Equipment Requiring Repair (ERR) Prioritization Model - Purpose

- This document is a model to help divisions prioritize the equipment on the ERR list by impact and probability.
- It is intended to be used in conjunction with the ORT meetings
- The ERR budget can then be applied to the equipment with the highest priority and will have the most impact to reliability.
- As you move forward in the year this model may need to be re-applied and equipment re-prioritized due to new outages.
- Funding for replacement of UG cable on the ERR list will be handled by MWC 56

GRC2011-Ph-I_DR_DRA_206-Q02fAtch01

Corrective Maintenance Significance Definitions

Degree of Significance	Probability of Equipment Failure and Exposure	Impact of Failure and/or exposure
High	✓Nonfunctional & likely to be needed within less than 6 months ✓Equipment/facility already failed, broken or failure is highly probable. ✓Equipment has significant damage or high probability the equipment will fail prior to needed ✓Strong likelihood that condition will result in exposure to general public	✓Large # of customer minutes and large # of customers ✓Failure or exposure will lead to serious injuries, significant outages or will result in significant impact to PG&E operations or customers. ✓Public or regulatory perception (PBR) ✓Creates an imminent reliability concern or safety issue. ✓Significant increase in operating time/cost
Low	✓Nonfunctional and likely to be needed within greater than 6 months ✓Requires repair but no immediate impact to operations, reliability, or customer minutes ✓Low likelihood or history of failures or contact. ✓Low likelihood will result in exposure to general public	✓No immediate impact on Safety to the public or utility workers. ✓No immediate impact on Reliability. ✓Little potential for significant outages. ✓Low number of customers and customer minutes.

GRC2011-Ph-I_DR_DRA_206-Q02fAtch01

Corrective Maintenance -Selected Model

SIGNIFICANCE RANKING

Probability / Impact	High	Moderate	Low
High	**1**	**1**	**2**
Moderate	**2**	**3**	**3**
Low	**2**	**4**	**4**

- **Probability**
  - Outage history of Source Side Device
  - How often equipment is used
  - Frequency reaches trigger levels, recent outage history
  - Facility failure
  - Likelihood of hazardous exposure to the public or utility workers
- **Impact**
  - Close to substation
  - Critical customers involved
  - Severity – estimate of potential loss
  - Hazardous exposure to the public or utility workers
  - # of Customers
  - Duration of Outage
  - Public or regulatory impact/perception
  - Internal/external standards
  - Seasonal usage
- **Significance Ranking**
  - Priority 1 thru 4

GRC2011-Ph-I_DR_DRA_206-Q02fAtch01

Significance Ranking

Impact of equipment failure or exposure to public or workers	Probability of equipment failure and exposure to public or workers	Priority Rank
High High	High Moderate	1
High Moderate Low	Low High High	2
Moderate Moderate	Moderate Low	3
Low Low	Moderate Low	4

