



Total Power Quality Management in a large Distribution System : A Case Study

By

**U K Deshpande & P A Chitre
TATA Motors Ltd, Pune.**

At

**National Seminar on “Total Power Quality Management”
December’12, 2009
Mumbai.**

Introduction

- **TATA Motors Ltd. is India's Largest Automobile Company having its one of the manufacturing plants in Pune.**
- **From Pune Plant, 1st Commercial Vehicle rolled out in 1977. Since then the plant has witnessed major expansion projects.**
- **The manufacturing capacity has increased multifold both for Commercial vehicles and Passenger Cars.**
- **State of the art fully / semi automated Weld shops, Paint shops, Machine shops, Press shops, Assembly lines and Vehicle testing facilities have been established over this period, employing new technologies and processes.**
- **There are now around 100, 22KV/ 415V substations for power distribution spread over in 700 acres of land. Large interconnected 22KV underground cable networks feed power to these substations from Main 220KV S/s.**

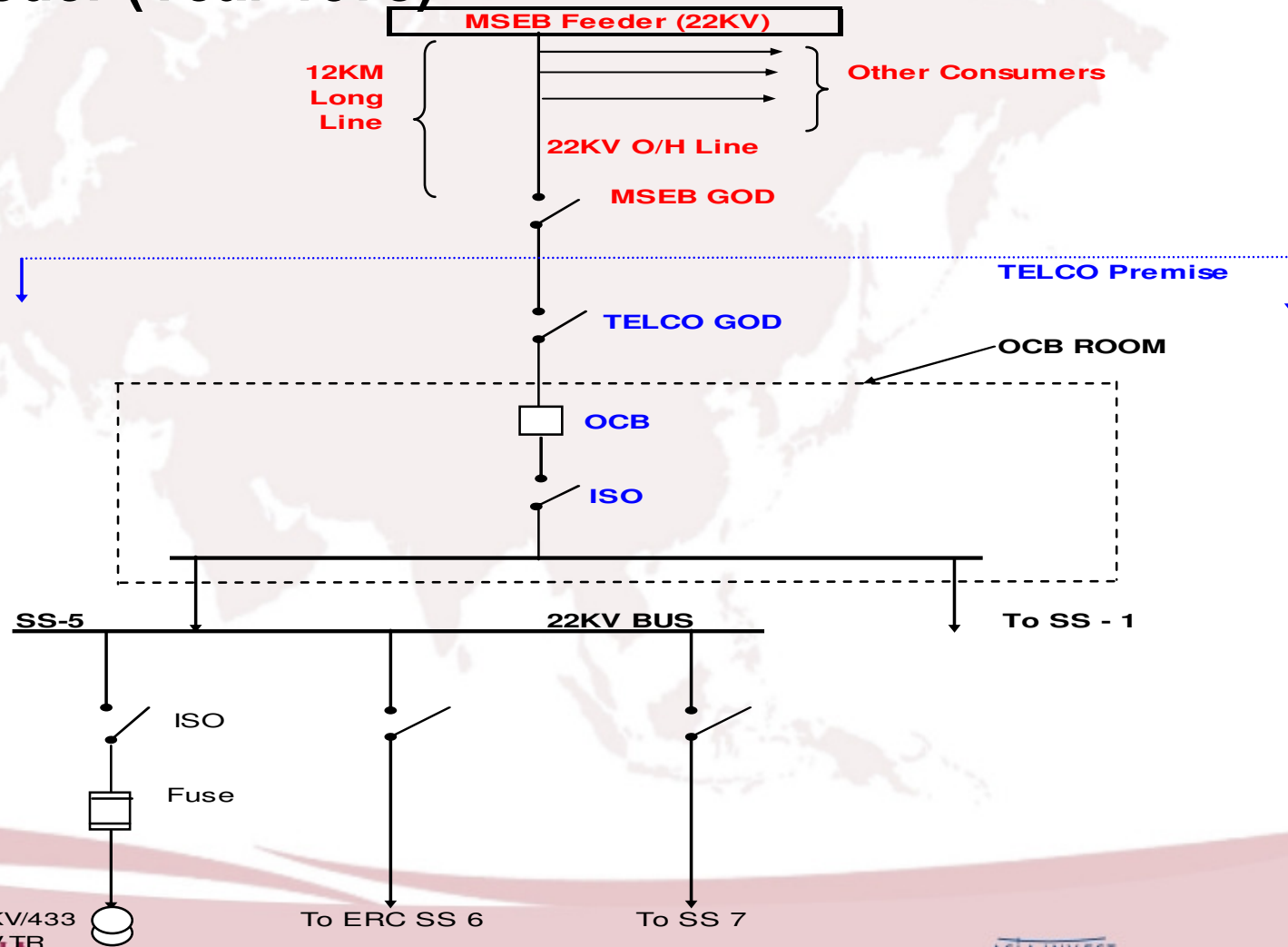
- **The incoming supply from State Utility was upgraded from 22KV Single feeder to 22KV, 2 Nos. Express Feeders in 1978 and finally to 220KV system in 1993. Maximum Demand of the plant has now reached 50MVA.**
- **During this journey of over three decades, different issues of Power Quality of varying nature and impact were cropped up from time to time.**
- **This presentation mainly covers the Power Quality issues in Plant Electrical Distribution System and the process adopted to arrive at the most appropriate solutions.**
- **The presentation is divided into 2 parts.**
- **Part I: Abnormal Voltages (Under Voltage and Over Voltage) due to the type of utility Power Connection and Plant Substation Equipment.**
- **Part II: Over Voltage & Reactive Power Management.**

Part – I : Abnormal Voltages.

Effect of type of Utility Power Connection & Plant Substation Equipments on Power Quality.

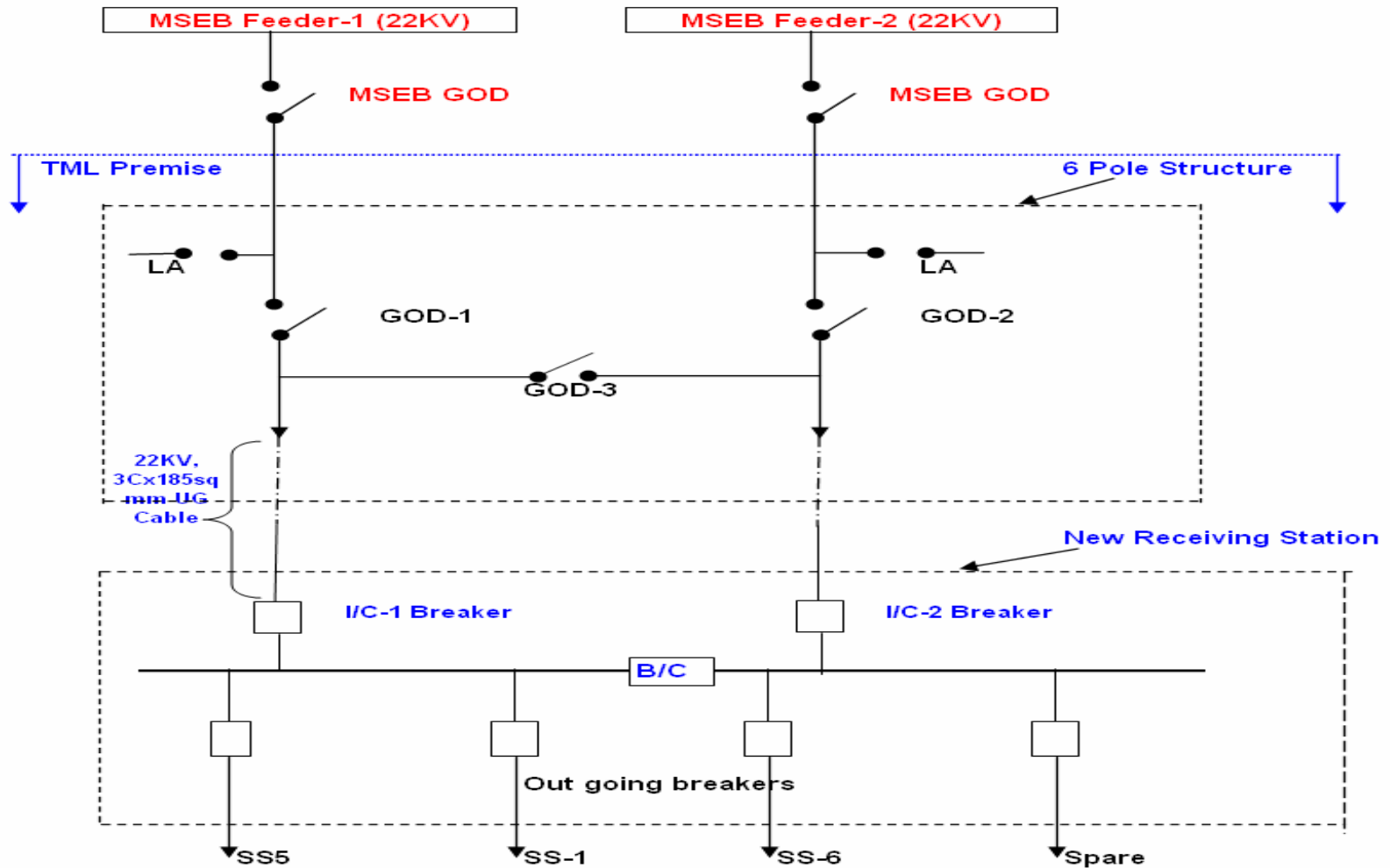
Year	Power Supply Source	Nature of Load	Load	Remarks
Up to 1978	22KV Single Ordinary Feeder	Machine Shops, Heat Treatment furnaces, Small Paint Shop, Assembly Shops, Tool Room.	7-8 MVA	<p>Major Problems faced:</p> <ul style="list-style-type: none"> • Around 12Km long line with number of tapings. • Very High Interruptions. • Forced interruptions / Load shedding by MSEB. • Low Voltage during peak hours. • Voltage dips.

