“Fast Trip Setting” California IOU Comparison

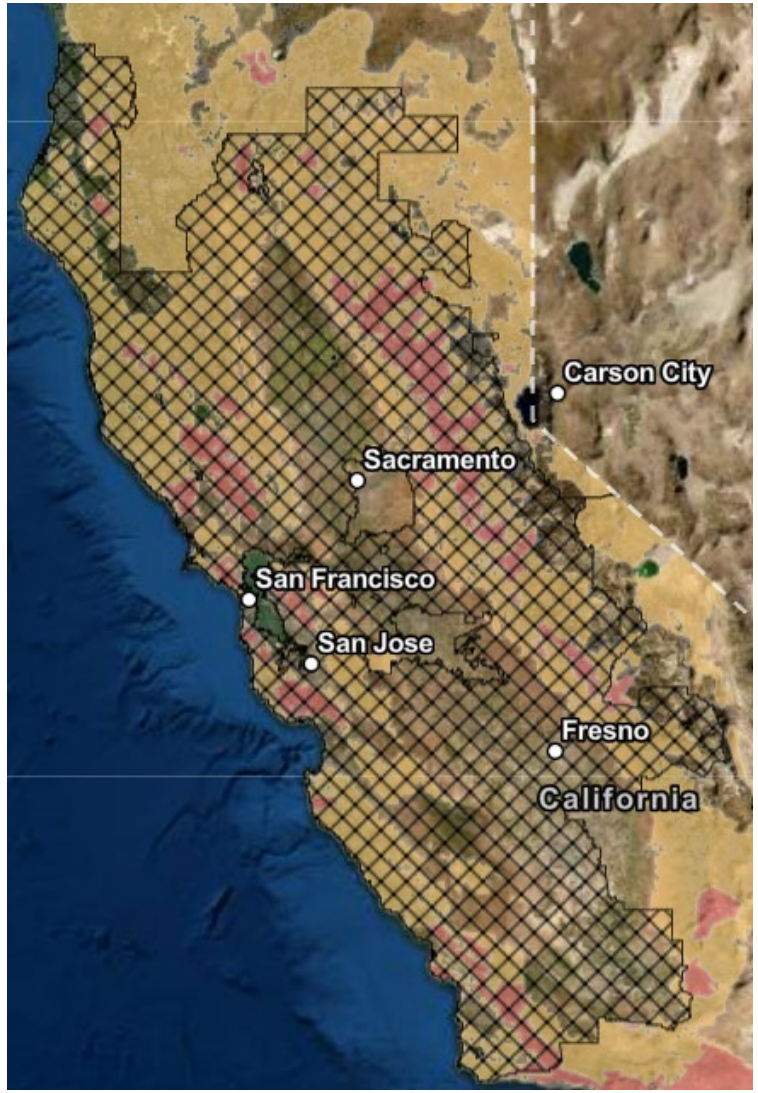
June 2022

Together, Building a Better California

PG&E Fast Trip Setting Program

Together, Building
a Better California

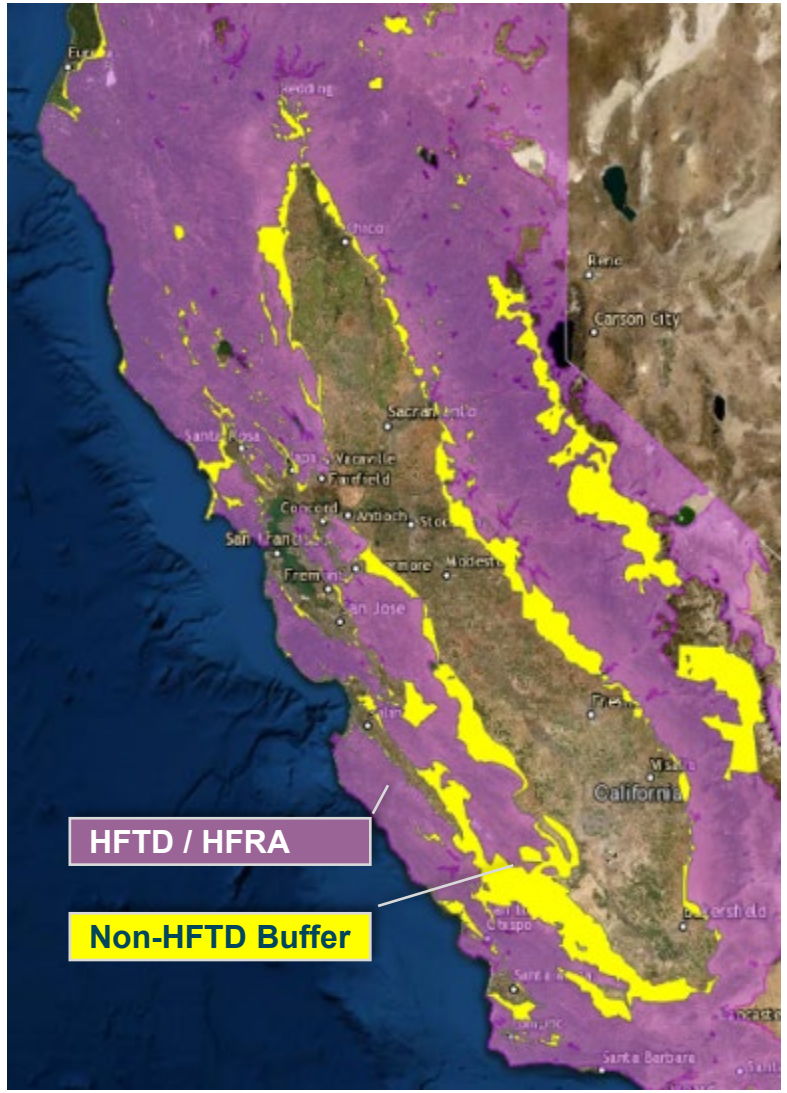
PG&E Service Territory Overview



PG&E Service Territory

PG&E Service Territory Overview	
Service Area	~70K Square Miles
Customers	~5.4M Electric Utility Customers
Distribution Circuit Miles	~107K Line Miles
Transmission Circuit Miles	~18K Line Miles
Service Territory Description	There is high wildfire risk across many remote areas within PG&E's ~70,000 square mile service territory. California contains thousands of microclimates in which fire conditions differ based on location and topography.