GRC2011-Ph-I_DR_DRA_206-Q02fAtch01

Exercise for Corrective Maintenance Prioritization Model – Part A

Example	Description	Priority	Impact	Probability	Notes
1	Broken Bushing on Pole top regulator ==> Regulator is bypassed	4	L	M	Probability of needing it to function as required depends on season (in this case winter)
2	NG 600A separable connector on Mainline, Cable is cleared	1	H	H	High probability will need cables since on mainline, lower priority if it were on the local loop
3	Overhead switch is welded shut	2	L	H	Probability is dictated by location of switch in relation to substation (assumed close to sub carrying many customers)
4	Overhead switch is out of adjustment; currently in open position	1	H	M	Impact driven by location of switch relative to the substation/LR and high customer count sectionalized by it.
5	NG A phase SCADA Reading on Station A 1102 on DO's SCADA monitor	4	L	L	Impact is low since the relays and breaker still work and D.O. has other phases that can be read
6	SCADA line recloser will not reclose remotely	1	H	H	Assumed lots of customers and does not function today
7	NG 4-way LBOR with one of the switches contacts will not open (welded shut)	1	H	M	This is an old mainline switch that can not be operated. This switch has a moderate probability of failure and a high impact because it is assumed that the mainline switch position is not working.
8	Broken fuse holder on looped fuse has been bypassed	4	L	M	
9	NG UG primary with load picked up via back tie - Mainline	1	H	H	
10	NG UG primary with load picked up via local loop back-tie.	2	L	H	Cable is 28 years old and thus has a high probability of failure. Local fuse protection is OK so it has a low impact since it can only affect the local loop.
11	NG cable between T1234 and T1235 - customers restored, however fuse protection bypassed so that if a subsequent failure occurs on this 25 year old cable it will result in an outage to the entire circuit.	1	H	M	Probability is based on likelihood of continued failure on the same vintage cable. Impact based on potential of affecting the entire circuit.
12	Communications non functional to SCADA mainline switch S12	1	H	M	Impact driven by switch location relative to substation and high customer count sectionalized by it
13	Capacitor bank off line and tagged due to blown fuses	3	M	M	April time frame - would move to higher impact and higher prob as it gets closer to summer
14	Line regulators with non functional controls - found in August	1	H	H	Needed to correct summer voltage
15	SEO of SCADA switch is leaking; unsafe to operate	2	M	H	Assumes SCADA installed because switch was in remote location and critical to operate.
16	NG UG primary with load picked up via normal open disconnect of local loop.	4	L	M	Cable is 20 years old. No prior failures operated at 12 kV. Probability is low. Local fuse protection is still OK so impact is considered low.
17	NG UG primary with load picked up through normal back-tie of local loop.	2	L	H	Cable is DB, >25 years old, operated at 21kV, or experienced prior failures. Probability is based on likelihood of continued failures on same loop. Local fuse protection is still OK so impact considered low.

Exercise for Corrective Maintenance Prioritization Model – Part B

SIGNIFICANCE RANKING of Examples

Hypothetical Examples of Corrective Maintenance Conditions on ERR List:
Date: 11/19/04 – Winter Peaking Area in a Costal Division Type location

Probability / Impact	High	Moderate	Low
High	#2, #6, #9	#4, #12 #7, #11	
Moderate	#15	#13, #14	#6,
Low	#3, #10, #17	#1, #8 #16	#5,

1. Broken bushing on pole top regulator, regulator is bypassed
2. NG 600 amp separable connector on mainline, cable cleared
3. OH switch is welded shut
4. OH switch is out of adjustment; currently in the open position
5. NG A phase SCADA reading on Station "A" 1102/2, at the control center's SCADA console
6. SCADA Line Recloser will not close remotely
7. NG 4 way LBOR, with one of the switches' contacts will not open; contacts welded shut
8. Broken fuse holder on primary loop; fuse has been bypassed
9. NG UG mainline primary cable with load picked up via the back tie - mainline.
10. NG UG primary with load picked up via local loop back-tie.
11. NG cable between T-1124 & T-1125; all customers restored, however fuse protection bypassed so that if a subsequent failure occurs on this 25 year old cable it will result in an outage to the entire circuit.
12. Communications non functional to SCADA mainline switch
13. Capacitor bank off line & tagged due to blown fuse
14. Line regulator with non functional controls, found in August
15. SEO on SCADA switch is leaking
16. NG UG primary with load picked up via normal open disconnect of local loop.
17. NG UG primary with load picked up through normal back-tie of local loop.

GRC2011-Ph-I_DR_DRA_206-Q02fAtch01

Corrective Maintenance and SORD Prioritization – Suggested Timeframes

- Priority 1 : Work that should be done first with limited resources. Recommend it be completed at the site or 0 – 60 days
- Priority 2 : Work that should be addressed second when majority of higher priority work completed. Recommend it be completed 60 – 120 days
- Priority 3 : Lower priority work that should be completed as funding is available. Recommend it be completed 120 days – 1 year
- Priority 4: Lowest priority work to be done with available funding. (e.g. SCADA reading NG on one phase at workstation, Insulator sunk into 2ndary X-arm, etc.)

