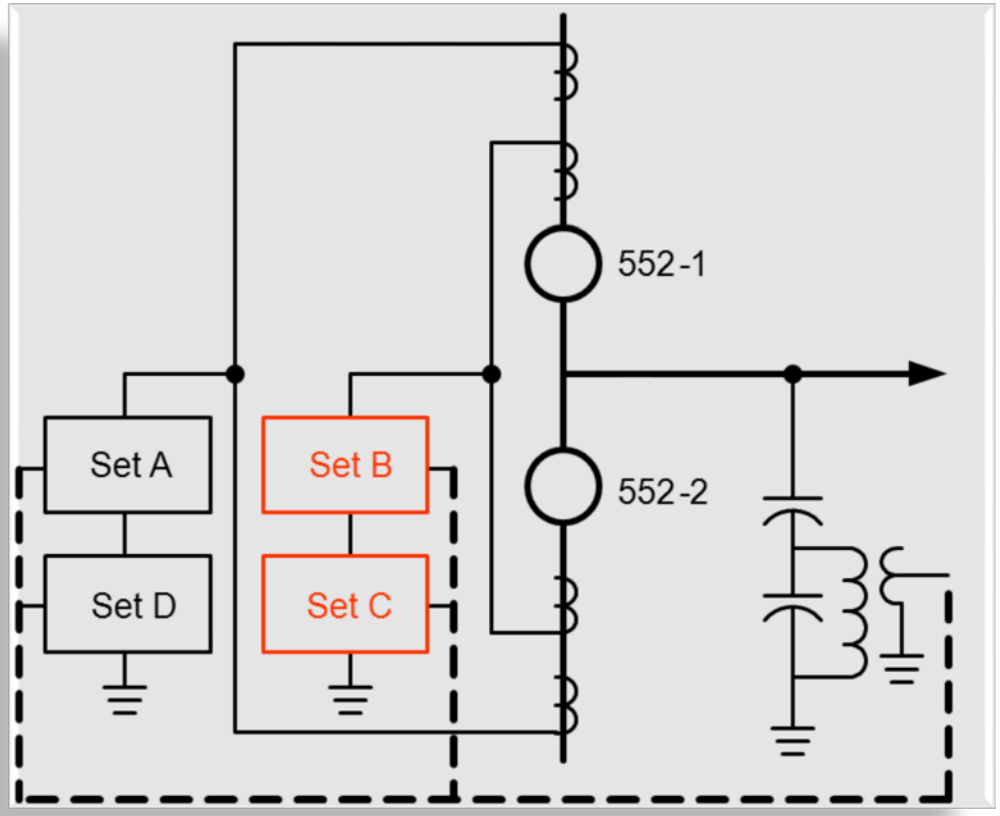
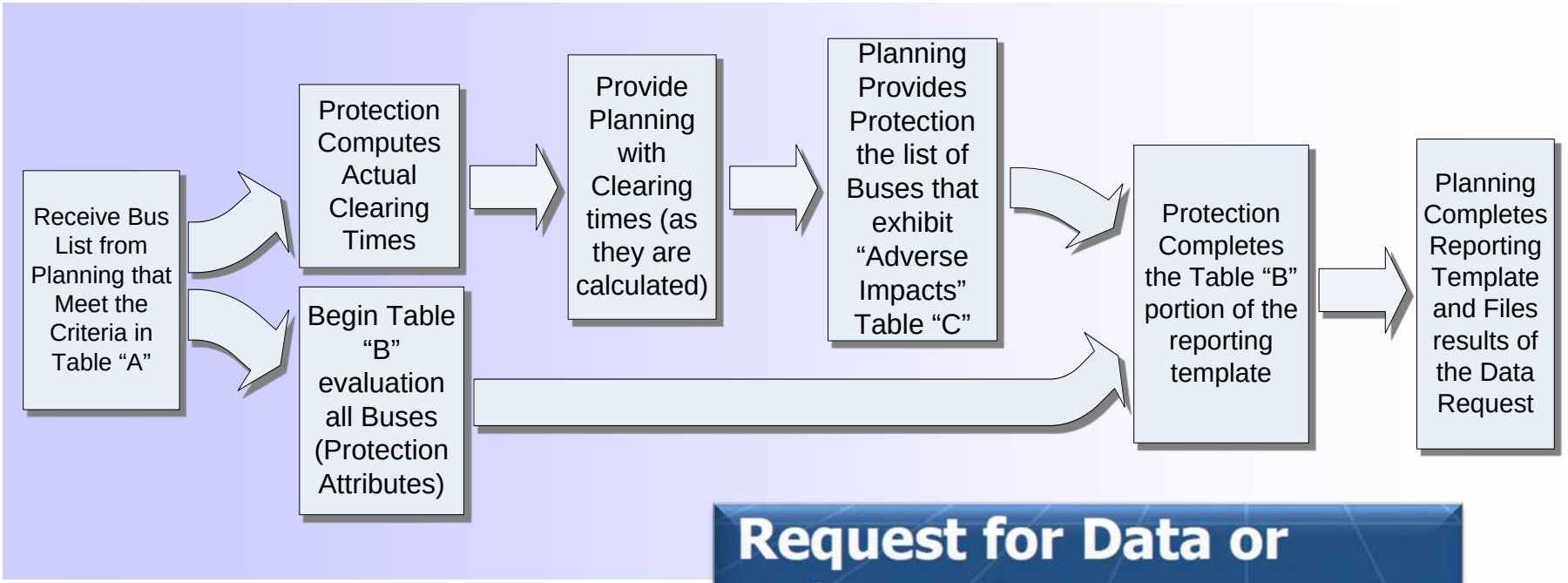
i-PCGRID Workshop 2014
PG&E – Order No. 754 Analysis: Protection