Fast Trip Program Summary



Fast Trip Program	
Program Name	**Enhanced Powerline Safety Settings**
First Deployed	2021
Current Scope	HFTD / HFRA / Select Non-HFTD Buffer
Devices Used	▪ Circuit Breakers ▪ Line Reclosers ▪ Fuse Savers
Protection Summary	▪ Circuit specific settings provide some level of coordination between devices ▪ Phase and ground instantaneous pickups set to see end-of-line protection beyond non-ganged devices within the expanded device protective zone (DPZ) ▪ 50P and 50N definite time set ≤ 0.1s with 0.02s coordination margin between devices ▪ When possible, a low-set ground current pickup and definite time delay element is enabled for high-impedance fault (HIF) detection (sensitive-ground-fault/50GS)
Activation Criteria	EPSS activated if any of the following: ▪ Fire Potential Index (FPI) >= R3 ▪ Relative Humidity below 20% ▪ Projected wind speeds 25+ mph ▪ Dead Fuel Moisture below 9%

Fast Trip Device Protection Overview

EPSS makes our system devices more responsive to wildfire risks by…

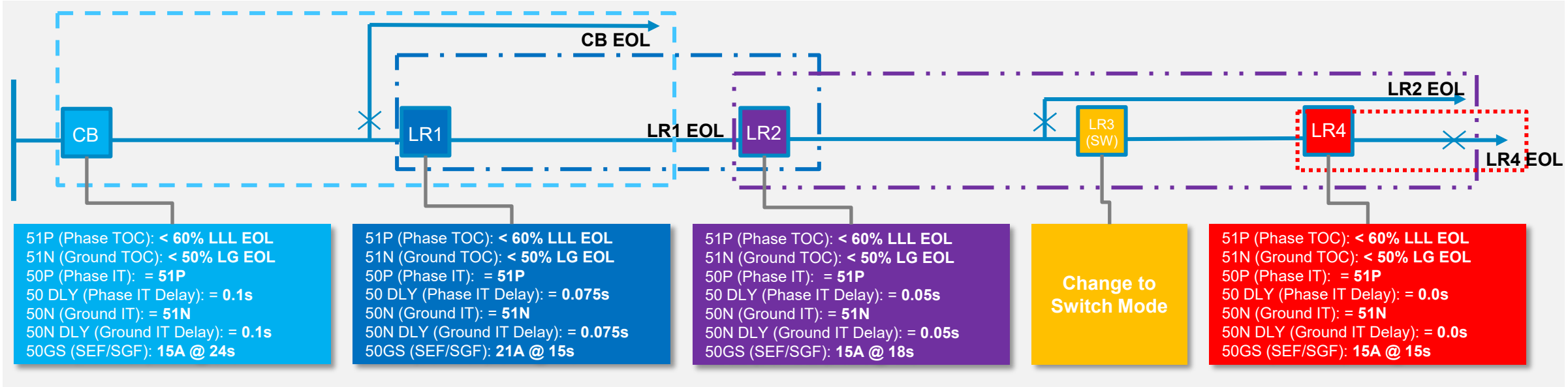
Faster Fault Detection
Faster trip settings detect distribution primary faults more quickly to reduce incident fault energy

Reduce Fuse Single Phase Operation
Detect faults beyond fuses to clear across all three-phases

Higher Impedance Fault Detection
Sensitive ground fault (SGF) elements implemented to help isolate for higher impedance faults

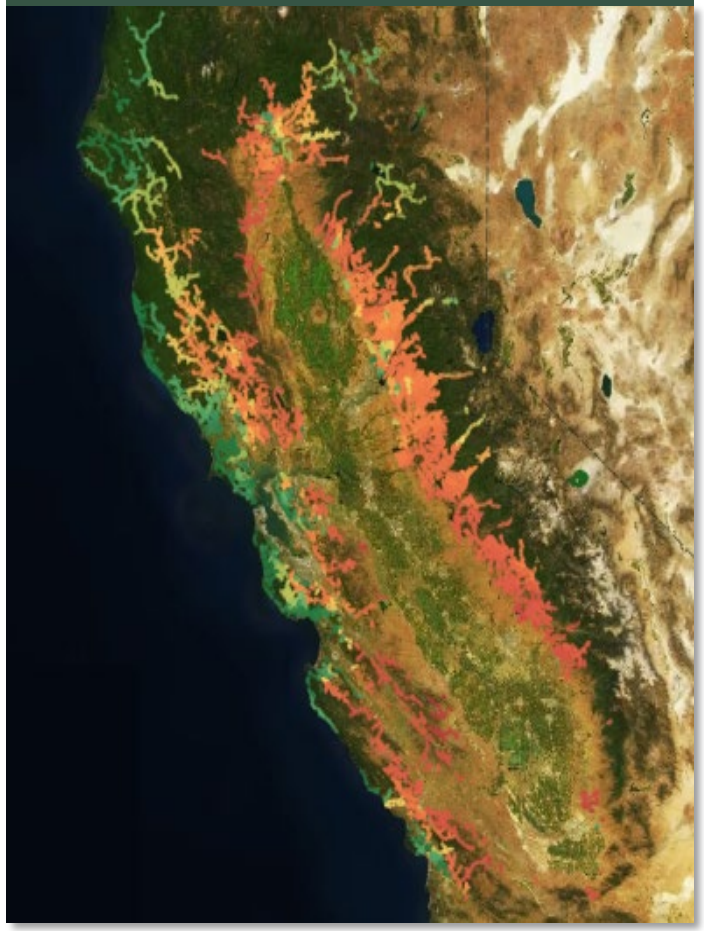
Fast Trip Device Protection

- EPSS Settings are stored in settings groups rather than with feature selection cut-in/cut-out.
- Settings are placed back into “normal” groups during energization following patrolling to avoid inrush trips
- Horstman Navigator LM Fault Indicators and Line Sensors can detect within the 0.1s programmed response time



Fast Trip Enablement Event-Driven Criteria

Circuit-level R3, R4, or R5 FPI Frequency



PG&E Utility Fire Potential Index

R1 R2 R3 R4 R5 R5+

R1: Moist fuels

R5: Very Dry Fuels

R5+: Very Dry Fuels + Wind Event

HFRA & HFTD

Disable EPSS if:

- Wind speed <19+ mph, or
- Relative humidity >75%, or
- Dead Fuel Moisture >9%

EPSS enabled on all circuits

LAST RESORT

PSPS considered if:

- Wind gusts 30-40+ mph
- Relative humidity <30%
- Dead Fuel Moisture <9-11%

Non-Tier Buffer

EPSS during RFW / FWW / PSPS adjacent conditions

NOTE: RFW = Red Flag Warning; **FWW** = Fire Weather Watch; **PSPS** = Public Safety Power Shutoff