Note: *The timeframes are only suggestions based on a survey of OM&C employees, and may be adjusted once the model has been implemented*

GRC2011-Ph-I_DR_DRA_206-Q02fAtch01

ORT Decision Matrix

SYMPTOMS	POSSIBLE CAUSES	POSSIBLE CORRECTIVE ACTION
Suspected Bird Caused Outage – Mid-Span	• Vertical construction where perched birds take off all at once and slap wires • Spans in an open field or near a body of water which could be in the bird flight path. Look for dead birds on the ground mid-span	• Review UO Standard S2321 to ensure compliance • Install BFD's (Bird Flight Diverters), dwg. 061149 page 27 • Install mid-span spacers, dwg. 061149 page 26 • Reframe for wider spacing on suspected spans (ie: 60" phase separation) • Install insulated/covered (tree) wire • Contact the Bird Protection Program Manager for guidance
Suspected Bird / Animal Caused Outage – at pole location	• Fruit or nut trees in area • Bodies of water nearby • Dead animal / birds around base of poles • Flash/burn marks indicating animal contact • Conductor spacing too close • Incorrect BIL	• Review UO Standard S2321 to ensure compliance • Install bushing covers, dwg. 061149 pages 18 – 20 • Install insulator/wire cover, dwg. 061149 page 21 • Replace steel arm with wood arm • Install insulated jumpers • Install electrostatic animal guard, dwg. 061149 page 22 • Install perch, perch deterrents, dwg. 061149 pages 24 – 25 • Install squirrel wrap, dwg. 061149 page 27 • Install 48" pole top bracket on middle phase, dwg. 061149 page 7 • Retrofit with under-arm jumpers, dwg. 061149 page 16 • Bird/Animal proof ALL riser poles • Reframe pole with raptor framing (ie: 60" phase separation) • Contact the Bird Protection Program Manager for guidance

