COUCH WHITE
COUNSELORS AND ATTORNEYS AT LAW

Couch White, LLP
540 Broadway
P.O. Box 22222
Albany, New York 12201-2222
(518) 426-4600

Leonard H. Singer
Partner

Direct Dial: (518) 320-3406
Telecopier: (518) 320-3499
email: lsinger@couchwhite.com

June 17, 2010

VIA E-MAIL & U.S. MAIL

Hon. Jaclyn Brilling
Secretary
State Board on Electric Generation Siting and the Environment
Three Empire State Plaza, 14th Floor
Albany, New York 12223-1350

Re: Case 08-F-1367 - Petition of Astoria Energy LLC and Astoria Energy II LLC, for the Amendment & Transfer of their Certificate of Environmental Compatibility & Public Need

Dear Secretary Brilling:

Enclosed please find a copy of Astoria Energy II LLC's Petition to Amend the Certificate to Allow for a New Submittal Date for the Relay Coordination Study.

Please contact me if you have any questions.

Very truly yours,

COUCH WHITE, LLP

Leonard H. Singer

Leonard H. Singer

LHS/dp
Enclosure
cc: David Drexler, Esq. (Petition only via Hand Delivery)
Active Parties in Case 99-F-1191 (Petition only via U.S. mail)
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NEW YORK STATE BOARD
ON ELECTRIC GENERATION
SITING AND THE ENVIRONMENT

IN THE MATTER	
-- of the --	**Case 08-F-1367**
Petition of Astoria Energy LLC and Astoria Energy II LLC, for the Amendment of Certificate of Environmental Compatibility and Public Need	

ASTORIA ENERGY LL LLC'S PETITION TO AMEND THE CERTIFICATE TO ALLOW FOR A NEW SUBMITTAL DATE FOR THE RELAY COORDINATION STUDY

Pursuant to 16 NYCRR § 1000.15, Astoria Energy II LLC ("Astoria Energy II") hereby petitions the New York State Board on Electric Generation Siting and the Environment ("Siting Board") to amend the Certificate of Environmental Compatibility and Public Need ("Certificate") transferred to Astoria Energy LLC and Astoria Energy II on April 7, 2010 for the construction and operation of an electric generation facility in Queens, New York. Specifically, Astoria Energy II seeks to shorten the filing time for the Relay Coordination Study from twelve months to approximately eleven and a half months prior to commercial operation of Astoria Energy II's generation facility.

I. BACKGROUND

Astoria Energy LLC ("Astoria Energy") and Astoria Energy II separately own, operate, and control the two power blocks of the Astoria facility, which will ultimately comprise an approximately 1,240 MW, natural-gas fueled wholesale electric generation complex in Queens County, New York ("Astoria Facility"). In New York State Public Service Commission ("Commission") Case No. 08-E-111[1], the Commission granted, inter alia, authorization for the transfer of ownership interests in the second power block of the Astoria Facility from Astoria Energy to Astoria Energy II. In Siting Board Case No. 08-F-1367[2], the Siting Board granted the request of Astoria Energy and Astoria Energy II to transfer the Certificate, issued for the Astoria Facility under Article X of the Public Service Law, to Astoria Energy and Astoria Energy II jointly. The second power block of the Astoria Facility is now separately owned by Astoria Energy II.

II. REQUESTED CERTIFICATE MODIFICATION

By this petition, Astoria Energy II seeks a modification to Certificate condition II. F (4), which refers to the submittal of a Relay Coordination Study. Certificate condition II. F (4) originally stated that Astoria Energy shall file with the Siting Board and the Commission a copy of a "Relay Coordination Study, which shall be filed not later than 18 months prior to the projected commercial operation date of the Project." Thereafter, on January 27, 2005, based on a request from Astoria Energy, the Board amended the Certificate by replacing Certificate condition II. F (4) with the following condition:

> [A] Relay Coordination Study, which shall be filed at least 45

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[1] Case 08-E-1111, *Astoria Energy II LLC and Astoria Energy LLC- Petition for Approval of a Transaction pursuant to Public Service Law Section 70, Authority to issue debt Pursuant to Public Service Law section 69 and for Lightened Regulation and Request for Expedited Action*, Order Approving Transfer and Financings and Making Other Findings (issued December 15, 2008).

[2] Case 08-F-1367, *Petition of Astoria Energy LLC and Astoria Energy II LLC for the Amendment and Transfer of Certificate of Environmental Compatibility and Public Need*, Order Granting Transfer and Amendment of Certificate of Environmental Compatibility and Public Need (issued April 7, 2009).

> days prior to the projected first energization of the Facility's generator step-up (GSU) transformer at the 138 kV terminal interconnection; if the current projected first energization date of March 17, 2005 is revised, the Certificate Holder shall notify Consolidated Edison Company of New York, Inc. in writing within 3 business days of the decision to revise such date and the 45-day period shall apply to any revision of such date.[3]

Certificate condition II. F (4) was further modified to state that Astoria Energy II shall file with the Siting Board and the Commission a copy of "the Relay Coordination Study, which shall be filed not later than twelve months prior to the projected date for commencement of commercial operation of the facilities."

Astoria Energy II is currently in the process of constructing the second power block of the Facility and expects that power block to commence commercial operations in June 2011. Accordingly, Certificate condition II. F (4) required Astoria Energy II to file a copy of its Relay Coordination Study with the Siting Board and the Commission by June 1, 2010.

However, Astoria Energy II has only recently completed its Relay Coordination Study because the inputs needed to conduct the Relay Coordination Study have only recently become available. The completed the Relay Coordination Study is attached to this Petition.

Accordingly, Astoria Energy II is hereby requesting to shorten the time for filing the Relay Coordination Study by 2 weeks. Specifically, Astoria Energy II requests that Certificate Condition II. F (4) be revised to read as follows: "the Relay Coordination Study, which shall be filed not later than eleven and a half months prior to the projected date for

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[3] Case 99-F-1191, *Application by Astoria Energy LLC for a Certificate of Environmental Compatibility and Public Need to Construct and Operate an Approximately 1,000 Megawatt Generating Facility in the Astoria Section of Queens County – Application for Amendment of Certificate Regarding Timing of Relay Coordination Study*, Order Granting Amendment of Certificate of Environmental Compatibility and Public Need (issued January 27, 2005) at 4-5.

commencement of commercial operation of the facilities." Approval of this request will not result in any adverse impact on the environment or electric system. Also, it is significant to note that no adverse environmental or electric system impacts resulted from a previouis modification granted by the Board of the date required for the Relay Coordination Study to be filed under Certifcate condition II. F (4). Finally, because Astoria Energy II is requesting a modification of the filing date of the Relay Coordination Study of only approximately two weeks, such modification is de minimis.

III. CONCLUSION

For the reasons set forth herein, Astoria Energy II respectfully requests that the Siting Board grant this petition and amend the Certificate by changing the date for submission of the Relay Coordination Study.

Dated: June 17, 2010
Albany, New York

Respectfully submitted,

Leonard H. Singer

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Leonard H. Singer
William J.McCarthy
COUCH WHITE, LLP
Attorneys for Astoria Energy II LLC
540 Broadway – Suite 7
Albany, New York 12207
Telephone: (518) 426-4600
Telecopier: (518) 426-0376
E-Mail: lsinger@couchwhite.com

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MSE Power Systems, Inc.

PROJECT NAME: CHARLES POLETTI SUBSTATION

PROJECT NUMBER: S029-011C

CLIENT: SNC LAVALIN CONSTRUCTORS INC.

CALCULATIONS FOR: SHORT CIRCUIT AND RELAY SETTING

Rev.	Date	Description	Prepared	Review	Approved
A	11/09/2009	Issued for review	MSE	MSE	MSE
B	05/27/2010	Revised per NYPA and Con Ed’s comments	MSE	MSE	MSE
C	06/04/2010	Revised per Con Ed’s provided relay data	MSE	MSE	MSE

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EXECUTIVE SUMMARY

INTRODUCTION

A new 345kV SF6 gas insulated substation, Charles Poletti Substation, is to be constructed to support a new 650 MW combined cycle power plant, Astoria Energy II Plant (AEII Plant). The configuration of Charles Poletti Substation will be a five breaker ring bus with four installed breakers and one future breaker position. The Charles Poletti Substation will be the point of connection (POI) between the AEII Plant and existing 345kV Feeders Q35L and Q35M, owned by NYPA. These two feeders, along with Con Edison's 345kV Feeder B47 and Feeder 48, are each part of a three terminal feeder system operating between Con Edison's Farragut and East 13th Street Substations and NYPA's Poletti Generating Station. The Poletti Generating Station and its existing 345kV substation are to be retired from service and replaced by the Charles Poletti Substation. The Q35L and Q35M Feeders will each connect to a different bus section in the Charles Poletti Substation. Existing 345kV Shunt Reactors R1 and R2, utilized for Feeder Q35L and Q35M, will be relocated from the retired Poletti Substation to the Charles Poletti Substation.

The Charles Poletti Substation will be designed as a bulk power system facility. The protection system design must be in accordance with applicable NPCC criteria. The protection at the Charles Poletti Substation consists of the following new microprocessor based primary and secondary protection packages.

A. Q35L and Q35M Line Relaying

- a) Primary Line Protection System (21L-P / 21GL-P)
  - i. Relay: Areva P546
  - ii. Scheme: Direct Under-reaching Transfer Trip (DUTT)
  - iii. Communications (DTT):
    1. Route 1: Verizon T1 via RFL Gard 8000
    2. Route 2: Con Ed CCTN via RFL IMUX 2000
- b) Secondary Line Protection System (21L-S / 21GL-S)
  - i. Relay: SEL 311L
  - ii. Scheme: Direct Underreaching Transfer Trip (DUTT)
  - iii. Communications (DTT):
    1. Route 1: Verizon T1 via RFL Gard 8000
    2. Route 2: Con Ed CCTN via RFL IMUX 2000

A new two position Zone 2 Timer Bypass switch, identical in design and function as the switch provided at the Farragut Substation, is to be installed at Charles Poletti Substation.

c) High Set Fault Protection (50HS)

i. Relay: Function with Areva P546 and SEL 311L relays described in a) and b) above

ii. Scheme: High Set Non-directional Phase Overcurrent

This protection will be programmed into the Primary and Secondary Line Protection System's numerical relays (Areva P546 and SEL 311L) as a separate function and will provide high speed direct trip for all internal close-in phase faults. The 50HS function must not operate for remote bus faults or reverse faults (local line end) with appropriate operating margin. If this function cannot be set securely, then it shall not be used.

d) Stub Bus Protection (50SB)

i. Relay: Function with Areva P546 and SEL 311L relays described in a) and b) above

This protection will be programmed into the Primary and Secondary Line Protection System's numerical relays (Areva P546 and SEL 311L) as a separate function and will be used to detect faults for the system operating condition with the associated line ring bus breakers closed and the line motor operated disconnect (MOD) switch open. The function is to be supervised by the MOD's 89b contact or other combination. This protection is not required if the voltage source is on the bus side of the MOD.

e) Switch-On-To-Fault Protection (50SOTF)

i. Relay: Function with Areva P546 and SEL 311L relays described in a) and b) above

This protection will be programmed into the Primary and Secondary Line Protection System's numerical relays (Areva P546 and SEL 311L) as a separate function and will only be armed when the circuit breakers are open and the associated line is de-energized. While closing the first circuit breaker to energize the line this function shall only be in service for the first 15 cycles and will reset if no fault is detected.

f) Directional Ground Overcurrent Backup Protection (67N)

i. Relay: Function with Areva P546 and SEL 311L relays described in a) and b) above

This protection will be programmed into the Primary and Secondary Line Protection System's numerical relays (Areva P546 and SEL 311L) as a separate function. The time-overcurrent (TOC) function will be used to provide backup protection for ground faults on the system. The instantaneous-overcurrent (IOC) function can be used to provide close-in ground fault detection if it can be set selectively.

B. Breaker Failure Relaying

a) Primary Breaker Failure Relaying (50BF/62-P)

i. Relay: Areva P141

ii. Communications: same routes as A. (a.)(iii.) above

b) Secondary Breaker Failure Relaying (50BF/62-S)

i. Relay: GE C60

ii. Communications: same routes as A. (b.)(iii.) above

Although NPCC does not require dual breaker failure protection systems, the Charles Poletti Substation is designed with dual and independent breaker failure protection systems for maintenance and testing conditions. Separate primary and secondary relays of different manufacture are used for this protective function.

The fault detectors are used and set to supervise the relay operation. Normal operation of the breaker failure relaying system will energize a lockout relay after an acceptable time delay to trip all the local breakers and initiate the direct transfer trip system to open all the associated remote breakers.

C. SF6 Bus Protection Relaying

a) Primary Bus Protection Relaying (87B-P)

i. Relay: SEL 387

ii. Scheme: Current Differential for fault targeting only; no tripping function except as noted below.

iii. The primary bus protection relaying (87B-P) will be provided for all bus sections in the Charles Poletti Substation and will be a permanent system. It will normally provide fault targeting for all ring bus sections. Initially, the 87B-P will trip circuit breakers CB-2 and CB-5 for bus faults on the bus section between these two breakers. When the future facility's interconnecting line is connected to this bus section, the 87B-P will be used for fault targeting only.

b) Secondary Bus Protection Relaying (87B-S only)

i. Relay: GE B30

ii. Scheme: Low Impedance Current Differential

iii. The secondary bus protection relaying (87B-S) will initially trip circuit breakers CB-2 and CB-4 for bus faults on the bus section between these two breakers. When the future interconnecting line is installed, the secondary bus protection relay (87B-S) will be removed from service.

c) When the future facility is installed, new primary and secondary line protection relays will be designed and installed to protect the new interconnecting line.

D. Q35L and Q35M Current Differential Relaying

a) Primary Current Differential Relaying (85)

i. Relay: SEL 311L (Stand-alone)

ii. Communications:

1. Route 1: Verizon T1 via RFL Gard 8000 (only).

This system will include primary relays only, no secondary relaying is required. The primary function of this relay scheme will be to provide line fault targeting only; the tripping function will be enabled for certain feeder configurations. Two current differential systems will be configured; one will operate between Charles Poletti Substation and East 13th Street and the other will operate between East 13th Street and Farragut.

E. Shunt Reactor R1 and R2 Protection Relaying

a) Primary Shunt Reactor Protection (87R1(R2)-P / 51R1 (R2)-P)

i. Relay: SEL 387

ii. Scheme: Current Differential / Time Overcurrent

iii. Communications: same routes as A. (a.)(iii.) above

b) Secondary Shunt Reactor Protection (87R1& (R2)-S / 51R1& (R2)-S)

i. Relay: GE T60

ii. Scheme: Low Impedance Differential / Time Overcurrent

iii. Communications: same routes as A. (b.)(iii.) above

The existing Poletti Shunt Reactors R1 and R2 will be relocated to Charles Poletti Substation. Both reactors are oil-filled type and equipped with sudden pressure relays (63SP) set to trip.

F. Generator (AEII Plant) – GIS (Charles Poletti Substation) Interconnection Cable Relaying

a) Primary Interconnecting Line Differential Relaying (85L1-P)

i. Relay: Areva P546

ii. Scheme: Current Differential with Distance Back-up

50HS, 50SB, 50SOTF and 67N are considered as A.(c) through A.(f) above.

iii. Communications: Dedicated Fiber Optic (Cable 1)

b) Secondary Interconnecting Line Differential Relaying (85L1-S)

i. Relay: SEL 311L

ii. Scheme: Current Differential with Distance Back-up

50HS, 50SB, 50SOTF and 67N are considered as A.(c) through A.(f) above.

iii. Communications: T1 network (using an IMUX 2000 as the T1 interface).

G. Automatic Circuit Breaker Reclosing (79)

Automatic circuit breaker reclosing relays (79) are not required for Charles Poletti Substation.

H. Synchronism Check Relaying

Synchronism check relays will not be required for Charles Poletti Substation.

SCOPE OF WORK

The study addresses 345kV line protection setting, 345kV bus differential settings, and 345kV breaker failure settings etc at the Charles Poletti Substation and relay coordination between Charles Poletti Substation and its connected adjacent substations.

METHODOLOGY

The system model in ASPEN software has been received from NYISO. We have added the planned relay settings in the model. The short circuit calculation, protection calculation and coordination study were performed using ASPEN model.

ASSUMPTION

Charles Poletti Substation relay settings are set for addition of Astoria Energy II Plant (AEII Plant) only. When adjacent BERRIANS 3 station is added in the future as indicated in NYSIO Aspen model “NYISO_2012_Q308_ON.orl”, reviewing and revising of Charles Poletti Substation relay setting may be necessary.

SHORT CIRCUIT STUDY

Short circuit study results at Charles Poletti Substation have been provided and can be found in Appendix 27. The results generated by ASPEN show fault values for Three-Phase-to-ground, Phase-to-Ground, Phase-to-Phase-to-Ground and Phase-to-Phase. The numbers shown are fault magnitudes, in amps for faults at the corresponding bus. The Thevenin equivalent impedance in ohms, X/R ratio and fault angles are also given in the ASPEN report.

RELAY COORDINATION

A. Relay Coordination between Charles Poletti Station and Farragut Station

Q35L/Q35M line directional ground over-current backup protection (67N) at Charles Poletti station is set to trip for a ground fault at Farragut 345kV bus with 0.52 ~ 0.69 second time delays as shown in Appendix 28. Coordination between Q35L/M-67N at Charles Poletti and Farragut directional over-current relays has been done with the following worse case considerations:

(1) The strongest source is from upstream relay in order to have the fastest upstream relay clearing time;

(2) One of the strongest local sources to downstream relay is out of service (N-1 contingency), so that the downstream relay will clear a fault with relative slow speed comparing with normal condition.

(3) Q35L or Q35M is out of service is also considered for a fault at Farragut station, so that all the fault contributions from Charlie Poletti will not be shared by both Q35L and Q35M, and the Q35L-67N or Q35M-67N at Charlie Poletti will see the maximum contribution from Charlie Poletti.

