SONGS Interface With the Grid Operator

October 26, 2005

Agenda

- **Introduction**
- SONGS Grid Requirements
- CAISO and SCE Roles and Responsibilities
- SCE Grid Analysis and Operation
- PRA Model/Maintenance Rule Program
  - Break
- NRC Questions

Purpose of Meeting

- Discuss SCE and SONGS Interface with CAISO and SCE Generation Operation Center and Grid Control Center

- Discuss August 25, 2005 Event

Agenda

- Introduction
- **SONGS Grid Requirements**
  - **(Ken Johnson)**
- CAISO and SCE Roles and Responsibilities
- SCE Grid Analysis and Operation
- PRA Model/Maintenance Rule Program
  - Break
- NRC Questions

Implementing the GDC

GDC-17 → UFSAR → TS → CAISO TCA (App E)

The Transmission Control Agreement (TCA) is a FERC approved agreement that the CAISO is committed to fulfill.

GDC-17

...an offsite electric power system...shall...provide **sufficient capacity and capability** to assure that (1) specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded as a result of anticipated operational occurrences and (2) the core is cooled and containment integrity and other vital functions are maintained in the event of postulated accidents.

Electric power from the transmission network to the onsite electric distribution system shall be supplied by **two physically independent circuits** (not necessarily on separate rights of way) designed and located so as to minimize to the extent practical the likelihood of their simultaneous failure under operating and postulated accident and environmental conditions.

emphasis added

GDC-17 (Continued)

Each of these **circuits shall be** designed to be **available in sufficient time following a loss of** all onsite alternating current power supplies and **the other offsite electric power circuit**, to assure that specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded.

Provisions shall be included to **minimize the probability of losing electric power from any of the remaining supplies as a result of**, or coincident with, **the loss of power generated by the nuclear power unit, the loss of power from the transmission network**, or the loss of power from the onsite electric power supplies.