Enablement criteria as of 06/13/2022

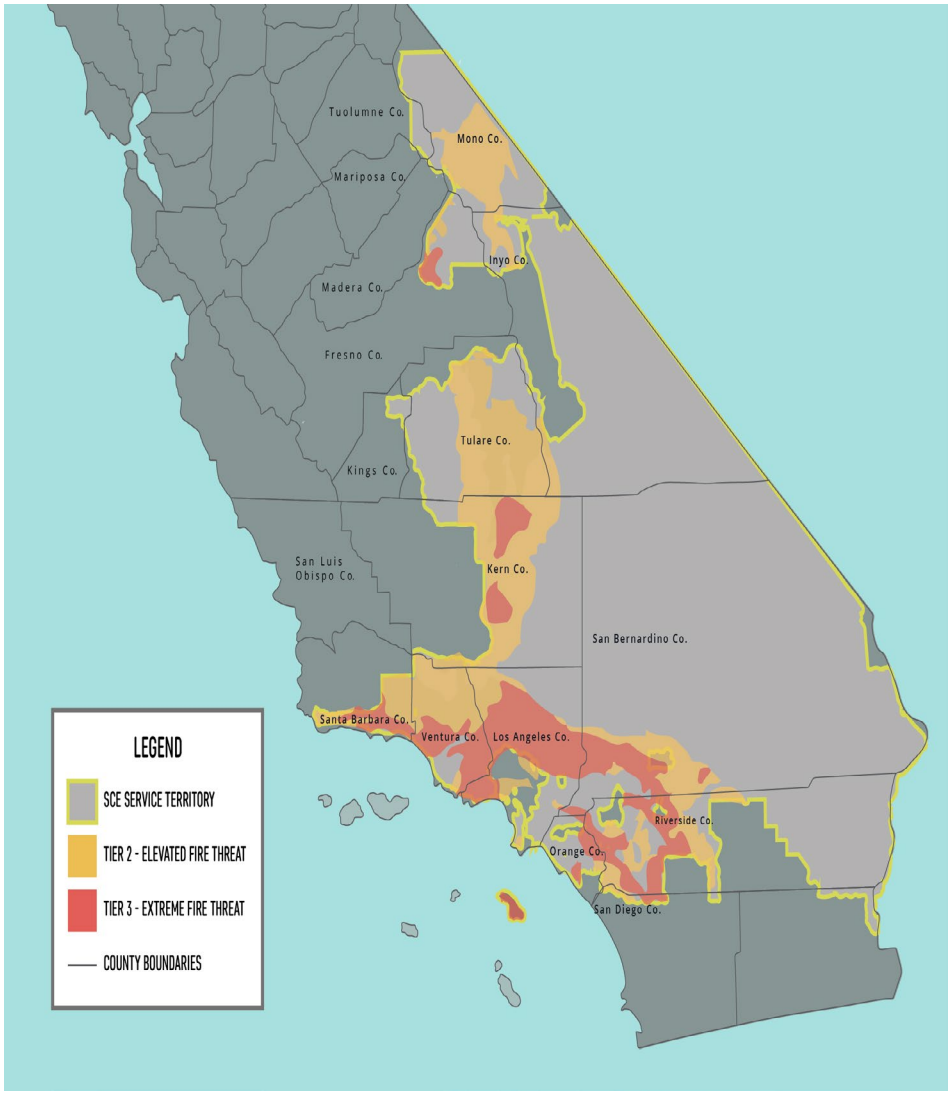
Outage Response & Restoration

Outage Response & Restoration	
Outage Response Target	**240 minutes**
Dedicated Response Crews & Resources	▪ Dedicated crews for restoration and readiness response ▪ Pre-position rapid response helicopters available to fly with 20 minutes notice. ▪ Leverage Fault indicators and refined patrol strategy to accelerate fault finding and restoration. ▪ Focus on having no unknown cause EPSS outages
Automatic Testing / Reclosing / Step Restoration	▪ Automatic testing is not performed and reclosing is disabled as part of the EPSS enablement instructions ▪ Patrol is required and step restore is performed for outages on EPSS enabled circuits
Fault Indicators	Fault indicators provide visual or remote indication of faults on the system – PG&E plans to deploy these to quickly identify hazards and improve restoration times. **PG&E's 2022 Plan Includes:** ▪ Install 1,600+ units on targeted locations by end of year ▪ Prioritize EPSS HRFA / HFTD circuits with lowest reliability ▪ Along circuits, install on fuse taps greater than 2 miles in length
Fuse Savers	A fuse saver provides faster response to faults than traditional fuses and can be SCADA enabled to operate in concert with EPSS protection schemes. **PG&E's 2022 Plan Includes:** ▪ Install 136 units with 88 in current scope by end of Q2, and 48 emergent units by end of Q3. ▪ Prioritize against EPSS HRFA / HFTD circuits with highest CEMI impact ▪ Upgrade fuses with fuse savers at critical locations that will result in lower CEMI impact
Outage Customer Support & Communications	Proactive communication efforts will be targeted to ~1.8M potentially impacted customers across the 1,018 EPSS capable distribution circuits. **PG&E's 2022 Plan Includes:** ▪ Advanced notification and regular updates for planned outages ▪ Updates after and during unplanned EPSS outages

SCE Fast Trip Setting Program

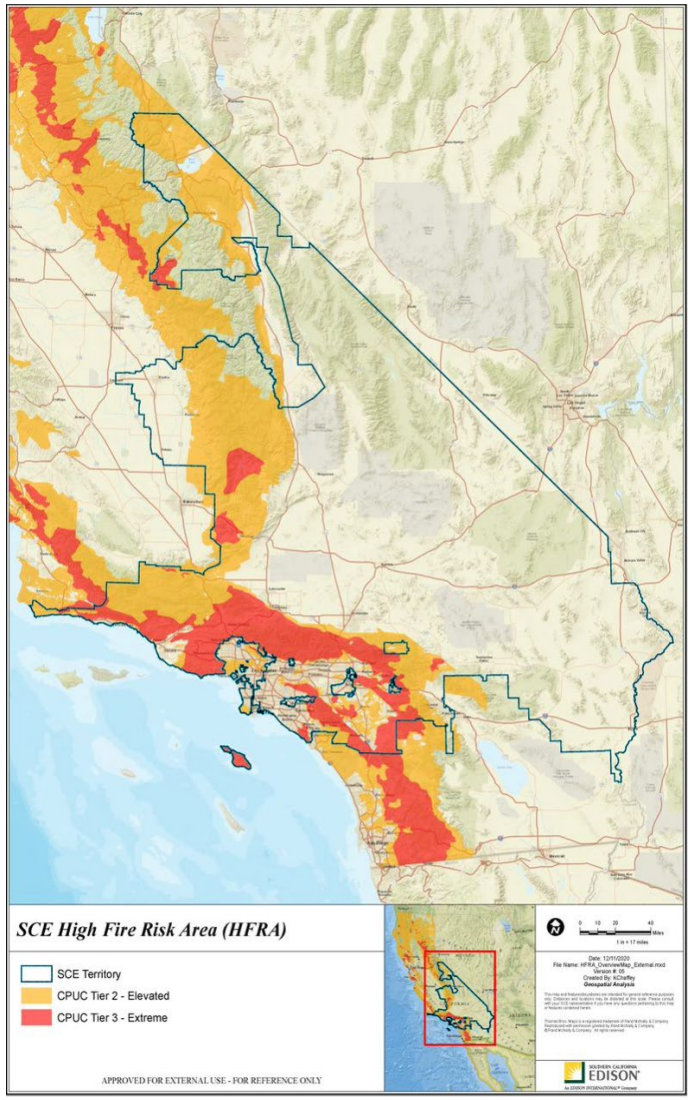
Together, Building
a Better California

SCE Service Territory Overview



SCE Service Territory Overview	
Service Area	~50K Square Miles
Customers	~5M Electric Utility Customers
Distribution Circuit Miles	~69.8K Primary Overhead & Underground
Transmission Circuit Miles	~13.1K Overhead & Underground
Service Territory Description	About a quarter of SCE's service area across central, coastal and southern California is in high fire risk areas

SCE's Fast Trip Program Summary



Fast Trip Program	
Program Name	**Fast Curve (FC) Settings**
First Deployed	2018
Current Scope	HFTD / HFRA
Devices Used	▪ Circuit Breakers ▪ Line Reclosers ▪ Current-Limiting Fuses
Protection Summary	▪ Circuit-specific settings which provide fault energy reduction and a level of coordination between the current-limiting fuses and the circuit breakers and/or line reclosers ▪ Phase and ground pickup elements set to a multiple of the device minimum trip no less than 2.3 times for phase and 5 times for ground ▪ Phase and ground pickups set to detect faults out to end-of-zone (downstream protection recloser/fuse or end of line) protective device ▪ 50P and 50N definite time elements set to 4 cycles which provides fast operation to reduce fault energy while still providing coordination with downstream fuses
Activation Criteria	Fast curve settings activated in the event of any of the following: ▪ Red Flag Warning declared by National Weather Service ▪ Fire Weather Threat declared by SCE Weather Service ▪ Fire Climate Zone declared by SCE Weather Service ▪ Thunderstorm Threat declared by SCE Weather Service

