Modernisation of Transmission System In MSETCL

Jaolikar S.A.[1], Rajurkar S.S., [2], and. Kulkarni A.R.[3]

[1] Jaolikar S.A.Superintending Engineer Testing and Communication Circle Vashi, MSETCL
[2] Rajurkar S.S. Deputy Executive Engineer, Tr. O&M Corporate Office Mumbai, MSETCL
[3] Kulkarni A.R., Assistant Engineer, Corporate Office Mumbai, MSETCL

Abstract - **Ministry of Power has an ambitious plan of providing Power to all by 2012.This task not only demands contributions from Generation and Distribution utilities but the transmission utility also has to play a vital role of transferring bulk power from source of generation to various load centres. It also becomes mandatory on account of transmission utility to complete various transmission projects in timeline with generation project commencement. Mere creating of transmission infrastructure is not enough but its reliable availability is of utmost importance. This calls for adoption of modern techniques and technologies in transmission system. This paper gives brief information about modernisation drive taken by Maharashtra State Electricity Transmission Company Ltd. (MSETCL/MAHATRANSCO) for overall improvement of its own transmission network in the state. Briefly this includes providing information on Substation Automation System (SMS), Use of modern Testing and Diagnostic equipments, Implementation of advanced SCADA and RTU system, Use of Emergency Restoration System (ERS), Hot line maintenance technique, Use of High Ampacity conductors etc in MSETCL.The paper also describes different features and advantages of these techniques/technologies. It also discusses in brief important aspects of practical implementation of some of these techniques/ technologies in MSETCL system.**

Index Terms— **Numerical Relays, Substation Automation System, Advanced Testing and diagnostic equipments, Emergency Restoration System, Hotline Maintenance, Advanced SCADA and RTU system**

I. NEED FOR MODERNISATION:

TOday, existing National grid in the country is characterised by interconnection between Western, Northern, and North-Eastern regions of India, whereas Southern region is operating in asynchronous mode. State transmission grid in Maharashtra is connected with the rest of the partial National grid calling the need for its smooth operation. Apart from this MSETCL has to cater demand of MSEDCL,various EHV consumers located in different parts of the state in various Maharashtra Industrial Development Corporations (MIDCs) and Special Economic Zones(SEZs).Since Electricity Act-2003 encourages generation by Private Producers, many IPPs are coming up in Maharashtra. Evacuation of Power from these IPPs as well as providing required corridor for power transfer to Open Access consumers is also a responsibility of state grid.Power Transmission utilities in the world are adopting proactive and preventive maintenance practices by using various state of the art technologies. Maharashtra being the progressive state in the country and is at the forefront in socio-economic development as well as in implementing new techniques/technologies in various sectors including power sector. In line with this MSETCL has taken up modernisation plan for its state grid.

II. PRESENT INFRASTRUCTURE:

MSETCL is the largest state transmission utility in India with 498 EHV substations with transformation capacity of around 61,500 MVA and EHV lines of around 36,300 Ckm. Further, MSETCL has installed 9000 ABT meters for proper energy accounting and transmission loss evaluation purpose. MSETCL is the only state transmission utility in India which is operating and maintaining +/- 500kV, 1500 MW HVDC bipole line between Chandrapur and Padghe.This link transfers bulk power from eastern side of Maharashtra to load centre located in Western Maharashtra.

III. MODERNISATION OF TRANSMISSION SYSTEM IN MSETCL

MSETCL is having ambitious Five year investment plan of around 21,000Cr.Transmission expansion plan of MSETCL includes incorporation of various modernisation plans. MSETCL has taken modernisation plans in following areas.

A. Providing Substation Monitoring System (SMS) at various EHV substations:

MSETCL is providing SMS at 26 numbers of EHV substations which includes all 400 kV substations along with 220kV and 132 kV substations attached to generating stations. Scope of this work includes replacement of existing old distance protection system by state of the art numerical distance protection relays having host of in built features. This SMS scheme also includes providing Event Sequence Recorder (ESR) and time synchronising equipments. It also includes provision of monitoring system.

Following are the benefits to MSETCL after implementing SMS system

i) Pinpointing cause of occurrence
ii) Use of numerical relays gives exact location of fault thereby reducing downtime of system, as immediate action for attending the fault can be taken.
iii) In-built disturbance recorder of Numerical relay helps in detailed analysis of trippings/occurrences.

