Attachment I
Reliability Criteria For Transmission System Planning

RELIABILITY CRITERIA FOR TRANSMISSION SYSTEM PLANNING

Sacramento Municipal Utility District

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The attached criteria is to be used by the Transmission Planning Area from this date forward until revised. The use of this criteria will be for planning purposes on the District's internal transmission system. Joint projects and projects within other utilities system's will be planned consistently with the owner system's criteria.

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1 INTRODUCTION

1.1 Purpose of Criteria

The mission of SMUD's Transmission Planning Area is to:

1) Formulate plans and make recommendations to management for the installation of transmission facilities to meet electric power needs in a reliable, efficient, environmentally sound, and economic manner.

2) Work closely with Engineering, Contracts, and Operations to assure the successful implementation, including licensing, of transmission plans.

and, 3) Work closely with neighboring utilities to coordinate the development of the SMUD, WAPA, and PG&E transmission systems.

A basic step necessary to accomplish this mission, is to establish a standard of reliability for SMUD's transmission system. The transmission system planning criteria provide this standard of reliability.

1.2 Objective of Criteria

Continuity of quality service to the customer is the primary objective of the criteria. The primary constraint on this objective is the cost of providing this service. Cost-effectiveness is viewed from the perspective of the electricity consumer. The system is planned to have sufficient strength or capacity to maintain continuity and quality of service to electrical loads during certain more common contingencies or system disturbances. For other less common contingencies, it may not be economical to provide enough capacity to maintain full service, so interruption of service or some reduction of quality of service may be allowed in the planning arena. The criteria is intended to provide margin in the transmission system to allow for unforeseen system conditions which may exist during actual system operation. Operating actions are not normally allowed as a means of achieving the performance levels required by the criteria.

1.3 Single System Planning

The transmission system is to be planned as if all generation and transmission facilities were owned by a single entity to minimize duplication of facilities, costs, environmental impact, and maximize system efficiency. Adjustments to this basic plan shall be made based upon financial, contractual, political, and institutional concerns.

1.4 Description of Criteria

The Reliability Criteria for Transmission System Planning set the performance requirements for planning the SMUD system. The performance requirements are given in terms of the effects that are allowed on electrical loads and the transmission system as a result of various contingencies. The Criteria are deterministic, that is, the same generalized performance is specified for the same generalized types of contingencies and applied uniformly over the system. Application of the criteria is expected to provide overall system cost-effectiveness. These criteria are used exclusively for system planning. A separate set of criteria apply to actual system operation.

1.5 WSCC Criteria

Criteria adopted by the Western Systems Coordinating Council (WSCC), "Reliability Criteria for System Design", set the limits of the effects that disturbances on one system can have on other systems. The SMUD system is planned to satisfy both the SMUD and WSCC criteria.

1.6 Application of Criteria

The criteria set minimum performance requirements. They are intended to provide firm guidance but not absolute standards for planning. Application of the criteria must be tempered by the judgment of experienced planners and the circumstances that apply in each specific situation. Where the planner deviates outside the criteria, those deviations shall be explicitly noted and justified.

2 DEFINITIONS

2.1 Transmission System

The transmission lines and related substations that carry bulk power to distribution facilities. The transmission system provides the primary connections among major load areas, large generating plants, major interties, and some intermediate load areas. The transmission system includes all 500 kV, 230 kV, and 115 kV lines, and those lower voltage lines that perform the transmission function such as the 69 kV transmission lines in the UARP. Those portions of substations, including transformers, supporting the transmission system are also included.

2.2 Region

A portion of the WSCC system, such as Northern California or the Northwest that operates as an interchange area.

2.3 Intertie

A line or lines and related substations that provide an interconnection between regions.

2.4 Point of Delivery or Receipt

Point, for contractual and accounting purposes, at which utility systems are connected with the primary purpose of one-way power delivery.

2.5 Point of Interconnection

Point at which utility systems are connected at which power can flow in either direction for power delivery, resource integration, and system reliability improvement.

2.6 Major Load Area

A major population or industrial center with a large load and strong integrating transmission facilities.

2.7 Inadvertent Interchange

The net actual interchange minus the net scheduled interchange for a specific time period.

