Power System Security Concepts

EE 521 Analysis of Power Systems

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Reliability Definitions (NERC)

**Reliability** — The degree of performance of the elements of the bulk electric system that results in electricity being delivered to customers within accepted standards and in the amount desired. Reliability may be measured by the frequency, duration, and magnitude of adverse effects on the electric supply. Electric system reliability can be addressed by considering two basic and functional aspects of the electric system — Adequacy and Security.

**Adequacy** — The ability of the electric system to supply the aggregate electrical demand and energy requirements of the customers at all times, taking into account scheduled and reasonably expected unscheduled outages of system elements.

**Security** — The ability of the electric system to withstand sudden disturbances such as electric short circuits or unanticipated loss of system elements.
System Security

• The ability of a power system in normal operation to undergo a *likely* disturbance without entering an emergency or a restorative state.

• The objective of security control is to keep the power system in the normal state.
Power System Constraints

• Dy Liacco framework considers the power system as being operated under two types of constraints:

• *Load* constraints - Demands must be met by the system.

• *Operating* constraints - Maximal and minimal operating limits, steady-state and stability limitations.
System Operating States

• *Normal* - Load and operating constraints satisfied
• *Emergency* - Operating constraints not completely satisfied.
• *Restorative* - Load constraints not completely satisfied.
Security Assessment / Control

- Secure
- Insecure

Normal
Preventive Control
Restorative Control

Emergency Control

Emergency
Restorative
Security Assessment

• The operating state of a power system is **SECURE** if no disturbance in the next contingency list leads to an emergency operating condition and is **INSECURE** otherwise.

• Needs a list of ‘next contingencies’
• N-1 or N-2 security criteria
Security Assessment and Control

- Security monitoring - limit checking
- Security analysis - contingency evaluation
- Preventive control - how sure, impact?
- Emergency control
- Fault diagnosis
- Restorative control
Security Related Software

- State estimation
- Security monitoring
- Network topology
- ‘External’ system equivalent model
- On-line power flow
- Optimal power flow (OPF)
- Contingency evaluation
Alarm Processing

yes

Security analysis
Energy transactions

Preventive controls
Maintenance actions

no

Fault diagnosis

Remedial controls
Restorative actions

Normal?
NERC: Available Transfer Capability (ATC)