B. Use of Numerical Relays and diagnostic equipments:

This section discusses manner in which various diagnostic equipments and numerical relays are effectively utilized for improving performance of the system characterized by increased reliability and availability.

1) *Tripping of 400/220/33kV, 3x105 MVA ICT on Neutral Displacement Protection.*

This particular incidence illustrates the effective use Numerical Relays, Diagnostic equipment for exactly detecting the cause of frequent fault of similar nature occurring at 400 kV Nagothane substation which is one of the major substation in MSETCL grid. Presently two numbers of 3x105 MVA, 400/220/33kV transformers are in parallel operation. 33 kV Tertiary winding is unloaded type and connected in delta. It is protected by surge arresters connected between phase to phase and phase to earth as standard procedure. 33kV PTs are connected between phase to earth and its supply is used for Neutral Displacement Protection.

It was observed that one of the transformers was frequently tripping on Neutral Displacement Protection. All the equipment and circuitry connected to the tertiary winding i.e. surge arresters for leakage current, potential transformers, post insulators, control cables and involved earthing connections were checked for healthiness, but no abnormality was observed.

However while checking 33kV bushings, one of the bushing 3a of Y phase unit was found to be deteriorating. The Capacitance and Tan delta value was recorded as 440pF and 14.0% respectively which were quite higher compared to other phases. High Capacitance values lead to draw the conclusion that 50% of capacitor foils must have been short circuited leading to reduction in capacitive reactance. Similarly increased Tan Delta value showed establishment of low resistance path for a discharge to earth within the bushing. These contentions were accepted by M/S BHEL when referred to them. Incidentally voltage waveforms of 33 kV winding gave clear picture of the phenomenon that was taking place leading to tripping of ICT.

2) Use of C and Tan delta measurement

On 01/04/2008, one of the 220kV CTs installed in bay at 400/220kV Jejuri substation near Pune failed. Detailed investigations revealed that hole was developed in the bottom tank due to development of pressure inside the tank. This is due to the fact that when CTs/PTs absorb moisture it develops high leakage current through insulation causing gases getting evolved which further results into high pressure inside. The pressure if developed substantially may break/open the joints on fabricated tank. The hole developed in case of CT at Jejuri was a result of these phenomena. Immediately after this occurrence, it was decided to ensure healthiness of remaining CTs. As such complete thorough checking and testing of CTs was carried out. The capacitance and Tandelta values of these CTs were found beyond permissible limits. These CTs were immediately taken out of service and sent to manufacturer for reconditioning. Thus remaining CTs and subsequent damages due to this failure could be avoided [1].

C. Use OF Under frequency (U/F) cum Frequency trend (FT) relay:

MSETCL has replaced all existing old static UF cum FT relays by modern numerical UF cum FT relays with built in disturbance recorder. One relay can be used for monitoring/tripping of number of feeders in a substation. Frequency trend relay can operate based on changed frequency settings in the Western regional system. This provision helps in efficient implementation of Automatic Underfrequency load shedding scheme (AUFLS).

D. Use of Modern Testing and diagnostic equipments

MSETCL is using various modern testing and diagnostic equipments as mentioned below:

i) SFRA test kit,
ii) C and Tan-δ measurement kit
iii) Leakage Current Monitor (LCM),
iv)Circuit Breaker analyzer and contact resistance measurement kit
v) Automatic Relay test kit
vi) PID kit
vii)EHV line analyzer system
viii) Thermo vision camera

Apart from this procurement of portable Battery Impedance Analyser (BIA), Dissolved Gas Analyser (DGA), Battery Ground (BG) fault locator is in process.

1) Sweep Frequency Response Analysis Test (SFRA)

Disturbances in the system or overloading of Transformers gives rise to short circuit forces which cause winding movement and changes in inductance and capacitance in transformer. DGA, Winding Resistance Measurement, capacitance and Tan-Delta measurement can not detect these changes. In such cases, Frequency response analysis becomes an effective tool to detect such changes. SFRA test is immune to weather conditions, as well as external interference. Damage of transformer during transportation from factory to site can also be detected by this technique before commissioning of transformer. MSETCL has included SFRA test as a routine factory test in specification so that reference is available for further future verification at site [2].

