

SAARC Training Workshop 'Power System Studies for Synchronization of Multiple Systems'

Synchronization of Multiple Systems

Day-1-B

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Multiple Systems in SAARC Countries

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- **Internal Asynchronous Multiple Systems in some countries**
 - **Afghanistan**
 - Kabul and surrounding network (local generation)
 - Kandahar and Hilmand system (local generation)
 - Herat (Import from Iran)
 - Balkh and Jowzjan (Import from Uzbekistan and Turkemanistan)
 - Qunduz (Import from Tajikistan)
 - **Bhutan**
 - Thimphu and surrounding (local generation)
 - Chhukha and surrounding network (import from India)
 - Trongsa, Mongar and surrounding network (import from India)
 - **Nepal**
 - Internally synchronised from Mahendranagar to Anarmani with importing interties from India at many places

Multiple Systems in SAARC Countries (contd.)

Internally Synchronised Multiple Systems at SAARC Level

- **Bangladesh:** with import of 500-1000 MW power from India through back-to-back HVDC (Bheramara-Behrampur intertie with BB station at Bheramara)
- **Pakistan:** with little import from Iran for feeding gawadar-Pasni Isolated system
- **Sri-Lanka: Externally isolated**
- **Maldives: Externally isolated**
- **India:** Exporting power to Bangladesh (HVDC-BB)
Exporting to Nepal and Bhutan radially (internally asynchronous)

Internal Synchronization of Multiple Systems

- **With no power import**
 - Interconnect through HVAC network of 220/230 kV and or 400 kV
 - Independent power dispatch control
- **With power import**
 - Interconnect through HVAC network of 220/230 kV and or 400 kV
 - Coordinated power dispatch control to maintain contracted power flow on interties
 - Interconnection through HVDC BB or Tie-Line
 - Limited coordination of power dispatch control

Necessary Analyses For Synchronisation Studies

1. Steady State Conditions

- Load Flow Analysis to evaluate power flows on lines and transformers, voltage profile, angular displacement under different operating conditions such as peak and off-peak, seasonal variations on power dispatch etc.
- Contingency/Reliability Analysis to evaluate same variables under contingency conditions i.e. N-1 or N-2 depending on reliability criteria

2. Short Circuit Conditions

- Short Circuit Analysis to evaluate fault currents
- Determine short circuit ratings of switchgear and other equipment

Necessary Analyses For Synchronisation Studies

3. Systems under disturbed conditions

- Transient Stability Analysis to see if the system stay in synchronism under fault conditions (transient or permanent faults)
 - Angular Stability
 - Frequency Recovery (both after under/over frequency due to trip of generator or a line/transformer)
- Voltage Stability Analysis to see if the system stay voltage-stable or undergoes voltage collapse
- Small Signal Stability Analysis to see any inter-area oscillatory modes exist
- Transient/Switching Studies to see the transient over-voltages, transient recovery-voltages, surge and traveling waves (Electromagnetic Transients) etc.

Analytical Tools/Software

- **For Load Flow, Short Circuit and Stability Analysis:**

- PSS/E of Siemens-PTI
- DigSilent
- CYME
- ETAP
- Eurostag
- IPSA
- EDSA

- **For Transient/Switching Studies (Electromagnetic Transient Program, EMTP)**

- PSCAD/EMTDC of Manitoba HVDC Research Centre
- ATP/EMTP
- RTDS/RSCAD

Scope of Present Workshop

- Basic training of analytical tools using PSS/E software:
 - Basic Load Flow
 - Basic Short Circuit Analysis
 - Basic Transient Stability Analysis
- Case Study of generic model of an internally asynchronous multiple systems (e.g. Afghanistan, Bhutan, Nepal)
- Case Study of generic model of internally synchronous but externally asynchronous multiple systems at SAARC level (e.g. Pakistan, India, Bangladesh, Sri Lanka)