
 California ISO Your Link to Power	OPERATING PROCEDURE	Procedure No.	E-503
		Version No.	1.8
		Effective Date	9/14/09
Under-Frequency Load Shedding		Distribution Restriction: NONE	

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Purpose

Provides guidance for Load restoration in coordination with the WECC RC, Adjacent Balancing Authorities (BA), Transmission Operators (TOP), Participating Transmission Owners (PTOs), Utility Distribution Companies (UDCs), Metered Subsystems (MSSs) and Participating Generators (PGs) following Under-Frequency Load Shedding (UFLS) caused by frequency decay and describes the restoration activities directed by the CAISO.


System Conditions

Adjacent Balancing Areas and WECC Sub-Regions

If a UFLS event occurs in the CAISO Balancing Authority (BA) or an adjacent BA

Then evaluate and stabilize the CAISO BA. Determine generation and Interconnection status, curtail Intercchange schedules as required and note pertinent information in the log

Step	CAISO Transmission Dispatcher Actions
1	Contact the Adjacent Balancing Area(s) and the WECC Reliability Coordinator.
2	Provide CAISO BA status information to the WECC Reliability Coordinator and Adjacent Balancing Areas as appropriate.
3	Request a concise report of conditions and additional reports as developing or significant events occur.
4	Provide a concise report of CAISO BA conditions and additional reports as developing or significant events occur.


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1. Declare a System Emergency Following A UFLS

UFLS within the CAISO Balancing Area

If an Under-Frequency Load Shedding (UFLS) occurs within the CAISO Balancing Area, then take the following steps:


Step	CAISO Shift Supervisor Actions	
1	Declare a System Emergency (to allow notifications to Market Participants).	
2	If... Appropriate,	Then... Instruct the Generation Dispatcher to issue a notice to Market Participants, stating that due to a System Emergency, the Real Time and HASP will be suspended, and suspend operation of CAISO Markets as detailed in Operating Procedure M-406, Administrative Price .
3	Evaluate the appropriateness of additional Operating Procedures.	
	If... Additional Operating Procedures are required,	Then... Order the implementation of additional related emergency CAISO Operating Procedures (which may include the following): <ul style="list-style-type: none"> • E-501, System Restoration • E-502, Emergency Manual Load Shedding Procedure • E-508 Electrical System Emergency
4	Notify the Emergency Response Team as described in CAISO Operating Procedures: <ul style="list-style-type: none"> • E-507, Emergency Response Team, and • N-703, Event Reporting and Regulatory Notification. 	

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Communications If Load Shedding occurs in the Service Territory of a PTO, UDC, or MSS due to a UFLS event, then take the following steps to establish or redirect communications:


Step	PTO, UDC, and MSS Control Centers Actions	
1	Contact the CAISO Transmission Dispatcher immediately and provide a concise report of conditions.	
2	Remain in contact with the CAISO for further instructions, until released by the CAISO, or until the Emergency is terminated by the CAISO.	
Step	CAISO Transmission Dispatcher Actions	
3	If... A UFLS event occurs in the Service Territory of a PTO, UDC, or MSS and they have not yet contacted the CAISO,	Then... <ul style="list-style-type: none"> • Contact the PTO, UDC, or MSS Control Center and request a concise report of conditions. • Establish contact (optional at CAISO discretion) with the PTO to whom a UDC or MSS is interconnected if the UDC or MSS agrees to accept instructions from the CAISO through the PTO and agrees to communicate to the CAISO through the PTO. • Remain in contact with the PTOs, UDCs, and MSSs until the Emergency is terminated.
4	If... A PTO, UDC, or MSS has contacted or is in contact with the CAISO but does not need to remain on the line,	Instruct them to report periodically, in a frequency of your choosing (i.e. hourly, half-hourly, etc) and to report additionally as developing or significant events occur.

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Step	CAISO Shift Supervisor Actions	
4	If... Communications can be managed more effectively from the CAISO Control Room in Alhambra (especially Southern California PTOs, UDCs, MSSs, or Adjacent Balancing Areas to Southern California), OR the Control Room in Folsom is not operational or cannot be reached,	Then... <ul style="list-style-type: none"> • Instruct the CAISO Transmission Dispatcher in Alhambra to contact the required parties, and • Direct the CAISO Transmission Dispatcher in Alhambra to remain in contact with the parties until the Emergency is terminated.
Step	PTOs, UDCs and MSSs Actions	
5	If... The CAISO Control Room in Folsom is not operational or cannot be reached,	Then... Direct all communications to the CAISO Transmission Dispatcher in Alhambra until instructed otherwise by the CAISO.