E. Bay Control Unit (BCU) based substation automation system:

MSETCL has decided to provide BCU based Substation Automation system at all new substations. The old concept of providing control panels has become obsolete and one single Intelligent Electronic Device (IED) called as BCU replaces the functionality of entire control panel. This BCU is housed in relay panel itself which are located in the air conditioned kiosks in the switchyard very near to primary switchgear and equipments. This results in reduced cabling and thus faults due to earth leakage etc can be avoided. The work stations are located in control room and this system can act as a complete control, monitoring and data acquisition system for effective and efficient monitoring of substation. In this only two fibre optic cables are taken to control room from switchyard.

F. Replacement of Old relays by Numerical relays by way of retrofit:

The existing old relays on the protection panels are replaced/retrofitted by modern numerical relays, thus old

protection panel is utilised with new relay. The retrofit works are normally carried out by availing shutdowns on the EHV line. However if shutdown is not possible due to system constraints, the live line replacement is also possible and has been carried out in MSETCL for critical lines. Currently around 304 old relays are being replaced by Numerical relays. This will ensure reliable and correct operation of protection system within state grid.

G.Fire fighting system for Transformers:

Transformers being heart of substation and costly equipment, its proper functioning is of utmost importance. Taking this point into account, Nitrogen injection type fire fighting system are being provided to take care of incidents of fire to transformers.
Ex.: This example illustrates effective use of fire fighting system in the substation. At Padghe, bushing of 220/100 kV transformer burst and resulted into small fire but Nitrogen injection type fire fighting system operated correctly draining the oil and the transformer was saved from major fire damage.

H.Emergency Restoration system (ERS):

Emergency Restoration system (ERS) consists of mobile tower erection unit which is useful in carrying out maintenance activities in emergencies or at the places where it is important to maintain the Power supply without availing outages.
MSETCL has successfully carried out power supply restoration of its 132 kV Babhaleshwar-Kopargaon-Vaijapur EHV line with the help of Emergency Restoration system (ERS) [3].The 132 kV Babhaleshwar-Kopargaon-Vaijapur line is fed from 220kV substation Babhaleshwar.The line feeds to 132 kV Kopargaon taluka in Ahmednagar district under Nashik zone of MSETCL as well as 132 kV Vaijapur taluka in Aurangabad district under Aurangabad zone of MSETCL. The completion of line works covering shifting of towers at Puntamba-Shirdi railway crossing was difficult due to following two reasons
i) There is no alternate feeding arrangement at Kopargaon and Vaijapur.
ii) Non-receipt of NOC for outages for shifting of 132 kV Babhaleshwar-Kopargaon-Vaijapur line.
These above mentioned difficulties led to use of Emergency Restoration system (ERS).The ground work started on 02/06/2007 which includes erection of ERS towers, stringing of conductors etc. The line was made through on 13/06/2007 after satisfactory completion of all the works. This helped in avoiding outages needed for 4-5 days to carry out this work which was difficult to obtain as area covered two important talukas of different districts in Maharashtra. Details of works involved are as shown in Table I.

TABLE I

Sr. No.	Date of	Time from	Time To	Remarks
1)	Outage 11/06/2007	12:45 pm	23:00 pm	Outage taken for Connecting jumpers to existing line of ERS line
2)	13/06/2007	9:00 am	15:45 pm	Outage taken for disconnecting jumpers to ERS line

I. Hot Line Maintenance:
MSETCL has established Hot Line Maintenance units to carry out works on live system helping in reduction of downtime of a system without availing outages [4]. This section gives brief information about how the hotline maintenance work was carried out by Hot Line unit under the guidance of senior MSETCL, MSPGCL officers. Chandrapur Super Thermal Power Station is the largest Thermal generation station in Maharashtra. It was observed that the conductor strands of twin jumper near two bushing terminal of Generation Transformer of 500 MW Generating unit No. V of Chandrapur T.P.S. were damaged. On 30/01/2008, temperature detected by IR scan was found to be more than 125^0 C at 8:00 Hrs calling need to have immediate maintenance with the outage of Generating unit number-V. In the evening there was emergency withdrawal of Generating unit number-III, which made outage of Unit number-V difficult thing leaving with the only alternative to go for Hotline maintenance. Hotline maintenance on 400kV Generating Transformer of 500 MW set probably was the first of its kind in India.
After inspecting the work spot, work was started on 31/01/2008 afternoon. Fig.1 shows damaged jumpers being repaired by Hotline unit. Bypass arrangement with flexible copper link was provided from bushing terminal clamp rod to the twin jumpers for both the individual bushings. This resulted in reduction of temperature from 125^0 C to 40^0 C. The dislocated strands of the conductors were repaired by using Hotline technique. Fig.2 shows repaired jumper after Hotline work.