emphasis added

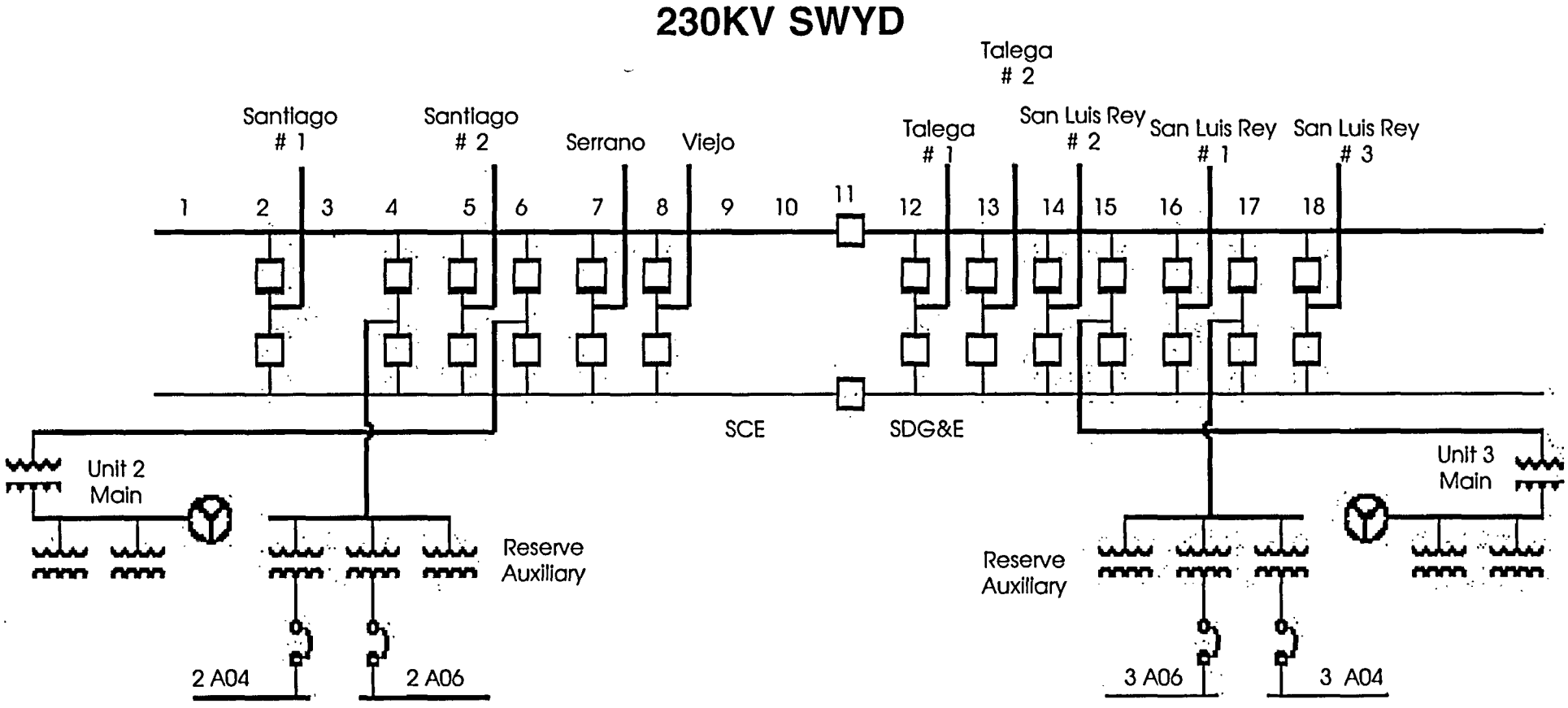
UFSAR

- The maximum sustained voltage fluctuation for the SCE switchyard is within the limits of 218-kV and 238-kV.
- The preferred power sources are two physically and electrically independent 230-kV systems, one SCE and the other the SDG&E system.
- Design provisions, which safeguard against loss of power to the switchyard due to electrical disturbances, are supported by detailed analytical electrical studies
- Loss of the single largest unit on the system will result in a momentary frequency drop of the system of less than 0.2 Hz.

SCE Southern Portion Grid Diagram

Confidential: Subject to FERC Standards of Conduct

SONGS SWYD One Line Diagram



Technical Specification

- Bases 3.8.1 Each offsite circuit must be capable of maintaining rated frequency and voltage, and accepting required loads during an accident, while connected to Class 1E buses.
- LCO. 3.8.1 Two qualified circuits between the offsite transmission network and the onsite Class 1E AC Electrical Power Distribution System (shall be OPERABLE)
- SR 3.8.1.1 Verify correct breaker alignment and power availability for each required offsite circuit.
- SR 3.8.1.8 Verify capability of automatic and manual transfer of AC power sources from the normal offsite circuit to each alternate required offsite circuit
- SR 3.8.1.11 Maintain steady state frequency $\geq$ 59.7 and $\leq$ 61.2 HZ

CAISO
Transmission Control Agreement

- The basic requirement for offsite power supply is that it provide sufficient capacity and capability to safely shut down the reactor and to mitigate certain specified accident scenarios.
- When this condition is met, the offsite power supply system is considered OPERABLE with respect to the SONG Operating License and Technical Specifications.
- It is a necessary condition of the Operating License that the offsite power supply be OPERABLE at all times.

CAISO
Transmission Control Agreement
(continued)

In order for the offsite power supply to be OPERABLE:

- ✓ The SONGS switchyard voltage must stay within the range of 218 to 238kV under all normal and plant accident conditions
- ✓ It is imperative that a unit trip not impair the Operability of the offsite power system.
- ✓ Following a trip of a SONGS unit, the SONGS switchyard voltage must recover and be maintained at or above 218kV within 2.5 seconds following the trip.
- ✓ The SONGS offsite power source shall be capable of providing 158MW and 96 MVAR to SONGS for normal operation and for shutting down the units during plant DBA conditions.
- ✓ A trip of one SONGS unit shall not cause a sustained grid frequency drop below 59.7 Hertz.

CAISO
Transmission Control Agreement
(continued)

System Operating procedures and programs shall be in place to ensure that various system operation conditions, including multiple contingency events, are evaluated and understood, such that impaired or potentially degraded conditions are recognized, assessed and communicated to the SONGS control room.

Agenda

- Introduction
- SONGS Grid Requirements

- **CAISO and SCE Roles and Responsibilities**
  - **(Jim McIntosh)**

- SCE Grid Analysis and Operation
- PRA Model/Maintenance Rule Program
  - Break
- NRC Questions

CAISO and SCE Roles and Responsibilities

- CAISO is the Control Area Operator
  - Responsible for balancing load and generation
  - Inter control area communication
  - Managing transmission system
  - Directing load curtailment if required:
    - to relieve transmission overloads
    - for a generation capacity shortage event