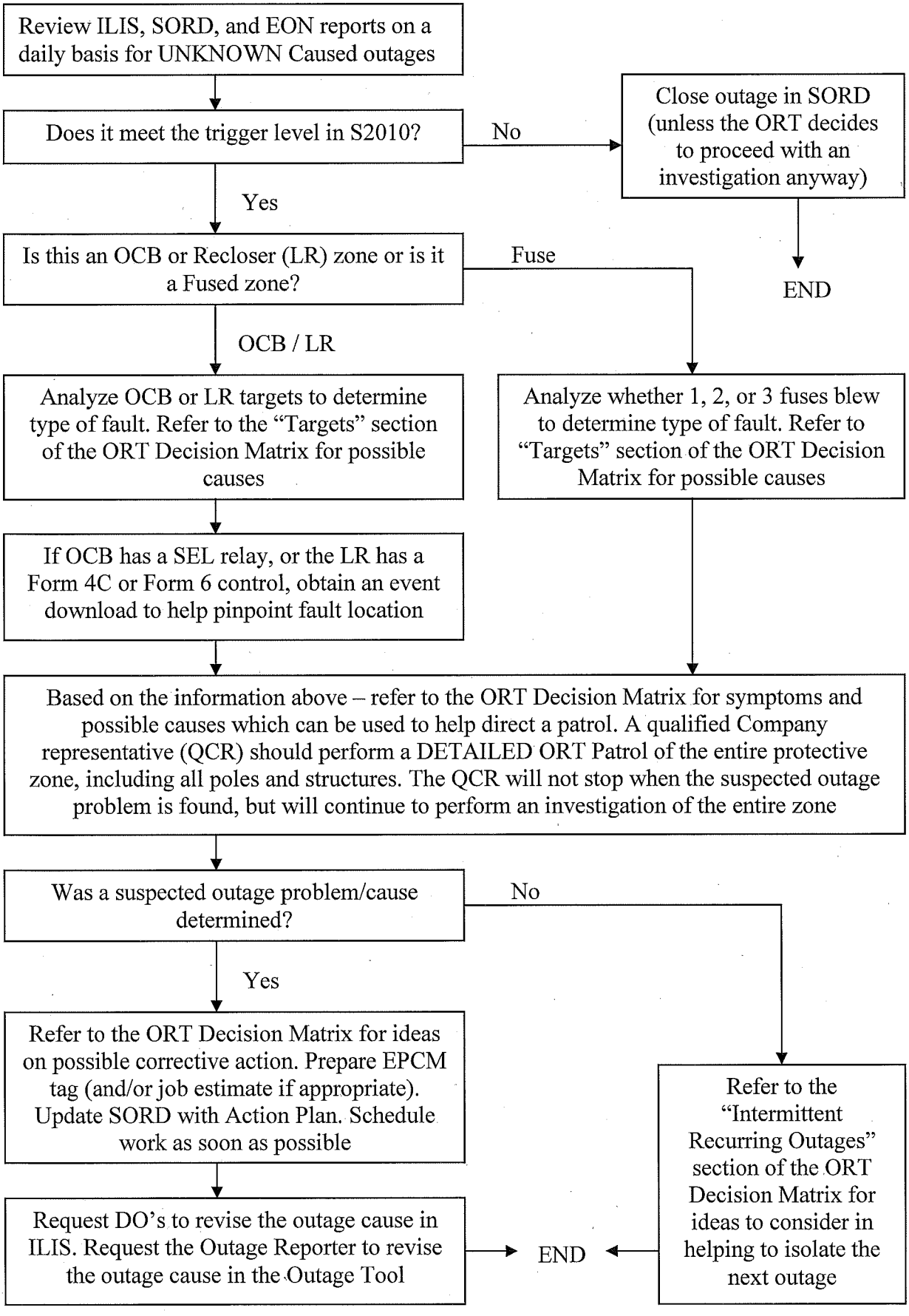
SYMPTOMS	POSSIBLE CAUSES	POSSIBLE CORRECTIVE ACTION
Unknown Caused Outage - Suspect cattle	• Cow, buffalo, horse, or bear rubbing down guy or pole, look for animal hair caught on pole or guy in open fields	• Install cattle guards • Install pole stub 5' high on pole side of anchor • Build a fence around the suspected pole and/or down guy
Unknown Caused Outage - Windy conditions	• Floater / wire on crossarm • Slack span slapping together • "Incorrect" phase transposition from flat to vertical, triangle to vertical, or triangle to flat creating reduced mid-span clearance between conductors • Conductor sag not even on "correct" phase transpositions from flat to vertical, triangle to vertical or triangle to flat creating reduced mid-span clearance between conductors • Very long spans • Tree branches hitting line • Palm fronds blowing into lines – look for nearby palm trees • Tree bark blowing into lines – look for nearby Eucalyptus trees • Broken guy	• Repair cross arm / equipment • Resag conductors • Trim and/or remove trees • Install covered tree wire • Install mid-span spacers • Reframe for wider spacing • Interset new pole • Proactively remove bark from line • Relocate lines • Convert suspected trouble span to underground
Unknown Caused Outage – Snowy/Icy conditions	• Snow/Ice unloading from lines • Snow blower shooting ice and snow into lines or equipment • "Incorrect" phase transposition from flat to vertical, triangle to vertical, or triangle to flat creating reduced mid-span clearance between conductors • Conductor sag not even on "correct" phase transpositions from flat to vertical, triangle to vertical or triangle to flat creating reduced mid-span clearance between conductors	• Resag conductors • Reframe for wider spacing • Interset new pole • Install metal plates towards road to block debris from snow blower • Relocate poles or equipment
Unknown Caused Outage - Recent Lightning storm followed by intermittent recurring outages	• NG lighting arresters. Ground lead disconnect may be blown out of the bottom of the arrester • Cracked or flashed bushings or insulators	• Repair / replace as necessary