Single Line Diagram: Power Supply from MSEB through General Feeder (Year 1978)



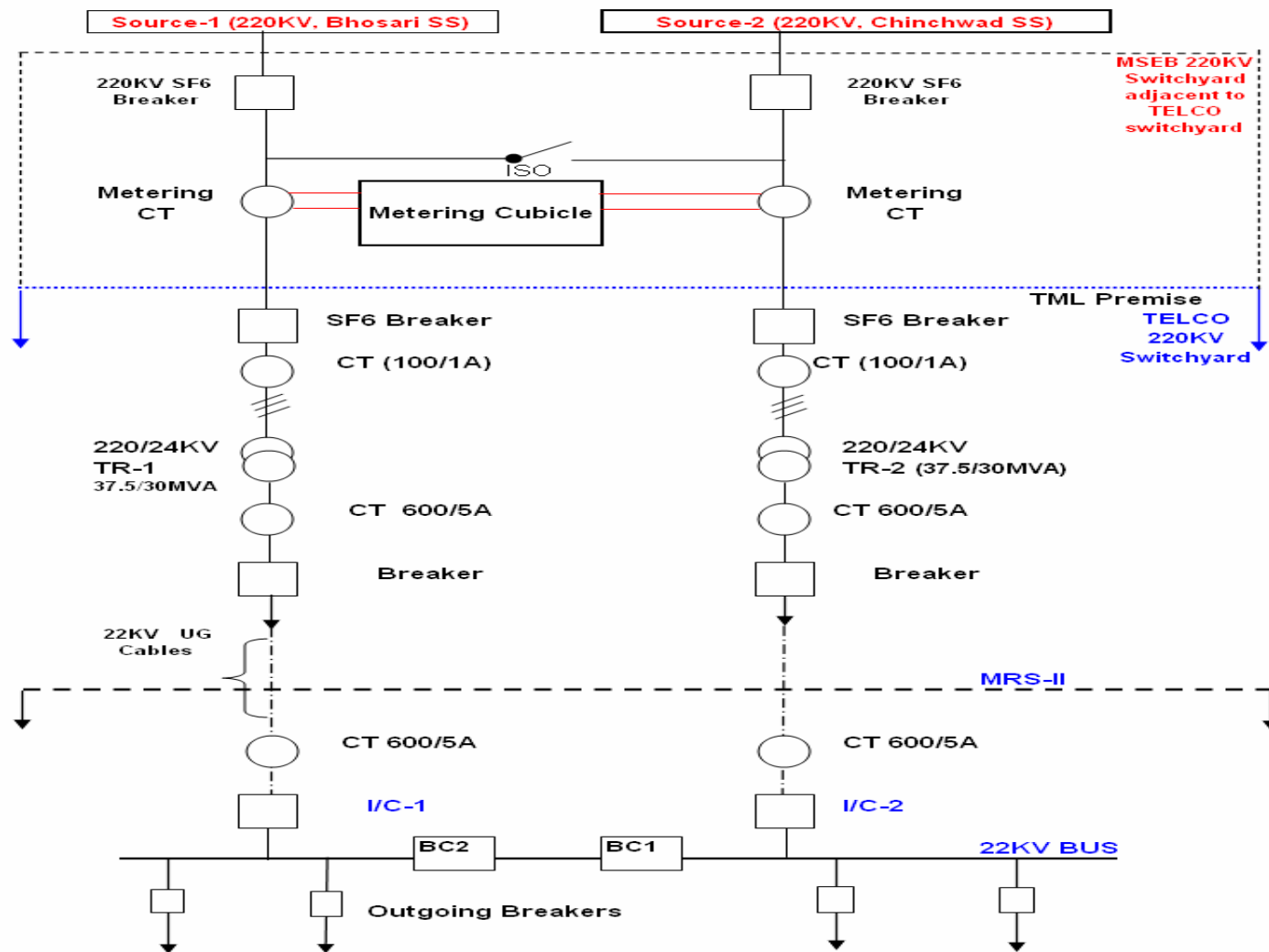
Year	Power Supply Source	Nature of Load	Load	Remarks
1978-1993	2 Nos 22KV Express Feeders	In addition to Stage-1 : Press Shop , Weld Shop and Assy Line.	8-20 MVA	<ul style="list-style-type: none"> • 433V Transformers added in new substations. • Installed 10MW DG House <p>Benefit:</p> <ul style="list-style-type: none"> • Reduced interruptions due to dedicated lines. <p>Major Problems faced:</p> <ul style="list-style-type: none"> • Low Voltage during Peak hours. • Forced interruption by utility / Load Shedding. • Voltage dips

Single Line Diagram: 22KV Double Express Feeders (Year 1978-1993)



Year	Power Supply Source	Nature of Load	Load	Remarks
1993-1996	220KV source with LILO arrangement	In addition to stage 1 &2 : Paint Shops, additional Assembly Lines, Weld Shops	20-25 MVA	<p>Benefits of EHV network are:</p> <ul style="list-style-type: none"> • Higher Power Reliability in View of major reduction in Power interruptions. • Low Voltage Issue resolved. <p>Problem faced:</p> <ul style="list-style-type: none"> • Over voltage problem on 22KV bus during light load conditions , Holidays and Monsoon period

Single Line Diagram: 220KV Power Supply (From 1993 to 1996)



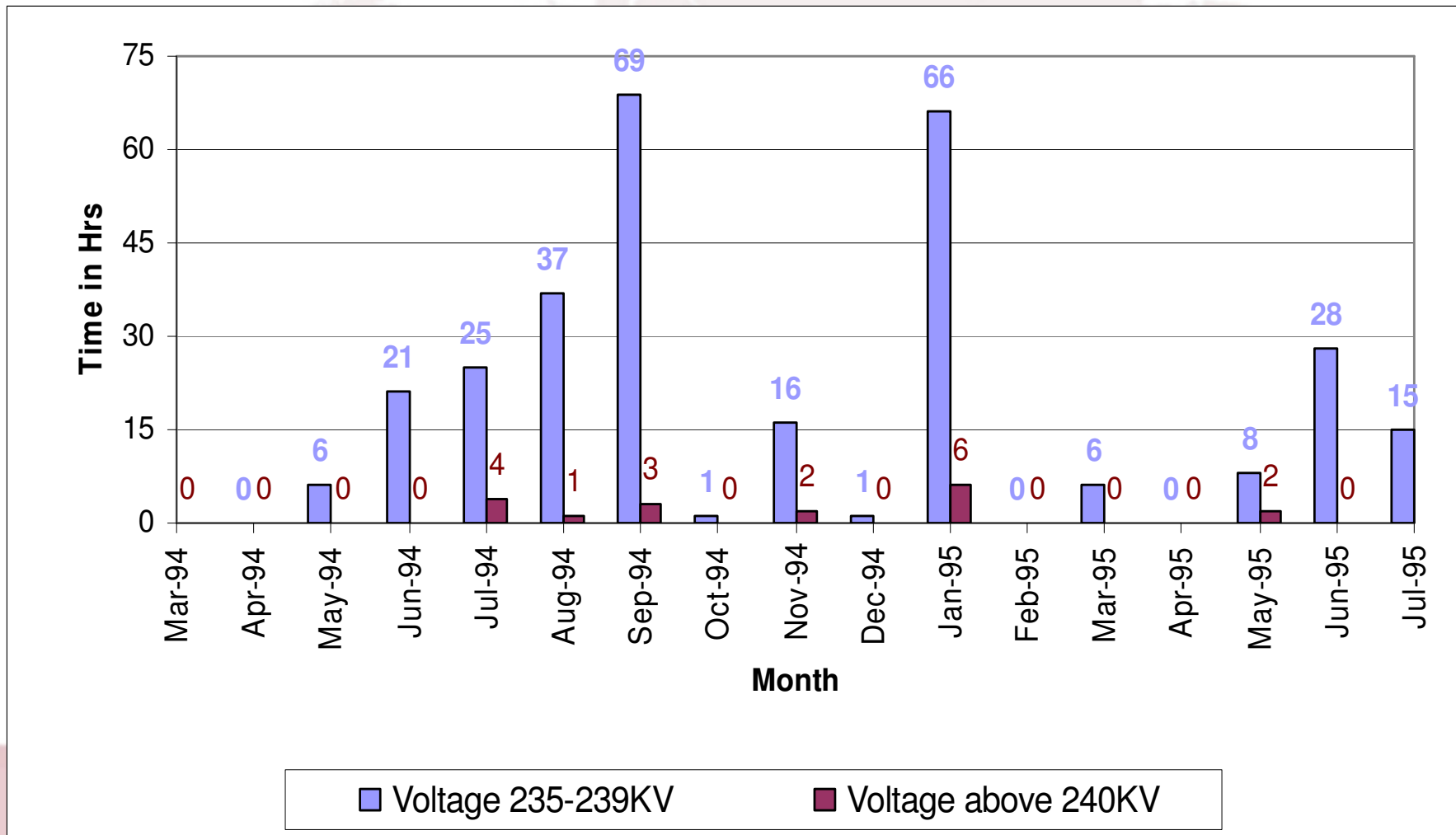
Scenario After 220KV Switchyard : Year 1993-94