Protection Evaluation Process
PG&E – Order No. 754 Analysis



Practical implementation of method Steps 1- 11 (Simplified)

Request for Data or Information

Order No. 754 Single Point of Failure on Protection Systems

August 16, 2012

Protection Evaluation

- 400kV ≤ **500kV** <600 kV
  - Protection Evaluation – “In-House”
  - 10 Buses – Terminals:
    - 39 Transmission Line
    - 16 Transmission Banks
    - 4 Generator Step-Up
    - 7 Shunt
    - 16 Buses

    TOTAL: 82 (greater than)

Protection Evaluation

- **500kV**
  - Completed: 2013-03-01
  - Revised: 2013-05-28
    - This updated evaluation complies with the interpretation of the April 30th 2013 “Request for Clarification” publication “*the data collection is focused on all single points of failure and the attributes in Table B are not specific to three-phase faults.*”
  - Submitted by Planning to NERC: 2013-10-02
  - Revised: 2014-02-26
  - Voluntarily Resubmitted to NERC: 2014-02-27 (Along with 230kV submittal)
    - Original Submittal included all buses in the original list

Protection Evaluation TABLE B

TABLE B: Protection System Attributes to be Evaluated	DPE4 Comments for Evaluating 500kV Line, Bus, and Transformer Protection
Protective Relays: The protection system includes two independent protective relays that are used to measure electrical quantities, sense an abnormal condition such as a fault, and respond to the abnormal condition.	All 500kv Line, Bus, and Transformer Protection packages, (i.e. relays), are redundant (2 or more)
Communication Systems: The protection system includes two independent communication channels and associated communication equipment when such communication between protective relays for communication-aided protection functions (i.e., pilot relaying systems) is needed to satisfy system performance required in NERC Reliability Standards TPL-002-0b and TPL-003-0a.	All communication scheme equipment used for 500kV line protection is redundant and communication routes are redundant (for 500kV, the "request for further documentation" statement "Once the communication routes leave the station - Communication Path (Route) Diversity is not considered for transmission line protection", does not need to be utilized for the 500kV portion of the data request.)
AC Current and Voltage Inputs: The protection system includes two independent AC current sources and related inputs, except that separate secondary windings of a free-standing current transformer (CT) or multiple CTs on a common bushing can be used to satisfy this requirement; and includes two independent AC voltage sources and related inputs, except that separate secondary windings of a common capacitance coupled voltage transformer (CCVT), voltage transformer (VT), or similar device can be used to satisfy this requirement.	~~All 500kv Line, Bus, and Transformer Protection packages utilize multiple CT's on a common bushing.~~ ~~Some 500kV line protection packages utilize the same secondary windings on Multiple CCVT's (there is one CCVT Per Phase). I justify NOT including this as a single point of failure due to the following statement in the "Instructions for Reporting Data": "For the purposes of this Data Request, Generator Owners, Transmission Owners, and Distribution Providers will assess single Points of Failures based on protection system operation for a three phase fault".~~ ~~Justification: If a single CCVT fails (say "A" phase), and sometime later a 3 phase fault occurs, the relay distance elements for B-C phase will work properly.~~ The REV 1 data provided by Protection has abandoned the position of regarding Single Phase CCVT redundancy (Based on the interpretation of the April 30th 2013 Request for Clarification document) . This results in delayed clearing for 8 of 23 500kV lines.
DC Control Circuitry: The protection system includes two independent DC control circuits with no common DC control circuitry, auxiliary relays, or circuit breaker trip coils. For the purpose of this data request the DC control circuitry does not include the station DC supply or the main DC distribution panel(s), but does include all the DC circuits used by the protection system to trip a breaker, including any DC control circuit (branch) fuses or breakers at the main DC distribution panel(s).	All 500kv redundant line protection and breaker trip coils (TC1 and TC2), are sourced by different DC breakers, sourced from one common station battery. (In some stations, the 500kV has a dedicated battery source).