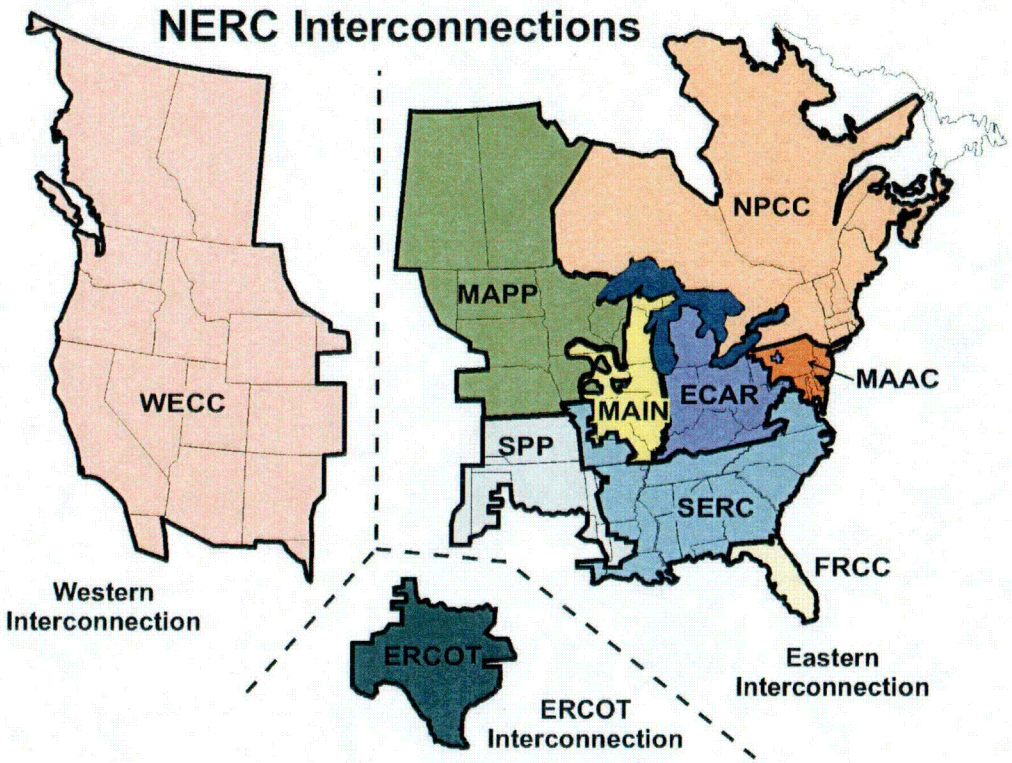
CAISO and SCE Roles and Responsibilities
(continued)

- SCE and SDGE are the Transmission Owners / Operators
  - Responsible for grid construction (additions and modifications)
  - Perform required maintenance
  - Operate all distribution and transmission assets
  - Coordinate transmission operations with the CAISO

- CAISO, SCE and SDGE comply with all applicable NERC/ WECC Planning and Operating Standards and Criteria.

NERC and WECC

- **NERC** – North American Electric Reliability Council
  - Historically a voluntary reliability organization that has developed voluntary reliability standards.
  - Energy legislation directs NERC to develop mandatory reliability standards.
- **WECC** – Western Electric Coordinating Council
  - Regional reliability council representing western US, Canada and Northern Mexico.
  - One of nine councils under NERC.
  - Developed mandatory reliability standards after 1996 Western interuption.
  - Reliability Coordination Centers have been in effect since 1998.



C01

Agenda

- Introduction
- SONGS Grid Requirements
- CAISO and SCE Roles and Responsibilities

- **SCE Grid Analysis and Operation**
  - **(Gary Tarplee)**

- PRA Model/Maintenance Rule Program
  - Break
- NRC Questions

Grid Analysis

- CAISO and SCE participate in reviewing grid limits for intertie lines.
  - System vulnerabilities change between different seasons
  - Results are approved by the WECC.

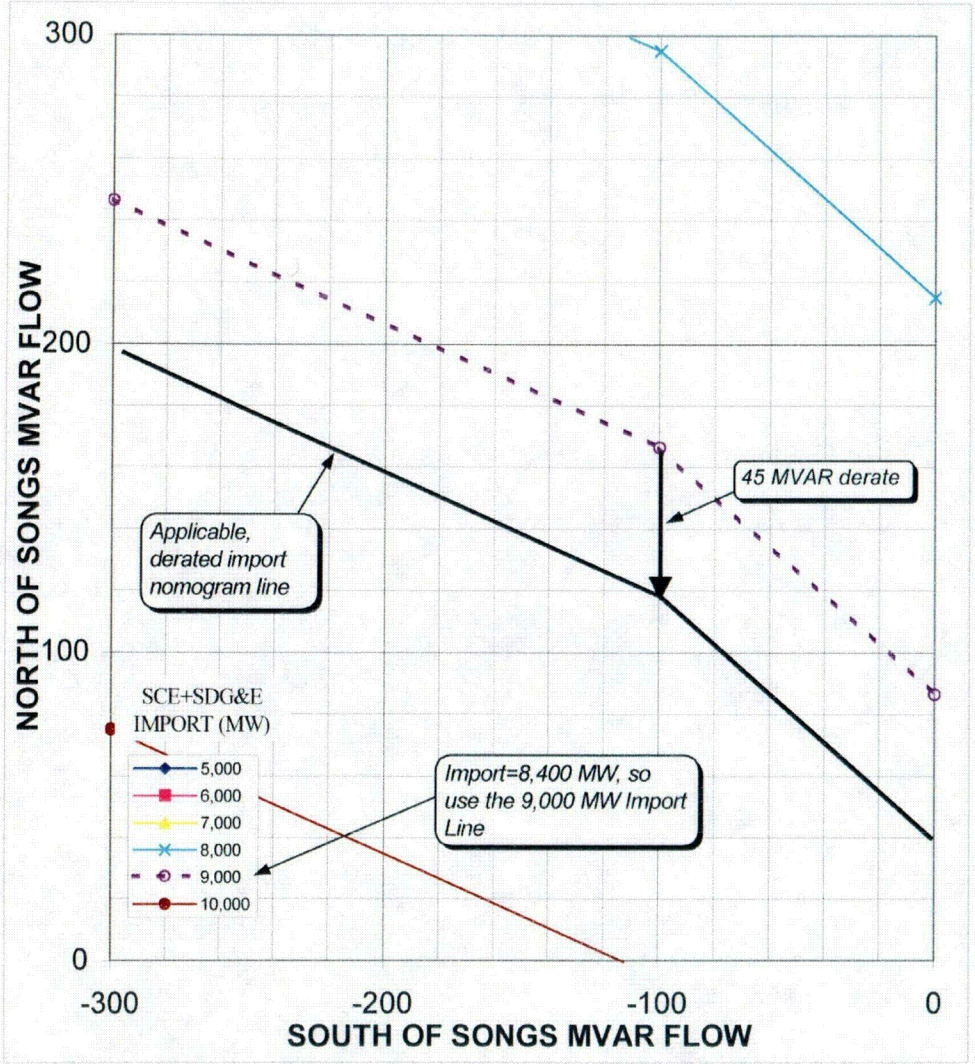
- SCE prepares operating nomograms as part of Grid Control Center Operating Procedure -13 (OP-13) that defines the safe operating region for SONGS and the surrounding grid to maintain adequate grid voltage for safety related systems.
  - CAISO reviews and accepts results.