1. 22 KV Power Supply became reliable.
2. Power Cuts / Load shedding and Voltage Dips reduced.
3. Low voltage problem resolved.
4. Voltage Variation brought down to acceptable limit of 21.5KV to 23.1KV since 220KV / 24KV transformers were in operation which are having $\pm 10\%$ taps with OLTC (Except Over Voltage Problem in certain conditions)

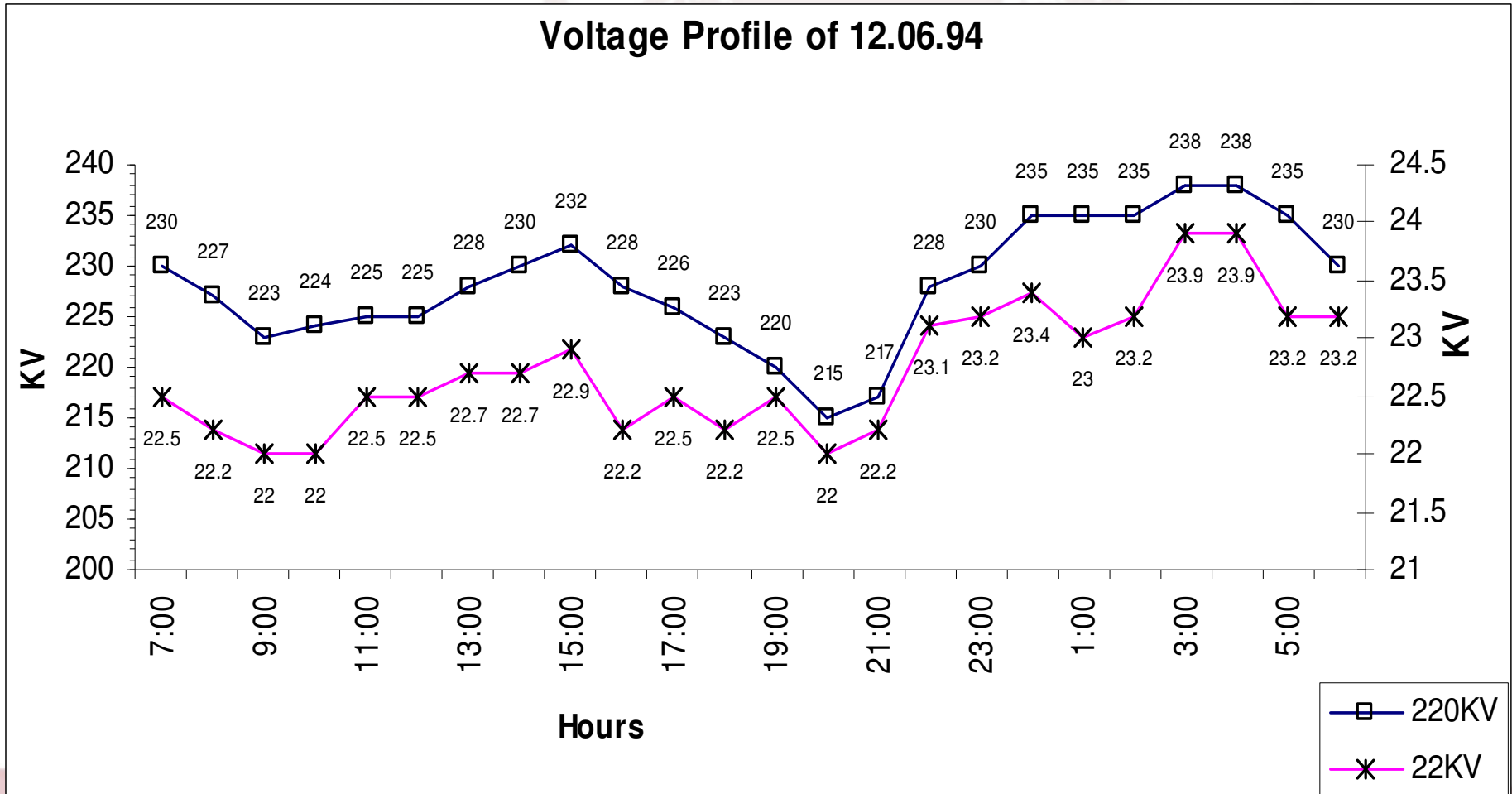
During Monsoon and Diwali Holidays

- Increase in Grid Voltage up to 245 KV.
- Existing OLTC with $\pm 10\%$ taps was unable to correct the voltage beyond the certain value.
- 22KV Bus Voltage was going beyond 23.5KV and even touched 24KV at several occasions.
- LT 415V side voltage exceeding beyond + 10% limit during this period.

MSEB POWER : Over voltage data for March 94- July95



MSEB POWER : Voltage recorded for 12.06.94



Assignment to TCE for study and suggesting solutions : Year 1995

- Major Expansion were planned and load growth expected to be up to 50 MVA
- 3rd 220KV Transformer was, therefore, required to meet this Load Growth and this transformer should be suitable to run in parallel with existing 2 Transformers .
- Before selection of 3rd 220KV Transformer, it was essential to study and resolve over-voltage problem.

Scope:->

1. Load flow study for full Load and Light Load Conditions from 220KV to 415 Volt, based on load data of 220/22/0.415Kv network: The preferred limit of 22KV Bus Voltage was agreed as 23.1KV.
2. Study of Alternative Solutions to overcome over voltage problem and arrive at techno economic solution for implementation.
3. Recommend specifications of 3rd 220KV Transformer.

Load Flow Study

Case I : Maximum Load Condition

1. Incoming voltage up to 245KV considered with 20 MW Load (maximum demand) and Transformers paralleled.
2. All 12000KVAR (i.e. 7500KVAR Directly connected & 4500KVAR through APFC panels) capacitors in circuit.

Case II : Light Load Condition on working Day

1. Incoming Supply Voltage up to 245KV considered with 14 MW Load and transformers paralleled.
2. Capacitors (4500KVAR) off by APFC Controllers.

Load Flow Study

Case III : Light Load Condition on Holidays

1. Incoming Supply Voltage up to 245KV considered with 8 MW Load and transformers paralleled.
2. All 4500KVAR Capacitors connected through APFC are disconnected.

Summary of Load Flow Study Results

System Voltage kV	Case-I		Case-II		Case-III (Load 8MW)									
	Load 20 MW		Load 14 MW		Case a		Case b		Case c		Case d		Case e	
	Bus Volt-Kv	Tap	Bus Volt-Kv	Tap	Bus Volt-Kv	Tap	Bus Volt-Kv	Tap	Bus Volt-Kv	Tap	Bus Volt-Kv	Tap	Bus Volt-Kv	Tap
220	23.07	8	22.1	3	22.1	3	23.05	8	22.1	4	22.66	9	22.91	8
225	22.72	5	22.66	3	22.09	1	22.43	4	22.39	3	22.93	8	22.28	4
230	22.06	1	22.93	2	22.62	1	22.13	1	22.38	1	22.55	5	22.53	3
235	22.63	1	23.19	1	23.14	1	22.64	1	22.94	1	22.5	3	22.49	1
			(22.73)											
240	23.19	1	23.73	1	23.66	1	23.16	1	23.49	1	22.45	1	23	1
	(22.72)		(23.26)											
245	23.75	1	24.27	1	24.18	1	23.67	1	24.05	1	22.98	1	23.51	1
	(23.27)		(23.79)											
			*23.30											

Note: Figures in pranteses are the 22kV voltages without the capacitors connected through APFC (4500KVAr)

* Voltage value with all capacitors disconnected

case **a** : 2 Nos. Transformer in Parallel- Directly connected capacitors (7500KVAr) in circuit

case **b** : 2 Nos. Transformer in Parallel- All capacitors disconnected

case **c** : 1 No. Transformer in Operation- Directly connected capacitors (7500KVAr) in circuit

case **d** : 1 No. Transformer in Operation- All capacitors disconnected

case **e**: 2 Nos. Trafos in Parallel- Directly connected capacitors (7500KVAr) & 10MVAr shunt reactor in circuit

Alternate Solutions

Solution I : To increase present Tap range from $\pm 10\%$ to $\pm 15\%$ (25 position) of 220/24KV Transformer

Capital Investment Required

- Rs 51.20 Lakhs (Year 1995)

Work Involved

- Additional turns to be introduced in HV Winding to increase tap range to $\pm 15\%$
- Replacement of existing 17 positions OLTC by 25 Position OLTC

Time Required

- Transformers Need to be sent to CGL Factory.
- 8 to 9 months required..

