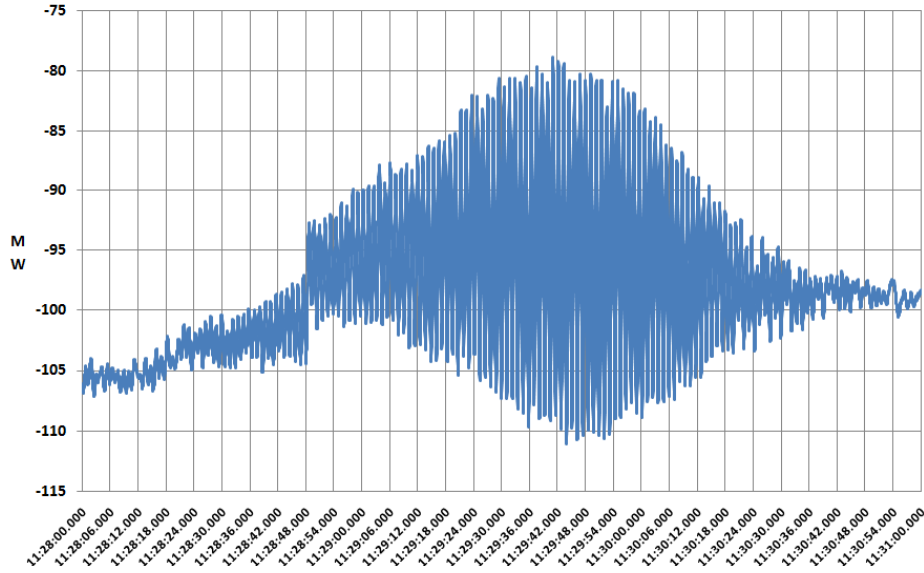
■ Gradual narrowing

- 2011: 49.7 to 50.2 Hz with a Step Size of 0.01 Hz
- 2012: 49.8 to 50.1 Hz with a Step Size of 0.01 Hz

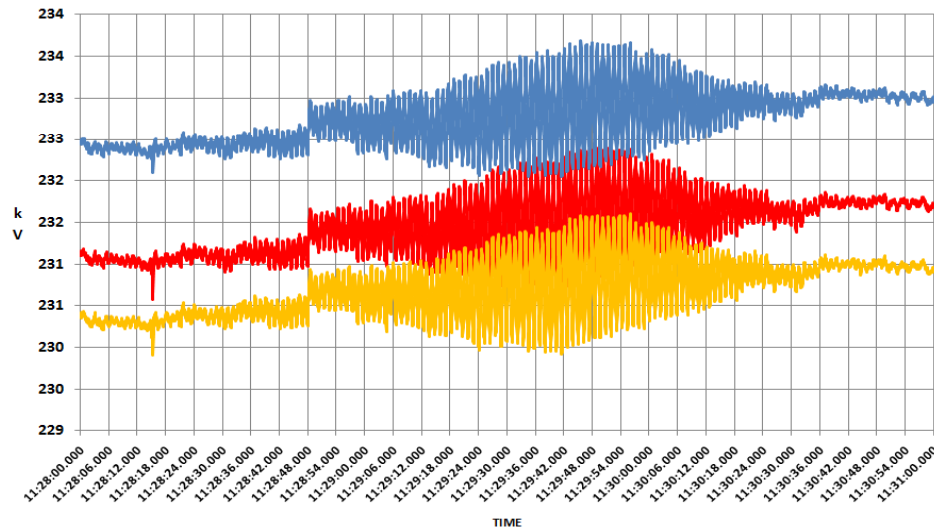
Other Measures:
Experience of PMUs in India -
Communication & Protection
Related Issues

Oscillations observed in the System (Tehri Testing Feb 2011)