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PTO with Open Interconnection If an Interconnection opens due to a UFLS event, then **immediately** take the following steps:


Step	PTO Actions					
1	Immediately notify the CAISO of the open Interconnection.					
2	Provide a concise report of conditions and relay reports including those received from interconnected UDCs or MSSs who may have reported to you.					
3	Remain in contact with the CAISO for further instructions, until released by the CAISO, or until the Emergency is terminated by the CAISO.					
Step	CAISO Transmission Dispatcher Actions					
4	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr style="background-color: #e0ffff;"> <th style="text-align: left; padding: 5px;">If...</th> <th style="text-align: left; padding: 5px;">Then...</th> </tr> </thead> <tbody> <tr> <td style="padding: 5px; vertical-align: top;"> An Interconnection opens due to a UFLS event and the PTO has not contacted the CAISO, </td> <td style="padding: 5px; vertical-align: top;"> <ul style="list-style-type: none"> • Immediately Contact the PTO. • Request a concise report of conditions including reports received from interconnected UDCs or MSSs who may have reported to the PTO. • Remain in contact with the PTO until the Emergency is terminated. </td> </tr> </tbody> </table>		If...	Then...	An Interconnection opens due to a UFLS event and the PTO has not contacted the CAISO,	<ul style="list-style-type: none"> • Immediately Contact the PTO. • Request a concise report of conditions including reports received from interconnected UDCs or MSSs who may have reported to the PTO. • Remain in contact with the PTO until the Emergency is terminated.
If...	Then...					
An Interconnection opens due to a UFLS event and the PTO has not contacted the CAISO,	<ul style="list-style-type: none"> • Immediately Contact the PTO. • Request a concise report of conditions including reports received from interconnected UDCs or MSSs who may have reported to the PTO. • Remain in contact with the PTO until the Emergency is terminated. 					

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**Conference
Call Bridge**

If it is determined that events require a Conference Call Bridge, or restoration can be more effectively managed by the use of a Conference Call, then complete all of the following steps:

Step	CAISO Shift Supervisor Actions
1	Establish a Conference Call using the CAISO's established conference call services.
2	Direct Control Room personnel of the desired PTOs, UDCs, MSSs and Reliability Coordinators to dial-in.
3	Request Adjacent Balancing Areas who can expedite restoration, provide assistance, or who need information from other CAISO Participants on the Conference Call Bridge to expedite their own restoration, to dial-in.
4	Request that the Reliability Coordinator(s) participate and manage restoration operations via this conference call.
5	Provide all participants with associated dial-in number and pass-code.
6	Conduct a public roll-call (to determine who is on line and to provide other participants the opportunity to know who else is listening).
7	Issue dispatch instructions to CAISO participants from this conference call bridge.
8	Call non-participants as dispatch instructions are issued or information is shared that is relevant to all participants (to ensure all are adequately instructed and fully appraised).

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2. System Adjustment

Adjust for Automatic Load Restoration¹

To identify Automatic Load Restoration (ALR) status and to adjust the system, take the following steps:

Step	PTOs, UDCs and MSSs Actions	
1	If... The Automatic Load Restoration (ALR) is enabled,	Then... Advise the CAISO Transmission Dispatcher immediately and provide the estimated amount, timing and conditions under which the ALR will operate.
Step	CAISO Transmission Dispatcher Actions	
2	If... A PTO, UDC or MSSs has not notified the CAISO of whether or not they have ALR,	Then... Inquire whether or not they have ALR, and if so, the estimated amount, timing, and conditions under which ALR will operate.
Step	CAISO Shift Supervisor Actions	
3	If... ALR has been identified and may cause frequency decay or grid instability during restoration,	Then... Direct Control Room operators of service territories where ALR is enabled to: <ul style="list-style-type: none"> • Disable ALR if possible without jeopardizing reliability and safety, <li style="padding-left: 20px;">OR (where disabling is not possible), • Shed other Load in amounts necessary to maintain stable and sufficient frequency during ALR.


