

INDUCTION OF NEW TECHNOLOGIES IN TRANSMISSION/SUBSTATION

1. Flexible AC Transmission System (FACTS)

Flexible AC Transmission Systems (FACTS) technology is an evolving technology based solution for power transmission at small additional investment with a short gestation period. The IEEE has defined FACTS as "Alternating Current Transmission Systems incorporating power electronics based and other static controllers to enhance controllability and increase power transfer capability". Thus FACTS increases the flexibility of power systems, makes them more controllable and allows increased utilization of existing network closer to its thermal loading capacity without jeopardizing the stability. FACTS technology can boost power transfer capability in stability limited systems by 20 - 30 %. By this process not only is there increase in capacity but also cost savings in design and installation.

It provides increased stability, improved voltage regulation, reactive power balance and also improves load sharing between parallel AC transmission lines. The other advantages include damping of inter-area oscillations and mitigation of sub-synchronous resonance. This technology regulates the reactance of a line or voltages at both line ends or angle difference between the line ends or any combination of the three parameters by fast acting switches.

A FACTS Project under R&D, which envisages installation of Fixed Series Capacitor and Thyristor Controlled Series Compensation, has been taken up at Ballabgarh end of the 400 kV Kanpur- Ballabgarh S/C line of Power Grid. The project has been executed in two phases. Phase-I covers design, development, supply, erection and commissioning of the fixed part of series capacitor bank of 35%. Phase-I was commissioned in April 2002 and has been performing satisfactorily and with this there is increase of about 120 MW in power carrying capacity of the line. Phase-II, which covers design, development, supply, erection and commissioning of Thyristor Controlled Series Compensator with range of 8 to 20% has been commissioned and charged successfully on 29th November 2004.

2. National High Voltage Direct Current (NHVDC) Project

The first stage of NHVDC project between Lower Sileru (AP) and Barsoor (MP) was commissioned in October 1989 with total indigenous know-how. The second stage of uprating the link to 200 MW at 200 kV was approved in September 1993 at a cost of Rs. 105.00 crores (since revised to Rs. 95.41 crores). The same was completed in August 2000. Successful power flow was achieved between Lower Sileru & Barsoor at full rated voltage of 200 kV DC. Much of its future operation on continuous basis, however, will depend upon long term commercial agreement between the two participating states Chattisgarh and Andhra Pradesh.

The third stage envisages addition of another pole to convert the monopole DC system to a bipole operation with a voltage level of 200 kV DC and power transfer level of 400 MW.

3. Standardisation of 800 kV and 400 kV Transmission Systems

Standardization of the parameters and specifications of major items of 400 kV and 800 kV substation equipment and transmission line materials was carried out by CEA. The standing EHV committee has been revived to review the standardization of the parameters and specifications in respect of 400 kV & 800 kV transmission line and major substation equipment. Revision I of Report on 800 kV Sub-Station and Transmission Line material was issued in December 2002.

4. Technology Improvement Programme in Power systems

A Technology Improvement Programme in Power Systems was conducted by CEA at various places in USA and Canada . M/s Harza Engineering Inc., Chicago, were the consultants for the above programme. CEA Engineers gained the knowledge/know-how on the following topics:

- Residual Life Assessment of Sub-Stations and Transmission Lines
- Upgradation of Sub-Stations and Transmission Lines
- Polymer Insulators
- Design of Transmission Lines in snow bound areas
- Application Software for Computer Aided Design of EHV Sub-Stations
- FACTS and FACTS like devices (multi-terminal HVDC)
- High phase order Transmission

5. Software Packages available with CEA to deal with Sub-station and Transmission system design

a) PLS- CADD software package of M/S Power Line Systems Inc., Madison , USA

Power Line Systems Computer Aided Design & Drafting (PLS-CADD) software package is capable of integrating all aspects of transmission line design including terrain modeling, route selection and automatic minimum cost spotting, sag-tension, clearance and strengths, material list, general plan/profile drafting for new lines as well as existing lines to be upgraded.

b) i-TOWER software package of M/S IMI Softwares, Hyderabad , India

i-Tower software package is capable of designing steel lattice structures like transmission towers/microwave towers including design of foundation for various loading combinations .

c) CDEGS software of M/S Safe Engineering Services & Technology Ltd., Canada

Current Distribution, Electromagnetic interference, Grounding and Soil analysis (CDEGS) software package consisting of 8 modules, RESAP, MALT, MALTZ, TRALIN, SPLITS, FCDIST, HIFREQ AND FFTSES, has the capabilities of carrying out various design computations associated with EHV transmission lines and substations (including design of earth mat for substations using multi layer soil model, computation of magnetic/electric field in the air and earth being generated by buried and above ground current carrying conductor etc.)

d) PSCAD / EMTDC

PSCAD / EMTDC is a simulator of High Voltage AC and DC transmission, electronic circuits of low voltage power electronics system and Flexible AC Transmission Systems (FACTS) and complex controllers. Some of the studies that can be conducted with PSCAD / EMTDC are AC networks consisting of rotating machines, exciters, governors, turbines, transformers, transmission lines, cables and loads, Insulation Co-ordination of AC and DC equipment, Designing power electronic systems and controls, Sub-synchronous resonance studies, Evaluation of filter design and harmonic analysis, Control system design and co-ordination of FACTS and HVDC including STATCOM, VSC and Cyclo-converters, Optimal design of controller parameters, Power Quality analysis and improvement, Variable speed drives, their design and control.

e) **Software from M/S ASPEN**

It has three modules. ASPEN One liner is a Short circuit and relay co-ordination programme. ASPEN Line Constant Programme computes the electrical parameters of overhead transmission lines and the underground cables. Breaker Rating module is a tool designed for checking the rating of circuit breakers against the short circuit currents they need to interrupt.

f) **CYMCAP from M/S CYME**

CYMCAP is used for ampacity calculations for cables at all alternating voltages and direct voltages upto 5 kV. It performs the Steady State thermal analysis for calculations of ampacities and/or temperature rise when cable currents are not a function of time. It also performs the transient analysis for calculations where the cable loading is a function of time and/ or transient conditions are sought.

e) **iSWITCHYARD software of IMI Softwares , Hyderabad**

iSWITCHYARD software is capable of doing design of switchyard and Sub-Station structures using stiffness matrix analysis and calculating the member sizes based upon various Indian and International codes.

6. **R&D Projects**

CEA has been involved in the R&D initiative launched by Ministry of Power under "National Perspective Plan of R&D". R&D projects in the following areas under Transmission have been identified and the project reports are being finalized.

- Power System Stability
 - Load Modelling and Assessment of its Aggregated Behaviour for Stability Studies.
 - Power System Controllers- Flexible AC Transmission System (FACTS) & Power System Stabilizers (PSS)
 - Wide Area Measurement for Protection and Control

- To develop a prototype of 132 kV Optical Current Transformer for the use in the 132 kV system.