SYMPTOMS	POSSIBLE CAUSES	POSSIBLE CORRECTIVE ACTION
Repeated overhead conductor down	• Calculate I^2T to see if overstressed • Possible annealed wire, send sample to TES for testing and verification • NG connectors – Infrared the line to check for hot spots • Moisture entering under improperly sealed and/or damaged insulated aluminum conductor (tree wire & insulated secondary conductors)	• Repair / replace as necessary • Reconductor • Infrared patrol line
Recloser failed to trip	• Miscoordination with backup device • For 3A control: the battery is likely dead • For Form 4C and Form 6 controls: the 120vac power supply is out AND the battery is dead • Improper CT ratio	• Cut-in ground relay • Download control's event recorder • Replace battery • Replace power supply • Replace control cable • Replace recloser control • Replace recloser unit
OCB or Recloser tripped or locked out for fault beyond a load-side protective device	• Device miscoordination • "Wire gallop" or "wire roping" - long spans slapping together • See possible causes under "Recloser failed to trip"	• Check device coordination • Look for flat crossarm or triangular steel bracket construction • Install mid-span spacers • Reframe for wider spacing • Interset new pole
OCB or Recloser incorrectly locking out in 1 shot	• Test for possible NG reclosing relay • Check position of reclosing relay switch • Check for properly installed reclose settings • Instantaneous lockout feature is turned on • Closing Coil is located on the wrong side of recloser • See possible causes under "Recloser failed to trip"	• Replace / repair equipment • Cut-in reclosing relay • Change reclose settings • Turn off instantaneous lockout feature • Reverse reclose unit or install unit with the Closing Coil Transfer accessory
OCB or Recloser tripping or locking out but no faults found on patrols	• Check for insects throughout entire cabinet for insects / nests shorting out electrical contacts • Water intrusion in control cabinet	• Clean / repair as necessary • Seal cabinet
4-wire system - OCB or Recloser tripping or locking out with ground or SGF target	• Phase unbalance • Open-Delta regulator installed between Y-Grd station and Y-Grd Autobank causing neutral shift problem	• Take load readings as required • Change single phase tap connections to balance load • Change to Closed-Delta regulator

SYMPTOMS	POSSIBLE CAUSES	POSSIBLE CORRECTIVE ACTION
Fuse blowing or OCB/Recloser tripping via over-current	• Peak overload condition • Phase unbalance • Incorrect equipment settings	• Change fuse size • Raise minimum trip levels • Check settings versus records • Check position of alternate trip switch • Change single phase tap connections to balance load
Padmount / subsurface equipment flashover	• Snake or animal into subsurface or pad-mounted enclosure • Vegetation growing into enclosure • Water leaking into padmounted equipment	• Seal off all entry points into enclosure • Seal off all ducts leading into enclosure • Remove vegetation
Time of day similar on recurring outages	• School kids waiting for bus and swinging / shaking down guy • Train horn startling perched birds causing wires to slap when they take off • Faulty / large load coming on by time-clock (sprinkler/pump timer)	• See suggestions under "Bird outages, mid-span" • Take load readings as required to record and track down location of faulty / large load
Recurring gun shot insulators	• Vandals • Bored hunter	• Replace porcelain insulators with non-porcelain insulators in affected area
Distribution Transformer fuses blowing or secondary breaker tripping	• Secondary or service problems • Transformer overload condition (tripping during peak periods is a definite sign of overloading) • Secondary transformer breaker may be NG	• Replace / repair secondary equipment • Replace transformer
Recurring vehicle pole / vehicle pad mounted equipment	• Winding road • Pole/equipment too close to traffic area	• Install visibility strips • Install barricades • Relocate pole, down guy, or equipment • Work with city/county to install road signs
Unknown cause for tap line fuse blowing but problem likely on secondary side of transformer	• Line fuse does not coordinate with transformer fuse (fusing on large transformer is unlikely to coordinate with tap fuse) • Overload • Damaged fuse from earlier event	• Identify which fuse(s) blew and log • Take clamp on reading, upsize tap line fuse as necessary