¹ For the purpose of this procedure, Automatic Load Restoration includes load restored to correct frequency overshoot as required in the [WECC Coordinated Off-Nominal Frequency Load Shedding and Restoration Plan](#). Consult Operating Procedure [E-503A, UFLS and Islanding – Real Time Monitoring](#), for additional guidance.

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**Stabilize
Frequency**

To correct the frequency by adjusting Loads and to distribute Load Shedding equitably, take the following steps:

Step	CAISO Shift Supervisor Actions	
1	If... Additional Load Shedding is required to correct low Frequency or to enable restoration,	Then... Order additional manual Load Shedding until Frequency is corrected.
2	If... Load Restoration is required to correct over-Frequency,	Then... Order portions of Load to be restored until Frequency is corrected.
3	If... The CAISO Balancing Area has <i>not</i> broken into islands and distribution of additional Load Shedding and/or Load Restoration can be accomplished in proportion to loads prior to the event without compromising grid stability or delaying restoration,	Then... Distribute additional Load Shedding and/or Load Restoration among UDCs and MSSs in proportion to loads prior to the event, but only if it does not compromise grid stability or delay restoration.

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**Synchronize
Open Lines and
Interconnection**

If a UFLS event occurs that causes:

- (A) line(s) to open
- (An) Interconnection (s) to open
- Generation to separate or trip

The CAISO Shift Supervisor, Transmission Dispatcher and the WECC Reliability Coordinator collaborate and take the following steps:


Step	CAISO Shift Supervisor, Transmission Dispatcher and Reliability Coordinator Actions
<i>Note: Overall system reliability will be maximized by re-establishing interconnections, prioritized by closing the strongest ones first, between separated Adjacent Balancing Areas at the earliest possible stage of restoration.</i>	
1	Consult Operating Procedure E-501, System Restoration , for additional guidance (not shared on the Internet for security reasons).
2	Identify islands (if any, which also requires Operating Procedure E-501, System Restoration not shared on the Internet for security reasons).
3	Establish a restoration plan.
4	Prioritize restoration of the strongest lines and ties first, to the extent possible and prudent as this most quickly re-establishes grid stability.
5	Coordinate and Communicate plans with: <ul style="list-style-type: none"> • PTOs, UDCs, and MSSs within the CAISO Balancing Area, and • Adjacent Balancing Areas with the CAISO Balancing Area where ties or lines are opened.
6	Provide changes or updates to restoration plans.
7	Ensure that once restoration begins, that lines are closed non-simultaneously (i.e. one at a time) to allow transient instability to subside before proceeding to the next Interconnection.

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**Check
Synchronization
Values**

If the PTOs, UDCs and MSSs are instructed by the CAISO to close a line or Interconnection, take the following steps:

Step	PTOs, UDCs and MSSs Actions					
1	Check: <ul style="list-style-type: none"> • <i>Line and Bus Voltages</i> to ensure voltage disparity is no more than ten percent. • <i>Rotation of the Synchroscope</i> to ensure it rotates no faster than one revolution in thirty seconds. • <i>Phase angle</i> to ensure it is within acceptable closing limits or within limits established by procedures for the specific line. 					
2	Close the line breaker.					
Step	CAISO Shift Supervisor Actions					
3	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr style="background-color: #e0ffff;"> <th style="text-align: left; padding: 5px;">If...</th> <th style="text-align: left; padding: 5px;">Then...</th> </tr> </thead> <tbody> <tr> <td style="padding: 5px; vertical-align: top;"> In consultation with the WECC Reliability Coordinator, it is determined that deviation from established synchronization values is required to expedite system restoration, it is prudent, and safe, </td> <td style="padding: 5px; vertical-align: top;"> <ul style="list-style-type: none"> • Provide the Control Center operator, prior to closing the line, with the line name and modified limits and/or closing guidelines. • Specify clearly, prior to closing the line, that such modified limits and closing guidelines are valid only for the single synchronization attempt. • Ensure the Control Center operator acknowledges these instructions through three way communication. • Direct the operator to close the line breaker. </td> </tr> </tbody> </table>		If...	Then...	In consultation with the WECC Reliability Coordinator, it is determined that deviation from established synchronization values is required to expedite system restoration, it is prudent, and safe,	<ul style="list-style-type: none"> • Provide the Control Center operator, prior to closing the line, with the line name and modified limits and/or closing guidelines. • Specify clearly, prior to closing the line, that such modified limits and closing guidelines are valid only for the single synchronization attempt. • Ensure the Control Center operator acknowledges these instructions through three way communication. • Direct the operator to close the line breaker.
If...	Then...					
In consultation with the WECC Reliability Coordinator, it is determined that deviation from established synchronization values is required to expedite system restoration, it is prudent, and safe,	<ul style="list-style-type: none"> • Provide the Control Center operator, prior to closing the line, with the line name and modified limits and/or closing guidelines. • Specify clearly, prior to closing the line, that such modified limits and closing guidelines are valid only for the single synchronization attempt. • Ensure the Control Center operator acknowledges these instructions through three way communication. • Direct the operator to close the line breaker. 					