SCE's Fast Trip Device Protection Overview

Fast curve makes our system devices more responsive to wildfire risks by…

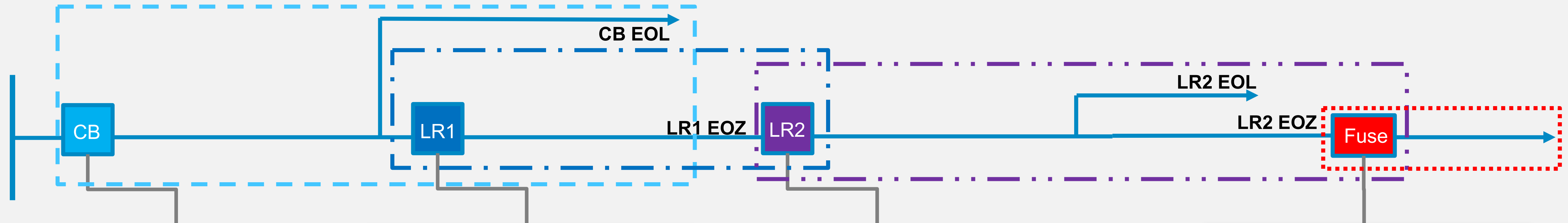
Faster Fault Detection
Faster trip settings detect distribution primary faults more quickly to reduce incident fault energy

Use of Current-Limiting Fuses
Use of current-limiting fuses reduce fault energy up to 25 times which lessens incandescent particles and wire downs

Reducing Total Fault Energy
Fast curve reduces risk of initial fault impact (wire down) by limiting the fault energy

Fast Trip Device Protection

- Fast curve settings make use of previously unused instantaneous/definite time overcurrent elements within the relays which are locally or remotely enabled
- Normal relay settings are always active and don't change even if the fast curve settings are enabled or disabled
- Fast curve settings are disabled during energization of a circuit or circuit section following a patrol to avoid inrush trips
- Fast curve-enabled line reclosers and/or current-limiting fuses are strategically placed near HFRA boundaries and may allow fast curve settings to be disabled on upstream non-HFRA circuit sections
- Use of fast curve-enabled line reclosers and current-limiting fuses reduces the outage area and subsequent patrol times



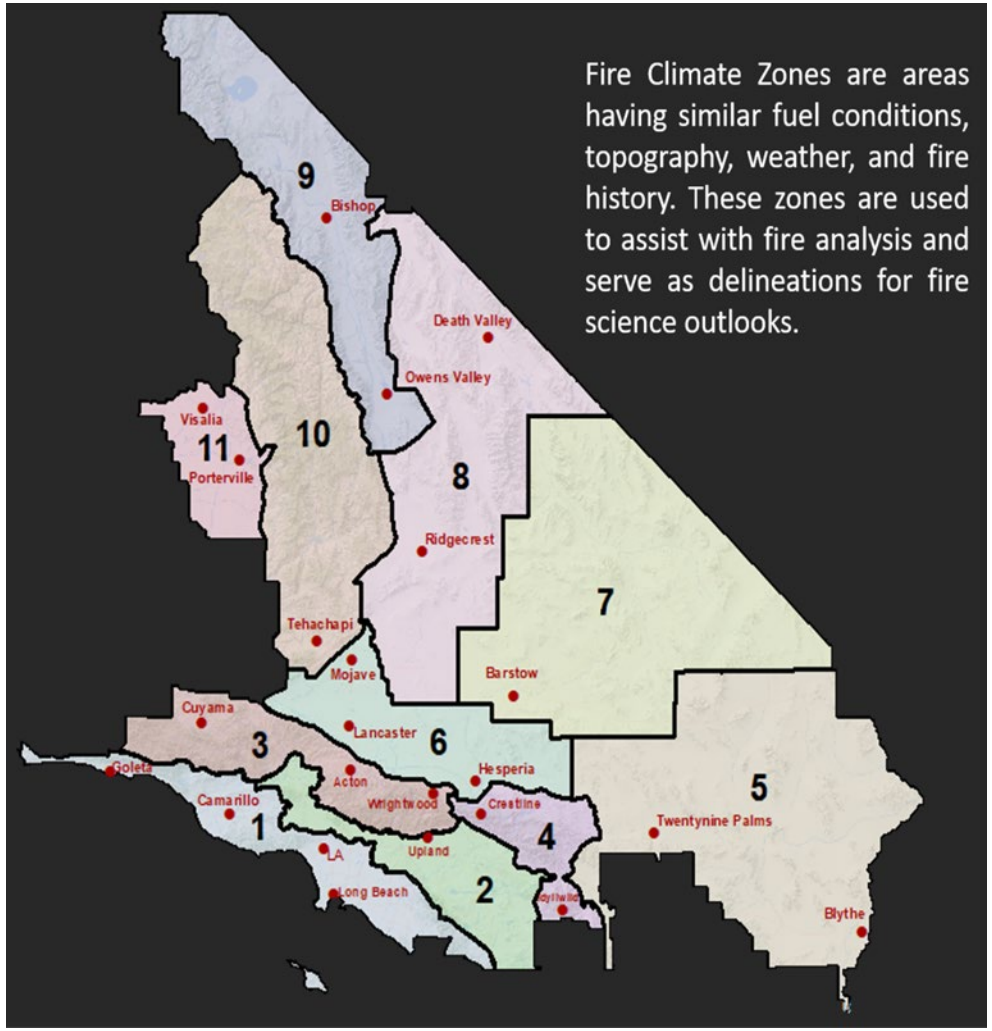
51P (Phase TOC): **< 43% LLL EOZ**
51N (Ground TOC): **< 20% LG EOZ**
50P (Phase IT): **≥ 2.3x 51P**
50 DLY (Phase IT Delay): = **0.066s**
50N (Ground IT): = **≥ 5x 51N**
50N DLY (Ground IT Delay): = **0.066s**

51P (Phase TOC): **< 43% LLL EOZ**
51N (Ground TOC): **< 20% LG EOZ**
50P (Phase IT): **≥ 2.3x 51P**
50 DLY (Phase IT Delay): = **0.066s**
50N (Ground IT): = **≥ 5x 51N**
50N DLY (Ground IT Delay): = **0.066s**

51P (Phase TOC): **< 43% LLL EOZ**
51N (Ground TOC): **< 20% LG EOZ**
50P (Phase IT): **≥ 2.3x 51P**
50 DLY (Phase IT Delay): = **0.066s**
50N (Ground IT): = **≥ 5x 51N**
50N DLY (Ground IT Delay): = **0.066s**

Current-Limiting Fuse
- Sized to provide selective (1 cyc) coordination with upstream protective device

SCE's Fast Trip Enablement Event-Driven Criteria



Activation Criteria Overview

SCE enables fast curve settings for equipped devices on impacted circuits and circuit sections that traverse HFRA in the event of any of the following:

- **Red Flag Warning** declared by National Weather Service
- **Fire Weather Threat** declared by SCE Weather Services
  - Circuit conditions forecasted for Fire Potential Index (FPI) greater than or equal to 11 and wind speeds greater than or equal to 31 mph sustained and/or 46 mph gust
- **Fire Climate Zone Threat** declared by SCE Weather Services
  - Seasonal approach based on zone-specific historical occurrence of fuel-driven fires
- **Thunderstorm Threat** declared by SCE Weather Services
  - Weather models predicting 30% or higher chance of dry lightning occurring over HFRA area

SCE's Outage Response & Restoration

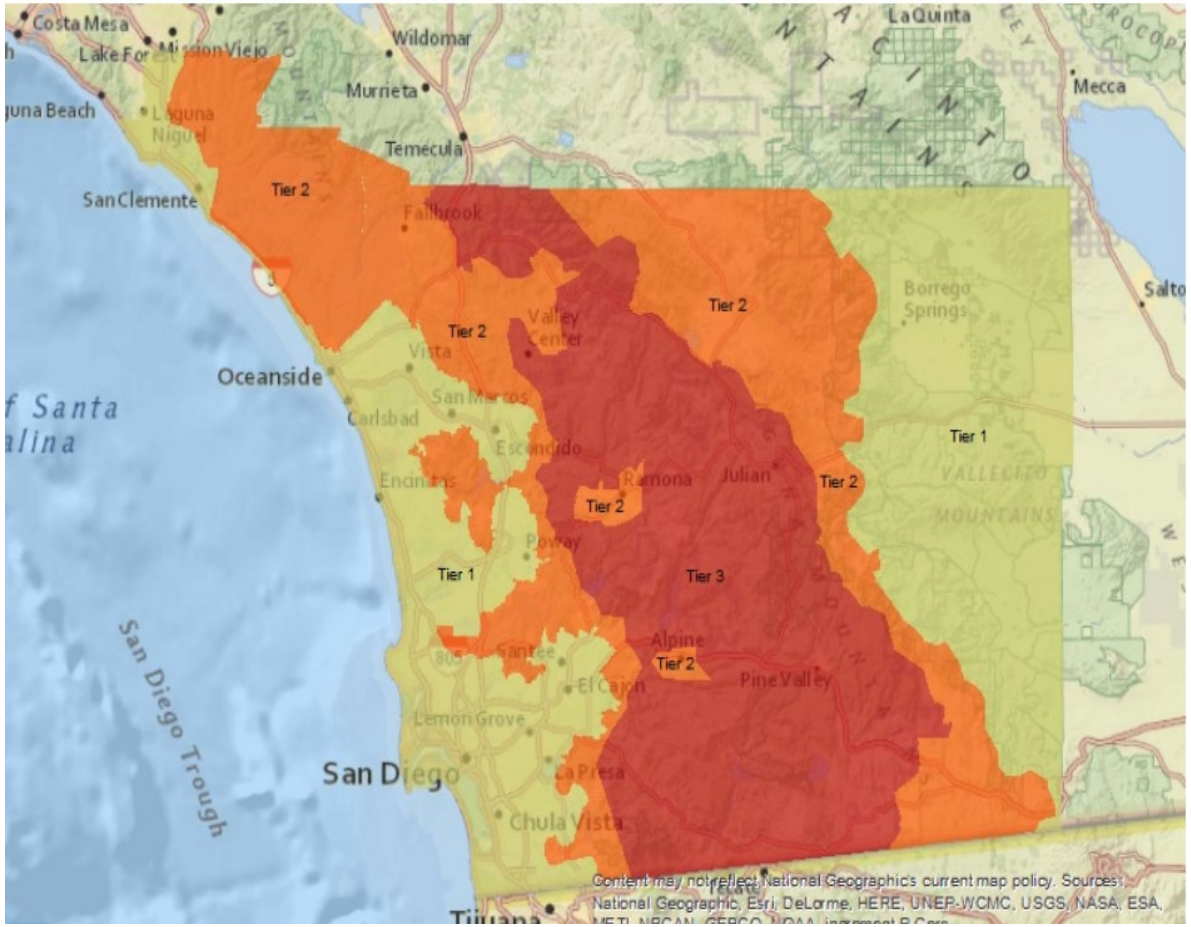
Outage Response & Restoration	
Outage Response Target	60 minutes. Fast curve activations receive similar treatment to trouble calls in high fire risk areas and take top priority.
Dedicated Response Crews & Resources	Although resources are not dedicated specifically for fast curve settings: ▪ Additional crews may be put on standby associated with storm conditions or leading up to PSPS events as needed ▪ Helicopter patrols and drones are leveraged for difficult-to-access locations
Automatic Testing / Reclosing / Step Restoration	▪ Automatic reclosing is disabled upon declaration of Red Flag Warning, Fire Weather Threat, Fire Climate Zone and/or Thunderstorm Threat conditions in high fire risk areas ▪ Patrol is required prior to re-energization and step restoration is performed
Fault Indicators	▪ SCE has both mechanical and remote-monitored fault indicators; 4,200+ installed in high fire risk areas ▪ Even with the presence of fault indicators, SCE requires all high fire circuitry which is de-energized following a fault to be patrolled before re-energizing during elevated fire weather and fuel conditions
Fuse Savers	▪ Fuse savers are not part of SCE's current fast curve strategy
Outage Customer Support & Communications	▪ SCE does not alter communication to customers when fast curve settings are enabled ▪ Customers receive standard repair outage alerts and updates through their preferred channel and outage details are also updated on SCE's Outage Map at sce.com/outagemap