As shown in Appendix 28, the minimum coordination time interval (CTI) is 0.25 second per case 19 which a single phase to ground fault is at relay (67N-1/B7E or 67N-2/B7E) or feeder 48 close-in with the largest source (Line 41) out of service and maximum contribution from Charlie Poletti station and line Q35M at Charlie Poletti out of service. This is considered acceptable since the 0.25 second CTI will only happen when the high speed pilot relaying schemes at feeder 48 fail to operate for the fault, with both line 41 at Farragut and line Q35M at Charlie Poletti out of service.

Q35L/Q35M-67N setting will also ensure its proper coordination with Farragut protection by considering Con Ed standard breaker failure timer of 160 ms for a ground fault. Q35L/Q35M line high set fault protection (50HS) and directional instantaneous-over-current function are not used at Charles Poletti station side since they cannot be set securely.

Per case 20 through case 25 in Appendix 28, 67N-1/B7E or 67N-2/B7E for B47 at Farragut, or 67N-1/F2W or 67N-2/F2W for 48 at Farragut will also properly coordinate with the 67N elements used Charlie Poletti for a relay close in fault.

B. Relay Coordination between Charles Poletti Station and East 13th street Station

Relay coordination between Charles Poletti Station and East 13th street station is as shown in Appendix 29. The minimum CTI is 0.53 second which is acceptable. It is noted that coordination between Q35L-67N or Q35M-67N at Charlie Poletti and 67N/48 or 67N/B47 at East 13th street for a relay close-in fault at East 13th line 48 or B47 is not needed, since there is no 345kV breaker at East 13th station. Q35L/Q35M line distance elements at Charles Poletti Station are set per NYPA & Con Ed standard and will not over-reach transformer low side at East 13th street station. It is also noted that the ground fault contribution differences between the existing Poletti Station and the new Charles Poletti station is neglectable. No ground over-current relay setting change at East 13th street is found necessary due to the modifications to the system caused by this project.

C. Relay Coordination between Charles Poletti Station and Astoria Energy II Plant Station

Relay coordination between Charles Poletti Station and Astoria Energy II Plant Station is not stringently required since there is no breaker at 345kV side of Astoria Energy II Plant Station, and distance elements at Charles Poletti Station side for the line between two stations are set per NYPA & Con Ed standard and will not over-reach transformer low side at Astoria Energy II Plant Station.

<u>RELAY LOADABILITY CHECK</u>

Per Standard PRC-023-1 Transmission Relay Loadability, each transmission owner, generator owner, and distribution provider shall evaluate relay loadability at 0.85 per unit voltage and a power factor angle of 30 degrees. Per equation from *Power System Relaying* by Stanley H. Horowitz, and Arun G. Phadke, Loadability S = $(kV_{L-L})^2$ / Zsec / cos(Z1ANG-30) * (CTR/PTR).

Where,

kV_{L-L} – system line to line voltage, 0.85 per unit voltage shall be used per PRC-023-1.

Zsec – distance element with the longest reach setting in secondary ohm.

Z1ANG – transmission line angle.

CTR – CT ratio.

PTR – PTR ratio.

For either 345kV Q35L or Q35M line, Zone 2 setting is the distance element with the longest reach as Z2P = 0.98 secondary ohm. kV_{L-L} is 0.85*345. Line angle Z1ANG is 78.20. CTR is 600 and PTR is 3000. Zone 2 loadability is 26329.22 MVA. This is far more than 150% of the highest seasonal facility rating of the line, or 115% of the highest seasonal 15-minute facility rating of the line, or 115% of the maximum theoretical power transformer capability.

For 345kV line from Charles Poletti to Astoria II generation station, Zone 2 setting is the distance element with the longest reach as Z2P = 0.1 secondary ohm. kV_{L-L} is 0.85*345. Line angle Z1ANG is 83.96. CTR is 600 and PTR is 3000. Zone 2 loadability is 293235.87 MVA. This is far more than 150% of the highest seasonal facility rating of the line, or 115% of the highest seasonal 15-minute facility rating of the line, or 115% of the maximum theoretical power transformer capability.

CONCLUSION

Adequate protection at 345kV Charles Poletti Substation and proper coordination with the relays in its connected adjacent stations have been developed and demonstrated by this study.

REFERENCE

1. NYPA - Protection Application Document For the 345kV SF6 Gas Insulated Substation, Revision 1.
2. NYPA – Relay Settings Database for Poletti Station.
3. *Power System Relaying* By Stanley H. Horowitz, Arun G. Phadke

Appendix 01 11L-1-Q35L (Areva-P546) Setting Calculation

1. Data

MVA_Base =	100	kV_Base =	345	Z_Base =	1190.25	ohms
CTR =	600	PTR =	3000	CTR/PTR=	0.2	

Line ID	From	To	R1(ohms)	X1(ohms)	R0(ohms)	X0(ohms)
Q35L+B47	Charles Poletti	FARRAGUT	0.499905	2.3924025	4.308705	6.1297875

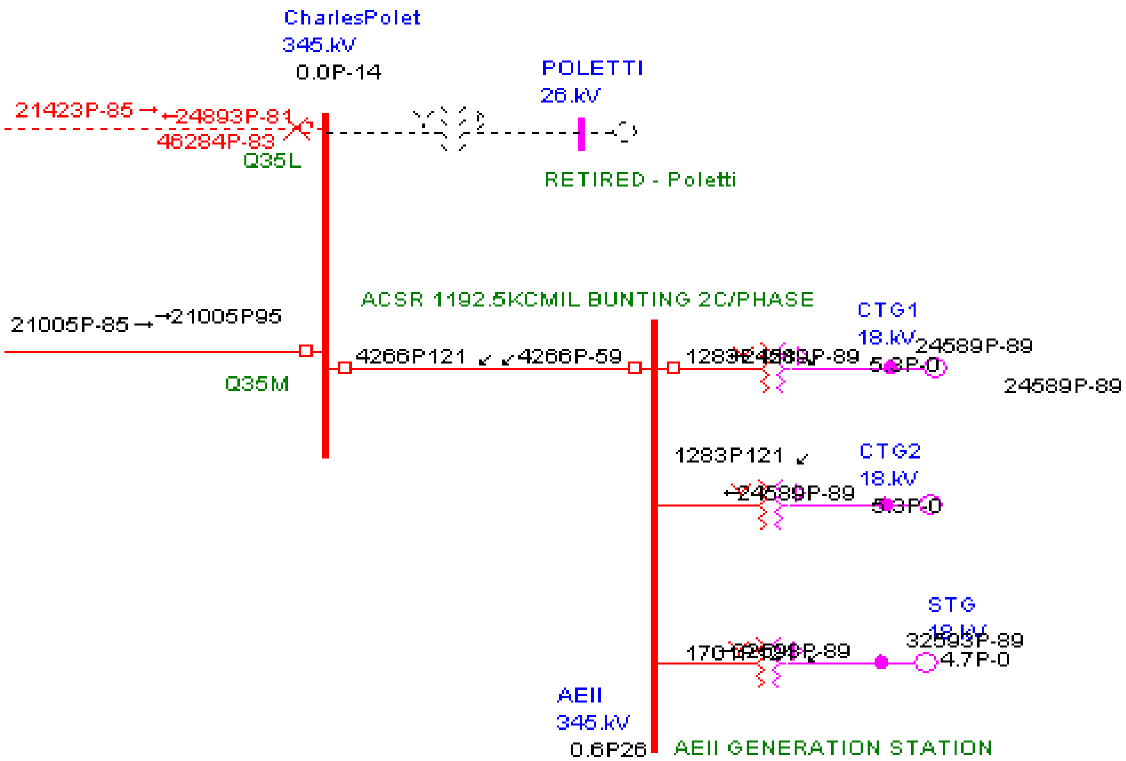
Secondary Ohms = Primary Ohms • (CTR/PTR)

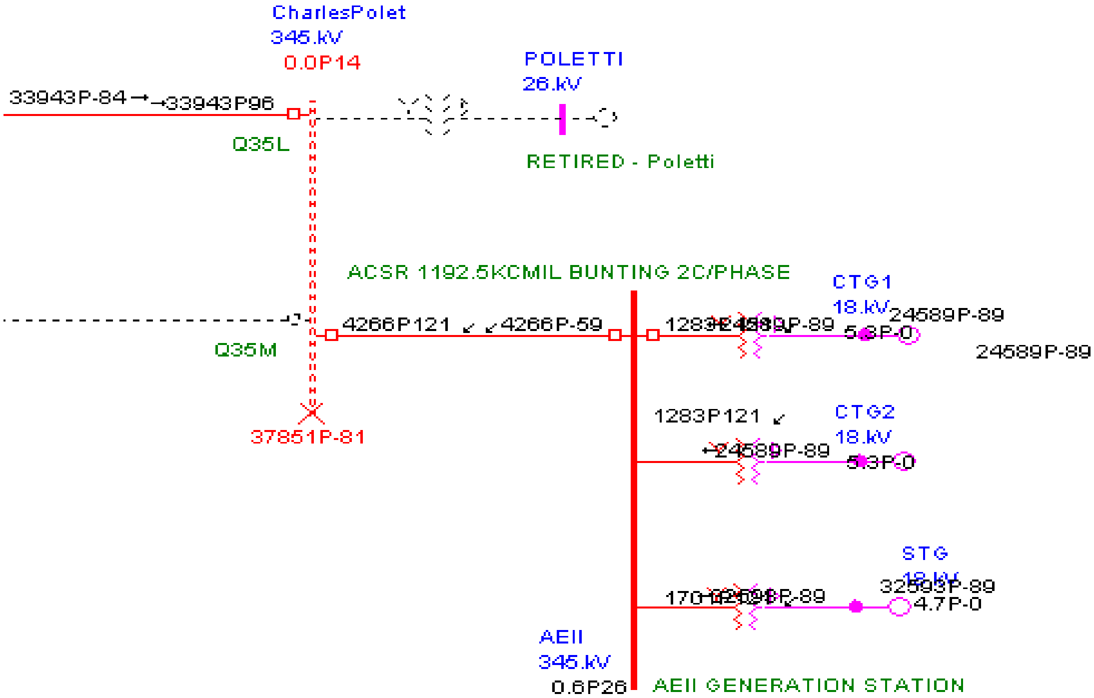
Line ID	From	To	R1(2nd ohm)	X1(2nd ohm)	R0(2nd ohm)	X0(2nd ohm)
Q35L+B47	Charles Poletti	FARRAGUT	0.10	0.48	0.86	1.23

Z1 = Sqrt (R1*R1+X1*X1) Z1Ang = Arctan (X1/R1) Z0 equations are the same.

Line ID	From	To	Z1(2nd ohm)	Z1Ang	Z0(2nd ohm)	Z0Ang
Q35L+B47	Charles Poletti	FARRAGUT	0.49	78.20	1.50	54.90

2. Setting Criteria
2.1 Set Zone 1 phase distance at 87% of the line impedance with no time delay.
2.2 Set Zone 2 phase distance at 200% of the line impedance with 0.35 second delay. (ConEd 0.3s)
2.3 Set Zone 1 ground distance at 70% of the line impedance with no time delay.
2.4 Set Zone 2 ground distance at 200% of the line impedance with 0.6 second delay. (ConEd 0.3s)
2.5 Line differential and other distance elements are not used.
2.6 High Set Fault Protection (50HS):
For 3LG fault at Charles Poletti 345kV bus, the fault contributions are as following.





50HS shall provide high spped direct trip for all internal close-in phase faults and must not operate for remote bus faults or reverse faults with appropriate operating margin. Based on the fault current contribution above, 50HS if set to clear a fault of 24,893 Amp, it may false trip for a reverse fault (21,423 Amp), especially when Q35M is out of service (33,943 Amp), so 50HS cannot be set securely and therefore is disabled.

Noted that the Aspen model (NYISO_2012_Q308_ON) provided by NYISO shows a higher fault level due to consideration of future BERRIANS 3 station. However, it will not impact the conclusion.

2.7 Stub Bus Protection (50SB):

The voltage source of 11L-1-Q35L (Areva-P546) relay is at the bus side of the MOD, so 50SB is not required.

2.8 Switch-On-To-Fault Protection (50SOTF)

50SOTF will only be armed when the circuit breakers are open and the asscoated line is de-energized. While closing the first circuit breaker to energize the line this function shall only be in service for the first 15 cycles and will reset if no fault is detected. 50SOTF is fulfilled by SOTF tripping Zone 2 with 200 ms drop-out timer, instead of 15 cycles or 250 ms drop-out timer, due to 100 ms step of the setting.

2.9 Directional Ground Overcurrent Backup Protection (67N)

67N will be used to provide backup protection for ground faults on the system. 67N pickup shall be higher than the worst unbalance and can be set at 1/3 of maximum full load (1255Amp/600/3=0.7Amp). US inverse is the selected curve for this time delay element. It shall coordinate with primary protection with a proper CTI (Coordination Time Interval) and trip a ground fault at Farragut 345kV with 0.69 second time delays under normal and 0.52 second time delay when the Q35M line is out. Refer to Appendix 28 for TCC.

The instantaneous -overcurrent (IOC) function can be used to provide close-in ground fault detection if it can be set selectively.

Applying 2LG and 1LG faults at Farragut 345kV bus under four conditions of normal, B47 out, Line 48 out, and Q35M out, the maximum ground fault current seen by 11L-1-Q35L relay would be

a 2LG at Farragut 345kV bus with line 48 out, and is 6484.00 Amp

Appendix 01 11L-1-Q35L (Areva-P546) Setting Calculation

With margin of 30% , IOC = 8429.20 Primary Amp

However, applying 1LG faults at AEII Generation station, Aspen voltage sag analysis shows 0.003 pu voltage or 0.2V secondary at 11L-1-Q35L relay.With voltage below 1V, directionality is in doubt. With fault level of more than 40kA at AEII Generation station 345kV bus, falsely tripping is possible. So, it is not recommended to use 67N-IOC.

SYSTEM DATA:

Language =	English	
Sys Fn Links =	0	
Decription =	11L-1-Q35L	
Plant Reference =	CHARLES POLETTI	
Frequency =	60 Hz	

CB CONTROL:

CB Control by =	Disabled	
Rst CB mon L0 by =	CB Close	
CB mon Lo RstDly =	5.000 S	
CB1 Status Input =	52B 3 pole	
CB Status Time =	5.000 S	
CB2 Status Input =	52B 3 pole	

DATE AND TIME:

IRIG-B Sync =	Enabled	
Battery Alarm =	Enabled	
Other Time Settings =	Default	

CONFIGURATION:

Setting Group =	Select via Menu	
Active Settings =	Group 1	
Setting Group 1 =	Enabled	
Setting Group 2 =	Disabled	
Setting Group 3 =	Disabled	
Setting Group 4 =	Disabled	
Distance =	Enabled	# 21Z1,21Z2
Directional E/F =	Disabled	# Not used
Phase Diff =	Disabled	# Not used
Overcurrent =	Disabled	# Not used
Neg Sequence O/C =	Disabled	# Not used
Broken Conductor =	Disabled	# Not used
Earth Fault =	Enabled	# 67N
Sensitive E/F =	Disabled	# Not used
Residual O/V NVD =	Disabled	# Not used
Thermal Overload =	Disabled	# Not used
PowerSwing Block =	Disabled	# Not used
Volt Protection =	Disabled	# Not used
Freq Protection =	Disabled	# Not used
df/dt Protection =	Disabled	# Not used
CB Fail =	Disabled	# Not used
Supervision =	Enabled	
System Checks =	Disabled	
Auto-Reclose =	Disabled	
Input Labels =	Visible	
Output Labels =	Visible	

CT & VT Ratios = Visible
Record Control = Visible
Disturb Recorder = Visible
Measure't Setup = Visible
Comms Settings = Visible
Commission Tests = Visible
Setting Values = Secondary
Control Inputs = Invisible
Ctrl I/P Config = Invisible
Ctrl I/P Labels = Invisible
Direct Access = Enabled
InterMiCOM 64 = Disabled
Function Key = Invisible
LCD Contrast = 11

CT AND VT RATIOS

Main VT Primary = 345.0 kV
Main VT Sec'y = 115.0 V
CB1 CS VT Prim'y = 345.0 kV
CB1 CS VT Sec'y = 115.0 V
CB2 CS VT Prim'y = 345.0 kV
CB2 CS VT Sec'y = 115.0 V
Phase CT Primary = 3000 A
Phase CT Sec'y = 5.000 A
SEF CT Primary = 1.000 A
SEF CT Secondary = 1.000 A
MComp CT Primary = 1.000 A
MComp CT Sec'y = 1.000 A
CS Input = A-N
CT1 Polarity = Standard
CT2 Polarity = Standard
SEF CT Polarity = Standard
M CT Polarity = Standard
VT Connected = Yes
CB1 CS VT PhShft = 0 deg
CB1 CS VT Mag = 1
CB2 CS VT PhShft = 0 deg
CB2 CS VT Mag = 1

MEASURE'T SETUP:

Default Display = 3Ph + N Current
Local Values = Primary
Remote Values = Primary
Measurement Ref = VA
Measurement Mode = 0
Fix Dem Period = 30.00 min
Roll Sub Period = 30.00 min
Num Sub Periods = 1
Distance Unit = Miles
Fault Location = Distance

COMMISSION TESTS:

Monitor Bit 1 = 1060 # Red LED1

	Monitor Bit 2 =	1062	# Red LED2
	Monitor Bit 3 =	1064	# Red LED3
	Monitor Bit 4 =	1066	# Red LED4
	Monitor Bit 5 =	1068	# Red LED5
	Monitor Bit 6 =	1070	# Red LED6
	Monitor Bit 7 =	1072	# Red LED7
	Monitor Bit 8 =	1074	# Red LED8
CB MONITOR SETUP:	All disabled		# Not required
OPTO CONFIG:			
	Global Nominal V =	110/125V	
	Opto Filter Cntl =	111111111111111111111111	
	Characteristic =	Standard 60%-80%	
CONTROL INPUTS:		Not used	
CTRL I/P CONFIG:		Not used	
CTRL I/P LABELS:		Not used	

Group 1:

GROUP 1 LINE PARAMETERS:

Line Length =	9.635 mi		
Line Impedance =	0.49	Ohm	
Line Angle =	79.00	deg	
kZN Res Comp =	0.73		
kZN Res Angle =	-34.00		
Mutual Comp =	Disabled		
Phase Sequence =	Standard ABC		
CB1Tripping Mode =	3 Pole		
CB2Tripping Mode =	3 Pole		