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4	If...	Then...
	Subsequent attempts are necessary because a previous attempt failed or the line did not remain synchronized,	<ul style="list-style-type: none"> • Re-evaluate the ability and need to attempt another closure, noting whether it is still prudent and safe. • Provide modified limits and/or closing guidelines before attempting again. • Specify clearly that such modified limits and/or closing guidelines are valid only for the next single synchronization attempt. • Direct the operator to close the line breaker.

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Adjust System Conditions for Synchronization

To correct voltage disparity and reduce phase angle, take the following steps:


Step	CAISO Generation Dispatcher Actions	
1	If... Voltage disparity can be corrected by an increase or decrease in Vars supplied from reactive devices or by a change in Generation,	Then... <ul style="list-style-type: none"> • Coordinate with Control Room personnel from both ends of the open line and the CAISO Transmission Dispatcher. • Adjust voltage as necessary by dispatching available voltage control devices such as Generators, capacitor banks, reactors, or by increasing or decreasing generation output etc. • Attempt line closure per procedures.
Step	CAISO Transmission Dispatcher Actions	
2	If... Voltage disparity can only be corrected by additional Load Shedding	Then... <ul style="list-style-type: none"> • Coordinate with Control Room personnel from both sides of the open line. • Instruct the operator on the side with lower voltage to shed additional load. • Attempt line closure per procedures.

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P. **Generation Stabilization and Restoration**

Determine Status of Generating Units If frequency decays to 59.5 Hz or lower (as may be evidenced by AGC and/or frequency alarms at Participating Generating stations), **immediately** take the following steps:


Step	Scheduling Coordinator Actions	
1	Notify the CAISO Generation Dispatcher of the frequency decay.	
Step	CAISO Generation Dispatcher Actions	
2	If... Advised by a Scheduling Coordinator (SC) that frequency at a generating station decayed to 59.5 Hz or lower (as may be evidenced by their AGC and/or frequency alarms),	Then... <ul style="list-style-type: none"> • Evaluate immediately the status of Participating Generators (if the reporting generating station is islanded, only generators within that island are necessary to evaluate) to identify available generating capacity that may help stabilize and or restore frequency. • Contact the PTO to whom the generator is connected to ascertain whether or not Load was shed due to a UFLS event and, if so, in what amount.

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Re-Start Off-Line Generation

If Generation separates or trips due to a UFLS event and (a) generator(s) is/are islanded from other power sources, take the following steps:

Step	CAISO Generation Dispatcher Actions	
1	If... Any Nuclear Generating Stations have separated or tripped due to the UFLS event and the Generator(s) is/are islanded from other power sources,	Then... <ul style="list-style-type: none"> • Prioritize the provision of power back to the nuclear generator station. • Contact the generating station immediately to identify their most urgent needs and their capability to re-synchronize. • Coordinate with the Reliability Coordinator to start off-site generation, close lines, and re-route power to the station. • Restore power to the station as soon as possible.
2	If... (A) Generating Unit(s) (other than nuclear) separate(s) due to a UFLS event and restoration requires generation from the unit(s),	Then... <ul style="list-style-type: none"> • Dispatch the Generating Units that separated but are otherwise available to re-synchronize and load to a desired level, • Instruct the Scheduling Coordinators of those units to immediately notify the CAISO Generation Dispatcher if any unexpected circumstances delay restart or the ability to load to the instructed level.