2.8 Inadvertent Flow

Power flows resulting from inadvertent interchange.

2.9 Loop Flow

The difference between the scheduled and actual power flow, assuming zero inadvertent interchange, on an interconnection between control areas. Also called parallel flow.

2.10 Remedial Actions

Special preplanned corrective measures which are initiated following a disturbance to provide for acceptable system performance. These actions can either be manual or automatic. Typical automatic remedial actions include generator tripping or equivalent reduction of energy input to the system, controlled tripping of interruptable load, DC line ramping, insertion of braking resistors, insertion of series capacitors and controlled opening of interconnections and/or other lines including system islanding. Typical manual remedial actions include manual tripping of load, tripping of generation, etc.

2.11 Remedial Action Scheme

A protective system which automatically initiates one or more remedial actions. Also called Special Protection System or Remedial Action System.

2.12 Interregional Separation

Separation of a region from the rest of the interconnected system.

2.13 Area Separations

Disconnection of a load area by protective relay or operator actions. All or part of the disconnected area may be blacked out.

2.14 Contingency

Automatic disconnection (momentary or permanent) or emergency manual disconnection of a transmission facility, load, or generator.

2.15 Cascading

The uncontrolled successive loss of system elements in which the loss of each successive element is contingent upon prior losses of elements.

2.16 Control Area

A system capable of regulating its generation to maintain its interchange schedule with other systems and contribute its frequency bias obligation to the interconnection.

2.17 Operational Transfer Capability

The rated transfer capability less reductions caused by, but not limited to, physical limitations as a result of, among other things, line or equipment outages, stability limits, or loop flow.

2.18 Rated Transfer Capability

The maximum capability of a transmission line or system to transfer electric power in a reliable and safe manner as mutually determined and consistent with safe utility practice.

2.19 Single Contingency Rating

The capability, determined in accordance with WSCC criteria and as mutually agreed by the parties, of a transmission line or system to transfer a specified amount of electric power in a direction, with all major facilities initially in-service, such that following loss of any one major facility, the transfers may be continued in a reliable and safe manner while allowing the operators sufficient time to adjust the system to prepare for a further contingency.

3 ASSUMPTIONS

3.1 Loads

The load forecast and load allocation used should be the most recent versions provided in the Transmission Planning Handbook.

3.2 Generation

The base case generation schedules modeled shall be consistent with the most recent official generation schedule provided in the Transmission Planning Handbook.

3.3 Equipment Ratings

Lines, transformers, switchgear, and terminal equipment shall not be loaded so as to exceed limits established by the Electric System Design Department. These ratings, along with ratings for neighboring systems, are provided in the Transmission Planning Handbook.

3.4 Bus Arrangements

A variety of bus arrangements of varying costs are possible for any substation (main and transfer, ring, breaker and one half, etc.). It is necessary to coordinate with the Electric System Design Department and the Energy Operations Department to select an optimum bus arrangement. Transmission Planning's responsibility is to assess the transmission system reliability requirements of the bus arrangement. Refer to the Transmission Planning Handbook for additional information concerning bus arrangements.

4 SYSTEM TESTS/PERFORMANCE REQUIREMENTS

4.1 Steady-state Voltage Requirements

System voltages shall not be more than 5% above or 5% below nominal voltages (69 kV/115 kV/230 kV). Cases with voltages outside this range shall be investigated to determine if an unacceptable system condition would result such as loss of load or a voltage collapse.

4.1.1 Line Switching to Control Voltages

With normal light loads and average or better hydro conditions, it shall not be necessary to switch lines out of service to keep voltages from exceeding maximum levels.

4.1.2 Capacitor/Reactor Switching Voltage Changes

Voltage changes caused by shunt capacitor or reactor switching shall not exceed 3.0 percent on any bus with all lines in service.

4.1.3 Voltage Regulating Equipment Assumptions

To meet the steady-state voltage requirements, all regulating equipment, including generators, must be operated within limits. An allowance, developed from operating records (generators, capacitors, or reactors) shall be made for that equipment which is typically unavailable because of scheduled or forced outages. Coordinated operation of the northern California reactive and voltage control facilities shall be assumed.