GROUP 1 DISTANCE SETUP:

Setting Mode =	Advanced	
Phase Chars. =	Quad	
Zone 1 Ph Status =	Enabled	
Zone 2 Ph Status =	Enabled	
Zone 3 Ph Status =	Disabled	
Zone 4 Ph Status =	Disabled	
Ground Chars. =	Quad	
Zone 1 Gnd Stat =	Enabled	
Zone 2 Gnd Stat. =	Enabled	
Zone 3 Gnd Stat =	Disabled	
Zone P Gnd Stat. =	Disabled	
Zone 4 Gnd Stat. =	Diabled	
Digital Filter =	Standard	
CVT Filters =	Disabled	# VT is used
Load Blinders =	Disabled	# Default
Dist. Polarizing =	1	
Dir. Status =	Enabled	
AidedDeltaStatus =	Disabled	
Dir. Char Angle =	60.00 deg	# Default

Appendix 01 11L-1-Q35L (Areva-P546) Setting Calculation

GROUP 1 DIST. ELEMENTS:

Z1 Ph. Reach =	420.000	mOhm
Z1 Ph. Angle =	79.00	deg
R1 Ph. Resistive =	5	Ohm
Z1 Tilt Top Line =	-3	deg
Z1 Sensit. Iph>1 =	0.25	A
Z2 Ph. Reach =	980	mOhm
Z2 Ph. Angle =	79.00	deg
R2 Ph. Resistive =	5	Ohm
Z2 Tilt Top Line =	-3	deg
Z2 Sensit. Iph>2 =	0.25	A
Z1 Gnd. Reach =	340	mOhm
Z1 Gnd. Angle =	79.00	deg
Z1 Dynamic Tilt =	Enabled	
Z1 Tilt Top Line =	-3	deg
kZN1 Res. Comp =	0.73	
kZN1 Res. Angle =	-34.00	deg
R1 Gnd Resistive =	5	Ohm
Z1 Sensit Ignd>1 =	0.25	A
Z2 Gnd. Reach =	980	mOhm
Z2 Gnd. Angle =	79.00	deg
Z2 Dynamic Tilt =	Enabled	
Z2 Tilt Top Line =	-3	deg
kZN2 Res. Comp. =	0.73	
kZN2 Res. Angle =	-34.00	
R2 Gnd Resistive =	5	Ohm
Z2 Sensit Ignd>2 =	0.25	A

GROUP 1 SCHEME LOGIC:

Zone1 Tripping =	Phase And Ground	
tZ1 Ph. Delay =	0	s
tZ1 Gnd. Delay =	0	s
Zone2 Tripping =	Phase And Ground	
tZ2 Ph. Delay =	350	ms
tZ2 Gnd. Delay =	600	ms
Zone3 Tripping =	Disabled	
ZoneP Tripping =	Disabled	
Zone4 Tripping =	Disabled	
Aid. 1 Selection =	Disabled	
Aid. 2 Selection =	Disabled	
SOTF Status =	Enabled PoleDead	
SOTF Delay =	600	ms
SOTF Tripping =	100010	# Allow fast fault clearance and Zone 2
TOR Status =	Disabled	
TOC Reset Delay =	200	ms, # In 100ms step, 250ms in 311L.
TOC Delay =	200	ms
Z1 Extension =	Disabled	
LOL Scheme =	Disabled	

Appendix 01 11L-1-Q35L (Areva-P546) Setting Calculation

GROUP 1 EARTH FAULT:

IN>1 Status =	Enabled		
IN>1 Function =	US Inverse		
IN>1 Directional =	Directional Fwd		
IN>1 Current Set =	700.00	mA	# 67N
IN>1 Time Dial =	2.5		
IN>1 Reset Char =	DT		
IN>1 tRESET =	0	s	
IN>2 Status =	Disabled		
IN>3 Status =	Disabled		
IN>4 Status =	Disabled		
IN> Blocking =	000001		# Block IN>1
IN> Char Angle =	-60	deg	# Default
IN> Polarisation =	Zero Sequence		
IN> VNpol Set =	1.000	V	# Minimum

GROUP 1 CB FAIL & P.DEAD:

I< Current Set =	250.0mA	# Default
ISEF< Current =	100.0mA	# Default
V< =	10.0 V	# Minimum

GROUP 1 SUPERVISION:

VTS Mode =	Measured Only
VTS Status =	Blocking
VTS Reset Mode =	Auto
VTS Time Delay =	5.000 s
VTS I> Inhibit =	3.150 A
VTS I2> Inhibit =	250.0 mA
I>2nd Harmonic =	10.00%
WI Inhibit =	Disabled
CTS Mode =	Disabled

GROUP 1 INPUT LABELS:

Opto Input 1	Spare
Opto Input 2	Spare
Opto Input 3	Zone 2 Timer Byp
Opto Input 4	Spare
Opto Input 5	52b/1 status
Opto Input 6	52b/3 status
Opto Input 7	89b/FQ35L status
Opto Input 8	89b/F1 status
Opto Input 9	86TT-1/Q35L stat
Opto Input 10	86TT-1/Q35L alm
Opto Input 11	86-1/Q35L status
Opto Input 12	86-1/Q35L alm
Opto Input 13	11LTSS-1A/Q35L M
Opto Input 14	11LTSS-1B/Q35L M
Opto Input 15	89b/GS9/A status
Opto Input 16	89b/GS9/B status
Opto Input 17	89b/GS9/C status
Opto Input 18	11LTSR-1A/Q35L M
Opto Input 19	11LTSR-1B/Q35L M
Opto Input 20	Spare

Opto Input 21 Spare
Opto Input 22 Spare
Opto Input 23 Spare
Opto Input 24 Spare

GROUP 1 OUTPUT LABELS:

Relay 1 Any Trip (SER)
Relay 2 67N TRIP
Relay 3 21(ZONE2) TRIP
Relay 4 21&21G TRIP
Relay 5 50SOTF TRIP
Relay 6 Spare # 50HS
Relay 7 Spare
Relay 8 Spare
Relay 9 Spare

GROUP 1 OUTPUT LABELS:

Relay 10 Spare
Relay 11 Spare
Relay 12 Spare
Relay 13 Spare
Relay 14 Spare
Relay 15 Spare
Relay 16 Spare
Relay 17 Spare
Relay 18 Spare
Relay 19 Spare
Relay 20 Spare
Relay 21 Spare
Relay 22 Spare
Relay 23 Spare
Relay 24 Spare
Relay 25 Spare
Relay 26 Spare
Relay 27 Spare
Relay 28 Spare
Relay 29 Spare
Relay 30 Spare
Relay 31 Spare
Relay 32 Spare

Appendix 02 11L-2-Q35L (SEL-311L) Setting Calculation

1. Data

MVA_Base =	100	kV_Base =	345	Z_Base =	1190.25	ohms
CTR =	600	PTR =	3000	CTR/PTR=	0.2	

Line ID	From	To	R1(ohms)	X1(ohms)	R0(ohms)	X0(ohms)
Q35L+B47	Charles Poletti	FARRAGUT	0.499905	2.3924025	4.308705	6.1297875

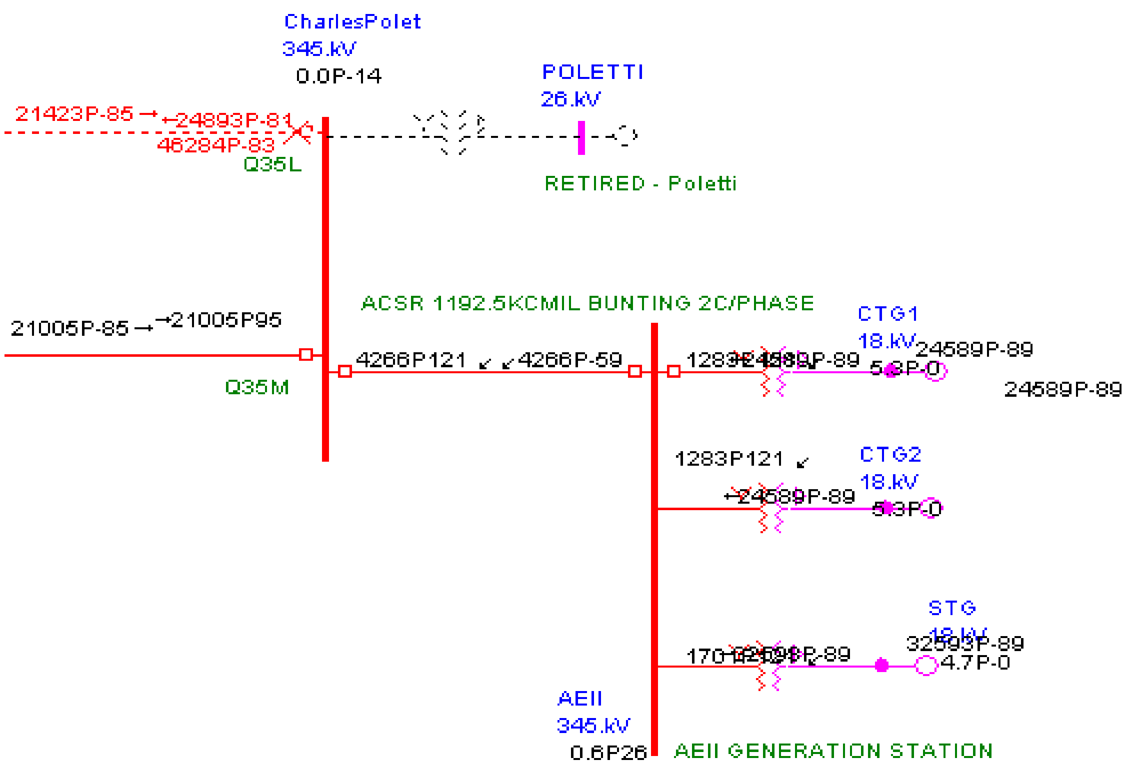
Secondary Ohms = Primary Ohms • (CTR/PTR)

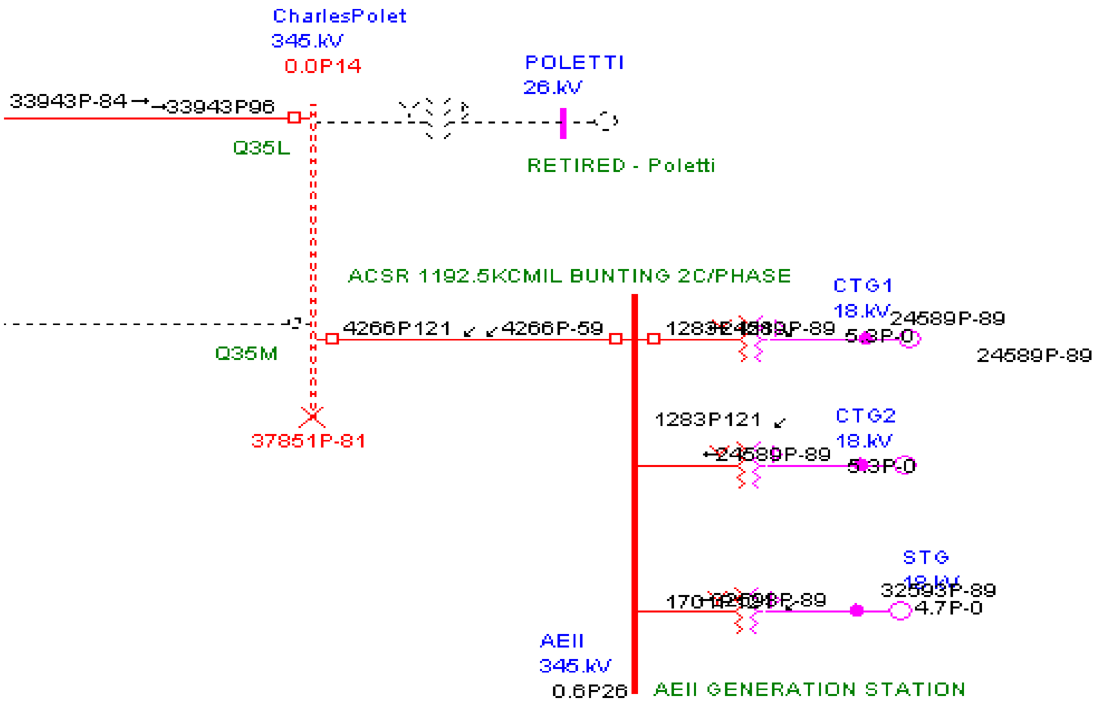
Line ID	From	To	R1(2nd ohm)	X1(2nd ohm)	R0(2nd ohm)	X0(2nd ohm)
Q35L+B47	Charles Poletti	FARRAGUT	0.10	0.48	0.86	1.23

Z1 = Sqrt (R1*R1+X1*X1) Z1Ang = Arctan (X1/R1) Z0 equations are the same.

Line ID	From	To	Z1(2nd ohm)	Z1Ang	Z0(2nd ohm)	Z0Ang
Q35L+B47	Charles Poletti	FARRAGUT	0.49	78.20	1.50	54.90

2. Setting Criteria
2.1 Set Zone 1 phase distance at 87% of the line impedance with no time delay.
2.2 Set Zone 2 phase distance at 200% of the line impedance with 0.35 second delay.
2.3 Set Zone 1 ground distance at 70% of the line impedance with no time delay.
2.4 Set Zone 2 ground distance at 200% of the line impedance with 0.6 second delay.
2.5 Line differential and other distance elements are not used.
2.6 High Set Fault Protection (50HS):
For 3LG fault at Charles Poletti 345kV bus, the fault contributions are as following.





50HS shall provide high spped direct trip for all internal close-in phase faults and must not operate for remote bus faults or reverse faults with appropriate operating margin. Based on the fault current contribution above, 50HS if set to clear a fault of 24,893 Amp, it may false trip for a reverse fault (21,423 Amp), especially when Q35M is out of service (33,943 Amp), so 50HS cannot be set securely and therefore is disabled.

Noted that the Aspen model (NYISO_2012_Q308_ON) provided by NYISO shows a higher fault level due to consideration of future BERRIANS 3 station. However, it will not affect the conclusion.

2.7 Stub Bus Protection (50SB):

The voltage source of 11L-2-Q35L (SEL-311L) relay is at the line side of the MOD, so 50SB is required.

50SB is to be enabled only when MOD is open, i.e. supervised by MOD's 89b, see 67P2TC setting.

For normal load current or external fault current through the stub bus, the current will ideally be zero.

Set 50SB pickup at 150% of the maximum full load current by considering all three GSUs with a possibility of one set of CT test switches left shorted.

Total MVA of all three GSUs = 750 ; Maximum full load current (amps) = 1255.11

2.8 Switch-On-To-Fault Protection (50SOTF)

50SOTF will only be armed when the circuit breakers are open and the asscoated line is de-energized. While closing the first circuit breaker to energize the line this function shall only be in service for the first 15 cycles and will reset if no fault is detected. 50SOTF pickup can be set the same as 50SB.

2.9 Directional Ground Overcurrent Backup Protection (67N)

67N will be used to provide backup protection for ground faults on the system. 67N pickup shall be higher than the worst unbalance and can be set at 1/3 of maximum full load (1255Amp/600/3=0.7Amp). US inverse is the selected curve for this time delay element. It shall coordinate with primary protection with a proper CTI (Coordination Time Interval) and trip a ground fault at Farragut 345kV with 0.69 second time delays under normal and 0.52 second time delay when the Q35M line is out. Refer to Appendix 28 for TCC.

The instantaneous -overcurrent (IOC) function can be used to provide close-in ground fault detection if it can be set selectively.

Appendix 02   11L-2-Q35L (SEL-311L) Setting Calculation

Applying 2LG and 1LG faults at Farragut 345kV bus under four conditions of normal, B47 out, Line 48 out, and Q35M out, the maximum ground fault current seen by 11L-2-Q35L relay would be a 2LG at Farragut 345kV bus with line 48 out, and is 6484.00 Amp

With margin of 30% , IOC = 8429.20 Primary Amp

However, applying 1LG faults at AEII Generation station, Aspen voltage sag analysis shows 0.003 pu voltage or 0.2V secondary at 11L-2-Q35L relay.With voltage below 1V, directionality is in doubt. With fault level of more than 40kA at AEII Generation station 345kV bus, falsely tripping is possible. So, it is not recommended to use 67N-IOC.

Group 1 - Set 1:

General Settings:

Relay ID	RID =	11L-2-Q35L	
Terminal ID	TID =	CHARLES POLETTI	
CT Ratio	CTR =	600	
Application	APP =	311L	
Advanced Setting Enable	EADVS =	N	

Line Current Differential Settings: Not used

All 87L settings are off or as default

Backup Protection and Line Parameters:

Polarizing (IPOL) CT Ratio	CTRP =	600	# Not used
Phase PT Ratio	PTR =	3000	
Synch Voltage (VS) PT Ratio	PTRS =	3000	# Not used

Pos-Seq Line Impedance Magnitude (Ohms secondary)	Z1MAG =	0.49	
Pos-Seq Line Impedance Angle (degrees)	Z1ANG =	78.20	
Zero-Seq Line Impedance Magnitude (Ohms secondary)	Z0MAG =	1.50	
Zero-Seq Line Impedance Angle (degrees)	Z0ANG =	54.90	
Line Length (unitless)	LL =	100	
Fault Locator Enable	EFLOC =	Y	

Phase Distance:

Enable Mho Phase Distance Elements	E21P =	2	
CCVT Transient Detection Enable	ECCVT =	N	# VT is used
Reach Zone 1 (Ohms secondary)	Z1P =	0.42	# 87% of line
Reach Zone 2 (Ohms secondary)	Z2P =	0.98	# 200% of line
Phase-Phase Overcurrent Fault Detector Zone 1 (2nd Amp)	50PP1 =	0.5	# minimum
Phase-Phase Overcurrent Fault Detector Zone 2 (2nd Amp)	50PP2 =	0.5	# minimum

Fault detectors can be set at the minimum if LOP (Loss Of Potential) is enabled.