- CAISO and SCE Operations Engineering will perform analysis on proposed grid changes / outages that are not covered by OP-13, SONGS Voltage, before they are allowed.

GCC Operating Procedure - 13

- Developed to identify any transmission outage(s) in conjunction with one SONGS unit off line that could result in the SONGS 230 kV switchyard voltage being below 218 kV.
  - 218 kV is required to assure proper operation of the safety systems should the remaining SONGS unit trip.
- Reviewed or updated annually or when necessary due to grid changes.
- Reviewed and approved by the CAISO.
- Includes twelve transmission contingencies with various combinations of 28 other generating units and 27 capacitor banks.
- Nomogram monitored by the SCE GCC and the CAISO.

OP-13 Nomogram



Palo Verde-Devers Line Out

SONGS Off-Line Unit Mode Derates*

Mode	
1-4	-30
5-6	0

No derate

Critical Units Status Derates*

Alamitos 3	-25	
Alamitos 4	-25	
Alamitos 5	-40	
Alamitos 6	-40	
Hunt. Beach 1	-15	
Hunt. Beach 2	-15	off-line
Encina 1	-5	
Encina 2	-5	
Encina 3	-5	
Encina 4	-20	off-line
Encina 5	-90	
Southbay 1	-10	
Southbay 2	-10	
Southbay 3	-10	
Southbay 4	-10	off-line

-45 MVAR derate

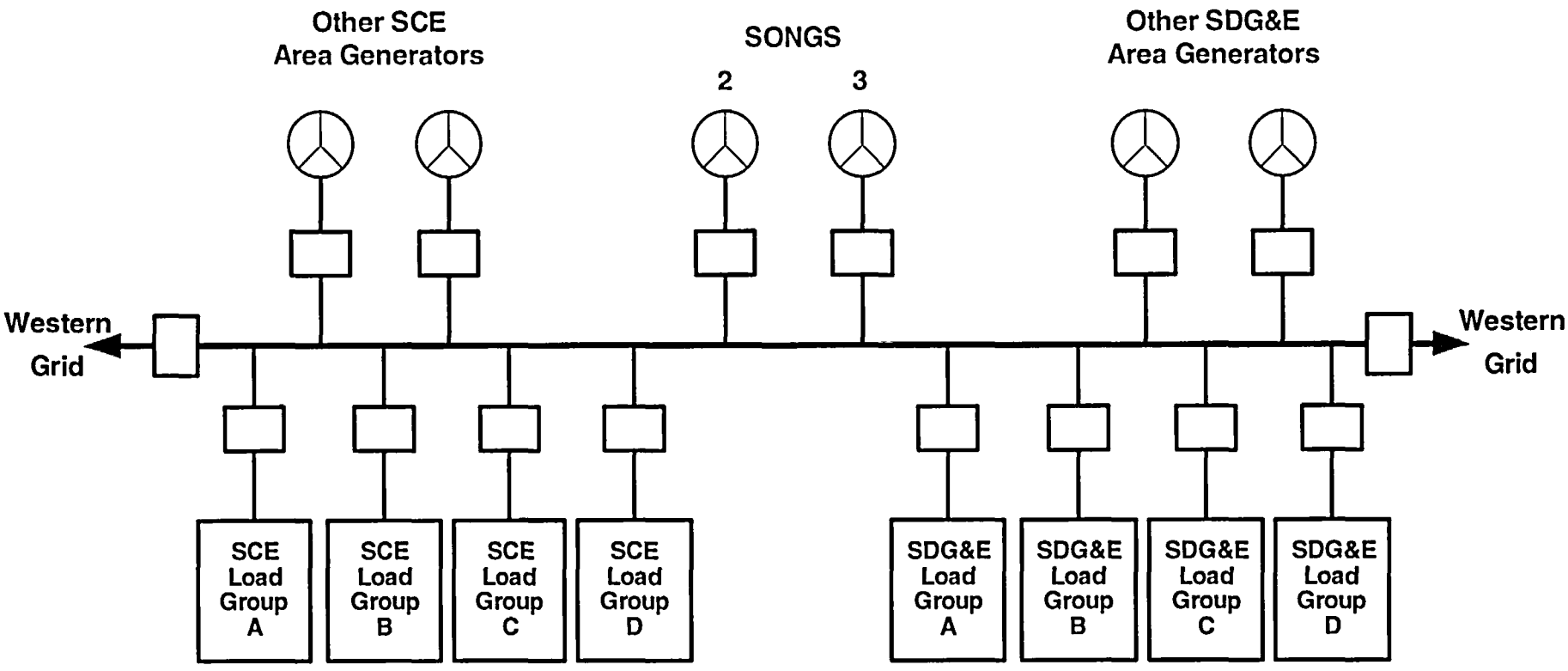
* Shift Nomogram Line Down
(in the negative Y-Direction)