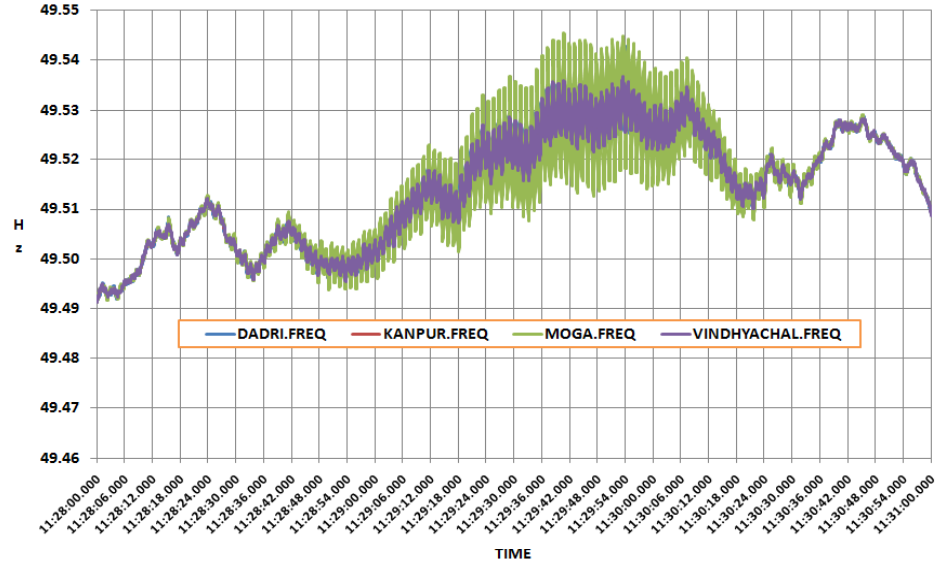
Oscillations observed in Power flow of 400kV Bhiwadi-Moga Ckt-2 line during controlled increase of flow on 765 kV Tehri Meerut Ckt#2 on 03rd Feb 2011 at 11:29 Hrs (40ms data plot)



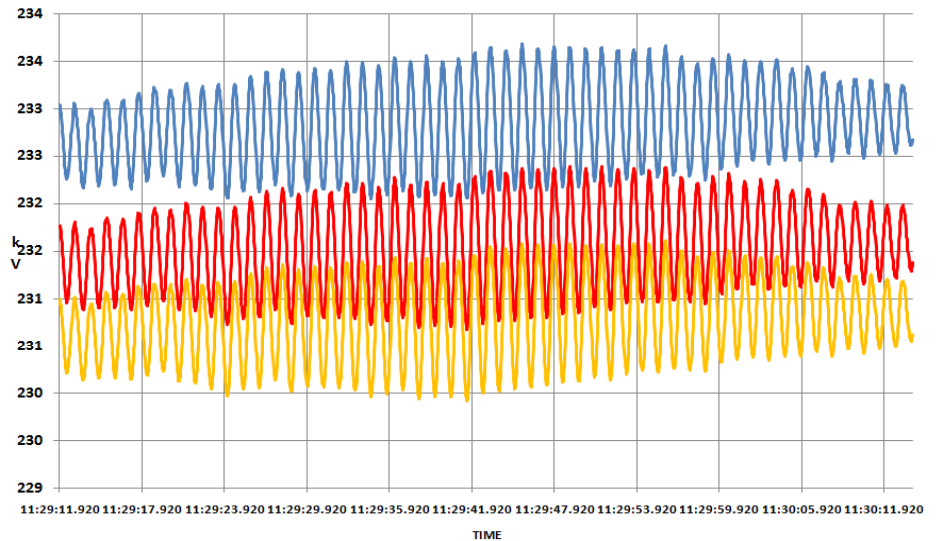
Oscillation observed in Voltage profile at Moga during controlled increase of flow on 765kV Tehri-Meerut Ckt#2 on 3rd February 2011 at 11:29 Hrs (40ms data plot)