Option Evaluation Summary

- At 245KV Voltage supply and light load condition of 8MW, 22KV Bus Voltage will be within limit of 23.1KV.
- High Capex and time required.
- Non availability of One Transformer for 8 to 9 months time.
- The new Transformer can operate in parallel with existing transformer in follower mode.

Alternate Solutions

Solution II : To replace 24KV LV Winding with new 22.95KV winding.

**Capital Investment
Required**

- **Rs 76 Lakhs (Year 1995)**

Work Involved

- **Modification of LV Winding.**
- **Both HV and LV Windings get disturbed.**

Time Required

- **Transformers Need to be sent to CGL Factory.**
- **8 to 9 months required..**

**Option Evaluation
Summary**

- **At 245KV Voltage and light load condition of 8MW, over voltage issue gets eliminated.**
- **High Capex and time required.**
- **Non availability of One Transformer for 8 to 9 months time.**
- **It will not be possible to operate new transformer in parallel with existing transformer.**

Alternate Solutions

Solution III : Disconnection of all Capacitors including directly connected Capacitors

Capital Investment Required

Rs 120 Lakhs (Year 1995)

Work Involved

- APFC Panels to be provided at 30 substations.
- Provision of Over voltage relay for all 40 substations.
- Provision of breaker panels at 10 substations for switching off capacitors.

Time Required

3 to 4 months required..

Option Evaluation Summary

- At 245KV Voltage and light load condition of 8MW, over voltage is restricted to 2.5% over tolerance limit of 23.1 KV.
- Power Factor for shorter period may drop to 0.7 but can be managed to 0.9 or above on average monthly basis.
- Power reliability is high as both transformers are available. Moreover, they can be operated in parallel as per the normal practice.

Alternate Solutions

Solution IV : Provision of 10MVAR Shunt Reactors at 22KV Bus

Capital Investment Required

- Higher than Rs 125 Lakhs (Year 1995)

Work Involved

- Additional space is required to install 22KV Reactors and Breakers.
- Provision of 22KV Breakers and Shunt Reactors.

Time Required

- 5 to 6 months required..

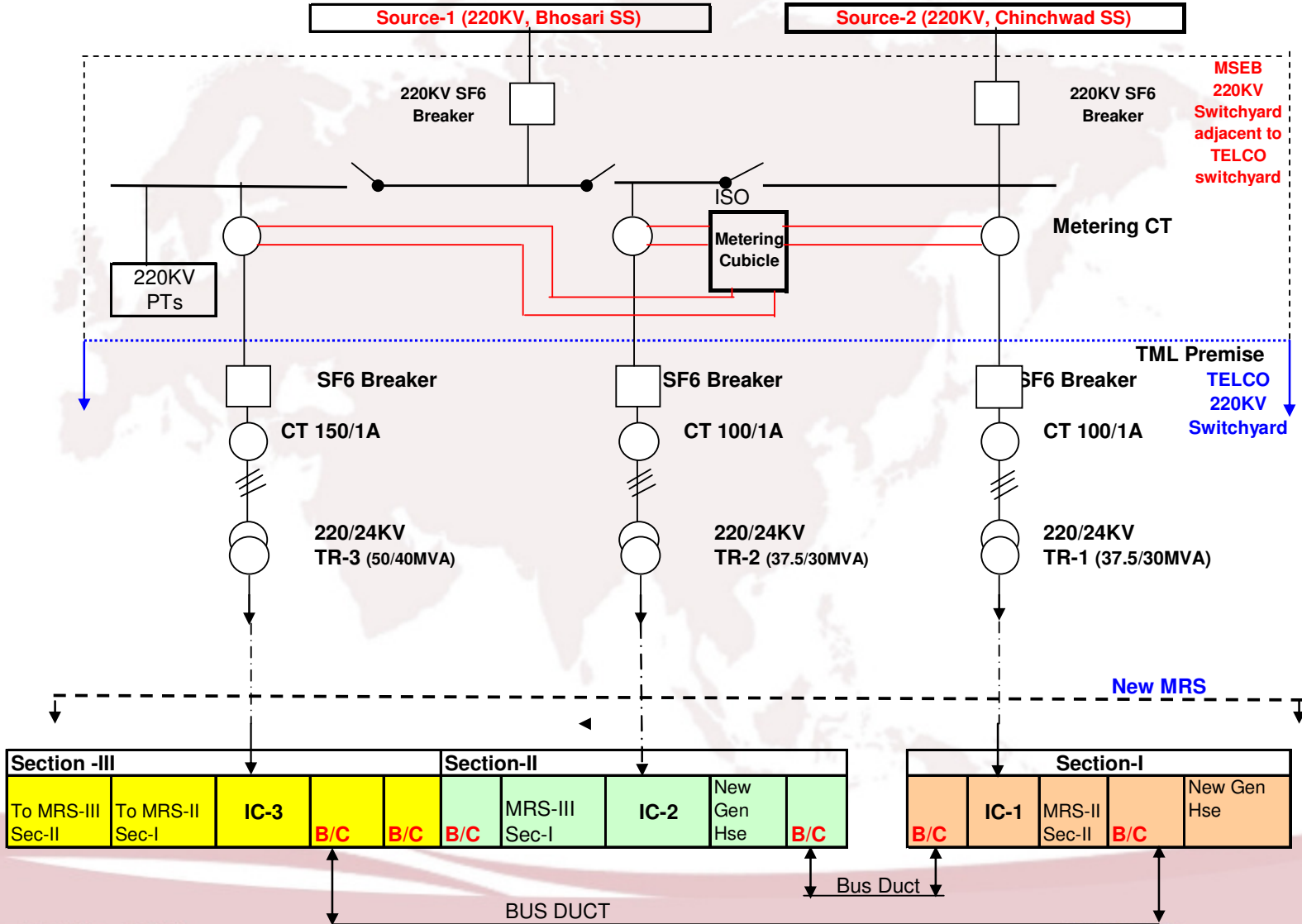
Option Evaluation Summary

- Over voltage at 22KV Bus is restricted for incoming supply up to 240KV.
- Operating PF would drop below 0.5
- Costliest Proposal.

Selecting solution for Implementation

1. Solution I, II and III were found technically acceptable.
2. Solution I was preferred over solution II as work involved was only on tapping winding and OLTC was to be replaced. The Main winding and LV Windings remain un-disturbed and it will completely eliminate the over voltage problem at 245KV and 8MW Load.
3. Though solution III was more expensive, it was decided to initiate implementation immediately considering following.
 - i. This facilitates modernization and better control of Capacitor banks and safety and ease in operation & maintenance.
 - ii. Work was restricted at 415 volt installations.
 - iii. Availability of both 220KV Transformers.
 - iv. Least Implementation period.
 - v. Implementation in phased manner.
 - vi. 3rd Transformer could be selected with appropriate tapping range.
4. Following action plan was also decided.
 - i. To meet the increased demand due to expansion, new (3rd) transformer be procured with $\pm 15\%$ OLTC.
 - ii. To review the situation after implementation of Solution III. In case the voltage not restricting within the desired limit, Solution I may also be implemented.