C02

Management of Load and Resource Balance

- CAISO as the control area operator, is responsible for providing adequate operating reserves.
- Operating reserves are unloaded generation or resources that can be made available within 10 minutes to respond to the loss of generation to restore load and resource balance.
- For normal operation, the operating reserve requirement is about 6.8%.
- If operating reserves are insufficient, the CAISO will procure additional reserves.
- If no additional reserves are available, then the CAISO will request voluntary load curtailment when reserves fall below 5%. Mandatory load is curtailed if reserves are expected to drop lower.

Protection of the Grid by Load Shedding



Protection of the Grid by Load Shedding (continued)

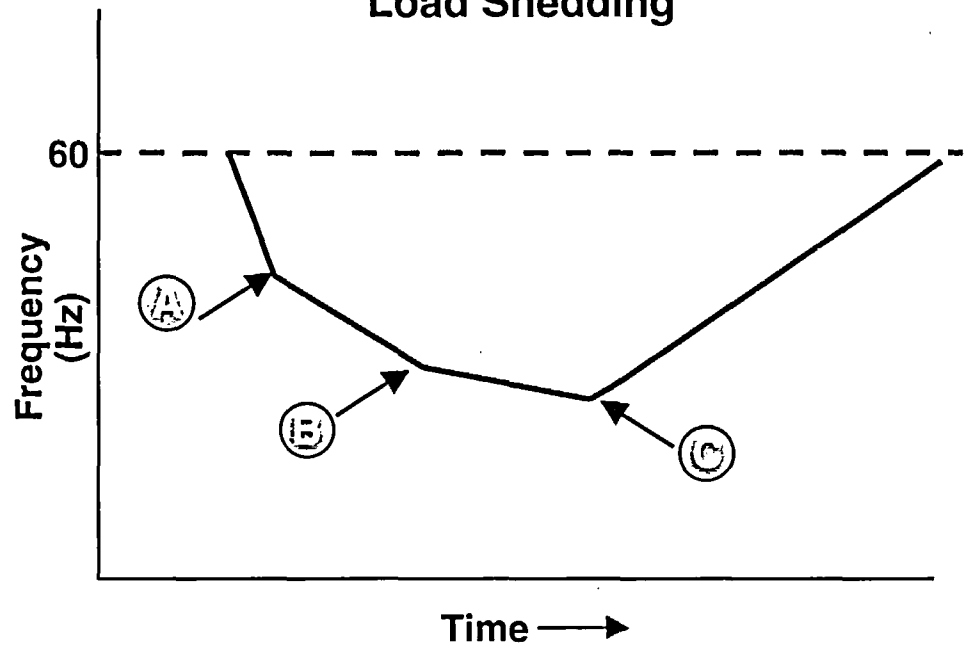
Manual Methods

1. Voluntary customer interruption
   - Customers sign up for lower rates in exchange for potential interruption
   - If time allows, first group of load interrupted
2. Mandatory customer interruption
   - If time allows, second group of load interrupted

Automatic Method

1. Underfrequency load shedding
   - When time does not allow manual interruption

Automatic Underfrequency Load Shedding



Point A = 400 MW Load Shed at 59.5 Hz

Point B = 400 MW Load Shed at 59.0 Hz

Point C = 400 MW Load Shed at 58.5 Hz

Communications

- Control areas such as CAISO, BPA and LADWP are responsible to communicate system events among effected parties.
- Control areas are also responsible for coordination of interconnecting transmission and generation outages that effect other control area grids.
- SCE responsible to coordinate with CAISO any planned maintenance and construction outages, and also forced outages of transmission lines.
- SCE Grid Control Center communicates to SONGS if offsite power operability cannot be maintained through OP-13.