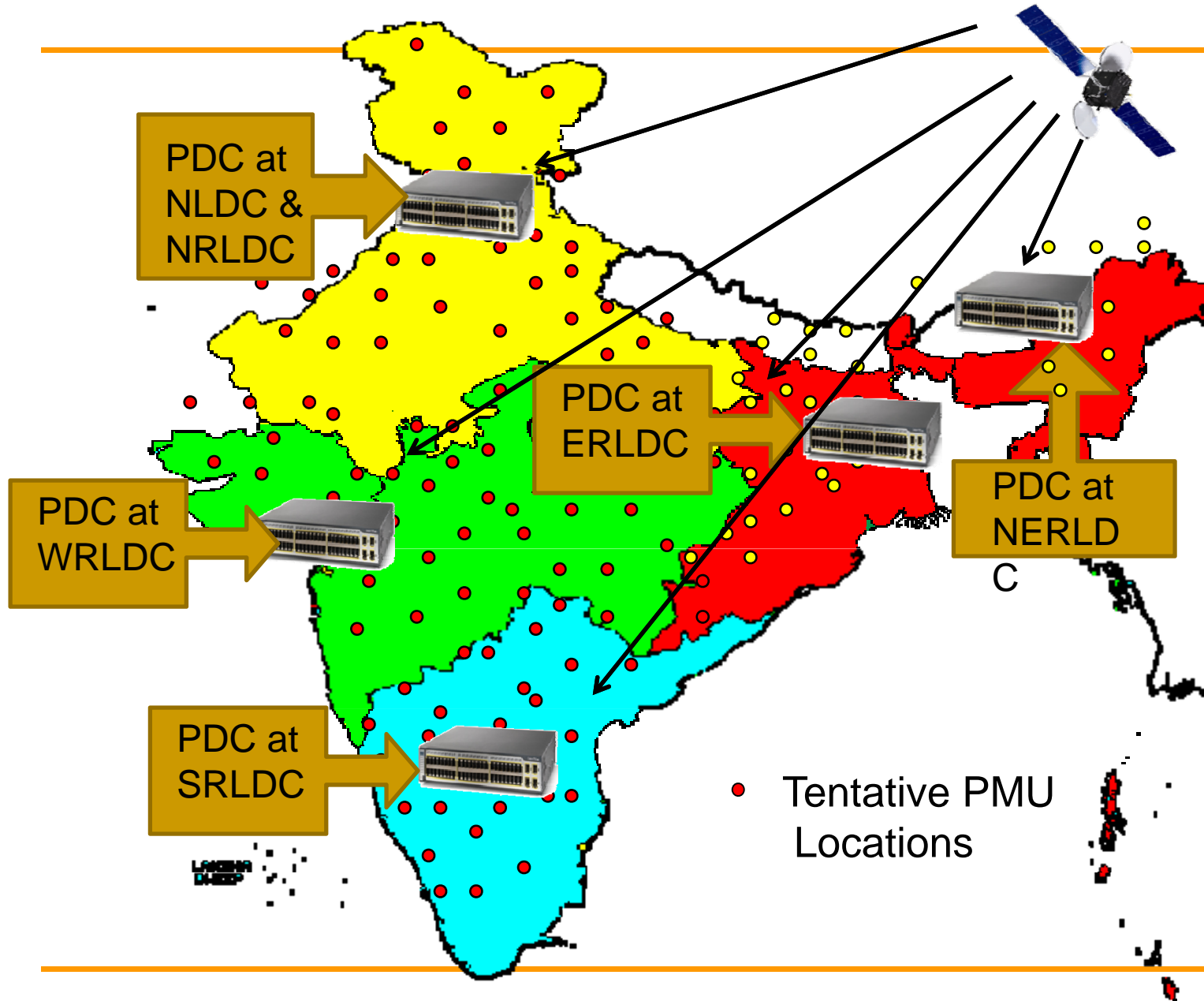
Oscillations observed in Frequency profile during controlled increase of flow on 765kV Tehri-Meerut Ckt#2 on 3rd February 2011 at 11:29 Hrs (40ms data plot)



Oscillations observed in voltage profile at Moga during controlled increase of flow on 765kV Tehri-Meerut Ckt#2 on 3rd February 2011 at 11:29 Hrs (40ms data plot)



WAMS Technology in Next 5-7 Years



Road Ahead and Issues

■ Power System Visualization

- Increase in PMU population
- Cross – Reporting PMUs

■ Major Issues in Near Future

- Communications
 - Increasing no. of stakeholders
 - Limiting factor for PMU Placements
- Protection Coordination

Need for an exclusive Regulation on Communications in Power Sector

Discussion

- **How much to tighten?**
 - **How fast to tighten?**
 - **Need for an exclusive Regulation**
 - Communications in Power Sector
 - **Capacity Building & International Best Practices**
-

Thank You !!