Fig.1: Damaged jumpers being repaired by Hotline unit

Fig.2: Repaired jumper after hotline work

Completion of this work resulted in avoiding 7-8 hours of outage on 500 MW Unit number-V, saving a loss of generation of about 4MUs without disturbing the system. This is one of the excellent example of how proper co-ordination between various utilities can be productive in handling emergency situations.

J. Implementation of Advanced SCADA and RTU system:

As per section 32 of Indian Electricity act 2003, State Load Despatch Centre (SLDC) is the apex body in the state for monitoring and control of grid operation in the state. Maharashtra is having one State Load Despatch Centre (SLDC) at Kalwa and one Area Load dispatch Centre (ALDC) at Ambazari. As power sector is going through the transition with regulatory rules requiring flexible functionalities as per the changes in the energy sector in India and for adoption of best suitable practices in advanced countries, it is very much essential to have efficient Energy Control Centre with state of the art technology meeting current demand of ABT, Open Access as well as that of future power exchanges. Keeping this in mind, MSETCL has taken an initiative to implement advanced SCADA and EMS system [5]. Fig.3 shows Modified Arrangement of Control Centre at SLDC Kalwa after the implementation of this system.

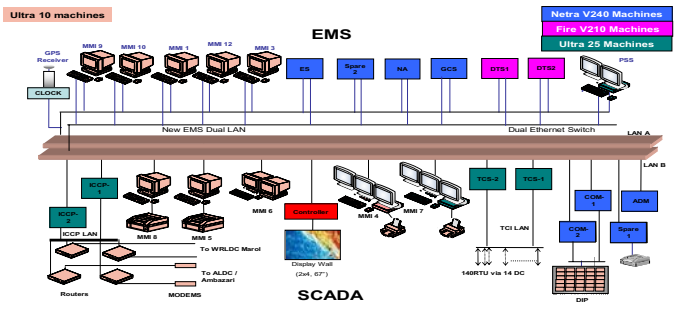

Fig.3: Modified Arrangement of Control Centre At SLDC Kalwa

It consists of upgradation of existing hardware as well as related software system.
Hardware system upgradation consists of replacement of following

i) 14 number of machines, being used for EMS
ii) 4 Nos. SCADA servers with new SUN Netra V240 servers and replacing the Front end servers with Ultra 25.

Apart from this following activities shall be carried out

i) Two new Ultra 25 machines will be used as Power System Simulator (PSS) with one Man Machine Interface (MMI) at control centre.
ii) Six numbers of Ultra 10 machines of SCADA will be used as MMIs
iii) Installation and commissioning of BARCO Display Wall (2x4, 67") with controller.

Software system upgradation has following features:

i) It is based on telemetry protocol – IEC 104
ii) Oracle- based RDBMS database allowing standard SQL query language
iii) Object oriented and context sensitive operator dialogue via dynamic toolbar
iv)Powerful navigation between summary & single line diagrams allowing fast access to fault areas
v) Capability of taking over of operational management by other control centers in the case of emergencies like major grid disturbances or natural calamity.

Fig.4 shows proposed configuration of RTU's in MSETCL system. Scalabe RTUs like SICAM-1703, based on international standards like 60870-5-101,102,103, 104 and following IEC-61850 protocol are used.