Ground Distance Elements:

Enable Mho Ground Distance Elements	E21MG =	N	
Enable Quad Ground Distance Elements	E21XG =	2	
XG1 Zone 1 Reactance (Ohms secondary)	XG1 =	0.34	# 70% of line
XG2 Zone 2 Reactance (Ohms secondary)	XG2 =	0.98	# 200% of line
Zone 1 Resistance (Ohms secondary)	RG1 =	5.00	
Zone 2 Resistance (Ohms secondary)	RG2 =	5.00	

Zone 1 Phase Current FD (Amps secondary)	50L1 =	0.5	# minimum

Zone 2 Phase Current FD (Amps secondary)	50L2 =	0.5	# minimum
Zone 1 Residual Current FD (Amps secondary)	50GZ1 =	0.5	# minimum
Zone 2 Residual Current FD (Amps secondary)	50GZ2 =	0.5	# minimum

Fault detectors can be set at the minimum if LOP (Loss Of Potential) is enabled.

Zone 1 ZSC Factor Mag (unitless)	k0M1 =	0.73	
Zone 1 ZSC Factor Ang (degrees)	k0A1 =	-33.74	
Zone 2,3,4 ZSC Factor Mag (Unitless)	k0M =	0.73	# As k0M1
Zone 2,3,4 ZSC Factor Ang (degrees)	k0A =	-33.74	# As k0A1

$$\mathrm{k0M1}\ \angle \mathrm{k0A1} = \frac{(\mathrm{Z0MAG}\ \angle \mathrm{Z0ANG}) - (\mathrm{Z1MAG}\ \angle \mathrm{Z1ANG})}{3 \bullet (\mathrm{Z1MAG} \angle \mathrm{Z1ANG})}$$

<u>Mho Phase Distance Element Time Delay Settings:</u>

Zone 1 Time Delay (cycles in 0.25 increments)	Z1PD =	OFF	
Zone 2 Time Delay (cycles in 0.25 increments)	Z2PD =	21	# 0.35 second

<u>Mho Ground Distance Element Time Delay Settings:</u>

Zone 1 Time Delay (cycles in 0.25 increments)	Z1GD =	OFF	
Zone 2 Time Delay (cycles in 0.25 increments)	Z2GD =	36	# 0.6 second

<u>Phase Instantaneous Overcurrent Elements:</u>

Enable Phase Overcurrent Elements	E50P =	3	
Phase Instantaneous Overcurrent Level 1 (Amps secondary)	50P1P =	OFF	# 50HS OFF
Phase Instantaneous Overcurrent Level 2 (Amps secondary)	50P2P =	3.14	# 50SB
Phase Instantaneous Overcurrent Level 3 (Amps secondary)	50P3P =	3.14	# 50SOTF
Phase Definite-Time Overcurrent Element Level 1 (cycles)	67P1D =	0	# Not used
Phase Definite-Time Overcurrent Element Level 2 (cycles)	67P2D =	0	# Not used
Phase Definite-Time Overcurrent Element Level 3 (cycles)	67P3D =	0	# Not used

<u>Residual Ground Instantaneous Overcurrent Elements:</u>

Enable Residual Ground Overcurrent Elements	E50G =	1	
Residual Ground Inst O/C Level 1 (Amps secondary):	50G1P =	OFF	# Section 2.9

<u>Negative-Sequence Instantaneous Elements:</u>

Enable Negative-Sequence Overcurrent Element	E50Q =	N	# Not used.

<u>Phase Time-Overcurrent Elements:</u>

Enable Phase Time-Overcurrent Elements	E51P =	N	# Not used

<u>Residual Ground Time-Overcurrent Elements:</u>

Enable Residual Ground Time Overcurrent Elements	E51G =	Y	
Residual Ground Time-Overcurrent Pickup (Amp secondary)	51GP =	0.70	# 67N-TOC
51GC Curve	51GC =	U2	
51GTD Time Dial	52GTD =	2.5	
51GRS Electromechanical Reset Delay	51GRS =	N	

<u>Negative-Sequence Time-Overcurrent Elements:</u>

Enable Negative-Sequence Time-Overcurrent Elements	E51Q =	N	# Not used

<u>Out-of-Step Settings:</u>

Enable Out-of-Step Elements	EOOS =	N	# NotRequired

Load-Encroachment Elements:

As per NERC Task Force requirement, phase distance settings and other applicable phase and ground distance zone settings must permit loading of the line without trip to 150% of emergency line ampere rating, with 0.85 per unit bus voltage and a load angle of 30 degrees.

Loadability S = (0.85*kV)*(0.85*kV)/(Zsec*cos(Z1ANG-30)*CTR/PTR = 26329.22 MVA

Where, Zsec is Z2P in this application, kV is 345 and Z1ANG is line angle.

Conclusion: Loadability is more than 150% of maximum generation at AEII, no load encroachment.

Enable Load-Encroachment Element	ELOAD =	N	# Calc above

Directional Elements:

Enable Directional Elements	E32 =	AUTO	
Loss-Of_Potential Enable	ELOP =	Y1	

When ELOP = Y1 and a lop occurs, directional O/C elements are blocked.

Busbar PT LOP Logic Enable	EBBPT =	N	# N/A
Level 3 Direction	DIR3 =	F	# Default
Level 4 Direction	DIR4 =	F	# Default
Ground Directional Element Priority	ORDER =	Q	

Enable Voltage Elements:

Enable Voltage Elements	EVOLT =	Y	
Phase Undervoltage Pickup (Volts secondary)	27P =	45	# Note below

Under-voltage setting is not required in NYPA PAD revision 1. The existing Poletti setting shows under-voltage setting as 45V secondary. This element is set in relay and for alarm ONLY unless a trip is required by NYPA/ConEd.

Other voltage elements are all OFF.

Synchronism Check Elements

Enable Synchronism Check Elements	E25 =	N	# Not used

Frequency Elements

Enable Frequency Elements	E81 =	N	# Not used

Relcosing Relay:

Enable Reclosing Relay Elements	E79 =	N	# Not used

Switch-Onto-Fault:

Enable Switch-Onto-Fault Elements	ESOTF =	Y	# Section 2.8
Close Enable Time Delay (cycles in 0.25 increments)	CLOEND =	OFF	# Not used
52A Eanble Tim Delay (cycles in 0.25 increments)	52AEND =	36	# 0.6 second
SOTF Duration (cycles in 0.25 increments)	SOTFD =	15	# Section 2.8

Commnunications Assisted Tripping Schemes:

Enable Communication Assisted Tripping Schemes	ECOMM =	N	# Not used

Zone 1 Extension Settings:

Enable Zone 1 Extension Elements	EZ1EXT =	N	# Not used

Demand Metering Settings:

Appendix 02 11L-2-Q35L (SEL-311L) Setting Calculation

Enable Demand Metering Method	EDEM =	THM	
DMTC Time constant	DMTC =	15	
Phase Pickup (Amps secondary)	PDEMP =	OFF	# Not used
Residual Ground Pickup (Amps secondary)	GDEMP =	OFF	# Not used
Negative-Sequence Pcikup (Amps secondary)	QDEMP =	OFF	# Not used

Other Setting:

Minimum Trip Duration Time (cycles in 0.25 increments)	TDURD =	9	# Default
Close Failure Time Delay (cycles in 0.25 increments)	CFD =	0	# Not used
Three-Pole Open Time Delay (cycles in 0.25 increments)	3POD =	0.5	# Default
Open Pole Option	OPO =	52	# BKR status
Load Detection Phase Pickup (Ampes secondary)	50LP =	0.25	# Minimum

SELogic Control Equation Variable Timers:

SELogic Latch Bits Enables	ELAT =	N
SELogic Display Points Enables	EDP =	8
Enable SELogic Control Variable Timers	ESV =	N

Group 1 - Logic 1:

Trip/Comm.-Assisted Trip Logic:

Direct trip conditions TR = M1P+Z1G+M2PT+Z2GT+(M2P+Z2G)*IN103+67P2T+51GT

For LED2 Target; IN103 - Zone 2 timer bypass; 67P2T is 50SB; 51GT is 67N-TOC;

Switch-onto-fault trip conditions	TRSOTF =	50P3	# SOTF
Direct transfer trip conditions	DTT =	0	# Not used
Unlatch trip conditions	ULTR =	!52A	# Default

Close Logic Equations:

Circuit breaker status	52A =	!IN104+!IN105	CB1&3 Status
Close conditions	CL =	0	# Not used
Unlatch close conditions	ULCL =	0	# Not used

Latch Bits Set/Reset Equations: # Not used

Torque Control Equations for Inst./Def.-Time Overcurrent Elemements:

67P1TC Level 1 phase	67P1TC =	1	# Not used
67P2TC Level 1 phase	67P2TC =	IN106+IN301	# MOD-89b
67P3TC Level 1 phase	67P3TC =	1	# See below
67G1TC Level 1 phase	67G1TC =	1	# Not used
51GTC Residual Ground	51GTC =	32GF	# DIR = F

Other Torque Controls are not enabled.

SELogic Control Equation Variables: # ESV = N

Output Contacts:

Output Contact 101	OUT101 =	TRIP	# Any Trip
Output Contact 102	OUT102 =	51GT	# 67N
Output Contact 103	OUT103 =	M2PT+Z2GT+(M2P+Z2G)*IN103	# 21 Zone 2
Output Contact 104	OUT104 =	M1P+Z1G	# 21 & 21G
Output Contact 105	OUT105 =	SOTFT	# 50SOTF
Output Contact 106	OUT106 =	0	# Not used

Output Contact 107	OUT107 =	67P2T	# 50SB
Output Contact 201	OUT201 =	IN106	# DS Open
Output Contact 201	OUT2012 =	!IN106	# DS Close

Output Contact 203 ~ 206, 301 ~ 312 are all 0.

Display Points:

Display Point 1	DP1 =	0	
Display Point 2	DP2 =	0	
Display Point 3	DP3 =	IN103	# Z2T Bypass
Display Point 4	DP4 =	IN104	# 52b/BKR1
Display Point 5	DP5 =	IN105	# 52b/BKR3
Display Point 6	DP6 =	IN106	# 89b/FQ35L
Display Point 7	DP7 =	IN301	# 89b/F1
Display Point 8	DP8 =	3P27	# Low Voltage
Display Point 9 ~16			# Not used

Setting Group Selection Equations:

Select Setting Group 1	SS1 =	1	
Select Setting Group 2 ~ 6 are all 0	SS2~SS6 =	0	# Not used

Other Equations:

Event report trigger conditions ER = /M2P+/Z2G+/50P2+/51G+/LOP

Fault indication FAULT = M2P + Z2G + 50P2 + 51G

Block synchronism check elements	BSYNCH =	0	# Not used
Close bus monitor	CLMON =	0	# Not used
Enable for V0 polarized and IN polarized elements	E32V =	1	
Stub Bus Logic Enable	ESTUB =	0	# Not used

50SB is done by setting its torque control 67P2TC as MOD-89b. 87L is not used, ESTUB won't work.

Mirrored Bits Transmit Equations: # Not used

87L Transmit Equations: # Not used

General Settings:

Group Change Delay (cycles in 0.25 increments)	TGR =	0	# Not used
Nominal Frequency (Hz)	NFREQ =	60	
Phase Rotation	PHROT =	ABC	
Date Format	Date_F =	MDY	
Front Panel Timeout (minutes)	FP_TO =	5	# 5 minutes
Display Update Rate (seconds)	SCROLD =	5	# 5 seconds
Length of Event Report (cycles)	LER =	60	
Cycle Length of Prefault in Event Report (cycles)	PRE =	4	
DC Battery LO Voltage Pickup (Vdc)	DCLOP =	OFF	
DC Battery HI Voltage Pickup (Vdc)	DCHIP =	OFF	

Optoisolated Input Timers: IN101D ~ IN106D, IN301D ~ IN308D = 0.5 # 0.5 cycle

Breaker Monitor Settings:

Breaker Monitor Enable	EBMON =	N	# Not used

Synchronized Phasor Settings:

Synchronized Phasor Measurement	EPMU =	N	# Not used

SER:

SER1 = M1P, Z1G, M2P, M2PT, Z2G, Z2GT, 67P2T, SOTFT, 51G, 51GT, 3P27, LOP
SER2 = SV1T, SV2T, IN103, IN104, IN105, IN106, IN301, IN302, IN303, IN304, IN305, IN306, IN307
SER3 = OUT102, OUT103, OUT104, OUT105,OUT106, OUT107

Text:

Local Bit Labels			# Not used
Display-Point Labels	DP1_1 =	NA	
	DP1_0 =	NA	
	DP2_1 =	NA	
	DP2_0 =	NA	
	DP3_1 =	ZONE 2 T BYPASS	
	DP3_0 =	NA	
	DP4_1 =	BREAKER 1 OPEN	
	DP4_0 =	BREAKER 1 CLOSED	
	DP5_1 =	BREAKER 3 OPEN	
	DP5_0 =	BREAKER 3 CLOSED	
	DP6_1 =	MOD FQ35L OPEN	
	DP6_0 =	MOD FQ35L CLOSED	
	DP7_1 =	MOD F1 OPEN	
	DP7_0 =	MOD F1 CLOSED	
	DP8_1 =	LOW VOLTAGE	
	DP8_0 =	NA	

Appendix 03 85-Q35L (SEL-311L) Setting Calculation

1. Data

MVA_Base =	100	kV_Base =	345	Z_Base =	1190.25	ohms
CTR =	600	PTR =	3000	CTR/PTR=	0.2	

2. Setting Criteria

2.1 87LPP is to detect three-phase faults. It must be set above line charging current. Set 87LPP at its minimum of 1 secondary amp at 3000/5 CT.

2.2 87L2P is to detect all internal unbalanced faults. It must be set above expected maximum line charging current unbalance. Set 87L2P at its minimum of 0.5 secondary amp at 3000/5 CT.

2.3 87LGP is to detect all internal ground faults. It must be set above expected maximum line charging current unbalance. Set 87LGP at its minimum of 0.5 secondary amp at 3000/5 CT.

2.4 Settings of CTALRM, 87LP AND 87LANG can be at default.

Group 1 - Set 1:

General Settings:

Relay ID	RID =	85-Q35L	
Terminal ID	TID =	CHARLES POLETTI	
CT Ratio	CTR =	600	
Application	APP =	87L	
Advanced Setting Enable	EADVS =	N	

Line Current Differential Settings:

Number of 87L Terminals	E87L =	2	
High Speed Tripping	EHST =	N	
Enable High Speed Direct Transfer Trip	EHSDTT =	N	
Enable Disturbance Current Detect	EDD =	Y	
Tapped Load Coordination	ETAP =	N	
Enable Open CT Logic	EOCTL =	N	
CTR at Terminal Connected to Channel X	CTR_X =	400	# 2000/5 CT
Phase 87L (Amp secondary)	87LPP =	1	# Minimum
Negative Sequence 87L (Amp secondary)	87L2P =	0.5	# Minimum
Ground 87L (Amp secondary)	87LGP =	0.5	# Minimum
Ph. Diff. Current Alarm Pickup (Amp secondary)	CTALRM =	0.5	# Minimum
Outer Radius	87LR =	6	# Default
Angle (Degree)	87LANG =	195	# Default

Backup Protection and Line Parameters:	# Not used
Phase Distance:	# Not used
Ground Distance Elements:	# Not used
Phase Instantaneous Overcurrent Elements:	# Not used
Residual Ground Instantaneous Overcurrent Elements:	# Not used
Negative-Sequence Instantaneous Elements:	# Not used
Phase Time-Overcurrent Elements:	# Not used
Residual Ground Time-Overcurrent Elements:	# Not used
Negative-Sequence Time-Overcurrent Elements:	# Not used
Out-of-Step Settings:	# Not used
Load-Encroachment Elements:	# Not used
Directional Elements:	# Not used
Enable Voltage Elements:	# Not used

Appendix 03 85-Q35L (SEL-311L) Setting Calculation

Synchronism Check Elements		# Not used
Frequency Elements		# Not used
Relcosing Relay:		# Not used
Switch-Onto-Fault:		# Not used
Commnunications Assisted Tripping Schemes:		# Not used
Zone 1 Extension Settings:		# Not used
Demand Metering Settings:		# Not used
Other Setting:		# Not used
SELogic Control Equation Variable Timers:		# Not used
Group 1 - Logic 1:		
Trip/Comm.-Assisted Trip Logic:		
Direct trip conditions	TR = TRIP87	# Target Only
Switch-onto-fault trip conditions	TRSOTF = 0	# Not used
Direct transfer trip conditions	DTT = 0	# Not used
Unlatch trip conditions	ULTR = !TRIP87	# Not used
Close Logic Equations:		
Circuit breaker status	52A = 0	# Not used
Close conditions	CL = 0	# Not used
Unlatch close conditions	ULCL = 0	# Not used
Latch Bits Set/Reset Equations:		# Not used
Torque Control Equations for Inst./Def.-Time Overcurrent Elemements:		# Not used
SELogic Control Equation Variables:		# Not used
Output Contacts:		
Output Contact 101	OUT101 = Trip	# Any Trip
Output Contact 102	OUT102 = 0	# Not used
Output Contact 103	OUT103 = Trip	# CSM@E13
Output Contact 104	OUT104 = 0	# Not used
Output Contact 105	OUT105 = 0	# Not used
Output Contact 106	OUT106 = 0	# Not used
Output Contact 107	OUT107 = 0	# Not used
Output Contact 201 ~ 206, 301 ~ 312 are all 0.		
Display Points:		# Not used
Setting Group Selection Equations:		# Not used
Other Equations:		
Event report trigger conditions ER = /TRIP		
Mirrored Bits Transmit Equations:		# Not used
87L Transmit Equations:		# Not used
General Settings:		

Appendix 03 85-Q35L (SEL-311L) Setting Calculation

Group Change Delay (cycles in 0.25 increments)	TGR =	0	# Not used
Nominal Frequency (Hz)	NFREQ =	60	
Phase Rotation	PHROT =	ABC	
Date Format	Date_F =	MDY	
Front Panel Timeout (minutes)	FP_TO =	5	# 5 minutes
Display Update Rate (seconds)	SCROLD =	5	# 5 seconds
Length of Event Report (cycles)	LER =	60	
Cycle Length of Prefault in Event Report (cycles)	PRE =	4	
DC Battery LO Voltage Pickup (Vdc)	DCLOP =	OFF	
DC Battery HI Voltage Pickup (Vdc)	DCHIP =	OFF	