SDG&E Fast Trip Setting Program

Together, Building
a Better California

SDG&E Service Territory Overview

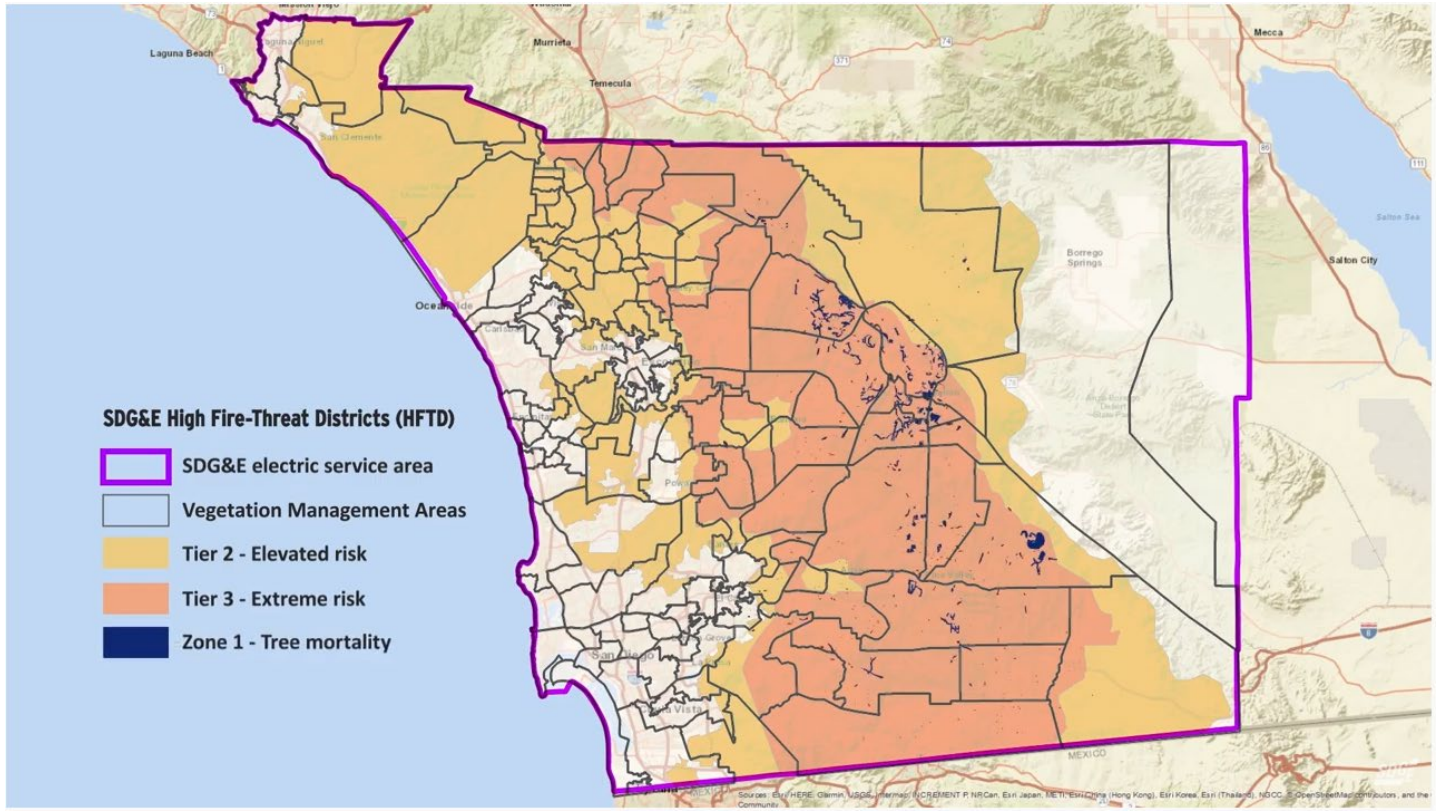
SDG&E HFTD Districts



SDG&E Service Territory Overview	
Service Area	4,100 square miles
Customers	3.7M people through 1.5M electric meters
Distribution Circuit Miles	17,401
Transmission Circuit Miles	1,995
Service Territory Description	64% of service territory within HFTD.

SDG&E's Fast Trip Program Summary

SDG&E HFTD Districts

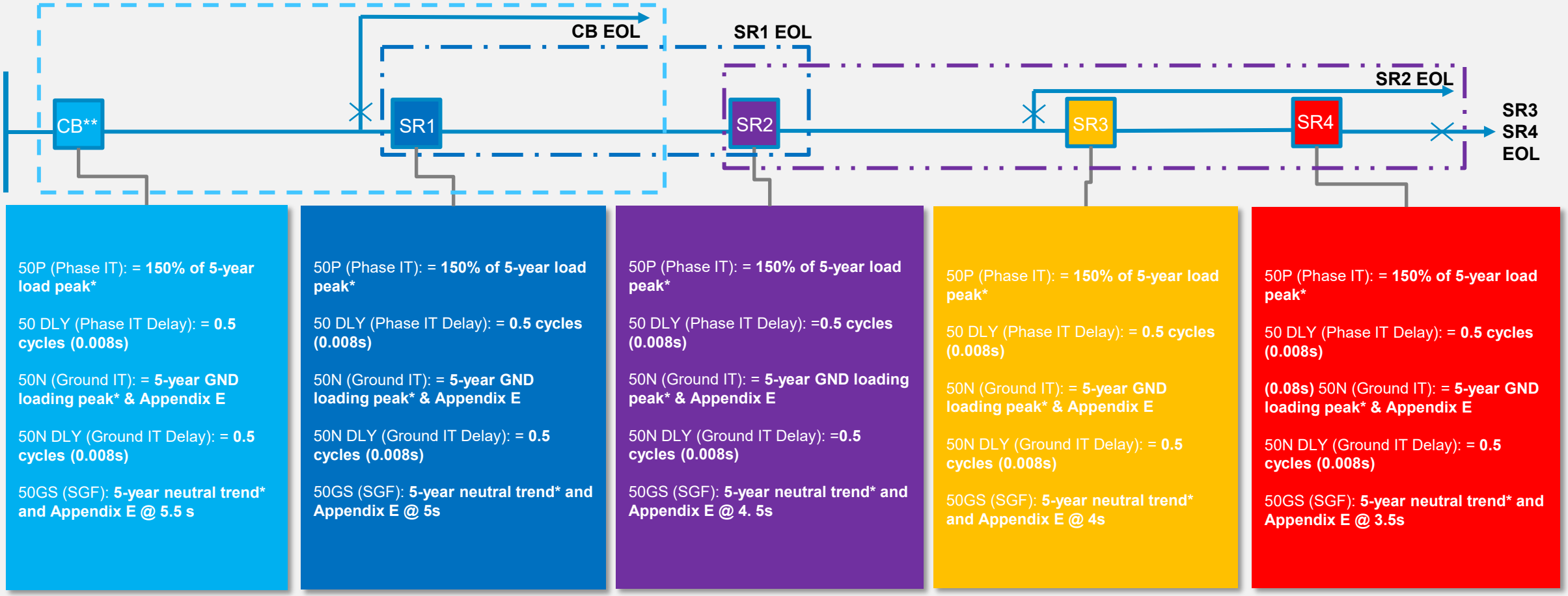


Fast Trip Program	
Program Name	**SRP: Sensitive Relay Profile**
First Deployed	2011
Current Scope	RFW / PSPS
Devices Used	▪ Circuit Breakers ▪ Line Reclosers ▪ Pad mounted fault interrupters
Protection Summary	▪ Setpoint for SRP is determined by reviewing a 5-year load trend for phase and ground over SCADA ▪ Phase element is set by 150% of peak load ▪ 85% coordination factor with adjacent SRP devices, but also prioritize reaching EOL ▪ All reclosers lock out on initial trip ▪ Devices are set to clear instantaneously with .5 cycle delay
Activation Criteria	▪ Extreme FPI ▪ Forecasted PSPS events