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**Start-Up Power
Provided to
Tripped
Generating Units**


If a Generating Unit trips due to a UFLS event and restoration requires off-site start-up power, but de-energized lines preclude start-up, take the following steps:

Step	CAISO Transmission Dispatcher and CAISO Generation Dispatcher Actions
1	Coordinate with the PTO to re-route power sufficient to enable start-up to the tripped units.

**Procure
Additional
Generation**

If restoration requires additional Generation, take the following steps:


Step	CAISO Generation Dispatcher Actions
1	Dispatch , as needed, starting with quick start units.
2	Acquire additional Generation in amounts sufficient to satisfy system (island) requirements with OOM dispatches to SCs.
3	Instruct the Scheduling Coordinators of those units to immediately notify the CAISO Generation Dispatcher if any unexpected circumstances delay startup or the ability to load to the instructed level.

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**Scheduling and
Logging
Generation**

If time allows, reliability is not compromised, and restoration will not be delayed, take the following steps to schedule and log the changes:

Step	CAISO Real-Time Schedulers and CAISO Grid Resource Coordinators Actions	
1	Coordinate with Scheduling Coordinators to ensure Generation changes are scheduled through Scheduling Infrastructure (SI) if the CAISO Markets were not previously suspended.	
2	If... Schedules were not entered because Emergency Conditions did not provide sufficient time or information or the CAISO Markets were suspended,	Then... Log all generating instructions that were issued in SLIC.

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P. Load Restoration

MW Blocks to be Restored

When Load Shedding was due to a UFLS event, the Blocks of MWs to be restored must be identified. Take the following actions to achieve this:


Step	UDCs and MSSs Actions
1	Provide the CAISO Transmission Dispatcher with a list of the blocks to be restored, denoting the approximate MW value of Load for both peak and minimum load periods for each block.

Restoring and Distributing Load

When it is determined, in consultation with the WECC Reliability Coordinator, that the capacity from connected resources are sufficient to restore Load and the grid is sufficiently stable, take the following steps:

Step	CAISO Shift Supervisor Actions	
1	Coordinate with the WECC Reliability Coordinator to direct Load restoration within the CAISO Balancing Areas, careful to maintain control and reliability of the interconnected system.	
Step	UDCs and MSSs Actions	
2	If... Instructions are issued by the CAISO to restore Load,	Then... <ul style="list-style-type: none"> • Restore Load in quantities as close to the amount ordered as possible. • Advise the CAISO if you are unable to restore Load in the amounts ordered or if circuit Loads are excessively higher than estimated (due, e.g., to cold-load pickup).

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Step	CAISO Shift Supervisor Actions	
4	If... Distribution of Load Restoration can be accomplished equitably (i.e. restoring Loads to ratios as close as possible to the ratios of UDC demand coincident to last year's total CAISO Balancing Area peak demand ²) without jeopardizing reliability or delaying restoration,	Then... Restore Loads among UDCs and MSSs equitably (proportional, as close as possible to ratios of UDC demand coincident to last year's total CAISO Balancing Area peak demand ³) to the extent this is possible.


P. Market Restoration

If the CAISO Markets were previously suspended and grid conditions allow for resumption of the HASP and Real-Time market for Ancillary Services, Energy, and Transmission Service, take the following steps:

Step	CAISO Shift Supervisor Actions
1	Notify Market Participants that HASP and the Real-Time Market will be resume, noting the time the market will open and the time it will resume
2	Begin market operations according to procedures for those specific markets.

² See CAISO Operating Procedure [E-508, Electrical Emergency Plan](#), Attachment A "Current Year Percentages."


³ Ibid

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P. **Termination of Emergency**

When grid conditions allow for resumption of all markets for Ancillary Services, Energy, and Transmission Service can be restored, take the following steps:

Step	CAISO Shift Supervisor Actions
1	Issue a notice stating that the Emergency has been terminated and the time at which this is effective.
2	Notify all Market Participants that normal operations will resume and the times at which they start.
3	Resume normal Market and Grid Operations.