Optoisolated Input Timers: IN101D ~ IN106D, IN301D ~ IN308D = 0.5 # 0.5 cycle

Breaker Monitor Settings:

Breaker Monitor Enable EBMON = N # Not used

Synchronized Phasor Settings:

Synchronized Phasor Measurement EPMU = N # Not used

SER:

SER1 = TRIP87, 87L,87L2,87LG,87LA,87LB,87LC,R87L2,R87LG,R87LA,R87LB,R87LC
SER2 = IN101,IN102
SER3 = OUT103

Text:

Reclosing Relay Labels # Not used

Appendix 04 87B-BS1 (SEL-387) Setting Calculation

1. Data

MVA_Base =	100	kV_Base =	345	Z_Base =	1190.25	ohms
CTR =	600	PTR =	3000	CTR/PTR=	0.2	

Total MVA of all three GSUs = 750 ; Maximum full load current (amps) = 1255.11

2. Setting Criteria

2.1 Differential Settings:

Maximum Transformer **MVA** =	750	MVA
The nominal transformer Winding 1 terminal voltage **VWDG1** =	345	kV
The nominal transformer Winding 2 terminal voltage **VWDG2** =	345	kV
The nominal transformer Winding 3 terminal voltage **VWDG3** =	345	kV
CT ratio for winding 1---**CTR1**=	600	
CT ratio for winding 2---**CTR2**=	600	
CT ratio for winding 3---**CTR3**=	600	
Winding 1 Current Tap **TAP1** = MVA/(Sqrt(3) x VWDG1 x CTR1) =	2.09	A
Winding 2 Current Tap **TAP2** = MVA/(Sqrt(3) x VWDG2 x CTR2) =	2.09	A
Winding 3 Current Tap **TAP3** = MVA/(Sqrt(3) x VWDG3 x CTR3) =	2.09	A
O87P ≥ 0.1 x 5A / TAPmin = 0.24 Set **O87P=**	0.24	# Per manual
Dual-Slop variable-percentage differential characteristic is used.		
Restraint Slop 1 Percentage (5-100%) **SLP 1** =	25	
Restraint Slope 2 Percentage (OFF, 25–200%) **SLP2** =	50	
Restraint Current Slope 1 Limit ((1–20) multiple of tap) **IRS1** =	6.8	
Unrestrained Element Current PU ((1–20) multiple of tap) **U87P** =	10.2	
Second-Harmonic Blocking Percentage (OFF, 5–100%) **PCT2** =	OFF	
Fifth-Harmonic Blocking Percentage (OFF, 5–100%) **PCT5** =	OFF	
Independent Harmonic Blocking **IHBL =**	N	

2.2 Winding 1 Elems (for event triggering)

2.2.1 Set phase IOC element 50P11P at 7.3 CT secondary amp or 4,393 CT primary amp, i.e. 3.5 times of the maximum full load current (FLC).

2.2.2. Set phase TOC element 51P1P at 2.95 CT secondary amp or 1,770 CT primary amp, i.e. 1.4 times of the maximum FLC.

2.2.3. Set residual IOC element 51N11P at 2.95 CT secondary amp or 1,770 CT primary amp, i.e. 1.4 times of the maximum FLC.

2.2.4. Set residual TOC element 51N1P at 1.65 CT secondary amp or 1,004 CT primary amp, i.e. 80% of the maximum FLC.

Group 1 - Set 1:

Config. Settings:

Relay Identifier	RID =	87B-BS1
Terminal Identifier	TID =	CHARLES POLETTI
Enable Wdg1 in Differential Element	E87W1 =	Y
Enable Wdg2 in Differential Element	E87W2 =	Y
Enable Wdg3 in Differential Element	E87W3 =	Y
Enable Wdg4 in Differential Element	E87W4 =	N
Enable Wdg1 O/C Elements and Dmd. Thresholds	EOC1 =	Y
Enable Wdg2 O/C Elements and Dmd. Thresholds	EOC2 =	N
Enable Wdg3 O/C Elements and Dmd. Thresholds	EOC3 =	N

Enable Wdg4 O/C Elements and Dmd. Thresholds	EOC4 =	N	
Enable Combined O/C Elements	EOCC =	N	
Enable RTDA Elements	E49A =	N	
Enable RTDB Elements	E49B =	N	
Enable SELogic Set 1	ESLS1 =	Y	
Enable SELogic Set 2	ESLS2 =	N	
Enable SELogic Set 3	ESLS3 =	N	
General Data:			
Wdg1 CT Connection	W1CT =	Y	
Wdg2 CT Connection	W2CT =	Y	
Wdg3 CT Connection	W3CT =	Y	
Wdg4 CT Connection	W4CT =	Y	# Not Used
Wdg1 CT Ratio	CTR1 =	600	
Wdg2 CT Ratio	CTR2 =	600	
Wdg3 CT Ratio	CTR3 =	600	
Wdg4 CT Ratio	CTR4 =	600	# Not Used
Maximum Power Xfmr Capacity	MVA =	750	
Define Interal CT Connection Compensation	ICOM =	N	
Wdg 1 Line-to-Line Voltage	VWDG1 =	345	# kV
Wdg 2 Line-to-Line Voltage	VWDG2 =	345	# kV
Wdg 3 Line-to-Line Voltage	VWDG3 =	345	# kV
Wdg 4 Line-to-Line Voltage	VWDG4 =	345	# Not used
Diff Elems:			
Restrained Element Current PU	O87P =	0.24	
Restrain Slope 1 Percentage	SLP1 =	25	
Restrain Slope 2 Percentage	SLP2 =	50	
Restraint Current Slope 1 Limit	IRS1 =	6.8	
Unrestrained Element Current PU	U87P =	10.2	
2nd Harmonic Blocking Percentage	PCT2 =	OFF	
5th Hamronic Blocking Percentage	PCT5 =	OFF	
5th Harmonic Alarm Threshold	TH5P =	OFF	
Independent Harmonic Blocking	IHBL =	N	
Restriced Earth Fault:			# Not Used
Winding 1 Elems:			
Phase Def-Time O/C Level 1 PU	50P11P =	7.3	# 3.5xFLC
Phase Level 1 O/C Delay	50P11P =	0.5	# cycle
50P11 Torque Control (SELogic Equation)	50P11TC =	1	
Oher Phase Inst O/C elements			# Not used
Phase Inv-Time O/C PU	51P1P =	2.95	# 1.4xFLC
Phase Inv-Time O/C Curve	51P1C =	C2	
Phase Inv-Time O/C Time-Dial	51P1TD =	0.2	
Phase Inv-Time O/C EM Reset	51P1RS =	N	
51P1 Torque Control (SELogic Equation)	51P1TC =	1	
Neg-Seq Def-Time O/C			# Not used
Residual Def-Time O/C Level 1 PU	50N11P =	2.95	# 1.4xFLC
Residual Level 1 O/C Delay	50N11D =	0.5	# cycle
50N11 Torque Control (SELogic Equation)	50N11TC =	1	

Other Residual Inst O/C elements			# Not used
Residual Inv-Time O/C PU	51N1P =	1.65	# 80% FLC
Residual Inv-Time O/C Curve	51N1C =	C2	
Residual Inv-Time O/C Time-Dial	51N1TD =	0.35	
Residual Inv-Time O/C EM Reset	51N1RS =	N	
51N1 Torque Control (SELogic Equation)	51N1TC =	1	
Demand Ammeter Time Constant	DATC1 =	15	# Default
Phase Demand Ammeter Threshold	PDEM1P =	7	# Default
Neg-Seq Demand Ammeter Threshold	QDEM1P =	1	# Default
Residual Demand Ammeter Threshold	NDEM1P =	1	# Default
Winding 2 Elems:			# Not Used
Winding 3 Elems:			# Not Used
Winding 4 Elems:			# Not Used
Combined Elems:			# Not used
RTD A Elems:			# Not used
RTD B Elems:			# Not used
Misc. Timers			# Default
SELogic Set 1:			
Set 1 Variable 1 (SELogic Equation)	S1V1 =	87R	
S1V1 Timer Pickup	S1V1PU =	0	
S1V1 Timer Dropout	S1V1DO =	24	# 0.4 second
Set 1 Variable 2 (SELogic Equation)	S1V2 =	51P1T+51N1T	
S1V2 Timer Pickup	S1V2PU =	0	
S1V2 Timer Dropout	S1V2DO =	0	
Set 1 Variable 3 (SELogic Equation)	S1V3 =	S1V2+87R	
S1V3 Timer Pickup	S1V3PU =	60	# 1 second
S1V3 Timer Dropout	S1V3DO =	300	# 5 seconds
Set 1 Variable 4 (SELogic Equation)	S1V4 =	87R+50N11T+50P11T+51P1T+51N1T	# Event trigger
S1V4 Timer Pickup	S1V4PU =	0	
S1V4 Timer Dropout	S1V4DO =	0	
Set 1 Latch Bits			# Not used
SELogic Set 2:			# Not used
SELogic Set 3:			# Not used
Trip Logic:			
	TR1 =	50P11T + 51P1T +50N11T +51N1T	
	TR2 =	87R + 87U	
	TR3 =	0	
	TR4 =	0	
	TR5 =	0	
	ULTR1 =	!(51P1 + 51N1)	
	ULTR2 =	!(87R + 87U)	
	ULTR3 =	0	
	ULTR4 =	0	
	ULTR5 =	0	
Close Logic:			# Not used
Event Trigger			
	ER =	/S1V4	
Output Contact Logic:			
Output Contact 101	OUT101 =	TRIP1+TRIP2	# Any Trip
Output Contact 102	OUT102 =	0	# Not used

Output Contact 103	OUT103 = 0	# Not used
Output Contact 104	OUT104 = 0	# Not used
Output Contact 105	OUT105 = S1V3T	# Alarm
Output Contact 106	OUT106 = 0	# Not used
Output Contact 107	OUT107 = 0	# Not used
Output Contact 201 ~ 212 are all 0.		# Not used

Global # Default

SER:
SER1 = 87R,87U,50P11,50P11T,51P1,51P1T,50N11,50N11T,51N1,51N1T
SER2 = S1V1,S1V1T,S1V2,S1V3,OUT105,S1V4
SER3 = 0
SER4 = 0

Appendix 05 11L-1-Q35M (Areva-P546) Setting Calculation

1. Data

MVA_Base =	100	kV_Base =	345	Z_Base =	1190.25	ohms
CTR =	600	PTR =	3000	CTR/PTR=	0.2	

Line ID	From	To	R1(ohms)	X1(ohms)	R0(ohms)	X0(ohms)
Q35M+48	Charles Poletti	FARRAGUT	0.499905	2.42811	4.38012	6.213105

Secondary Ohms = Primary Ohms • (CTR/PTR)

Line ID	From	To	R1(2nd ohm)	X1(2nd ohm)	R0(2nd ohm)	X0(2nd ohm)
Q35M+48	Charles Poletti	FARRAGUT	0.10	0.49	0.88	1.24

Z1 = Sqrt (R1*R1+X1*X1) Z1Ang = Arctan (X1/R1) Z0 equations are the same.

Line ID	From	To	Z1(2nd ohm)	Z1Ang	Z0(2nd ohm)	Z0Ang
Q35M+48	Charles Poletti	FARRAGUT	0.49	78.37	1.52	54.82

2. Setting Criteria

2.1 Set Zone 1 phase distance at 87% of the line impedance with no time delay.

2.2 Set Zone 2 phase distance at 200% of the line impedance with 0.35 second delay. (ConEd 0.3s)

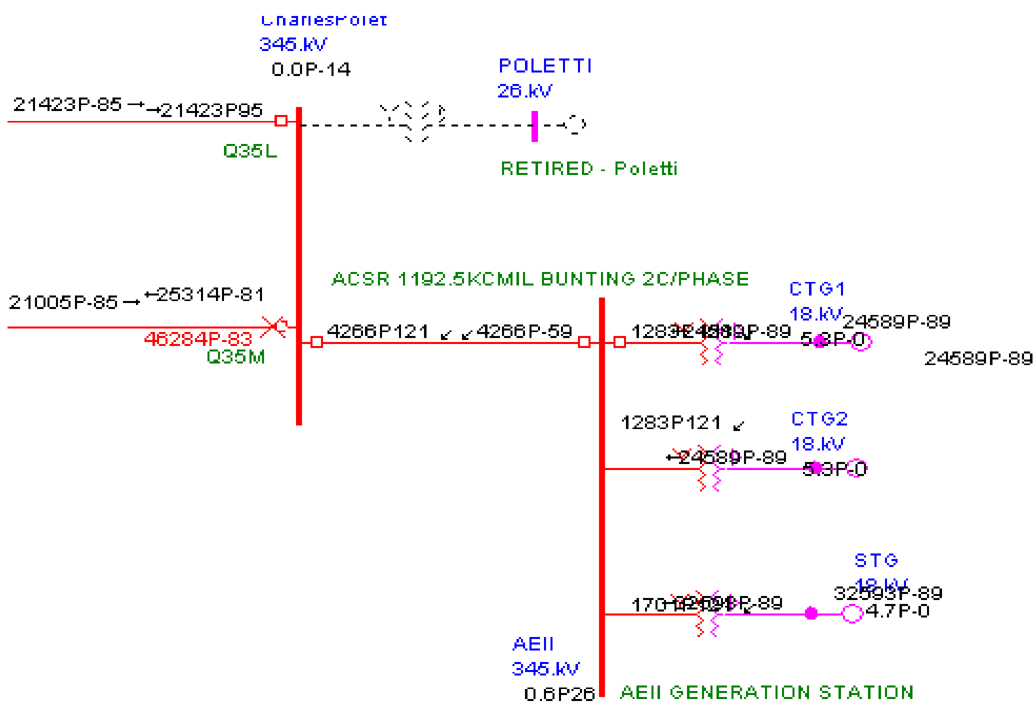
2.3 Set Zone 1 ground distance at 70% of the line impedance with no time delay.

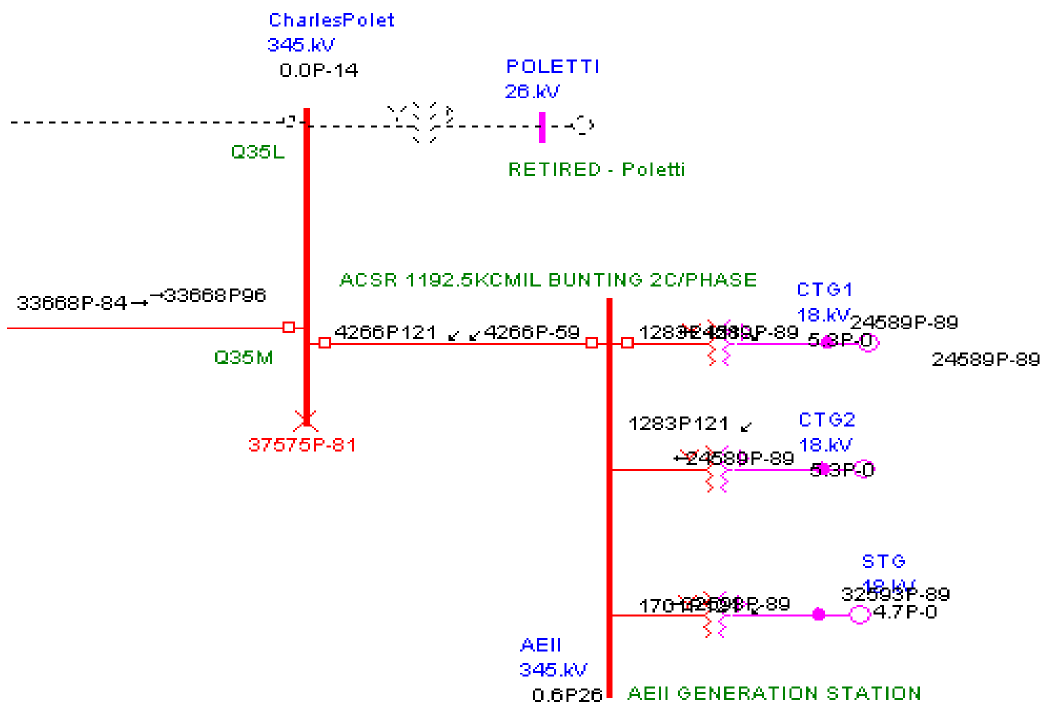
2.4 Set Zone 2 ground distance at 200% of the line impedance with 0.6 second delay. (ConEd 0.3s)

2.5 Line differential and other distance elements are not used.

2.6 High Set Fault Protection (50HS):

For 3LG fault at Charles Poletti 345kV bus, the fault contributions are as following.





50HS shall provide high spped direct trip for all internal close-in phase faults and must not operate for remote bus faults or reverse faults with appropriate operating margin. Based on the fault current contribution above, 50HS if set to clear a fault of 25,314 Amp, it may false trip for a reverse fault (21,005 Amp), especially when Q35L is out of service (33,668 Amp), so 50HS cannot be set securely and therefore is disabled.

Noted that the Aspen model (NYISO_2012_Q308_ON) provided by NYISO shows a higher fault level due to consideration of future BERRIANS 3 station. However, it will not impact the conclusion.

2.7 Stub Bus Protection (50SB):

The voltage source of 11L-1-Q35M (Areva-P546) relay is at the bus side of the MOD, so 50SB is not required.

2.8 Switch-On-To-Fault Protection (50SOTF)

50SOTF will only be armed when the circuit breakers are open and the asscoated line is de-energized. While closing the first circuit breaker to energize the line this function shall only be in service for the first 15 cycles and will reset if no fault is detected. 50SOTF is fulfilled by SOTF tripping Zone 2 with 200 ms drop-out timer, instead of 15 cycles or 250 ms drop-out timer, due to 100 ms step of the setting.

2.9 Directional Ground Overcurrent Backup Protection (67N)

67N will be used to provide backup protection for ground faults on the system. 67N pickup shall be higher than the worst unbalance and can be set at 1/3 of maximum full load (1255Amp/600/3=0.7Amp). US inverse is the selected curve for this time delay element. It shall coordinate with primary protection with a proper CTI (Coordination Time Interval) and trip a ground fault at Farragut 345kV with 0.68 second time delays under normal and 0.52 second time delay when the Q35L line is out. Refer to Appendix 28 for TCC.