Protection Evaluation

- 200kV ≤ **230kV** <300 kV
  - Total: 174, Table A: 55 Buses (3 Submitted)
    - 500+ Terminals Evaluated - SPF
  - Clearing Time: In-House. Table “B”: Contractor.
  - Submitted: 2014-02-27
- 100kV ≤ **115kV** <200 kV
  - Total: Similar to 230kV, Table A: 45 Buses (Not Completed)
  - Clearing Time: Contractor. Table “B”: Contractor
  - Submitted: On-going work (Clearing Times being performed)

Protection Evaluation Submittal Example

Attributes of Evaluated Transmission Line Protection Systems						
		≥100 kV - <200 kV	≥200 kV - <300 kV	≥300 kV - <400 kV	≥400 kV - <600 kV	≥ 600 kV
1.	Total number of Transmission Line Terminals at which protection system attributes were evaluated by the Generator Owners, Transmission Owners, and Distribution Providers:		34			
2.	Number of Transmission Line Terminals at which protection systems does not meet all of the specified protection system attributes for redundancy in Table B:		34			
3.	Number of Transmission Line Terminals at which the protection system does not meet the specified protection system attributes for the Protective Relays:		0			
4.	Number of Transmission Line Terminals at which the protection system does not meet the specified protection system attributes for the Communication Systems:		26			
5.	Number of Transmission Line Terminals at which the protection system does not meet the specified protection system attributes for the AC Current and Voltage Inputs:		23			
6.	Number of Transmission Line Terminals at which the protection system does not meet the specified protection system attributes for the DC Control Circuitry:		34			
7.	Comments:					

Transmission Line Protection | Transmission Xfmr Protection | GSU Xfmr Protection | Step-down Xfmr Prot

90%

Protection Evaluation Clearing Time Example

43	Bus Study								
44	**Location:**								
45	**Study Condition: Disabled Bus Differential**								
46	***Clearing times shown are with all sources in.***								
47									
48	**Fault Condition: Fault on Bus - No Breaker Failure**								
49	**Relay Location**	**Breaker**	**Relay Type**	**Fault Type**	**Aspen Time**	**Breaker Op Time**	**Relay Op Time**	**Breaker Failure Scheme**	**Total Clearing Time**
50	Terminal Name	##1	GE L90	1LG (cyc)	45	4	2	0	51
51			GE L90	LL (cyc)	20		2	0	26
52			GE L90	3LG (cyc)	20		2	0	26
53	Step distance and or time overcurrent relaying clears Terminal Name terminal.								
54									
55	Terminal Name	##2	SEL-311L	1LG (cyc)	56	4	2	0	62
56			SEL-311L	LL (cyc)	20		2	0	26
57			SEL-311L	3LG (cyc)	20		2	0	26
200	**Summary:**								
201	**Step distance and/or time overcurrent relaying clears all the terminals for the fault on the XXX The worst case clearing is 62 cycles for ground faults and 26 cycles for phase faults.**								
202									
203									