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Supporting Information

Operationally Affected Parties

- N/A Posted on the Internet
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Responsibility & Authority


CAISO NERC Certified RT Operating Personnel	Authority, as delegated by the Executive Officers of the CAISO, to take or direct timely and appropriate real-time actions necessary to ensure reliable operation of the CAISO Controlled Grid, up to and including shedding of Firm Load to prevent or alleviate System Operating Limit or Interconnection Reliability Operating Limit violations. These actions may be performed without obtaining approval from higher-level personnel within the CAISO.
CAISO	Direct and coordinate restoration activities for the CAISO Balancing Area.
PTOs, UDCs, MSSs & PGs	Conduct restoration activities in accordance and coordination with CAISO directions.

References

CAISO Operating Procedure	E-501, System Restoration
CAISO Operating Procedure	E-502, Emergency Manual Load Shedding
CAISO Operating Procedure	E-507, Emergency Response Team
CAISO Operating Procedure	E-508, Electrical Emergency Plan
CAISO Operating Procedure	M-406, Administrative Price
CAISO Operating Procedure	N-703, Event Reporting and Regulatory Notification
SDG&E's Under-frequency Load Shedding Procedure EOP5130	
Southern California Edison Company System Operating Bulletin No. 115	
WECC Reliability Criteria	
NERC Reliability Standard EOP-003 Load Shedding Plans	
NERC Reliability Standard PER-001 bookmark: R1	

Policy

If the event of a Under-Frequency Load Shedding event (UFLS), the CAISO coordinates with Western Electricity Coordinating Council

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(WECC) member systems to match load demand with the available resources allowing frequency to recover, minimizing additional loss of Generation, and preventing a total system collapse. As necessary, the CAISO will order additional manual Load Shedding in amounts required to stabilize the electric system and expedite frequency recovery within the CAISO Balancing Area.


Restoration of the CAISO Balancing Area following a UFLS event will be under the direct control and authority of the CAISO Shift Supervisor who will coordinate with Participating Transmission Organizations (PTOs), Utility Distribution Companies (UDCs), Metered Subsystems (MSSs), Scheduling Coordinators (SCs), Participating Generators (PGs), other California Balancing Areas, and WECC Sub-Regions through their respective Reliability Coordinator. The Operating Bulletins and/or Operating Procedures of CAISO PTOs, UDCs, MSSs, SCs, and PGs are subordinate to the authority of the CAISO to direct system restoration.

Upon orders from the CAISO, PTOs, UDCs, MSSs, and SCs will immediately shed additional load by whatever means available and necessary. PTOs, UDCs and MSSs will have pre-assigned, prioritized blocks of load for the purpose of such additional Load Shedding and will maintain a means to immediately shed such load upon orders from the CAISO. Where possible, advance measures will be taken by PTOs, UDCs, and MSSs to avoid shedding loads critical for system reliability (e.g., control center power, thermal station auxiliaries).

SCs and PGs will immediately start and/or adjust generation upon orders from the CAISO as deemed necessary by the CAISO to enable, expedite and complete system restoration.


Definitions

Unless the context otherwise indicates, any word or expression defined in the Master Definitions Supplement to the CAISO Tariff shall have that meaning when capitalized in this Operating Procedure.

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		Effective Date	9/14/09
Under-Frequency Load Shedding		Distribution Restriction: NONE	

Version History

Version	Change	By	Date
1.0	First Draft		12/15/97
1.0	Revised		1/14/98
1.1	Reformat and structure Periodic Check for accuracy		4/13/00
1.2	Referenced E-508 for current years percentages		2/7/01
1.3	Annual Review, Added attachment A		1/14/03
1.4	Annual, minor clarifications to Purpose, Step 1, an added footnote to 4, and changes to 7.2.		11/2/04
1.5	Reformatted.		3/25/05
1.6	Added CAISO NERC Certified RT Operating Personnel to Responsibility section.		11/16/06
1.7	Annual revision and added MRTU terminology		5/6/09
1.8	Added System Conditions Section before Section 1.		9/14/09

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Technical Review

Reviewed By Content Expert	Signature	Date
Operations Support		
Operations Compliance		
Regional Transmission		
Grid Operations		
Market Operations		
Scheduling		

Approval

Approved By	Signature	Date
Manager of Operations Compliance		
Director of Grid Operations		

*Signed version 1.4; subsequent changes have been minor and do not require full approval.

Appendix

Attachment A: [UFLS and Islanding - Real Time Monitoring](#)