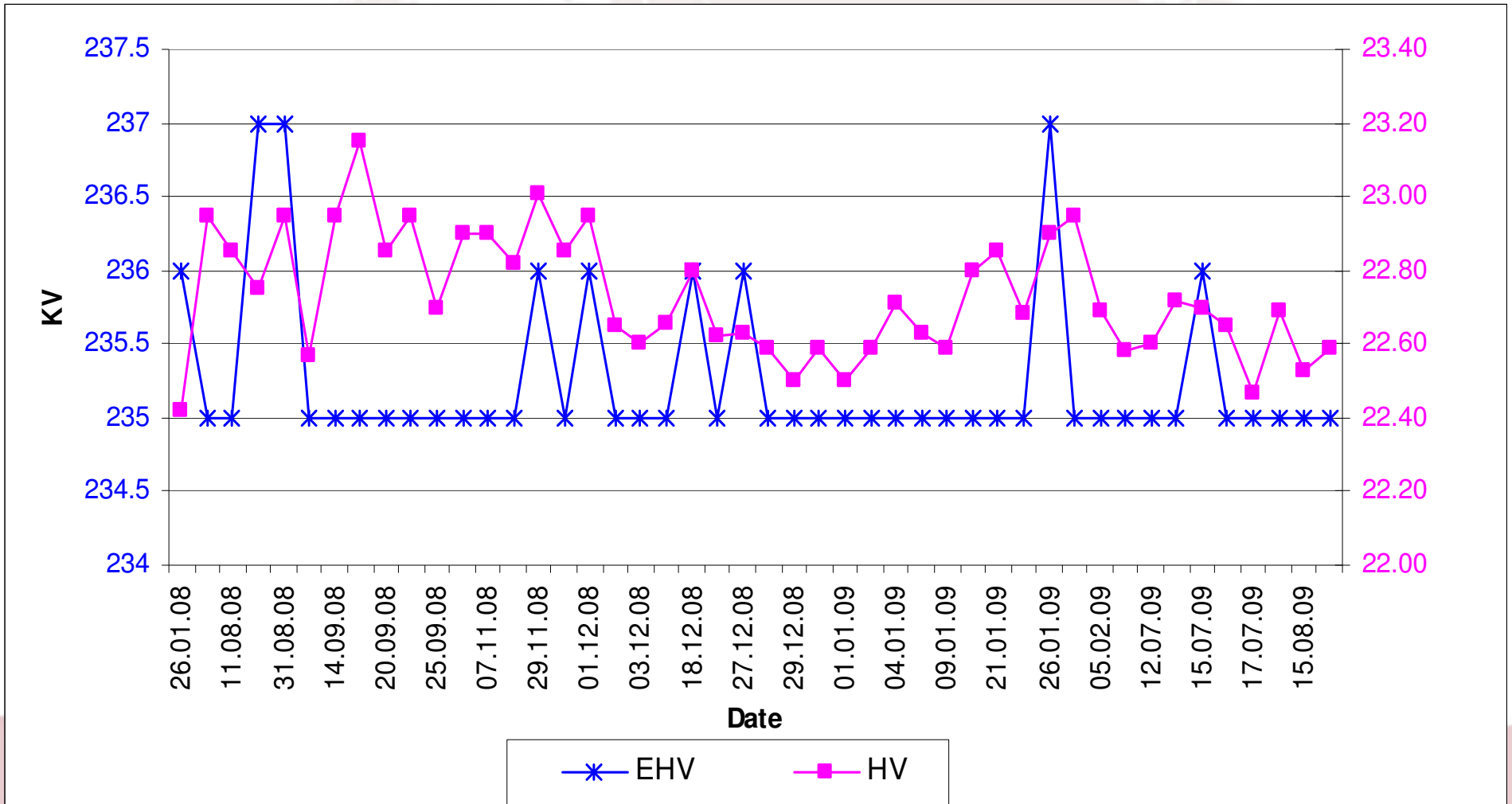
Single Line Diagram with Transformer No.3



Transformer No.3 Tap Matching with Existing Transformers

Transformer Details								
		Transformer No 1 & 2			Transformer No 3			
MVA		30 / 37.5			40 / 50			
KV (NO LOAD)	HV	220			220			
	LV	24			24			
Ampers	HV	78.7 / 98.4			104.97 / 131.22			
	LV	721.7 / 902.1			962.25 / 1202.28			
Phases		3			3			
Frequency		50Hz			50Hz			
Type of cooling		ONAN / ONAF			ONAN / ONAF			
Connection Symbol		Yyn0			Yyn0			
	Tap No	HV Volts	HV Amps	Impedance	Tap No	HV Volts	HV Amps	Impedance
					1	253000	91.3	13.46%
					2	250250	92.3	
					3	247500	93.3	
					4	244750	94.4	
	1	242000	71.6	13.71%	5	242000	95.4	
	2	239250	72.24		6	239250	96.5	
	3	236500	73.2		7	236500	97.7	
	4	233750	74.1		8	233750	98.8	
	5	231000	75		9	231000	100	
	6	228250	75.9		10	228550	101.2	
	7	225500	7608		11	225500	102.4	
	8	222750	77.8		12	222750	103.7	
	9A	220000	78.7		13A	220000	105	
	9B	220000	78.7	13.24%	13B	220000	105	12.40%
	9C	220000	78.7		13C	220000	105	
	10	217250	79.7		14	217250	106.3	
	11	214500	80.7		15	214500	107.7	
	12	211750	81.8		16	211750	109.1	
	13	209000	82.9		17	209000	110.5	
	14	206250	84		18	206250	112	
	15	203500	85.1		19	203500	113.5	
	16	200750	86.3		20	200750	115	
	17	198000	87.5	13.65%	21	198000	116.6	
					22	195250	118.3	
					23	192500	120	
					24	189750	121.7	
					25	187000	123.5	12.73%

Present Trend of Max Voltage



Present Status

- **Maximum Demand already reached to 49 – 50 MVA**
- **Expected to reach 55-60 MVA in next 5 years.**
- **All 100 substations are provided with Automatic PF Control (400 / 600 KVAR) and Unity Power Factor is maintained.**

Way Forward

In order to further enhance reliability of power system, improvements are required to meet the following conditions:

- **Two Transformers should always run in parallel.**
- **22KV Voltage to be maintained below 22.5KV (better than earlier target of 23.1KV) even if Incoming Supply Voltage is 245KV.**
- **Monthly Power factor is to be maintained at unity not only at plant level but also at each substation level.**

Part II: Over Voltage and Reactive Power Management

This part of presentation deals with the modernization program for reactive power management, which was undertaken in three phases.

Phase I: To overcome over voltage problem by replacing 7500KVAR directly connected capacitors by APFC panels.

Phase II: To achieve unity power factor for the plant.

Phase III: Sustaining unity power factor by adopting new technologies and continuous improvement in installation, specifications and maintenance processes.

Phase I : Modernization Program: Replacement of directly connected capacitors. (1996-2000)

1. Considering the large investment and complexity of network, 3 year master plan prepared and implemented as per time line. This included planning, engineering, procurement and commissioning of the following:
 - a) Replacement of 7500KVAR Directly connected capacitors by Contactor operated APFC panels in 30 substations.
 - b) Provision of over voltage relays in all 40 substations and extension breaker panels in 10 substations.
2. New Plant, adjacent to existing plant of Pimpri, Pune was established for manufacturing of cars. 24 substations of 22KV / 415V, 2MVA and 2 nos of 22KV / 6.6KV, 8MVA were commissioned in Car plant. APFC panels in these substations were provided as a part of total project.
3. Expansion of 220KV switchyard was also completed by providing 3rd 40 / 50MVA, 220 / 24KV transformer with $\pm 15\%$ OLTC.
4. Over voltage problem almost solved due to above changes and availability $\pm 15\%$ OLTC on Transformer 3
5. Maximum demand crossed 40MVA, average monthly power factor of > 0.95 lag.
(Total no of substations 70 nos).

Phase II: Modernization Program to attain Unity PF **(2000-2002)**

- 1. In year 1999-2000, TATA Motors proactively submitted views and suggestions to MERC on the tariff hike proposal of MESB. One of the suggestions was on reactive power management. It was emphasized that Reactive Power management is the responsibility of both Utility and Consumers and need to be addressed at voltage level-wise. It was explained with analysis of data, how the utility (entire power system) is benefited if power factor is improved close to unity. To encourage consumers to improve the PF above 0.95, incentive be provided to consumer since there will be huge gains to utility.**
- 2. There is potential of 1% reduction in MVA Demand & 2% reduction in T&D losses for every rise of 0.01 in PF; which can release about 500MW at state level by PF improvement, which means corresponding reduction in emission of green house gases.**
- 3. In our application of 2001-02, we again submitted to Honorable Commission to provide higher rate of incentive i.e. from 1% to 2% for improving PF from 0.99 to unity; in view of very high investment for this step.**
- 4. Hon'ble Commission MERC had given due consideration to our suggestions and granted incentive up to 5% in year 2000 and again increased to 7% in year 2002 in energy tariff.**

“Challenges for Achieving Unity Power Factor”

- Need to speedily attain unity PF to get full benefit of incentive for PF improvement introduced in the tariff structure of MSEDCL as per MERC order.
- Complex and large 22KV Distribution System spread over in 700 acres of area.
- Substations increased from 40 nos (1996) to 70 nos (2002).
- Complexity in maintaining unity PF due to growing load. The instantaneous demand is varying over the hours of the day from 10 -12 MW to Maximum 35 -40 MW.
- It was observed that total 15000 KVAR required to be pumped in the system for the replacement and capacity increase.
- Various production processes like Weld shop, Press shop, Heat Treatment lead to unbalanced, dynamic and unpredictable and complex nature of load.
- APFC step was 100KVAR which leads to under and over compensation at substation level.
- Localised Over voltage problem due to over compensation.
- De-rating and failure of capacitors due to type of capacitor design, voltage stresses, harmonic nature of load and contactor burning problems due to frequent On / Off operations.
- Non availability of space in certain old Substations.

“Challenges for Achieving Unity Power Factor”

Diversity in the Nature of Load :-

The various type of manufacturing operations namely Heat Treatment, Pressing, Welding, Painting etc. are carried out in various shops, spread over an area of more than 700 acres at Pimpri and Chikhali.

- **Paint shops:-** Heating and Ventilation Systems comprising of large capacity blowers operating at an average of 0.87 lag power factor.
- **Weld shop:-** Highly unbalanced low PF in the range of 0.4 to 0.65 lagging is due to Automatic (Robotic) welding and manual welding process. The load is of dynamic in nature and remains for 15~20 cycles with all complexity.
- **Press shop:-** The large automated presses operate dynamically for few seconds, similar to Weld shop load. Only when the press stroke is applied, the load increases manifold. The load operates at an average 0.8 lag power factor.
- **Heat Treatment Shop:-** The furnace load used for heat treatment purpose is Inductive and fairly constant. The load operates at an avg. 0.85 power factor.
- **Machine shop:-** The load of this shop is of dynamic nature and operates at low power factor of 0.80 lag.
- **Compressor House:-** Due to large scale of operation, the daily air consumption is of the order of 1,50,000 cfm. There are large Centrifugal and Screw type compressors driven by induction motors operating at an average power factor of 0.87.