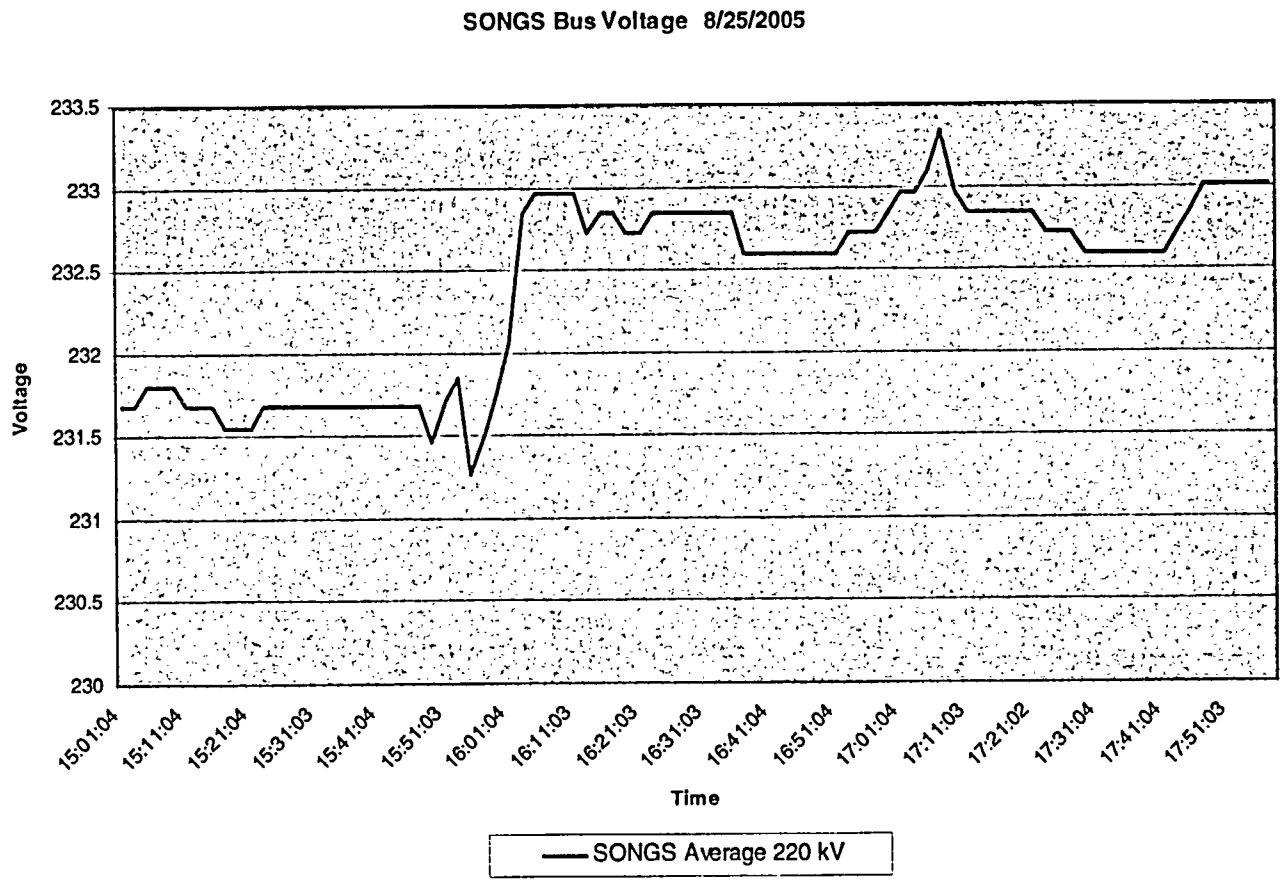
An Example of Grid Operation
August 25, 2005 HVDC Line Outage

Chronology of August 25 HVDC Line Outage

Time	Event
1547	Pacific HVDC line blocked and failed to restart (Sylmar Converter Relay Malfunction). DC Monopolar Ground Return Operation.
1550	DC Initiating Ramp to Zero in 5 Minutes. CAISO Declares Transmission Emergency and Requests Voluntary Load Curtailment in SP 26.
1553	System Frequency Declines (59.729 Hz) When BPA Remedial Action Responds to DC Ramp Down.
1557	CAISO Requests Mandatory Load Curtailment in SP 26.
1558	SCE Switching Centers Initiate Rotating Outages Using EMS.
1608	System Frequency Recovers to 60 Hz.
1617	CAISO Mandatory Load Curtailment Request Reduced by 350 MW.
1634	CAISO Mandatory Load Curtailment Request Terminated.
1708	Voluntary Load Curtailment Request Terminated.
1800	Transmission Emergency Terminated.