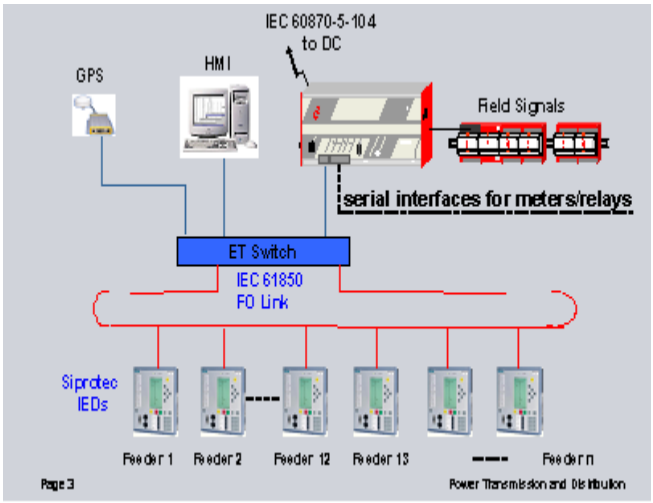

Fig.4: MSETCL - RTU Configuration

Fig.5 shows MSETCL's revamped telemetry network with location of Data Concentrators (DCs).Similarly required modifications are proposed at Area Load Dispatch Centre (ALDC) Ambazari, to carry out day to day functions as well as to takeover operations of SLDC in case of emergency.

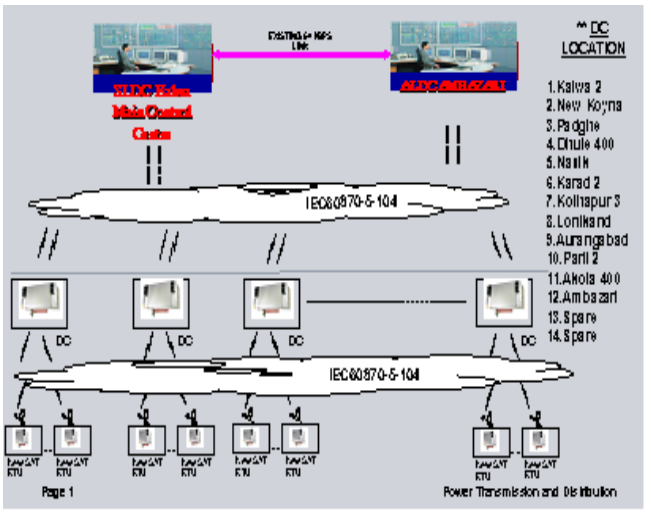

Fig.5: MSETCL - Revamped Telemetry Network

IV. Conclusion

The efforts taken by MSETCL in modernising and upgrading existing system has resulted in improved performance with respect to minimising downtime of a system resulting in improved availability, reduced interruptions and more insight on reasons of occurrences and remedies thereon.

V. Acknowledgment

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VI. References

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VII. Biographies

Jaolikar S.A He graduated from Nagpur University in the year 1975.He joined Maharashtra State Electricity Board (MSEB) in the year 1976 as a Trainee Engineer and working in Maharashtra State Electricity Transmission Company Ltd .(MSETCL) after restructuring of erstwhile MSEB. He is associated with Chandrapur-Paghe HVDC project since early stage. His special fields of interest include Operation and Maintenance of HVDC terminal station, Extra High Voltage Transmission (EHV) testing.

Rajurkar S.S. He graduated from Nagpur University in the year 1982.He also obtained M.Tech. (Electrical) degree from Nagpur University in the year 1984.He joined Maharashtra State Electricity Board (MSEB) in the year 1984 and working in Maharashtra State Electricity Transmission Company Ltd (MSETCL) after restructuring of erstwhile MSEB. He is associated with 400kV and HVDC system planning, Operation and maintenance work for the same. He is presently working in Transmission O&M department at Corporate Office of MSETCL in Mumbai. His special fields of interest include power system protection, power system stability, HVDC applications.

Kulkarni A.R. He graduated from Shivaji University Kolhapur in the year 1999. He also obtained M.E. (Power System) from Pune University in 2004 and worked in project on power system stability at Electrical Engineering Department at IIT Bombay.He has both Industry as well as Academic experience. He joined Maharashtra State Electricity Transmission Company Ltd (MSETCL) in 2006.He is presently working in the office of Executive Director (Projects) at Corporate Office of MSETCL in Mumbai. His special fields of interest include power system stability, power system operation and control, power system protection and FACTS.