Large Scale Implementation of Control Switching Devices in Indian Power System- A Case Study

N S Sodha
Consultant & Advisor
Power- T&D, Smart Grids
Former Executive Director, POWERGRID
Email- nss5419@gmail.com
Mobile: +919717890988
Why Controlled Switching?

- **Controlled Switching**
  The principle of co-ordinating the instant of opening or closing of a circuit with a specific target point on an associated voltage or current waveform is called “Controlled switching”.

- **Uncontrolled Switching**
  When an Uncontrolled/Random switching is done it causes Re-strikes, Re-ignitions during opening operation in Shunt reactors

- **Uncontrolled Switching**
  High inrush currents during closing operation in Power Transformers & Reactors

- **Other common terminologies applied are**
  “Synchronized Switching” & “Point-on-Wave Switching”.
Additional capability added to a standard circuit breaker
Operate the circuit breaker at a precise electrical moment

Target angle
WHY USING CONTROLLED SWITCHING?

- Improvements of:
  - the **power network stability**
  - the **reliability of the service** supplied to customers
  - the **power quality** delivered to the customers

- Reductions of:
  - electrical **switching transients**
  - equipment **failures**
  - **maintenance costs** on the apparatus
  - **capitalization**: lower investments
HOW DOES IT IMPROVE THE SITUATION?

- Controls the exact moment the circuit breaker is operated:
  - Reduces inrush currents
  - Eliminates the high voltage switching transients
- Eliminates pre-insertion resistors:
  - Reduce the circuit breaker maintenance costs
  - Improve the circuit breaker reliability
- Provides extended circuit breaker monitoring:
  - Detection of C/B degradation of performance
  - Detection of mechanical/electrical problems

The circuit breaker becomes a smart device!
HOW DOES IT WORK: BALL SHOOTING STAND!

INTELLIGENT SYSTEMS FOR THE SMART GRID.
Synchronization of the mechanical operation of the circuit breaker to the source voltage or current

1- Command is received
2- Command is synchronized
3- Command is executed
4- The target point is reached
Using patented operating algorithms, the unit automatically adjusts C/B operations according to the supply voltage, air temperature, pressure of the drive mechanism and so on.

It not only controls C/B switching; it also monitors and reports C/B performance, and...
Power Transformer Application

- 765/400 kV 500MVA Auto transformer bank at PGCIL, Tamnar Substation, India
Power Transformer Application

- CSD installed in the C&R panel of the Autotransformer
Power Transformer Application

- Waveform recorded for uncontrolled switching. In rush Current 2954 A.
Power Transformer Application

- Waveform recorded with Controlled Switching. Inrush current is 7.08 A, Reduction 0.2 %
Controlled conduction by arc

Dielectric strength/CB contacts gap
NOT CLOSING AT PEAK VOLTAGE

INTELLIGENT SYSTEMS FOR THE SMART GRID.
SHUNT REACTOR CONTROLLED OPENING

Conduction by arc

INTELLIGENT SYSTEMS FOR THE SMART GRID.
Phase A current zero crossing

Dielectric strength/CB contacts gap must be high enough at current zero crossing

Arc time should be around 135°

Target relative to phase A
No current flowing allowed beyond this vertical bar

INTELLIGENT SYSTEMS FOR THE SMART GRID.
Dielectric strength/ CB contacts gap not high enough at current zero crossing.

Current flowing by arc: energy dissipated in the CB!
Shunt Reactor Application

- 50 MVAr Line reactor at 400kV PGCIL Maithon substation
Shunt Reactor Application

- CSD Installed in C& R Panel of the Mejia-1 Line reactor
Shunt Reactor Application

- Closing waveform uncontrolled switching
- Symmetrical Current is 895 A
Shunt Reactor Application

- Closing waveform with controlled switching
- Symmetrical Current 87 A.
Shunt Reactor Application

Re-ignition during uncontrolled opening.
Shunt Reactor Application

- Open waveform without re-ignition by controlled switching
SYNCHROTEQ/SYNCHROTEQ PLUS

- **FIELD PROVEN** technology
- C/B Manufacturer **AGNOSTIC** solution
- Applicable to either **NEW** or **EXISTING** circuit breakers
- Controlled switching system & **CB MONITORING**
- One system for all C/Bs + one common interface = **LESS TRAINING**
- IEC 60870, IEC 61850, MODBUS & DNP3 compatible
Achievements

Till date more than 450+ Controlled Switching Devices have been successfully installed & Commissioned in India with Power Grid Corporation of India Ltd. being major Power Utility (400+ CSDs)

& other customers being EHV Circuit Breaker OEMs like

• Alstom T&D
• Siemens Ltd.
• CG Global
THANK YOU FOR YOUR KIND ATTENTION
PLEASE

INTELLIGENT SYSTEMS FOR THE SMART GRID

Transmission Networks
- Increase network stability & reliability
- Eliminate disturbances on Power lines
- Control & monitoring of HV equipment

Substation Automation
- Secure and interoperable solutions
- From legacy level to full DNP3/IEC 61850
- IEC 61850-9-2/8-1 Merging Units

Renewable Production
- Connect & control more sites
- Seamless power interconnection
- Remain grid code compliant

Distribution Automation
- Smarter and self-healing grids
- New operational practices
- Decentralized intelligence

Co-authors;
Sanjay Kulkarni, CMD, SCOPE T & M,
Yash Kulkarni, Business Development Manager, SCOPE T&M