The instantaneous -overcurrent (IOC) function can be used to provide close-in ground fault detection if it can be set selectively.

Appendix 05 11L-1-Q35M (Areva-P546) Setting Calculation

Applying 2LG and 1LG faults at Farragut 345kV bus under four conditions of normal, B47 out, Line 48 out, and Q35L out, the maximum ground fault current seen by 11L-1-Q35M relay would be

a 2LG at Farragut 345kV bus with line 48 out, and is			6484.00	Amp
With margin of	30%	, IOC =	8429.20	Primary Amp

However, applying 1LG faults at AEII Generation station, Aspen voltage sag analysis shows 0.003 pu voltage or 0.2V secondary at 11L-1-Q35M relay.With voltage below 1V, directionality is in doubt. With fault level of more than 40kA at AEII Generation station 345kV bus, falsely tripping is possible. So, it is not recommended to use 67N-IOC.

SYSTEM DATA:

Language =	English	
Sys Fn Links =	0	
Decription =	11L-1-Q35M	
Plant Reference =	CHARLES POLETTI	
Frequency =	60 Hz	

CB CONTROL:

CB Control by =	Disabled	
Rst CB mon L0 by =	CB Close	
CB mon Lo RstDly =	5.000 S	
CB1 Status Input =	52B 3 pole	
CB Status Time =	5.000 S	
CB2 Status Input =	52B 3 pole	

DATE AND TIME:

IRIG-B Sync =	Enabled	
Battery Alarm =	Enabled	
Other Time Settings =	Default	

CONFIGURATION:

Setting Group =	Select via Menu	
Active Settings =	Group 1	
Setting Group 1 =	Enabled	
Setting Group 2 =	Disabled	
Setting Group 3 =	Disabled	
Setting Group 4 =	Disabled	
Distance =	Enabled	# 21Z1,21Z2
Directional E/F =	Disabled	# Not used
Phase Diff =	Disabled	# Not used
Overcurrent =	Disabled	# Not used
Neg Sequence O/C =	Disabled	# Not used
Broken Conductor =	Disabled	# Not used
Earth Fault =	Enabled	# 67N
Sensitive E/F =	Disabled	# Not used
Residual O/V NVD =	Disabled	# Not used
Thermal Overload =	Disabled	# Not used
PowerSwing Block =	Disabled	# Not used
Volt Protection =	Disabled	# Not used
Freq Protection =	Disabled	# Not used
df/dt Protection =	Disabled	# Not used
CB Fail =	Disabled	# Not used
Supervision =	Enabled	
System Checks =	Disabled	

Appendix 05 11L-1-Q35M (Areva-P546) Setting Calculation

Auto-Reclose = Disabled
Input Labels = Visible
Output Labels = Visible
CT & VT Ratios = Visible
Record Control = Visible
Disturb Recorder = Visible
Measure't Setup = Visible
Comms Settings = Visible
Commission Tests = Visible
Setting Values = Secondary
Control Inputs = Invisible
Ctrl I/P Config = Invisible
Ctrl I/P Labels = Invisible
Direct Access = Enabled
InterMiCOM 64 = Disabled
Function Key = Invisible
LCD Contrast = 11

CT AND VT RATIOS

Main VT Primary = 345.0 kV
Main VT Sec'y = 115.0 V
CB1 CS VT Prim'y = 345.0 kV
CB1 CS VT Sec'y = 115.0 V
CB2 CS VT Prim'y = 345.0 kV
CB2 CS VT Sec'y = 115.0 V
Phase CT Primary = 3000 A
Phase CT Sec'y = 5.000 A
SEF CT Primary = 1.000 A
SEF CT Secondary = 1.000 A
MComp CT Primary = 1.000 A
MComp CT Sec'y = 1.000 A
CS Input = A-N
CT1 Polarity = Standard
CT2 Polarity = Standard
SEF CT Polarity = Standard
M CT Polarity = Standard
VT Connected = Yes
CB1 CS VT PhShft = 0 deg
CB1 CS VT Mag = 1
CB2 CS VT PhShft = 0 deg
CB2 CS VT Mag = 1

MEASURE'T SETUP:

Default Display = 3Ph + N Current
Local Values = Primary
Remote Values = Primary
Measurement Ref = VA
Measurement Mode = 0
Fix Dem Period = 30.00 min
Roll Sub Period = 30.00 min
Num Sub Periods = 1
Distance Unit = Miles

Fault Location = Distance

COMMISSION TESTS:

Monitor Bit 1 =	1060	# Red LED1
Monitor Bit 2 =	1062	# Red LED2
Monitor Bit 3 =	1064	# Red LED3
Monitor Bit 4 =	1066	# Red LED4
Monitor Bit 5 =	1068	# Red LED5
Monitor Bit 6 =	1070	# Red LED6
Monitor Bit 7 =	1072	# Red LED7
Monitor Bit 8 =	1074	# Red LED8

CB MONITOR SETUP: All disabled # Not required

OPTO CONFIG:

Global Nominal V = 110/125V
Opto Filter Cntl = 111111111111111111111111
Characteristic = Standard 60%-80%

CONTROL INPUTS: Not used
CTRL I/P CONFIG: Not used
FUNCTION KEYS: Not used
CTRL I/P LABELS: Not used

Group 1:

GROUP 1 LINE PARAMETERS:

Line Length = 9.635 mi
Line Impedance = 0.49 Ohm
Line Angle = 79.00 deg
kZN Res Comp = 0.73
kZN Res Angle = -34
Mutual Comp = Disabled
Phase Sequence = Standard ABC
CB1Tripping Mode = 3 Pole
CB2Tripping Mode = 3 Pole

GROUP 1 DISTANCE SETUP:

Setting Mode = Advanced
Phase Chars. = Quad
Zone 1 Ph Status = Enabled
Zone 2 Ph Status = Enabled
Zone 3 Ph Status = Disabled
Zone 4 Ph Status = Disabled
Ground Chars. = Quad
Zone 1 Gnd Stat = Enabled
Zone 2 Gnd Stat. = Enabled
Zone 3 Gnd Stat = Disabled
Zone P Gnd Stat. = Disabled
Zone 4 Gnd Stat. = Diabled
Digital Filter = Standard
CVT Filters = Disabled # VT is used
Load Blinders = Disabled # Default
Dist. Polarizing = 1
Dir. Status = Enabled

	AidedDeltaStatus =	Disabled		
	Dir. Char Angle =	60.00 deg		# Default
GROUP 1 DIST. ELEMENTS:		0		
	Z1 Ph. Reach =	420	mOhm	
	Z1 Ph. Angle =	79	deg	
	R1 Ph. Resistive =	5	Ohm	
	Z1 Tilt Top Line =	-3	deg	
	Z1 Sensit. Iph>1 =	0.25	A	
	Z2 Ph. Reach =	980	mOhm	
	Z2 Ph. Angle =	79	deg	
	R2 Ph. Resistive =	5	Ohm	
	Z2 Tilt Top Line =	-3	deg	
	Z2 Sensit. Iph>2 =	0.25	A	
	Z1 Gnd. Reach =	340	mOhm	
	Z1 Gnd. Angle =	79	deg	
	Z1 Dynamic Tilt =	Enabled		
	Z1 Tilt Top Line =	-3	deg	
	kZN1 Res. Comp =	0.73		
	kZN1 Res. Angle =	-34	deg	
	R1 Gnd Resistive =	5	Ohm	
	Z1 Sensit Ignd>1 =	0.25	A	
	Z2 Gnd. Reach =	980	mOhm	
	Z2 Gnd. Angle =	79	deg	
	Z2 Dynamic Tilt =	Enabled		
	Z2 Tilt Top Line =	-3	deg	
	kZN2 Res. Comp. =	0.73		
	kZN2 Res. Angle =	-34		
	R2 Gnd Resistive =	5	Ohm	
	Z2 Sensit Ignd>2 =	0.25	A	
GROUP 1 SCHEME LOGIC:		0		
	Zone1 Tripping =	Phase And Ground		
	tZ1 Ph. Delay =	0	s	
	tZ1 Gnd. Delay =	0	s	
	Zone2 Tripping =	Phase And Ground		
	tZ2 Ph. Delay =	350	ms	
	tZ2 Gnd. Delay =	600	ms	
	Zone3 Tripping =	Disabled		
	ZoneP Tripping =	Disabled		
	Zone4 Tripping =	Disabled		
	Aid. 1 Selection =	Disabled		
	Aid. 2 Selection =	Disabled		
	SOTF Status =	Enabled PoleDead		
	SOTF Delay =	600	ms	
	SOTF Tripping =	100010	# Allow fast fault clearance and Zone 2	
	TOR Status =	Disabled		
	TOC Reset Delay =	200	ms, # In 100ms step, 250ms in 311L.	
	TOC Delay =	200	ms	
	Z1 Extension =	Disabled		
	LOL Scheme =	Disabled		

GROUP 1 EARTH FAULT:

IN>1 Status =	Enabled		
IN>1 Function =	US Inverse		
IN>1 Directional =	Directional Fwd		
IN>1 Current Set =	700	mA	# 67N
IN>1 Time Dial =	2.5		
IN>1 Reset Char =	DT		
IN>1 tRESET =	0	s	
IN>2 Status =	Disabled		
IN>3 Status =	Disabled		
IN>4 Status =	Disabled		
IN> Blocking =	000001		# Block IN>1
IN> Char Angle =	-60	deg	# Default
IN> Polarisation =	Zero Sequence		
IN> VNpol Set =	1.000	V	# Minimum

GROUP 1 CB FAIL & P.DEAD:

I< Current Set =	250.0mA	# Default
ISEF< Current =	100.0mA	# Default
V< =	10.0 V	# Minimum

GROUP 1 SUPERVISION:

VTS Mode =	Measured Only
VTS Status =	Blocking
VTS Reset Mode =	Auto
VTS Time Delay =	5.000 s
VTS I> Inhibit =	3.150 A
VTS I2> Inhibit =	250.0 mA
I>2nd Harmonic =	0.1
WI Inhibit =	Disabled
CTS Mode =	Disabled

GROUP 1 INPUT LABELS:

Opto Input 1	Spare
Opto Input 2	Spare
Opto Input 3	Zone 2 Timer Byp
Opto Input 4	Spare
Opto Input 5	52b/2 status
Opto Input 6	52b/5 status
Opto Input 7	89b/FQ35M status
Opto Input 8	89b/F5 status
Opto Input 9	86TT-1/Q35M stat
Opto Input 10	86TT-1/Q35M alm
Opto Input 11	86-1/Q35M status
Opto Input 12	86-1/Q35M alm
Opto Input 13	11LTSS-1A/Q35M M
Opto Input 14	11LTSS-1B/Q35M M
Opto Input 15	89b/GS29/A status
Opto Input 16	89b/GS29/B status
Opto Input 17	89b/GS29/C status
Opto Input 18	11LTSR-1A/Q35M M
Opto Input 19	11LTSR-1B/Q35M M
Opto Input 20	Spare

	Opto Input 21	Spare	
	Opto Input 22	Spare	
	Opto Input 23	Spare	
	Opto Input 24	Spare	
GROUP 1 OUTPUT LABELS:			
	Relay 1	Any Trip (SER)	
	Relay 2	67N TRIP	
	Relay 3	21(ZONE2) TRIP	
	Relay 4	21&21G TRIP	
	Relay 5	Spare	
	Relay 6	Spare	# 50HS
	Relay 7	Spare	
	Relay 8	Spare	
	Relay 9	Spare	
GROUP 1 OUTPUT LABELS:			
	Relay 10	Spare	
	Relay 11	Spare	
	Relay 12	Spare	
	Relay 13	Spare	
	Relay 14	Spare	
	Relay 15	Spare	
	Relay 16	Spare	
	Relay 17	Spare	
	Relay 18	Spare	
	Relay 19	Spare	
	Relay 20	Spare	
	Relay 21	Spare	
	Relay 22	Spare	
	Relay 23	Spare	
	Relay 24	Spare	
	Relay 25	Spare	
	Relay 26	Spare	
	Relay 27	Spare	
	Relay 28	Spare	
	Relay 29	Spare	
	Relay 30	Spare	
	Relay 31	Spare	
	Relay 32	Spare	

Appendix 06 11L-2-Q35M (SEL-311L) Setting Calculation

1. Data

MVA_Base =	100	kV_Base =	345	Z_Base =	1190.25	ohms
CTR =	600	PTR =	3000	CTR/PTR=	0.2	

Line ID	From	To	R1(ohms)	X1(ohms)	R0(ohms)	X0(ohms)
Q35M+48	Charles Poletti	FARRAGUT	0.499905	2.42811	4.38012	6.213105

Secondary Ohms = Primary Ohms • (CTR/PTR)

Line ID	From	To	R1(2nd ohm)	X1(2nd ohm)	R0(2nd ohm)	X0(2nd ohm)
Q35M+48	Charles Poletti	FARRAGUT	0.10	0.49	0.88	1.24

Z1 = Sqrt (R1*R1+X1*X1) Z1Ang = Arctan (X1/R1) Z0 equations are the same.

Line ID	From	To	Z1(2nd ohm)	Z1Ang	Z0(2nd ohm)	Z0Ang
Q35M+48	Charles Poletti	FARRAGUT	0.49	78.37	1.52	54.82

2. Setting Criteria

2.1 Set Zone 1 phase distace at 87% of the line impedance with no time delay.

2.2 Set Zone 2 phase distace at 200% of the line impedance with 0.35 second delay. (ConEd 0.3s)

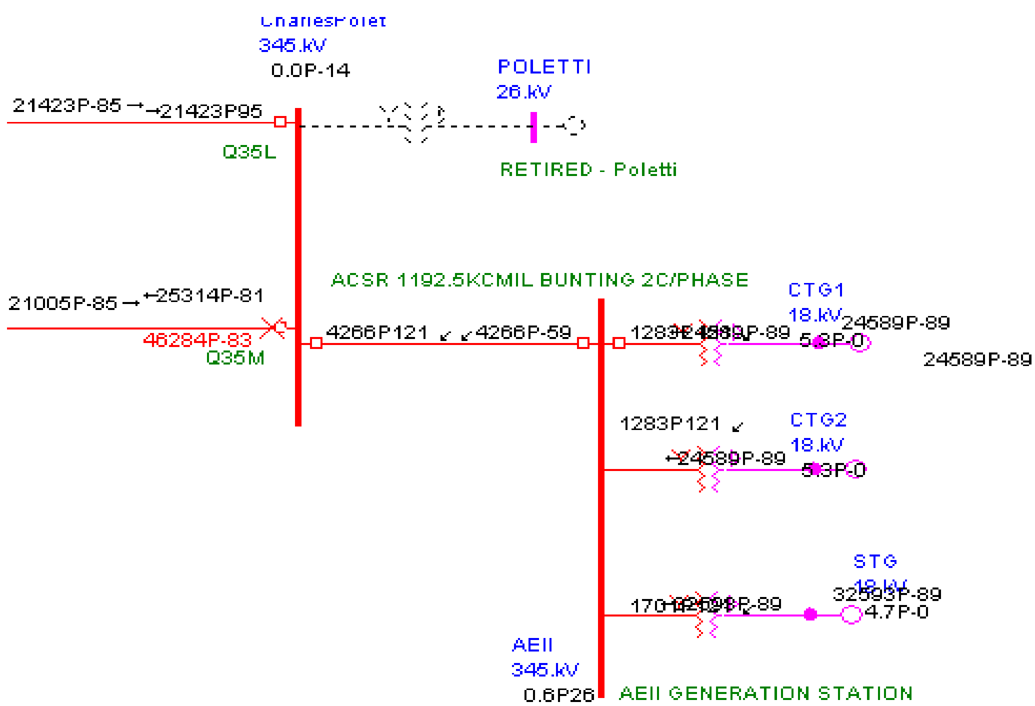
2.3 Set Zone 1 ground distance at 70% of the line impedance with no time delay.

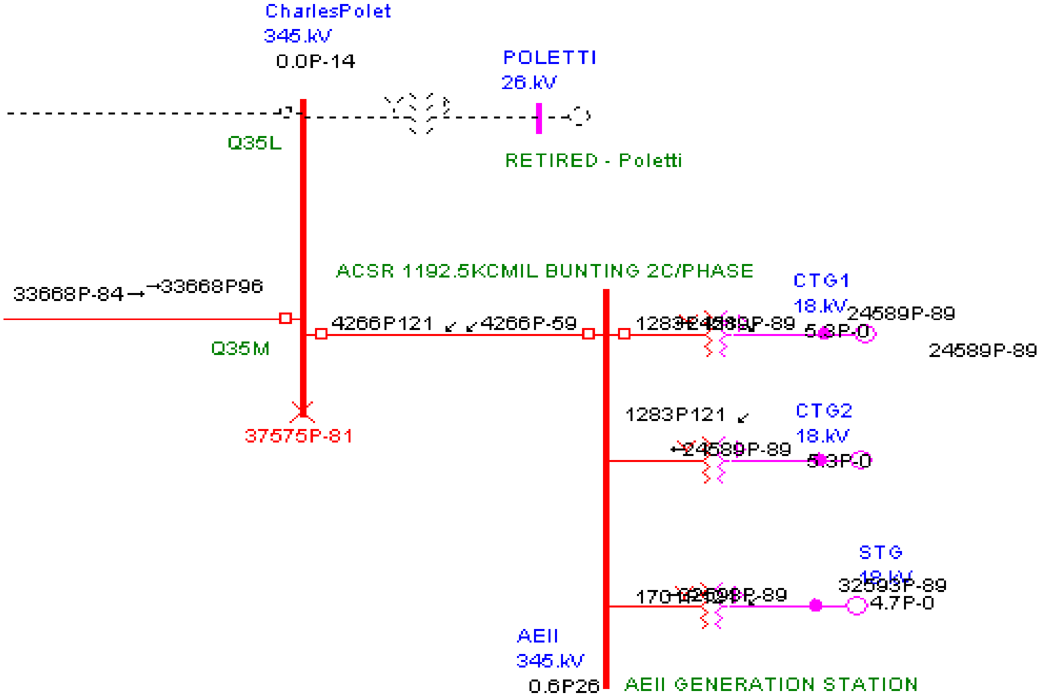
2.4 Set Zone 2 ground distance at 200% of the line impedance with 0.6 second delay. (ConEd 0.3s)

2.5 Line differential and other distance elements are not used.

2.6 High Set Fault Protection (50HS):

For 3LG fault at Charles Poletti 345kV bus, the fault contributions are as following.