4.2 Steady-state Line Loading Requirements

All transmission facilities shall be loaded within their normal ratings with all facilities in service and within their emergency ratings during contingencies. It may be acceptable for a facility to be loaded above its emergency rating for a short time following a disturbance depending on the type of disturbance as detailed in the Disturbance-Performance table. Any exceptions shall be explicitly noted and justified.

4.3 Voltage Stability

Sufficient reactive capability shall be provided to ensure that voltage collapse would not occur for contingencies as specified in the Disturbance-Performance Table. For the purpose of this criteria, the system will be considered stable if the post outage system operating point is above the nose point of the post outage PV curve. Voltage stability must be maintained for all performance levels in the Disturbance-Performance Table. Refer to the Transmission Planning Handbook for specific guidance on appropriate amounts of reactive margin.

4.4 Transient Stability

System transient stability must be maintained for all performance levels in the Disturbance-Performance Table.

4.4.1 Remedial Actions

Remedial actions other than those involving load dropping may be considered for any contingencies to maintain stability. Remedial actions involving load tripping or shedding may be considered if the requirements for serving load, as specified in the Disturbance-Performance Table, are met. All remedial actions used should be explicitly noted.

4.4.2 Faults

Stability shall be maintained for the following tests:

4.4.2.1 Single Contingencies

A three-phase permanent fault with no reclosure shall be assumed at the line terminals of the power circuit breaker. Stability shall also be tested for a single-phase fault at the line terminal of the power circuit breaker, with unsuccessful reclosure.

4.4.2.2 Multiple Contingencies

For non-simultaneous multiple contingencies, with either a line or a breaker out of service prior to a disturbance, a single-phase fault shall be assumed at the line terminal of the power circuit breaker, with unsuccessful reclosure.

For simultaneous multiple contingencies, such as a stuck breaker or a bus outage, a permanent single-phase fault at the breaker or bus shall be assumed.

4.4.2.3 Clearing Times

Clearing times shall be actual maximum times without added margin. Refer to the Transmission Planning Handbook for the most recent information on clearing times.

4.4.3 Load Models

In cases where specific load characteristics are not known, loads in stability studies shall be represented as P = constant current and Q = constant impedance. Otherwise known load characteristics shall be used. Refer to the Transmission Planning Handbook for specific information on load models.

4.4.4 Generation

Generation shall be represented as operated, with governor droop or blocking as appropriate. PSS shall be assumed in service per WSCC guidelines or as otherwise operated. Refer to the Transmission Planning Handbook for specific information on Generator modeling.

4.4.5 Voltage Swings

System performance shall be unacceptable if the voltage swing exceeds +/- 20% of the initial bus voltage and would cause unacceptable loss of load to the system. Voltage dips concurrent with faults are not to be considered.

4.4.6 Damping

Acceptable system performance requires positive damping of all appropriate machine quantities, bus voltage, frequency, and tie line power.

4.4.7 System Readjustment

For multiple contingencies involving lines, generators, or transformers; sectionalizing the system, reconnecting loads, or adjusting generation to control overloads on transformers or lines are permissible.

No adjustments are allowed for single line or transformer outages. Transformers may not be loaded above emergency limits (except for transient power swings) even to allow time for system adjustments.

4.4.8 Simultaneous Vs. Nonsimultaneous Outages

All multiple contingencies are considered to be independent events except for lines in the same corridor or that connect to a common bus or breaker. Independent contingencies are considered to be non-simultaneous, and 1/2 hour shall be assumed to be available between contingencies for system adjustments. Dependent contingencies shall be assumed to occur simultaneously.

4.5 Exceptions and Special considerations

The combined outage of the Rancho Seco-Hedge and Rancho Seco-Elk Grove 230 kV lines or the Hedge-Rancho Seco and Hedge-Elk Grove 230 kV lines shall be treated as a single circuit outage for the purposes of applying this criteria.

4.6 Disturbance-Performance Table

The Disturbance-Performance Table in the WSCC Criteria specifies the transmission system performance required for the contingencies that are considered generally credible events that merit consideration.