SDG&E's Fast Trip Device Protection Overview

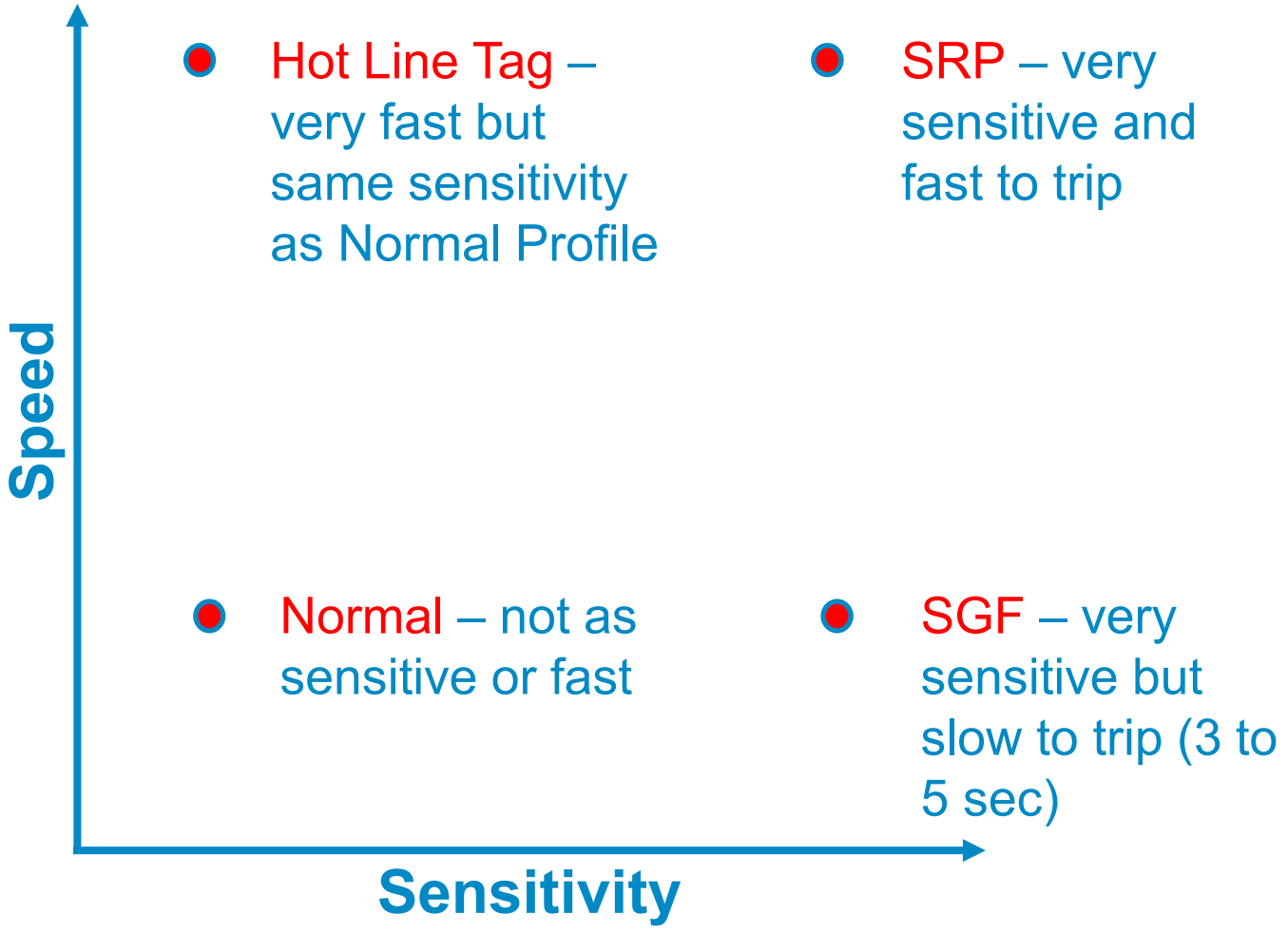
Fast Trip Device Protection

- SDG&E has been deploying Fast Trip Settings for over 10 years, referred to as Sensitive Relay Profile (SRP)



SR = Service Restorer
* - Excludes when devices are bypassed or in switch mode, denoting abnormal conditions
** - SRP only enabled on substation CB if SR directly outside the sub feeder is out of service or if there are circuit bifurcations between the CB and first downstream SR

SDG&E's Fast Trip Device Protection Overview



Normal Profile – Typical setting used to coordinate isolation of only faulted segments (Enabled when not in RFW or Extreme FPI)

SGF – Sensitive Ground Fault protection to detect high impedance faults (Always enabled)

SRP – Sensitive Relay Profile settings on phase and ground set to trip very fast to reduce fault energy (Enabled during PSPS or Extreme FPI)

Hot Line Tag – Enabled for crew safety when performing hot work. Same setpoints as Normal Profile, but very fast to trip.

Reclosing – Blocked year-round in HFTD

SDG&E's Fast Trip Enablement Event-Driven Criteria

Activation Criteria Overview

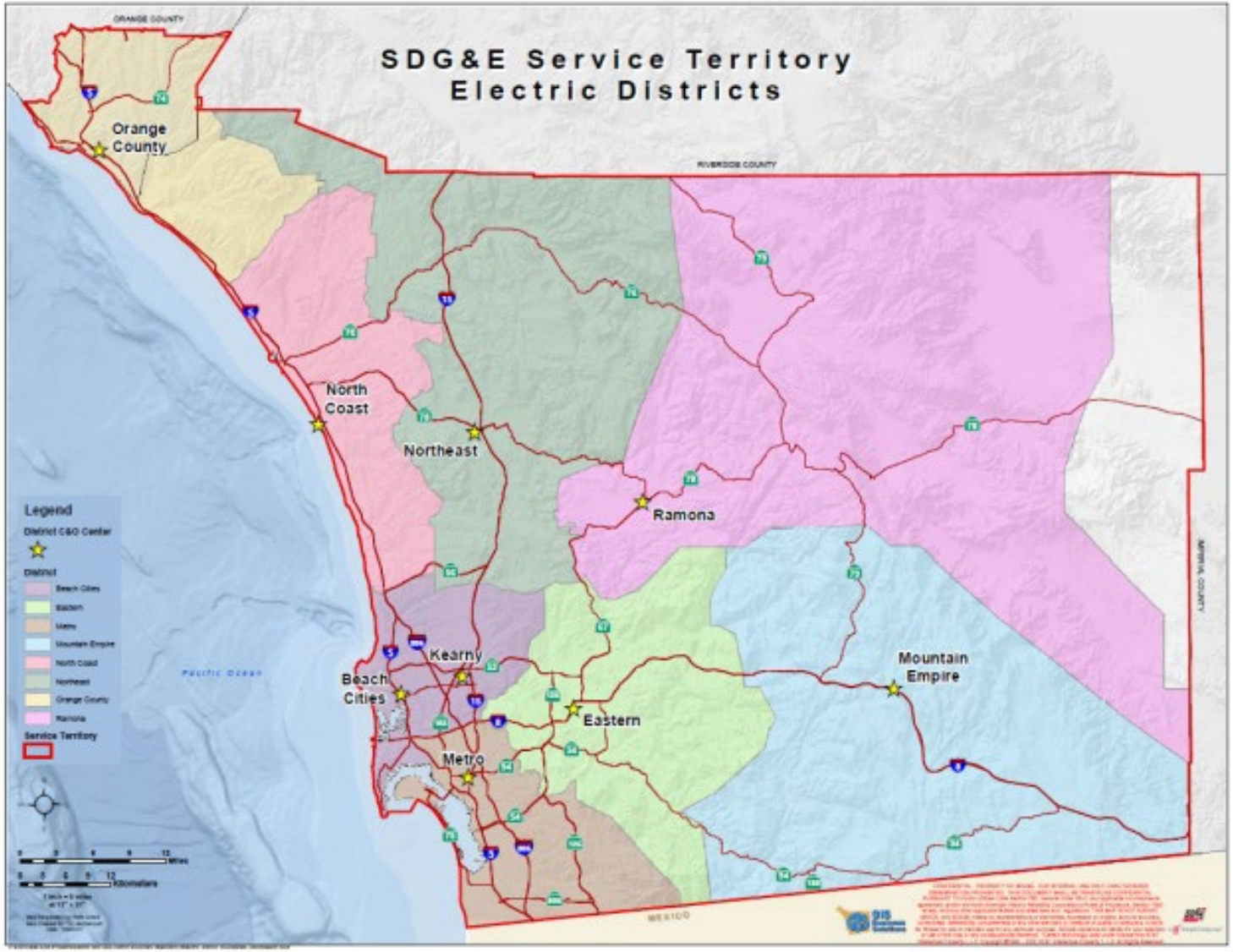
- Phase: 150% of the maximum 5-year load trend data obtained from SCADA (excludes when devices are bypassed or in switch mode, denoting abnormal conditions)
- Ground: Set using Appendix E table below