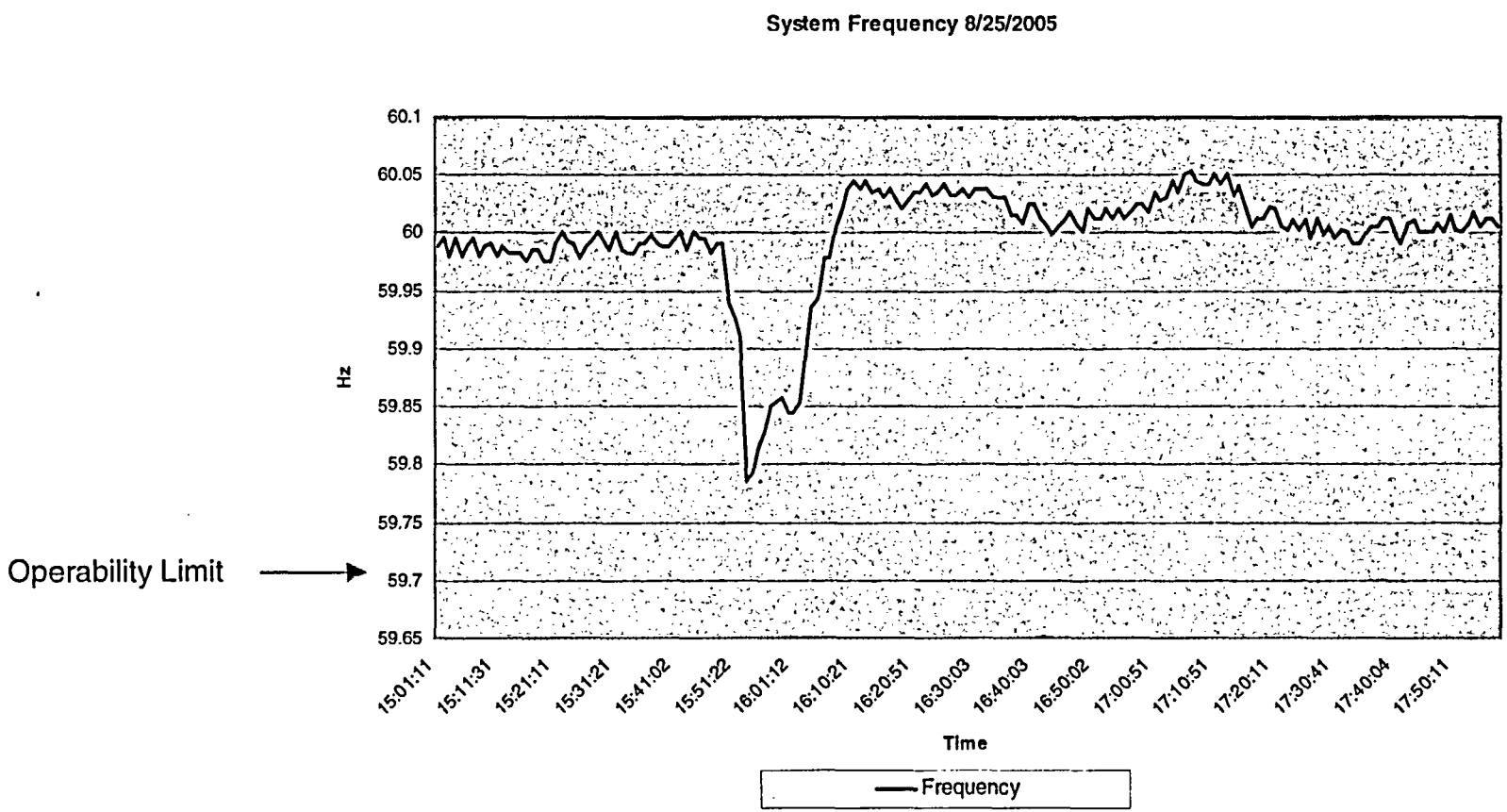
August 25, 2005 HVDC Line Outage
(continued)