50HS shall provide high spped direct trip for all internal close-in phase faults and must not operate for remote bus faults or reverse faults with appropriate operating margin. Based on the fault current contribution above, 50HS if set to clear a fault of 25,314 Amp, it may false trip for a reverse fault (21,005 Amp), especially when Q35L is out of service (33,668 Amp), so 50HS cannot be set securely and therefore is disabled.

Noted that the Aspen model (NYISO_2012_Q308_ON) provided by NYISO shows a higher fault level due to consideration of future BERRIANS 3 station. However, it will not affect the conclusion.

2.7 Stub Bus Protection (50SB):

The voltage source of 11L-2-Q35M (SEL-311L) relay is at the line side of the MOD, so 50SB is required.
50SB is to be enabled only when MOD is open, i.e. supervised by MOD's 89b, see 67P2TC setting.
For normal load current or external fault current through the stub bus, the current will ideally be zero.
Set 50SB pickup at 150% of the maximum full load current by considering all three GSUs with a possibility of one set of CT test switches left shorted.

Total MVA of all three GSUs = 750 ; Maximum full load current (amps) = 1255.11

2.8 Switch-On-To-Fault Protection (50SOTF)

50SOTF will only be armed when the circuit breakers are open and the asscoated line is de-energized. While closing the first circuit breaker to energize the line this function shall only be in service for the first 15 cycles and will reset if no fault is detected. 50SOTF pickup can be set the same as 50SB.

2.9 Directional Ground Overcurrent Backup Protection (67N)

67N will be used to provide backup protection for ground faults on the system. 67N pickup shall be higher than the worst unbalance and can be set at 1/3 of maximum full load (1255Amp/600/3=0.7Amp). US inverse is the selected curve for this time delay element. It shall coordinate with primary protection with a proper CTI (Coordination Time Interval) and trip a ground fault at Farragut 345kV with 0.68 second time delays under normal and 0.52 second time delay when the Q35L line is out. Refer to Appendix 28 for TCC.

The instantaneous -overcurrent (IOC) function can be used to provide close-in ground fault detection if it can be set selectively.

Applying 2LG and 1LG faults at Farragut 345kV bus under four conditions of normal, B47 out, Line 48 out, and Q35L out, the maximum ground fault current seen by 11L-2-Q35M relay would be

a 2LG at Farragut 345kV bus with line 48 out, and is 6484.00 Amp

With margin of 30% , IOC = 8429.20 Primary Amp

However, applying 1LG faults at AEII Generation station, Aspen voltage sag analysis shows 0.003 pu voltage or 0.2V secondary at 11L-2-Q35M relay.With voltage below 1V, directionality is in doubt. With fault level of more than 40kA at AEII Generation station 345kV bus, falsely tripping is possible. So, it is not recommended to use 67N-IOC.

Group 1 - Set 1:

General Settings:

Relay ID	RID = 11L-2-Q35M	
Terminal ID	TID = CHARLES POLETTI	
CT Ratio	CTR = 600	
Application	APP = 311L	
Advanced Setting Enable	EADVS = N	

Line Current Differential Settings: Not used

All 87L settings are off or as default

Backup Protection and Line Parameters:

Polarizing (IPOL) CT Ratio	CTRP = 600	# Not used
Phase PT Ratio	PTR = 3000	
Synch Voltage (VS) PT Ratio	PTRS = 3000	# Not used
Pos-Seq Line Impedance Magnitude (Ohms secondary)	Z1MAG = 0.49	
Pos-Seq Line Impedance Angle (degrees)	Z1ANG = 78.37	
Zero-Seq Line Impedance Magnitude (Ohms secondary)	Z0MAG = 1.52	
Zero-Seq Line Impedance Angle (degrees)	Z0ANG = 54.82	
Line Length (unitless)	LL = 100	
Fault Locator Enable	EFLOC = Y	

Phase Distance:

Enable Mho Phase Distance Elements	E21P = 2	
CCVT Transient Detection Enable	ECCVT = N	# VT is used
Reach Zone 1 (Ohms secondary)	Z1P = 0.42	# 87% of line
Reach Zone 2 (Ohms secondary)	Z2P = 0.98	# 200% of line
Phase-Phase Overcurrent Fault Detector Zone 1 (2nd Amp)	50PP1 = 0.5	# minimum
Phase-Phase Overcurrent Fault Detector Zone 2 (2nd Amp)	50PP2 = 0.5	# minimum

Fault detectors can be set at the minimum if LOP (Loss Of Potential) is enabled.

Ground Distance Elements:

Enable Mho Ground Distance Elements	E21MG = N	
Enable Quad Ground Distance Elements	E21XG = 2	
XG1 Zone 1 Reactance (Ohms secondary)	XG1 = 0.34	# 70% of line
XG2 Zone 2 Reactance (Ohms secondary)	XG2 = 0.98	# 200% of line
Zone 1 Resistance (Ohms secondary)	RG1 = 5.00	

Zone 2 Resistance (Ohms secondary)	RG2 = 5.00	
Zone 1 Phase Current FD (Amps secondary)	50L1 = 0.5	# minimum
Zone 2 Phase Current FD (Amps secondary)	50L2 = 0.5	# minimum
Zone 1 Residual Current FD (Amps secondary)	50GZ1 = 0.5	# minimum
Zone 2 Residual Current FD (Amps secondary)	50GZ2 = 0.5	# minimum

Fault detectors can be set at the minimum if LOP (Loss Of Potential) is enabled.

Zone 1 ZSC Factor Mag (unitless)	k0M1 = 0.74	
Zone 1 ZSC Factor Ang (degrees)	k0A1 = -33.91	
Zone 2,3,4 ZSC Factor Mag (Unitless)	k0M = 0.74	# As k0M1
Zone 2,3,4 ZSC Factor Ang (degrees)	k0A = -33.91	# As k0A1

$$k0M1 \angle k0A1 = \frac{(Z0MAG \angle Z0ANG) - (Z1MAG \angle Z1ANG)}{3 \cdot (Z1MAG \angle Z1ANG)}$$

<u>Mho Phase Distance Element Time Delay Settings:</u>

Zone 1 Time Delay (cycles in 0.25 increments)	Z1PD = OFF	
Zone 2 Time Delay (cycles in 0.25 increments)	Z2PD = 21	# 0.35 second

<u>Mho Ground Distance Element Time Delay Settings:</u>

Zone 1 Time Delay (cycles in 0.25 increments)	Z1GD = OFF	
Zone 2 Time Delay (cycles in 0.25 increments)	Z2GD = 36	# 0.6 second

<u>Phase Instantaneous Overcurrent Elements:</u>

Enable Phase Overcurrent Elements	E50P = 3	
Phase Instantaneous Overcurrent Level 1 (Amps secondary)	50P1P = OFF	# 50HS OFF
Phase Instantaneous Overcurrent Level 2 (Amps secondary)	50P2P = 3.14	# 50SB
Phase Instantaneous Overcurrent Level 3 (Amps secondary)	50P3P = 3.14	# 50SOTF
Phase Definite-Time Overcurrent Element Level 1 (cycles)	67P1D = 0	# Not used
Phase Definite-Time Overcurrent Element Level 2 (cycles)	67P2D = 0	# Not used
Phase Definite-Time Overcurrent Element Level 3 (cycles)	67P3D = 0	# Not used

<u>Residual Ground Instantaneous Overcurrent Elements:</u>

Enable Residual Ground Overcurrent Elements	E50G = 1	
Residual Ground Inst O/C Level 1 (Amps secondary):	50G1P = OFF	# Section 2.9

<u>Negative-Sequence Instantaneous Elements:</u>

Enable Negative-Sequence Overcurrent Element	E50Q = N	# Not used.

<u>Phase Time-Overcurrent Elements:</u>

Enable Phase Time-Overcurrent Elements	E51P = N	# Not used

<u>Residual Ground Time-Overcurrent Elements:</u>

Enable Residual Ground Time Overcurrent Elements	E51G = Y	
Residual Ground Time-Overcurrent Pickup (Amp secondary)	51GP = 0.70	# 67N-TOC
51GC Curve	51GC = U2	
51GTD Time Dial	52GTD = 2.5	
51GRS Electromechanical Reset Delay	51GRS = N	

<u>Negative-Sequence Time-Overcurrent Elements:</u>

Enable Negative-Sequence Time-Overcurrent Elements	E51Q =	N	# Not used

Out-of-Step Settings:

Enable Out-of-Step Elements	EOOS =	N	# NotRequired

Load-Encroachment Elements:

As per NERC Task Froce requirement, phase distance settings and other applicable phase and ground distance zone settings must permit loading of the line without trip to 150% of emergency line ampere rating, with 0.85 per unit bus voltage and a load angle

Loadability S = (0.85*kV)*(0.85*kV)/(Zsec*cos(Z1ANG-30)*CTR/PTR = 26416.37 MVA

Where, Zsec is Z2P in this application, kV is 345 and Z1ANG is line angle.

Conclusion: Loadability is more than 150% of maximum generation at AEII, no load encroachment.

Enable Load-Encroachment Element	ELOAD =	N	# Calc above

Directional Elements:

Enable Directional Elements	E32 =	AUTO	
Loss-Of_Potential Enable	ELOP =	Y1	

When ELOP = Y1 and a lop occurs, directional O/C elements are blocked.

Busbar PT LOP Logic Enable	EBBPT =	N	# N/A
Level 3 Direction	DIR3 =	F	# Default
Level 4 Direction	DIR4 =	F	# Default
Ground Directional Element Priority	ORDER =	Q	

Enable Voltage Elements:

Enable Voltage Elements	EVOLT =	Y	
Phase Undervoltage Pickup (Volts secondary)	27P =	45	# Note below

Under-voltage setting is not required in NYPA PAD revision 1. The existing Poletti setting shows under-voltage setting as 45V secondary. This element is set in relay and for alarm ONLY unless a trip is required by NYPA/ConEd.

Other voltage elements are all OFF.

Synchronism Check Elements

Enable Synchronism Check Elements	E25 =	N	# Not used

Frequency Elements

Enable Frequency Elements	E81 =	N	# Not used

Relcosing Relay:

Enable Reclosing Relay Elements	E79 =	N	# Not used

Switch-Onto-Fault:

Enable Switch-Onto-Fault Elements	ESOTF =	Y	# Section 2.8
Close Enable Time Delay (cycles in 0.25 increments)	CLOEND =	OFF	# Not used
52A Eanble Tim Delay (cycles in 0.25 increments)	52AEND =	36	# 0.6 second
SOTF Duration (cycles in 0.25 increments)	SOTFD =	15	# Section 2.8

Commnunications Assisted Tripping Schemes:

Enable Communication Assisted Tripping Schemes	ECOMM =	N	# Not used

Zone 1 Extension Settings:

Enable Zone 1 Extension Elements	EZ1EXT = N	# Not used
Demand Metering Settings:		
Enable Demand Metering Method	EDEM = THM	
DMTC Time constant	DMTC = 15	
Phase Pickup (Amps secondary)	PDEMP = OFF	# Not used
Residual Ground Pickup (Amps secondary)	GDEMP = OFF	# Not used
Negative-Sequence Pcikup (Amps secondary)	QDEMP = OFF	# Not used
Other Setting:		
Minimum Trip Duration Time (cycles in 0.25 increments)	TDURD = 9	# Default
Close Failure Time Delay (cycles in 0.25 increments)	CFD = 0	# Not used
Three-Pole Open Time Delay (cycles in 0.25 increments)	3POD = 0.5	# Default
Open Pole Option	OPO = 52	# BKR status
Load Detection Phase Pickup (Ampes secondary)	50LP = 0.25	# Minimum
SELogic Control Equation Variable Timers:		
SELogic Latch Bits Enables	ELAT = N	
SELogic Display Points Enables	EDP = 8	
Enable SELogic Control Variable Timers	ESV = N	
Group 1 - Logic 1:		
Trip/Comm.-Assisted Trip Logic:		
Direct trip conditions	TR = M1P+Z1G+M2PT+Z2GT+(M2P+Z2G)*IN103+67P2T+51GT	
# For LED2 Target; IN103 - Zone 2 timer bypass; 67P2T is 50SB; 51GT is 67N-TOC;		
Switch-onto-fault trip conditions	TRSOTF = 50P3	# SOTF
Direct transfer trip conditions	DTT = 0	# Not used
Unlatch trip conditions	ULTR = !52A	# Default
Close Logic Equations:		
Circuit breaker status	52A = !IN104+!IN105	CB2&5 Status
Close conditions	CL = 0	# Not used
Unlatch close conditions	ULCL = 0	# Not used
Latch Bits Set/Reset Equations:		# Not used
Torque Control Equations for Inst./Def.-Time Overcurrent Elemements:		
67P1TC Level 1 phase	67P1TC = 1	# Not used
67P2TC Level 1 phase	67P2TC = IN106+IN301	# MOD-89b
67P3TC Level 1 phase	67P3TC = 1	# See below
67G1TC Level 1 phase	67G1TC = 1	# Not used
51GTC Residual Ground	51GTC = 32GF	# DIR = F
Other Torque Controls are not enabled.		
SELogic Control Equation Variables:		# ESV = N
Output Contacts:		
Output Contact 101	OUT101 = TRIP	# Any Trip
Output Contact 102	OUT102 = 51GT	# 67N
Output Contact 103	OUT103 = M2PT+Z2GT+(M2P+Z2G)*IN103	# 21 Zone 2

Output Contact 104	OUT104 = M1P+Z1G	# 21 & 21G
Output Contact 105	OUT105 = SOTFT	# 50SOTF
Output Contact 106	OUT106 = 0	# Not used
Output Contact 107	OUT107 = 67P2T	# 50SB
Output Contact 201	OUT201 = IN106	# DS Open
Output Contact 201	OUT2012 = !IN106	# DS Close

Output Contact 203 ~ 206, 301 ~ 312 are all 0.

Display Points:

Display Point 1	DP1 = 0	
Display Point 2	DP2 = 0	
Display Point 3	DP3 = IN103	# Z2T Bypass
Display Point 4	DP4 = IN104	# 52b/BKR2
Display Point 5	DP5 = IN105	# 52b/BKR5
Display Point 6	DP6 = IN106	# 89b/FQ35M
Display Point 7	DP7 = IN301	# 89b/F5
Display Point 8	DP8 = 3P27	# Low Voltage
Display Point 9 ~16		# Not used

Setting Group Selection Equations:

Select Setting Group 1	SS1 = 1	
Select Setting Group 2 ~ 6 are all 0	SS2~SS6 = 0	# Not used

Other Equations:

Event report trigger conditions ER = /M2P+/Z2G+/50P2+/51G+/LOP

Fault indication FAULT = M2P + Z2G + 50P2 + 51G

Block synchronism check elements	BSYNCH = 0	# Not used
Close bus monitor	CLMON = 0	# Not used
Enable for V0 polarized and IN polarized elements	E32V = 1	
Stub Bus Logic Enable	ESTUB = 0	# Not used

50SB is done by setting its torque control 67P2TC as MOD-89b. 87L is not used, ESTUB won't work.

Mirrored Bits Transmit Equations: # Not used

87L Transmit Equations: # Not used

General Settings:

Group Change Delay (cycles in 0.25 increments)	TGR = 0	# Not used
Nominal Frequency (Hz)	NFREQ = 60	
Phase Rotation	PHROT = ABC	
Date Format	Date_F = MDY	
Front Panel Timeout (minutes)	FP_TO = 5	# 5 minutes
Display Update Rate (seconds)	SCROLD = 5	# 5 seconds
Length of Event Report (cycles)	LER = 60	
Cycle Length of Prefault in Event Report (cycles)	PRE = 4	
DC Battery LO Voltage Pickup (Vdc)	DCLOP = OFF	
DC Battery HI Voltage Pickup (Vdc)	DCHIP = OFF	

Optoisolated Input Timers: IN101D ~ IN106D, IN301D ~ IN308D = 0.5 # 0.5 cycle

Breaker Monitor Settings:

Breaker Monitor Enable	EBMON = N	# Not used

Synchronized Phasor Settings:

Synchronized Phasor Measurement	EPMU = N	# Not used

SER:

SER1 = M1P, Z1G, M2P, M2PT, Z2G, Z2GT, 67P2T, SOTFT, 51G, 51GT, 3P27, LOP

SER2 = SV1T, SV2T, IN103, IN104, IN105, IN106, IN301, IN302, IN303, IN304, IN305, IN306, IN307

SER3 = OUT102, OUT103, OUT104, OUT105,OUT106, OUT107

Text:

Local Bit Labels			# Not used
Display-Point Labels	DP1_1 =	NA	
	DP1_0 =	NA	
	DP2_1 =	NA	
	DP2_0 =	NA	
	DP3_1 =	ZONE 2 T BYPASS	
	DP3_0 =	NA	
	DP4_1 =	BREAKER 2 OPEN	
	DP4_0 =	BREAKER 2 CLOSED	
	DP5_1 =	BREAKER 5 OPEN	
	DP5_0 =	BREAKER 5 CLOSED	
	DP6_1 =	MOD FQ35M OPEN	
	DP6_0 =	MOD FQ35M CLOSED	
	DP7_1 =	MOD F5 OPEN	
	DP7_0 =	MOD F5 CLOSED	
	DP8_1 =	LOW VOLTAGE	
	DP8_0 =	NA	
Reclosing Relay Labels			# Not used

Appendix 07 85-Q35M (SEL-311L) Setting Calculation

1. Data

MVA_Base =	100	kV_Base =	345	Z_Base =	1190.25	ohms
CTR =	600	PTR =	3000	CTR/PTR=	0.2	

2. Setting Criteria

2.1 87LPP is to detect three-phase faults. It must be set above line charging current. Set 87LPP at its minimum of 1 secondary amp at 3000/5 CT.

2.2 87L2P is to detect all internal unbalanced faults. It must be set above expected maximum line charging current unbalance. Set 87L2P at its minimum of 0.5 secondary amp at 3000/5 CT.

2.3 87LGP is to detect all internal ground faults. It must be set above expected maximum line charging current unbalance. Set 87LGP at its minimum of 0.5 secondary amp at 3000/5 CT.