SYMPTOMS	POSSIBLE CAUSES	POSSIBLE CORRECTIVE ACTION
Intermittent Recurring Outages – Unknown Caused	• Any of the causes listed throughout this document	• Perform load transfer to help isolate possible outage area • Install temporary overhead fault indicators (manual reset) to help isolate problem (code M362135 for 450 amp, code M362148 for 200 amp, code M202248 for trip & reset magnet) • Install additional fault indicators in the underground system • Infrared zone to detect hot spots that may be flashing over • Prepare capital job to install new line fuses on un-fused tap lines in affected zone to help isolate future problems • If momentary outages – remove "fast curves" from recloser so downstream line fuses will blow
Unknown Caused Outage in OCB or LR zone – SEL relay, Form 4C or 6 control	• Unknown	• Download fault event data to help pinpoint outage location based on measured fault duty compared to calculated fault duty on COORD report
Unknown Caused Outage in OCB or Recloser zone – Examine relay targets	• Instantaneous target – fault is likely close-in which will help narrow the patrol zone • Phase-to-phase – wire slapping, floater, tree branch pushing wires together, bird cross phasing, etc… • Line-to-ground – wire on crossarm, floater, tree on line, NG lightning arrester, etc… • Sensitive Ground Fault (SGF) – cracked or flashed insulator, NG lightning arrestor, tree branch, wire down "away from station" on asphalt or snow, etc…. • Always a specific phase? Trace wire out throughout zone – check for phase unbalance	• Refer to various Symptoms and possible causes listed throughout this document for ideas and possible corrective actions • Repair / replace faulty equipment
Mainline outage with high fault current	• Stress from the high fault current may have damaged / weakened connectors and/or devices	• Consider performing an Infrared patrol from the fault location all the way back to the substation to detect any new hot spots

UNKNOWN CAUSED OUTAGE DECISION TREE



Priority for Repair of Distribution Line Equipment Requiring Repair (ERR)

Priority for repair of ERR is based on safety, operational and reliability impacts.

Priority 1 – Safety
Recloser/Fuses where source-side protective devices must see the end of line faults. These protective devices must be replaced or repaired ASAP to clear faults.
(Every attempt should be made to have equipment replaced at the time of the outage and charged to MWC 17 or BH)

Priority 2 – Priority 2A – Operational
Priority 2A – Line equipment / capacitor banks / regulator & booster banks needed to supply power and support system voltage so that service voltage can be maintained within rule 2 requirements. This equipment must be repaired/replaced ASAP. *(ASAP means "within the time it takes to get the equipment / parts in the yard so the repair can occur")*
Priority 2B - Seasonal peak operations - capacitor banks / regulator & booster banks needed to support system voltage and/or power factor during seasonal peak load period, July-September in the summer and December-February in the winter. This equipment must be repaired or replaced ASAP during the seasonal peak load period.

Priority 3 – Reliability: Tie Cable N-1 operations & Network SCADA (San Francisco & Oakland) & Equipment
Tie cable/Network - circuit(s) off line due to cable or equipment failures.
Network SCADA system

Priority 4 – Reliability: By-passed protective devices (not fault related)
Priority 4A – Reclosers/Interrupters/Sectionalizers
Priority 4B – Fuses

Priority 5 – Reliability: Emergency tie cable, OH/UG conductor & equipment
Priority 5A : Repair of regulating devices needed for emergency switching
Priority 5B : Repair of faulted cable and or ug equipment to maintain ties in mainline & local loops.

Priority 6 – Reliability: SCADA and sectionalizing devices
Priority 6A – Switches / cutouts / jumpers
Priority 6B – Field SCADA

Priority 7 – Reliability: seasonal peak load equipment during off peak seasons.
Repair/replacement of capacitor and regulator banks needed only for seasonal peak support during their off peak period. However, this equipment will become priority 2 if not repaired or replaced by May in the summer or/and October in the winter. Repair within 180 days per S-2010.

SUPERSEDED BY ERP PRIORITIZATION PROCESS ON MAR 05
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