SONGS Voltage



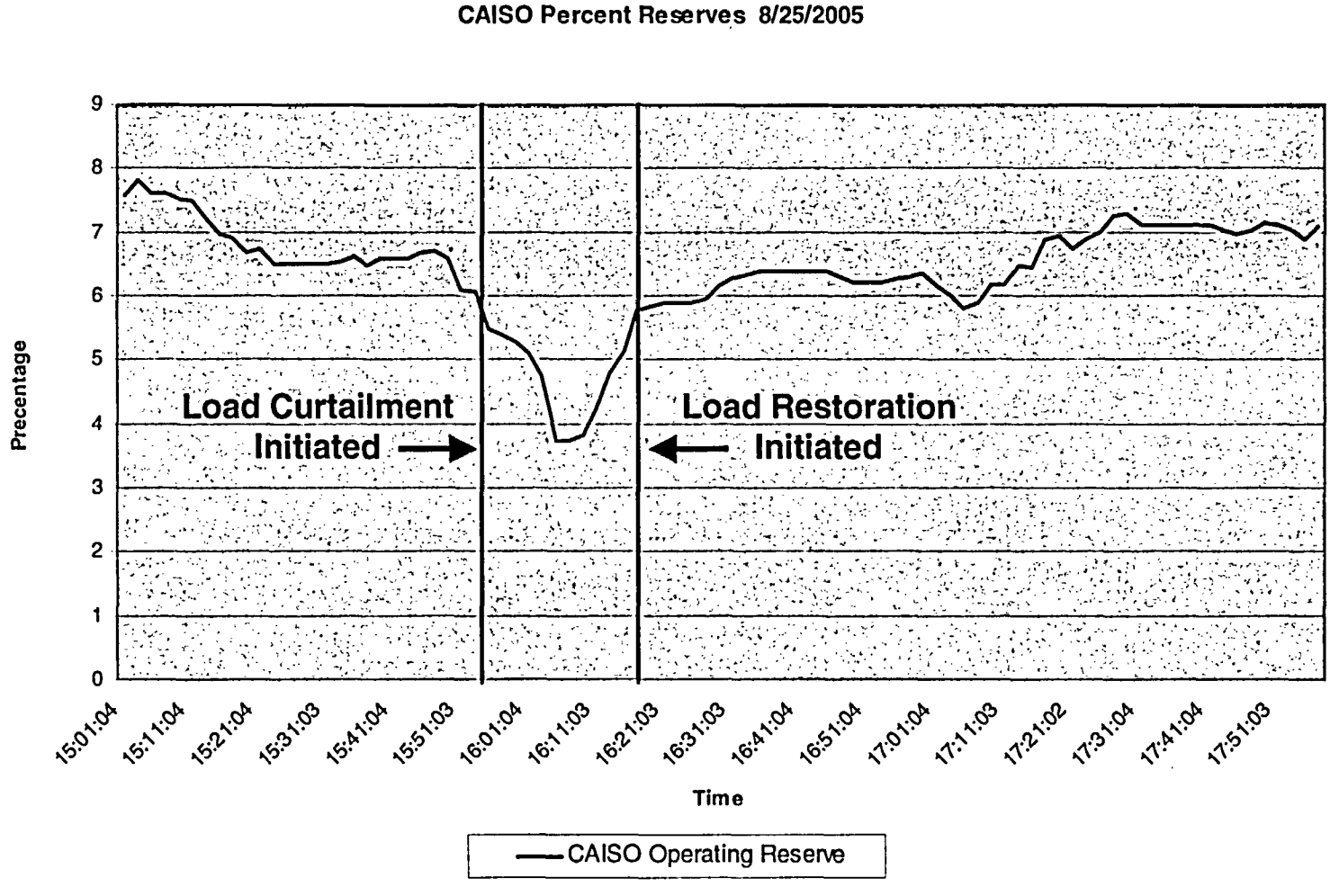
August 25, 2005 HVDC Line Outage
(continued)

System Frequency



August 25, 2005 HVDC Line Outage
(continued)

CAISO Reserves



August 25, 2005 HVDC Line Outage
(continued)

- CAISO had required NERC / WECC control area operating reserves prior to the event.
- Voltages were not an issue and the load / resource balance recovered within the required timeframe of 15 minutes.
- After the event the southern part of the ISO control area had insufficient reserves to mitigate an overload of the Midway-Vincent transmission path resulting in the need for load curtailment.
- Inadequate communication between CAISO, LADWP and BPA contributed to the need for shedding of CAISO load.
- Grid performed well and grid reliability preserved. All systems operated properly including BPA generator dropping scheme.

August 25, 2005 HVDC Line Outage
(continued)

- Observations from this event:

  - Communications between LADWP, CAISO and BPA need to improve on the operation of the HVDC line to reduce the exposure to unnecessary load curtailment.
  - CAISO management of the grid preserved grid reliability.
  - CAISO's broad view of system enabled framework for proper reliability decision.

  - During the 2003 NE blackout, proper management of grid reliability would have required early load curtailment.

Agenda

- Introduction
- SONGS Grid Requirements
- CAISO and SCE Roles and Responsibilities
- SCE Grid Analysis and Operation

- **PRA Model/Maintenance Rule Program**
  - **(Michelle Carr)**

  - Break
- NRC Questions

PRA Model /Maintenance Rule Program

- The SONGS 2/3 PRA model includes Loss of Offsite Power (LOOP) initiating event (IE) frequency based on data analysis of NUREG/CR-5496 and EPRI TR-1009889

- The calculated average LOOP IE used in the Safety Monitor for Maintenance Rule (a)(4) serves as a measure of grid reliability on any given day

PRA Model /Maintenance Rule Program (continued)

- Two "off-normal" operating conditions that increase the average LOOP IE
  - Switchyard Maintenance – Maintenance Personnel, Trucks/Cranes in the Switchyard; Plant-Centered LOOP IE increased by Factor ~ 3 based on latest draft update to NUREG/CR-5496
    - As a normal practice, switchyard maintenance is conservatively assumed to be in effect in San Onofre's (a)(4) maintenance planning process

PRA Model /Maintenance Rule Program (continued)

- Two "off-normal" operating conditions that increase the average LOOP IE (continued)
  - Grid Declared Inoperable –LOOP IE increased by a Factor of 100 based on engineering judgment

Orange 5×10^{-4} CDF

Agenda

- Introduction
- SONGS Grid Requirements
- CAISO and SCE Roles and Responsibilities
- SCE Grid Analysis and Operation
- PRA Model/Maintenance Rule Program
  - **Break**
- **NRC Questions**