California ISO

MRTU

Operating Constraints

CRR Educational Class #4

CAISO Market Operations

Why Are the Operating Constraints Important to Understand

- Operating constraints limit the amount of power that can flow over a given branch or set of branches
- These constraints may limit the amount of CRRs that can be allocated

Course Objectives

- Upon completion of this course, you will be able to:
  - Understand the characteristics of operating constraints
  - Understand the possible modifications to operating constrains so they can be applied within the CRR allocation

Contents

- What are operating constraints
- Types of operating constraints
- Example
- Operating constraints in the DC network model

What are Operating Constraints

- Operating constraints are limits/bounds of system operation where the system meets reliability and security criteria
- Criteria prescribed by various entities
  - NERC
  - WECC
  - ISO
  - PTO's

Why have Operating Constraints

- Prevents certain events that could lead to partial area blackouts
- Prevents cascading (chain reaction or domino effect) events that could lead to total area blackouts
- Prevents damage to power system equipment

Operating Constraints Criteria

- WECC's The Minimum Operating Reliability Criteria and other guidelines as prescribed by various entities (ISO, PTOs, NERC, ...)
- The Power System must
  - Remain within normal ratings and voltage ranges for all lines in service
  - Remain within emergency limits for outages of elements (contingency analysis)
  - Maintain frequency within specified ranges
    - Frequency deviations
    - Synchronous stability
  - Maintain voltages within specified ranges
  - Others

Development of Operating Constraints

- Generally, the development of Operating Constraints is performed in an **off-line** manner through off-line studies
- On-line, e.g., in real-time, is difficult to perform do to time limitations
- For example, in the IFM and real-time, analysis could be performed on-line to determine operating criteria, but such analysis as Transient Stability, Voltage Stability, along with the use of Remedial Action Schemes or Special Protection Schemes may take too much time, however, some of this analysis may be performed in the EMS in real-time
- Contingency analysis that only considers thermal branch/transformer limits can be performed on-line
- Generally, operating criteria that is in place to prevent transient stability and voltage stability problems are developed off-line and the resulting operating criteria are put into operating procedures