“Systematic Approach to Achieve Unity Power Factor”

- Considering the stiff target, the Power Factor improvement plan was prepared and closely monitored to ensure the time line. The plan was mainly divided in 5 stages.
- Stage 1: Changing MPP type capacitors to more reliable APP type capacitors.
- Stage 2: Dividing existing 100KVAR step of APFC panels in 3 steps for least count of 25KVAR with Beluk controller.
- Stage 3: Replacement of outdated APFC Panels.
- Stage 4: Installation of 3000KVAR HT fixed capacitor for base load application.
- Stage 5: Provision of APFC panels in newly added substations as part of the project.

These activities were completed as per time line and achieved the target of unity PF. Since Jan 2002, Unity PF rebate has been received in all the MSEB bills.

Phase III : Modernisation Program – Sustaining Unity PF **(2002-09)**

After attaining the unity power factor in Jan 2002, the real challenge ahead was to sustain the same as:

- a) There was major addition in welding loads and contactor operated APFC panels were not suitable for such type of load.**
- b) Increasing faults and breakdowns in contactor operated APFC panels. i.e. Very High Maint Cost.**
- c) Inadequate manpower as quick action was essential to find out abnormalities and attend the same.**
- d) High load growth due to expansion.**

Nature of Weld Shop Load

- Weld shop comprises more than 600 nos welding guns and their ratings vary from 35KVA to 250KVA. (Total connected load is more than 70 MVA)
- Mix of Robotic welding guns and manually operated guns.
- All guns are 2 Phase operated.
- Welding gun operates for few cycles (10 to 15 cycles i.e. 200 ms – 300 ms)
- A lot of automation in manufacturing processes, require to use sophisticated technology, PLC and microprocessor based controls, remote sensing and digital technology.
- The process load is unbalanced, dynamic, surging type and with high harmonic current.
- PF varies from 0.2 to 0.6 lag and Load varies from 0.1 to 1.8 MVA on 2MVA substation.

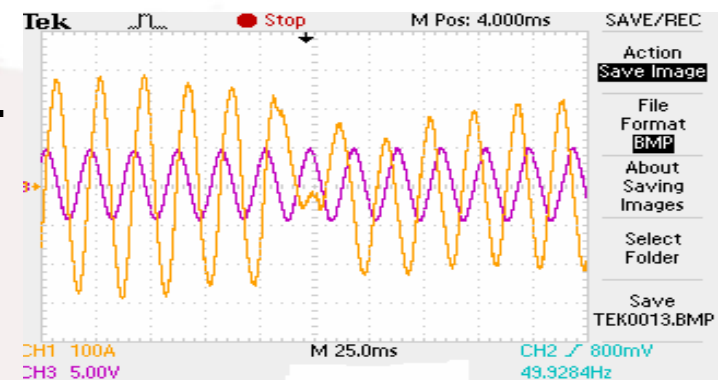
Why contactor operated APFC panels are not suitable for Weld load applications:

- a) **Failure rate of power modules, encoders, welding controller cards, hard disks etc. is very high when APFC Panel is in operation.**
- b) **Actual impact varies from one event to another. There is no uniform pattern of failures.**
- c) **Even though many components can be repaired, the cost of repair and production down time is very high.**
- d) **High response time.**
- e) **Delayed operation of APFC panels resulting into under compensation and over compensation during welding process.**
- f) **High rate of failures of SFUs, Contactors and Capacitors due to frequent switching and presence of harmonics.**
- g) **Delta operated capacitors are suitable for balanced load only.**

“Evolving technology for Weld load Application.”

- After discussing with many manufacturers of capacitor and APFC system, we concluded that suitable technology for direct use in weld shop was not available in India.
- We took the challenge to develop the party in India.
- After sharing basic engineering inputs and our requirements with some manufacturers, one Nashik based party came forward.
- They developed a prototype of 100 KVAR, using single phase controller, star connected capacitors, ultra fast switching device (Thyristor) having response time around 40 ms.
- Though the results of the initial trial were encouraging, the further progress could not materialised due to certain limitations.

- Trial was taken with small prototype model and performance was satisfactory.
- Full scale panel was then developed, installed and subsequently commissioned in August 2002.



Thus, first time in Indian Automobile Industry, this technology was developed and used for welding loads.

Development of RTPFC System is a good example of team work and knowledge sharing between manufacture and user.

System Benefits:

- Accommodated additional 5MVA load in existing 3 nos S/S thereby saving of one set of substation equipments and space. i.e. Saving of 3 millions INR and 150sqmtr space.
- Maintained PF in the range of 0.8 to 0.99 for Weld Shop till today without any major trouble.
- Reduced voltage drops due to back feed of instant reactive power.
- Improved welding quality

“New Reliable Systems used to maintain unity Power Factor.”

- Beyond year 2004, the new substations were planned with new design of TSC panels by changing the specifications of panels according to requirement and nature of load.
- Following Improvements took place:
 - PF Correction least count brought to 25KVAR using 8 stage & 12 stage controllers.
 - PF controller to Display PF in 0.999 format and stage condition.
 - TSC Panel with 7% & 13% Detuned Reactor as per the type of Load.
 - 525 to 650 Volt MPP (ABB make) Capacitors used.
 - Response Time improved to 40 ms

“Consistent Approach to reduce Life cycle cost and sustain UPF during Expansions.”

During Weld Shop expansion in year 2007, we found that RTPFC cost is increased by 200% and investment is not justifiable hence we were searching for the Cost Effective Solution.

- This time M/s Crompton Greaves came forward with unique technology.
- They offered, combination of 14% detuned 540KVAR Thyristor Switched Capacitor (TSC) panel having star connected capacitor and 100KVAR Active Harmonic Filter (AHF).
- TSC supplies bulk demand and AHF fine tunes the balance demand to inject accurate required reactive compensation.

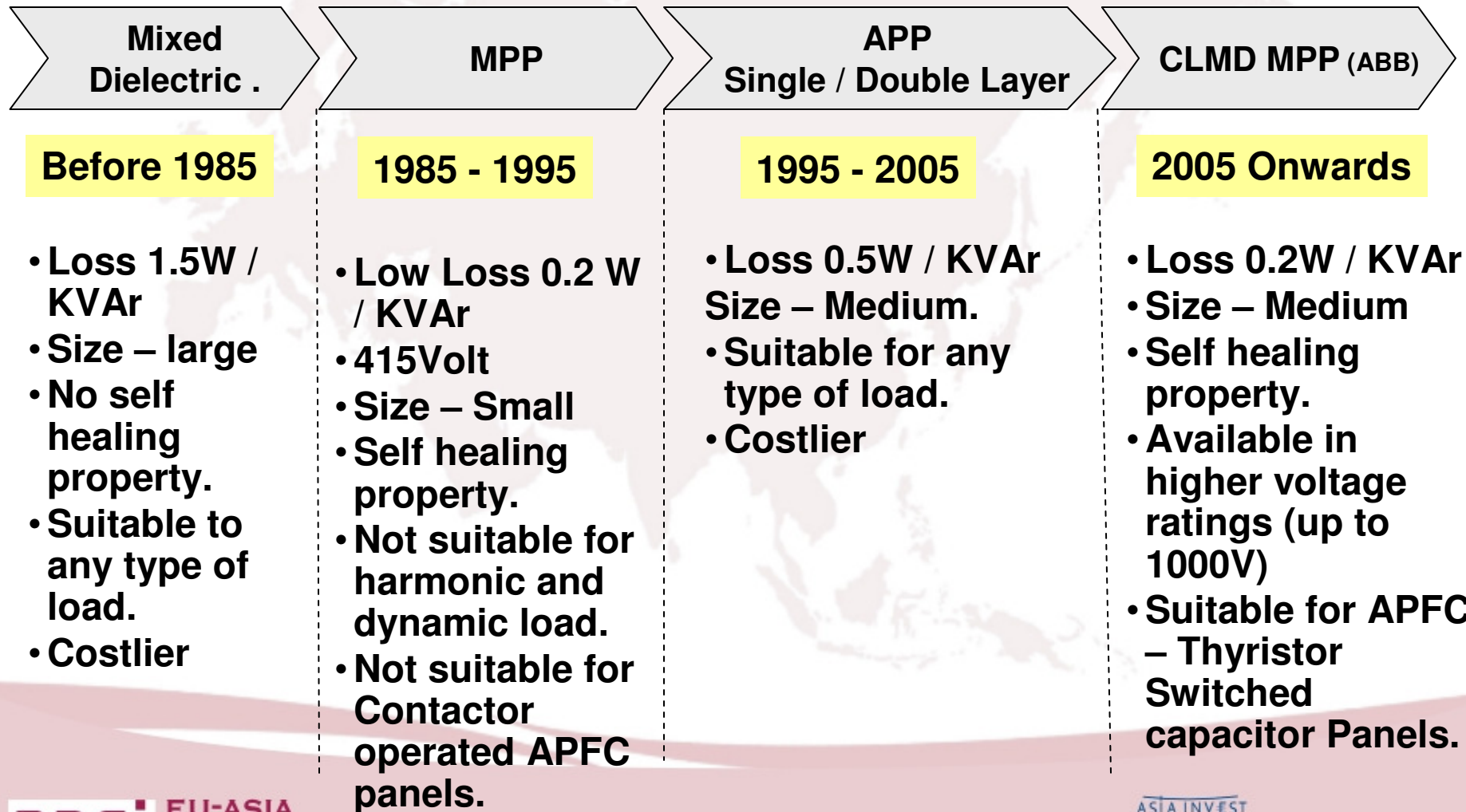
- **This system installed in Year 2008. System commissioned on partial load. As of today, the results are satisfactory and the system is under observation.**
- **The projected load is developing hence performance of the system is yet to be proved on full load.**

We are confident that this system will also work to our expectations.