Appendix E – SGF and Profile 3 ground setting guideline

Pick max PI ground Amps: exclude temp SGF blocking during switching	IR/651R SGF setting	P3 gnd setting for IR's Coopers and 651R's	Cooper SGF "backup": set well above P3 setting for growth (100 max)	Cooper 60hz buffer: T= typical load changing circuits	Cooper 60hz buffer: H= high load changing circuits
1	10	20	30	8	9
5	15	20	35	13	13
10	20	25	40	15	17
15	25	30	45	15	17
20	30	35	50	15	17
25	35	40	55	15	17
30	40	45	60	17	20
35	45	50	65	17	20
40	50	55	70	17	20
45	55	60	75	17	20
50	60	65	80	17	20
55	65	70	90	17	20
60	70	75	95	17	20
65	75	80	100	17	20
70	80	85	100	17	20
75	85	90	100	17	20
80	90	95	100	17	20
85	95	100	100	17	20
90	100	110	100	17	20
90+	OFF	OFF	OFF	OFF	OFF

*Based on five year historical trend

SDG&E's Fast Trip Enablement Event-Driven Criteria

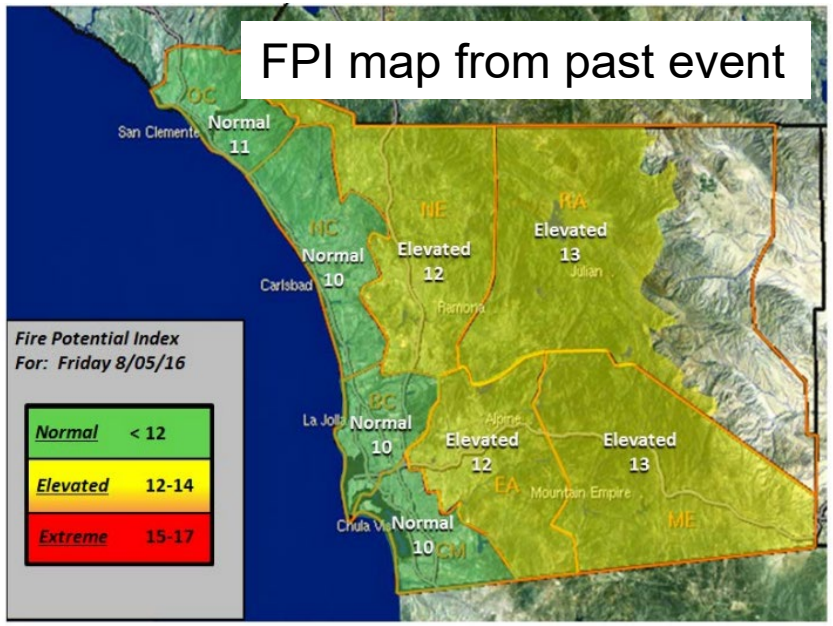


Activation Criteria Overview

Sensitive Relay Settings will be enabled for on devices as described below:

- If the FPI is Extreme in Mountain Empire and/or Ramona, Tier 3 should have Sensitive Relay Settings enabled
- If the FPI is Extreme in Eastern and/or Northeast, the entire HFTD (Tier 2 and Tier 3) should have Sensitive Relay Settings enabled
- If the FPI is Extreme in Orange County, then the HFTD in Orange County should have Sensitive Relay Settings enabled
- If the FPI is Extreme in any of the San Diego County coastal districts (North Coast, Beach Cities, Metro) all the Coastal Circuits with Fire Risk should have Sensitive Relay Settings enabled

SDG&E's Outage Response & Restoration



Seven Day FPI Outlook:

	Today 8/04	Fri 8/05	Sat 8/06	Sun 8/07	Mon 8/08	Tue 8/09	Wed 8/10	Thu 8/11
ME	Elevated 12	Elevated 13	Elevated 13	Elevated 13	Elevated 13	Elevated 13	Elevated 13	Elevated 13
RA	Elevated 12	Elevated 13	Elevated 13	Elevated 13	Elevated 13	Elevated 13	Elevated 13	Elevated 13
EA	Elevated 12	Elevated 12	Elevated 12	Elevated 12	Elevated 12	Elevated 13	Elevated 13	Elevated 13
NE	Elevated 12	Elevated 12	Elevated 12	Elevated 12	Elevated 12	Elevated 13	Elevated 13	Elevated 13
OC	Normal 11	Normal 11	Normal 11	Normal 11	Normal 11	Normal 11	Normal 11	Normal 11
NC	Normal 10	Normal 10	Normal 10	Normal 10	Normal 10	Normal 10	Normal 10	Normal 10
BC	Normal 10	Normal 10	Normal 10	Normal 10	Normal 10	Normal 10	Normal 10	Normal 10
CM	Normal 10	Normal 10	Normal 10	Normal 10	Normal 10	Normal 10	Normal 10	Normal 10

Normal	Elevated	Extreme
< 12	12-14	15-17

Outage Response & Restoration	
Outage Response Target	**60 minutes**
Dedicated Response Crews & Resources	▪ During Extreme FPI / PSPS Events, dedicated crews staffed for restoration and readiness response ▪ Line SCADA crews are staffed 24/7 ready to respond to collect relay event records. ▪ Records are sent to System Protection Engineering for review ▪ Records help determine proper operation and help with determining fault location ▪ Feedback from Engineering provided to the operations teams for better situational awareness
Automatic Testing / Reclosing / Step Restoration	▪ Protocols for testing / reclosing / restoration are no different between SRP and non-SRP conditions when under Extreme FPI / PSPS conditions ▪ Automatic testing is not performed, and reclosing is disabled ▪ Patrol is required and step restore is performed for all outages
Fault Indicators	Fault indicators provide visual or remote indication of faults on the system – SDG&E plans to deploy these to quickly identify hazards and improve restoration times. **SDG&E's 2022 Plan Includes:** ▪ Install 300-500 units on targeted locations by end of year ▪ Prioritize HFTD and WUI (Wildland Urban Interface) circuits based on results of sensitive relay outages ▪ Along circuits, install on bifurcations or midway on non-SCADA conductor sections, where facilities enter areas of high fuel concentrations, difficult to patrol areas, or transitions between HFTD tiers, overhead and underground unfused transitions, and downstream of non-SCADA substations.
Fuse Savers	SDG&E is currently not planning on deploying any fuse savers on our system.
Outage Customer Support & Communications	SDG&E does not alter communication to customers when SRP is enabled. ▪ Outage response is no different for SRP outages versus non-SRP outages during an event