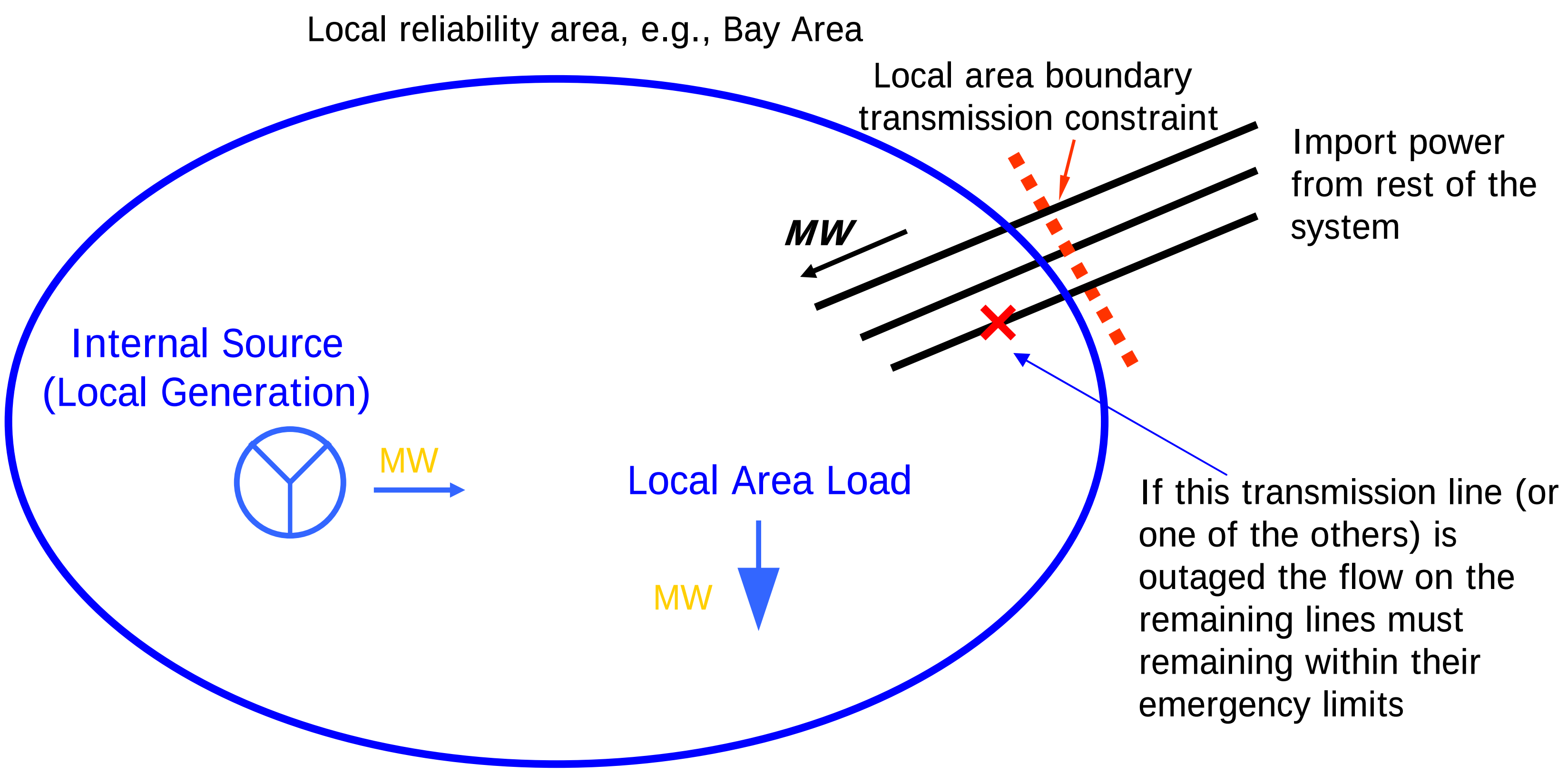
Types of Operating Constraints

- The operating constraint limits are expressed as one of the following
  - Flow limits for lines/branch groups
    - Path Flow/Area Import limit of a certain level of MW
  - Voltage schedules
    - Voltage at a substation to remain within a specified kV range
  - Nomograms
    - Functional relationship of various system parameters, e.g.,
      - X MW Gen. required for Y MW Area Load (e.g., SF nomogram)
      - May also include generation inertia in a nomogram

Example of a Local Area Operating Constraint

- Local area has limited generation
- Must import power from rest of the system over an interface
- The constraint limit (active power limit) imposed on the import interface satisfies security criteria
  - With a loss of one of the lines that is importing power
  - Remaining lines must be within emergency thermal ratings
  - This is a thermal/amperage based limitations
  - This is a classical contingency analysis problem, but an operating procedure can be developed for it and the operating procedure will dictate before hand the limit off power that can flow over the interface

Example: Local Area Operating Constraint



Operating Constraints in the DC Model

- The operating constraints used by the CAISO are based on an AC network model
- The AC model includes such items as
  - Variables voltages
  - Reactive power (MVAR)
  - Active (MW)
  - Transmission losses
  - Generation, import, export and load schedules
  - Generation inertia
- A DC model is used in the CRR allocation
- The DC model assumes
  - Constant voltages
  - No reactive load power modeling
  - Can only calculate active power flow on lines or interfaces
  - No Losses
  - No Generation, import, export and load schedules, but instead CRR Sources and Sinks
  - No generation inertia

Operating Constraints in the DC Model

- Cannot explicitly model any constraints associated with
  - Voltage levels
  - Reactive power
  - Inertia levels
- Can model limits associated with
  - thermal limits (active power)
  - interface limits (active power) that prevent thermal overloads
  - Other interface flow limits (active power) that prevent voltages or frequency deviations
- Need to create active power flow limits for those other limits that cannot be explicitly modeled (voltage, reactive power and inertia)
- Can model thermal limits in the contingency analysis
  - That is, can perform thermal limit based contingency analysis

Operating Constraints in the DC Model

- Consider the lack of Reactive Power modeling in the DC FNM
  - The constraints developed using an AC network model have reactive load and other reactive components modeled
  - The DC model does not include reactive load modeling and only models the active power flow
  - The active power flow constraints may need to be ***scaled downward*** to take into account this absence of reactive load modeling
  - If not, flows allowed in the DC model may not be feasible in the AC network

Any Questions?