We are happy to inform that such system is implemented first time in Automobile Industry.

This effort will also reduce the cost of installation and space.

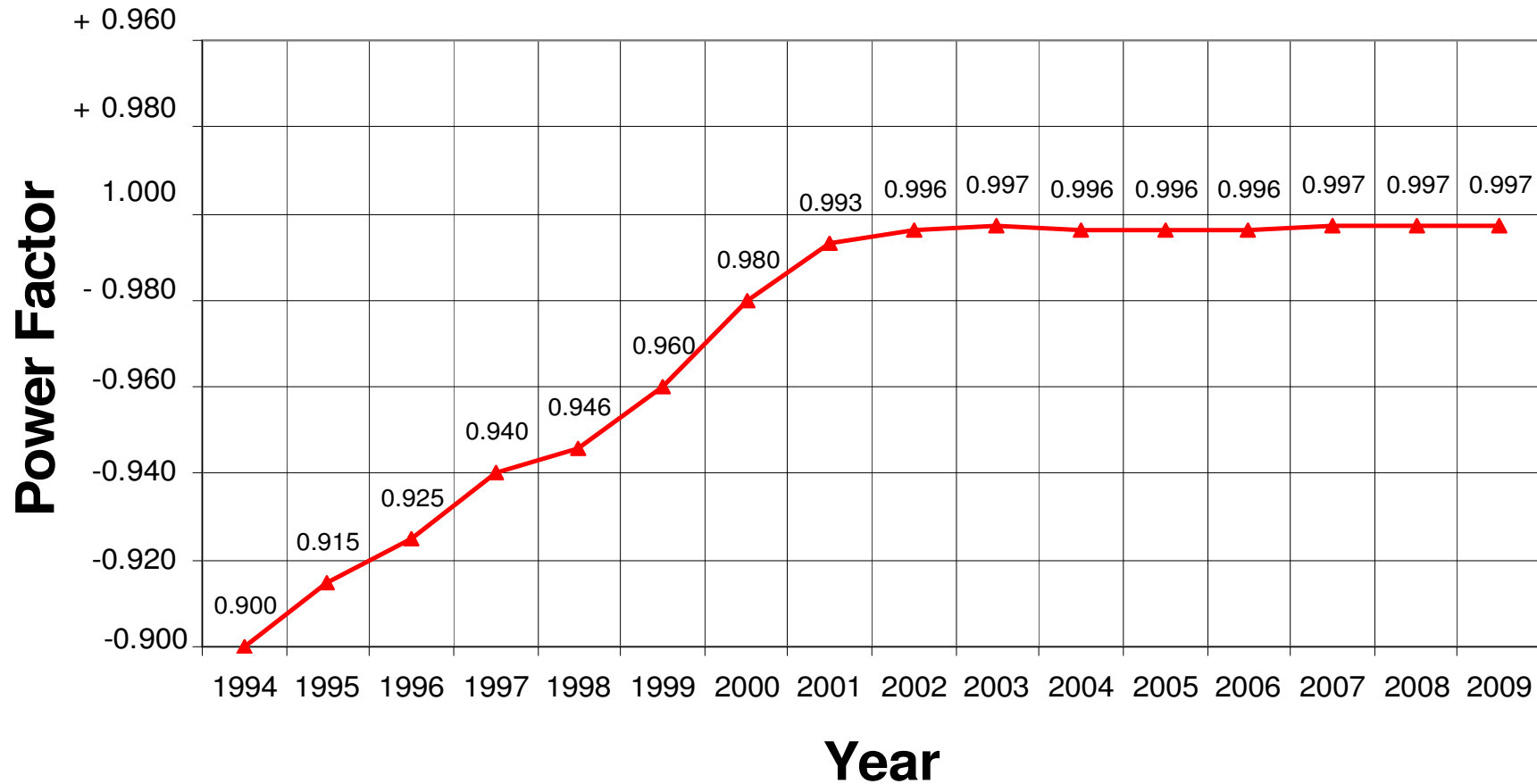
Use of Different Capacitor Designs.

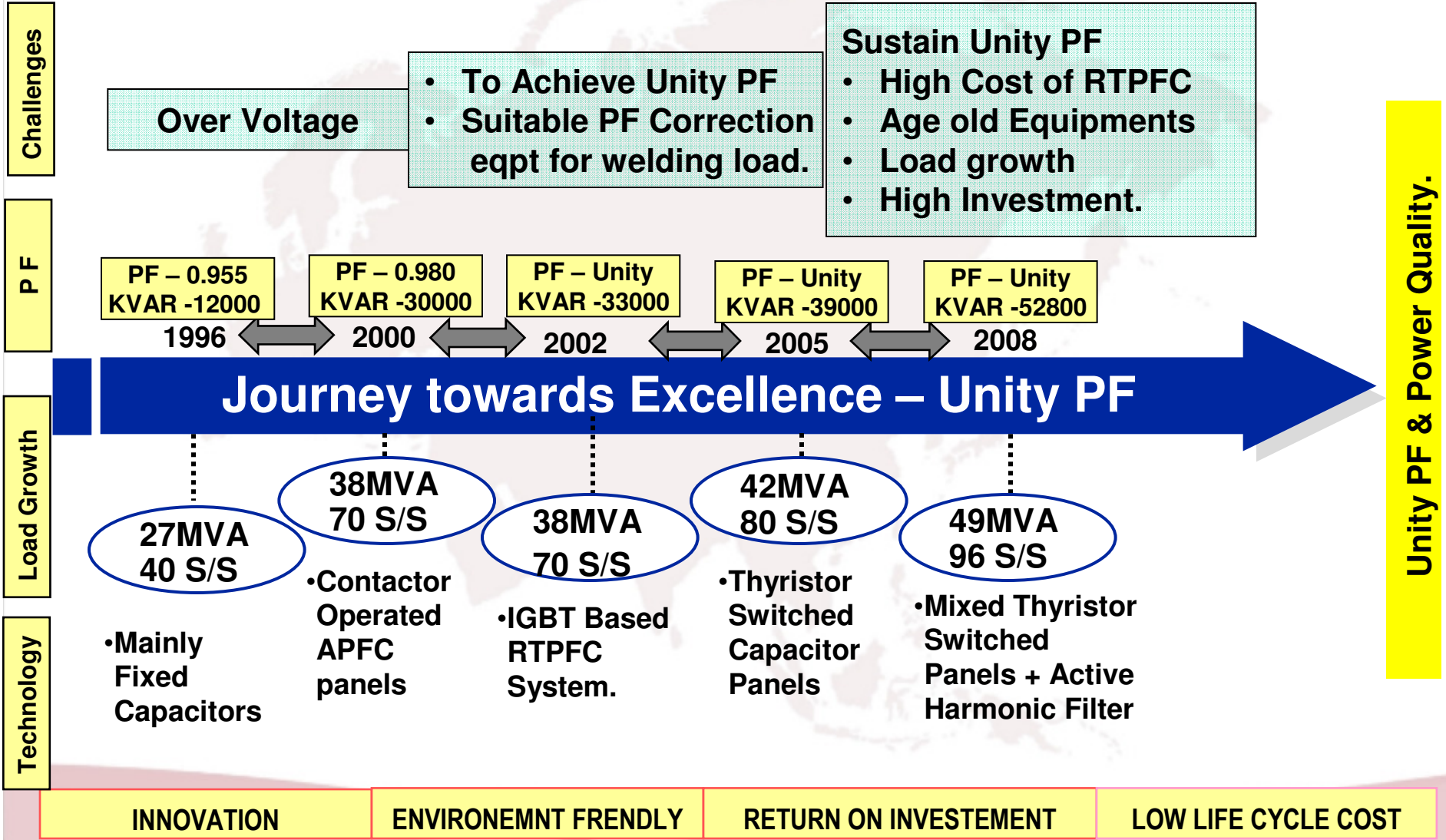


Now the plant having following system for unity PF.

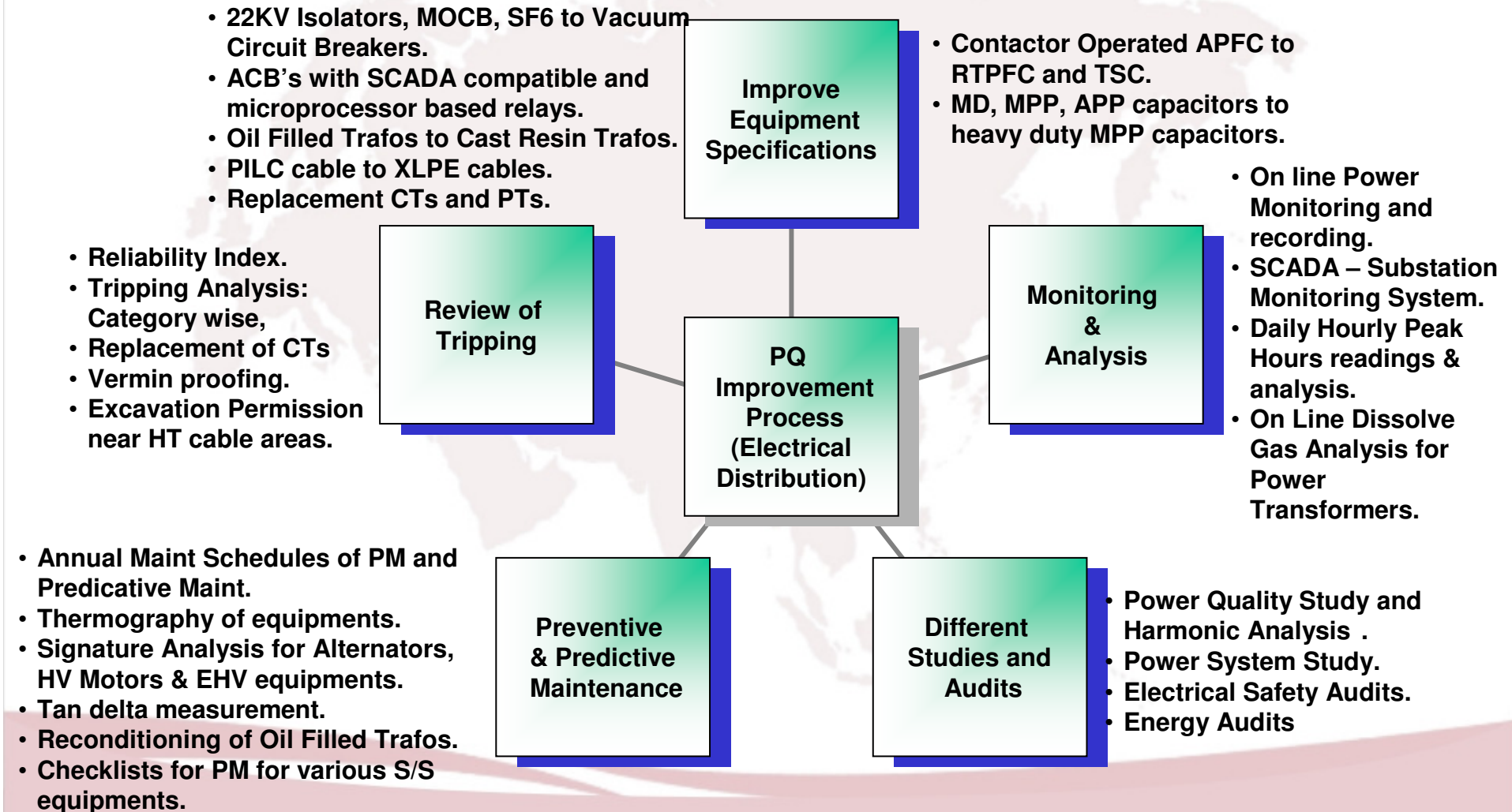
Sr No	Technology Used	Quantity	Load Profile	Total Kvar
1	3000KVAR Fixed HT Capapcitor	1 set	Base Laod Application	3000
2	Contactor operated APFC panels	60 nos	Less dynamic operations and failrly balance load.	28200
3	Thyristor Switched Capacitor (TSC)Panels	6 nos	Dynamic balance Load	3600
4	Thyristor Switched Capacitor (TSC) Panels with detuned reactor	21 nos	Dynamic balance Load with harmonics	12600
5	RTPFC Panel	9 nos	Dynamaic, Unbalanced and unpredictable load viz. Weld Shop	5400
			Total KVAR	52800

Yearwise Average Power Factor





Activities Involved for PQ Improvement in Plant Electrical Distribution Network.



“Way Forward ”

- To bring down present 23.1 KV Voltage tolerance limit to 22.5KV at 22KV Distribution Bus.
- Five year master plan for replacement for outlived contactor operated APFC panels by Low Life Cycle Cost panels and Capacitors.
- Bring entire reactive power management system under SCADA.
- Training of Engineers and workmen of O&M Contractors on regular basis.
- Monthly Power factor is to be maintained at unity not only at plant level but also at each substation level.
- To improve and sustain Power Quality in the internal distribution network by :→
 - Carrying out system study of entire network and take corrective measures.
 - Covering the Predictive Maintenance up to the lowest end of the network.

Power Quality Excellence Bridge

Govt:

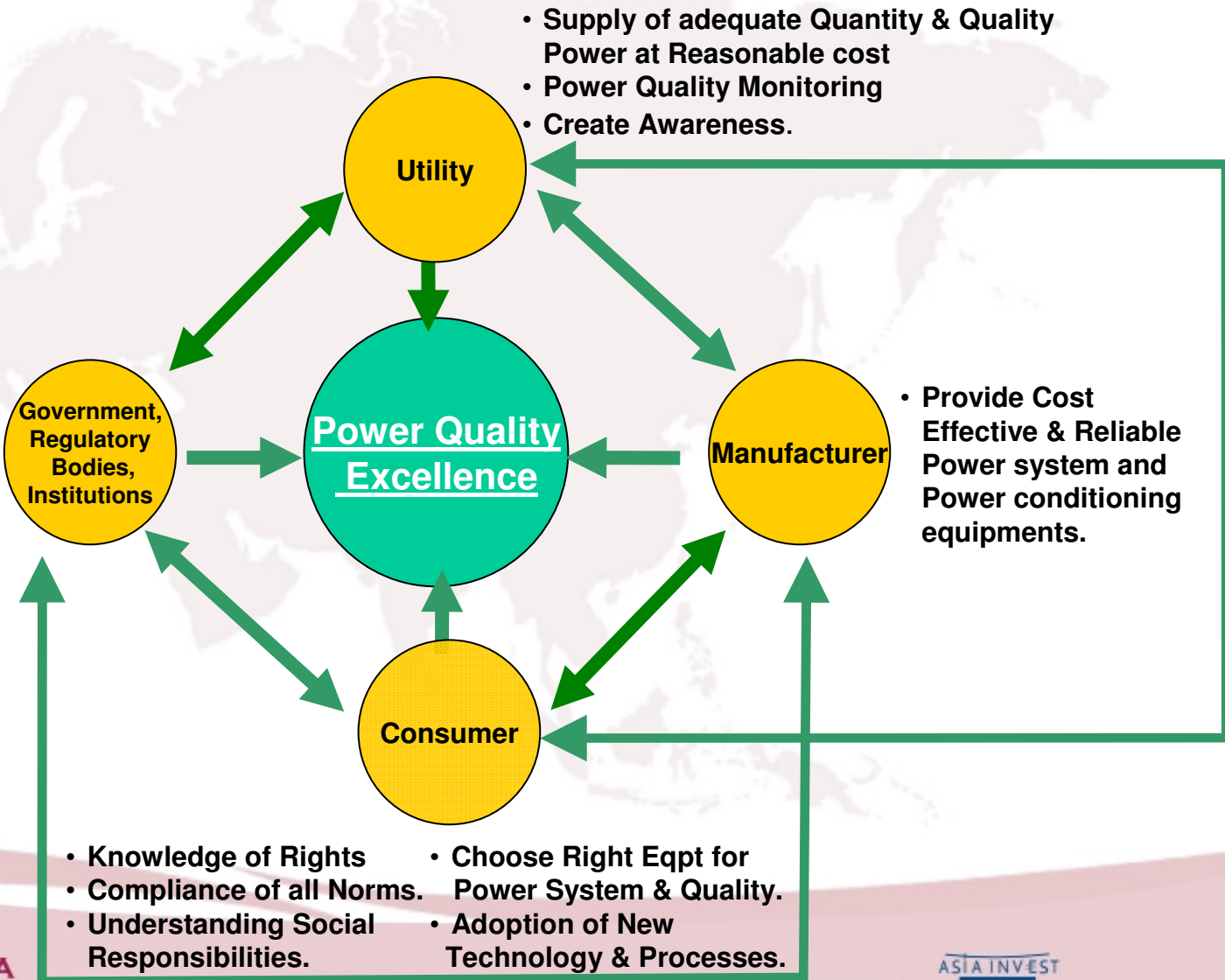
- To speedup reforms for strengthening of Generation, Transmission & Distribution.

Regulatory Bodies:

- To frame & enforce regulation & guidelines.

Institution:

- Education
- Awareness
- Standardization.





Thank You.