2.4 Settings of CTALRM, 87LP AND 87LANG can be at default.

Group 1 - Set 1:

General Settings:

Relay ID	RID = 85-Q35M	
Terminal ID	TID = CHARLES POLETTI	
CT Ratio	CTR = 600	
Application	APP = 87L	
Advanced Setting Enable	EADVS = N	

Line Current Differential Settings:

Number of 87L Terminals	E87L = 2	
High Speed Tripping	EHST = N	
Enable High Speed Direct Transfer Trip	EHSDTT = N	
Enable Disturbance Current Detect	EDD = Y	
Tapped Load Coordination	ETAP = N	
Enable Open CT Logic	EOCTL = N	
CTR at Terminal Connected to Channel X	CTR_X = 400	# 2000/5 CT
Phase 87L (Amp secondary)	87LPP = 1	# Minimum
Negative Sequence 87L (Amp secondary)	87L2P = 0.5	# Minimum
Ground 87L (Amp secondary)	87LGP = 0.5	# Minimum
Ph. Diff. Current Alarm Pickup (Amp secondary)	CTALRM = 0.5	# Minimum
Outer Radius	87LR = 6	# Default
Angle (Degree)	87LANG = 195	# Default

Backup Protection and Line Parameters:	# Not used
Phase Distance:	# Not used
Ground Distance Elements:	# Not used
Phase Instantaneous Overcurrent Elements:	# Not used
Residual Ground Instantaneous Overcurrent Elements:	# Not used
Negative-Sequence Instantaneous Elements:	# Not used
Phase Time-Overcurrent Elements:	# Not used
Residual Ground Time-Overcurrent Elements:	# Not used
Negative-Sequence Time-Overcurrent Elements:	# Not used
Out-of-Step Settings:	# Not used
Load-Encroachment Elements:	# Not used
Directional Elements:	# Not used
Enable Voltage Elements:	# Not used

Synchronism Check Elements		# Not used
Frequency Elements		# Not used
Relcosing Relay:		# Not used
Switch-Onto-Fault:		# Not used
Commnunications Assisted Tripping Schemes:		# Not used
Zone 1 Extension Settings:		# Not used
Demand Metering Settings:		# Not used
Other Setting:		# Not used
SELogic Control Equation Variable Timers:		# Not used

Group 1 - Logic 1:

Trip/Comm.-Assisted Trip Logic:

Direct trip conditions	TR = TRIP87	# Target Only
Switch-onto-fault trip conditions	TRSOTF = 0	# Not used
Direct transfer trip conditions	DTT = 0	# Not used
Unlatch trip conditions	ULTR = !TRIP87	# Not used

Close Logic Equations:

Circuit breaker status	52A = 0	# Not used
Close conditions	CL = 0	# Not used
Unlatch close conditions	ULCL = 0	# Not used

Latch Bits Set/Reset Equations: # Not used

Torque Control Equations for Inst./Def.-Time Overcurrent Elemements: # Not used

SELogic Control Equation Variables: # Not used

Output Contacts:

Output Contact 101	OUT101 = Trip	# Any Trip
Output Contact 102	OUT102 = 0	# Not used
Output Contact 103	OUT103 = Trip	# CSM@E13
Output Contact 104	OUT104 = 0	# Not used
Output Contact 105	OUT105 = 0	# Not used
Output Contact 106	OUT106 = 0	# Not used
Output Contact 107	OUT107 = 0	# Not used

Output Contact 201 ~ 206, 301 ~ 312 are all 0.

Display Points: # Not used

Setting Group Selection Equations: # Not used

Other Equations:

Event report trigger conditions ER = /TRIP

Mirrored Bits Transmit Equations: # Not used

87L Transmit Equations: # Not used

General Settings:

Group Change Delay (cycles in 0.25 increments)	TGR = 0	# Not used
Nominal Frequency (Hz)	NFREQ = 60	
Phase Rotation	PHROT = ABC	
Date Format	Date_F = MDY	
Front Panel Timeout (minutes)	FP_TO = 5	# 5 minutes
Display Update Rate (seconds)	SCROLD = 5	# 5 seconds
Length of Event Report (cycles)	LER = 60	
Cycle Length of Prefault in Event Report (cycles)	PRE = 4	
DC Battery LO Voltage Pickup (Vdc)	DCLOP = OFF	
DC Battery HI Voltage Pickup (Vdc)	DCHIP = OFF	

Optoisolated Input Timers: IN101D ~ IN106D, IN301D ~ IN308D = 0.5 # 0.5 cycle

Breaker Monitor Settings:

Breaker Monitor Enable EBMON = N # Not used

Synchronized Phasor Settings:

Synchronized Phasor Measurement EPMU = N # Not used

SER:

SER1 = TRIP87, 87L,87L2,87LG,87LA,87LB,87LC,R87L2,R87LG,R87LA,R87LB,R87LC

SER2 = IN101,IN102

SER3 = OUT103

Text:

Reclosing Relay Labels # Not used

Appendix 08 87B-BS5 (SEL-387) Setting Calculation

1. Data

MVA_Base =	100	kV_Base =	345	Z_Base =	1190.25	ohms
CTR =	600	PTR =	3000	CTR/PTR=	0.2	

Total MVA of all three GSUs = 750 ; Maximum full load current (amps) = 1255.11

2. Setting Criteria

2.1 Differential Settings:

Maximum Transformer **MVA** =	750	MVA
The nominal transformer Winding 1 terminal voltage **VWDG1** =	345	kV
The nominal transformer Winding 2 terminal voltage **VWDG2** =	345	kV
The nominal transformer Winding 3 terminal voltage **VWDG3** =	345	kV
CT ratio for winding 1---**CTR1**=	600	
CT ratio for winding 2---**CTR2**=	600	
CT ratio for winding 3---**CTR3**=	600	
Winding 1 Current Tap **TAP1** = MVA/(Sqrt(3) x VWDG1 x CTR1) =	2.09	A
Winding 2 Current Tap **TAP2** = MVA/(Sqrt(3) x VWDG2 x CTR2) =	2.09	A
Winding 3 Current Tap **TAP3** = MVA/(Sqrt(3) x VWDG3 x CTR3) =	2.09	A
O87P ≥ 0.1 x 5A / TAPmin = 0.24 Set **O87P=**	0.24	# Per manual
Dual-Slop variable-percentage differential characteristic is used.		
Restraint Slop 1 Percentage (5-100%) **SLP 1** =	25	
Restraint Slope 2 Percentage (OFF, 25–200%) **SLP2** =	50	
Restraint Current Slope 1 Limit ((1–20) multiple of tap**)** **IRS1** =	6.8	
Unrestrained Element Current PU ((1–20) multiple of tap) **U87P** =	10.2	
Second-Harmonic Blocking Percentage (OFF, 5–100%) **PCT2** =	OFF	
Fifth-Harmonic Blocking Percentage (OFF, 5–100%) **PCT5** =	OFF	
Independent Harmonic Blocking **IHBL =**	N	

2.2 Winding 1 Elems (for event triggering)

2.2.1 Set phase IOC element 50P11P at 7.3 CT secondary amp or 4,393 CT primary amp, i.e. 3.5 times of the maximum full load current (FLC).

2.2.2. Set phase TOC element 51P1P at 2.95 CT secondary amp or 1,770 CT primary amp, i.e. 1.4 times of the maximum FLC.

2.2.3. Set residual IOC element 51N11P at 2.95 CT secondary amp or 1,770 CT primary amp, i.e. 1.4 times of the maximum FLC.

2.2.4. Set residual TOC element 51N1P at 1.65 CT secondary amp or 1,004 CT primary amp, i.e. 80% of the maximum FLC.

<u>Group 1 - Set 1:</u>

<u>Config. Settings:</u>

Relay Identifier	RID =	87B-BS5
Terminal Identifier	TID =	CHARLES POLETTI
Enable Wdg1 in Differential Element	E87W1 =	Y
Enable Wdg2 in Differential Element	E87W2 =	Y
Enable Wdg3 in Differential Element	E87W3 =	Y
Enable Wdg4 in Differential Element	E87W4 =	N
Enable Wdg1 O/C Elements and Dmd. Thresholds	EOC1 =	Y
Enable Wdg2 O/C Elements and Dmd. Thresholds	EOC2 =	N
Enable Wdg3 O/C Elements and Dmd. Thresholds	EOC3 =	N

Enable Wdg4 O/C Elements and Dmd. Thresholds	EOC4 = N	
Enable Combined O/C Elements	EOCC = N	
Enable RTDA Elements	E49A = N	
Enable RTDB Elements	E49B = N	
Enable SELogic Set 1	ESLS1 = Y	
Enable SELogic Set 2	ESLS2 = N	
Enable SELogic Set 3	ESLS3 = N	
General Data:		
Wdg1 CT Connection	W1CT = Y	
Wdg2 CT Connection	W2CT = Y	
Wdg3 CT Connection	W3CT = Y	
Wdg4 CT Connection	W4CT = Y	# Not Used
Wdg1 CT Ratio	CTR1 = 600	
Wdg2 CT Ratio	CTR2 = 600	
Wdg3 CT Ratio	CTR3 = 600	
Wdg4 CT Ratio	CTR4 = 600	# Not Used
Maximum Power Xfmr Capacity	MVA = 750	
Define Interal CT Connection Compensation	ICOM = N	
Wdg 1 Line-to-Line Voltage	VWDG1 = 345	# kV
Wdg 2 Line-to-Line Voltage	VWDG2 = 345	# kV
Wdg 3 Line-to-Line Voltage	VWDG3 = 345	# kV
Wdg 4 Line-to-Line Voltage	VWDG4 = 345	# Not used
Diff Elems:		
Restrained Element Current PU	O87P = 0.24	
Restrain Slope 1 Percentage	SLP1 = 25	
Restrain Slope 2 Percentage	SLP2 = 50	
Restraint Current Slope 1 Limit	IRS1 = 6.8	
Unrestrained Element Current PU	U87P = 10.2	
2nd Harmonic Blocking Percentage	PCT2 = OFF	
5th Hamronic Blocking Percentage	PCT5 = OFF	
5th Harmonic Alarm Threshold	TH5P = OFF	
Independent Harmonic Blocking	IHBL = N	
Restriced Earth Fault:		# Not Used
Winding 1 Elems:		
Phase Def-Time O/C Level 1 PU	50P11P = 7.3	# 3.5xFLC
Phase Level 1 O/C Delay	50P11P = 0.5	# cycle
50P11 Torque Control (SELogic Equation)	50P11TC = 1	
Oher Phase Inst O/C elements		# Not used
Phase Inv-Time O/C PU	51P1P = 2.95	# 1.4xFLC
Phase Inv-Time O/C Curve	51P1C = C2	
Phase Inv-Time O/C Time-Dial	51P1TD = 0.2	
Phase Inv-Time O/C EM Reset	51P1RS = N	
51P1 Torque Control (SELogic Equation)	51P1TC = 1	
Neg-Seq Def-Time O/C		# Not used
Residual Def-Time O/C Level 1 PU	50N11P = 2.95	# 1.4xFLC
Residual Level 1 O/C Delay	50N11D = 0.5	# cycle
50N11 Torque Control (SELogic Equation)	50N11TC = 1	

Other Residual Inst O/C elements		# Not used
Residual Inv-Time O/C PU	51N1P = 1.65	# 80% FLC
Residual Inv-Time O/C Curve	51N1C = C2	
Residual Inv-Time O/C Time-Dial	51N1TD = 0.35	
Residual Inv-Time O/C EM Reset	51N1RS = N	
51N1 Torque Control (SELogic Equation)	51N1TC = 1	
Demand Ammeter Time Constant	DATC1 = 15	# Default
Phase Demand Ammeter Threshold	PDEM1P = 7	# Default
Neg-Seq Demand Ammeter Threshold	QDEM1P = 1	# Default
Residual Demand Ammeter Threshold	NDEM1P = 1	# Default
Winding 2 Elems:		# Not Used
Winding 3 Elems:		# Not Used
Winding 4 Elems:		# Not Used
Combined Elems:		# Not used
RTD A Elems:		# Not used
RTD B Elems:		# Not used
Misc. Timers		# Default
SELogic Set 1:		
Set 1 Variable 1 (SELogic Equation)	S1V1 = 87R	
S1V1 Timer Pickup	S1V1PU = 0	
S1V1 Timer Dropout	S1V1DO = 24	# 0.4 second
Set 1 Variable 2 (SELogic Equation)	S1V2 = 51P1T+51N1T	
S1V2 Timer Pickup	S1V2PU = 0	
S1V2 Timer Dropout	S1V2DO = 0	
Set 1 Variable 3 (SELogic Equation)	S1V3 = S1V2+87R	
S1V3 Timer Pickup	S1V3PU = 60	# 1 second
S1V3 Timer Dropout	S1V3DO = 300	# 5 seconds
Set 1 Variable 4 (SELogic Equation)	S1V4 = 87R+50N11T+50P11T+51P1T+51N1T	# Event trigger
S1V4 Timer Pickup	S1V4PU = 0	
S1V4 Timer Dropout	S1V4DO = 0	
Set 1 Latch Bits		# Not used
SELogic Set 2:		# Not used
SELogic Set 3:		# Not used
Trip Logic:		
	TR1 = 50P11T + 51P1T +50N11T +51N1T	
	TR2 = 87R + 87U	
	TR3 = 0	
	TR4 = 0	
	TR5 = 0	
	ULTR1 = !(51P1 + 51N1)	
	ULTR2 = !(87R + 87U)	
	ULTR3 = 0	
	ULTR4 = 0	
	ULTR5 = 0	
Close Logic:		# Not used
Event Trigger		
	ER = /S1V4	
Output Contact Logic:		
Output Contact 101	OUT101 = TRIP1+TRIP2	# Any Trip
Output Contact 102	OUT102 = 0	# Not used

Output Contact 103	OUT103 = 0	# Not used
Output Contact 104	OUT104 = 0	# Not used
Output Contact 105	OUT105 = S1V3T	# Alarm
Output Contact 106	OUT106 = 0	# Not used
Output Contact 107	OUT107 = 0	# Not used
Output Contact 201 ~ 212 are all 0.		# Not used

Global # Default

SER:
SER1 = 87R,87U,50P11,50P11T,51P1,51P1T,50N11,50N11T,51N1,51N1T
SER2 = S1V1,S1V1T,S1V2,S1V3,OUT105,S1V4
SER3 = 0
SER4 = 0

Appendix 09 85-1-G13 (Areva P546) Setting Calculation

1. Data

MVA_Base =	100	kV_Base =	345	Z_Base =	1190.25	ohms
CTR =	600	PTR =	3000	CTR/PTR=	0.2	

Line ID	From	To	R1(ohms)	X1(ohms)	R0(ohms)	X0(ohms)
G13	Charles Poletti	AEII GEN	0.01410275	0.1332769	0.038613481	0.32084775

Secondary Ohms = Primary Ohms • (CTR/PTR)

Line ID	From	To	R1(2nd ohm)	X1(2nd ohm)	R0(2nd ohm)	X0(2nd ohm)
G13	Charles Poletti	AEII GEN	0.00	0.03	0.01	0.06

Z1 = Sqrt (R1*R1+X1*X1) Z1Ang = Arctan (X1/R1) Z0 equations are the same.

Line ID	From	To	Z1(2nd ohm)	Z1Ang	Z0(2nd ohm)	Z0Ang
G13	Charles Poletti	AEII GEN	0.03	84.0	0.06	83.14

2. Setting Criteria

2.1 Zone 1 phase distace:

Set Zone 1 phase distace at 0.05 secondary ohm, or 167% of line impedance, same as the setting in 85-2-G13(SEL-311L). It may trip for a fault beyond the protected TL, such as a transformer fault. However, since there is no 345kV breaker at G13 station, such overreach is not a concern.

2.2 Set Zone 2 phase distace at 333% of the line impedance with 0.35 second delay.

2.3 Zone 1 ground distace:

Set Zone 1 ground distace at 0.05 secondary ohm, or 167% of line impedance, same as the setting in 85-2-G13(SEL-311L). It may trip for a fault beyond the protected TL, such as a transformer fault. However, since there is no 345kV breaker at G13 station, such overreach is not a concern.

2.4 Set Zone 2 ground distance at 333% of the line impedance with 0.6 second delay.

2.5 Line differential element

Set Is1, Is2 at the minimum and k1 and k2 at the default. Ph CT Corr'tion = (3000/5)/(1200/5) = 2.5

2.6 High Set Fault Protection (50HS):

50HS must not operate for reverse faults (local line end) or transformer inrush with appropriate operating margin. It may trip for a fault beyond the protected TL, such as a transformer fault. However, since there is no 345kV breaker at G13 station, such overreach is not a concern.

Both SEL-311L and Areva P546 can filter out 2nd harmonic etc major component of inrush current. Set 50HS at 7,200 Primary Amp or 12 Amp at CT secondary. It will be well below the forward fault current but above the reverse fault level. Refer to Appendix 01 Section 2.6 fault current distribution.

2.7 Stub Bus Protection (50SB):

The voltage source of 85-1-G13 (Areva P546) relay is at the bus side of the MOD. 50SB is not required.

2.8 Switch-On-To-Fault Protection (50SOTF)

50SOTF will only be armed when the circuit breakers are open and the asscoated line is de-energized. While closing the first circuit breaker to energize the line this function shall only be in service for the first 15 cycles and will reset if no fault is detected. Noting that 15 cycles or 250 ms can not be set in Areva P546 due to 100 ms step in "TOC Reset Delay" setting. 200 ms is used.

Set 50SOTF pickup the same as 50HS.

2.9 Directional Ground Overcurrent Backup Protection (67N)

67N will be used to provided backup protection for ground faults on the system. 67N pickup shall be higher than the worst unbalance and can be set 1/3 of maximum full load

1/3 of FLC = 1/3 * 1,255 Amp = 418.33 primary amp or 0.7 Amp at CT secondary.

Directional element is not necessary due to the strong utility source. Curve and time dial is set to provide security margin for reverse close-in faults.

Appendix 09 85-1-G13 (Areva P546) Setting Calculation

The instantaneous -overcurrent (IOC) function can be used to provide close-in ground fault detection and shall not trip for reverse faults or transformer inrush. Set it at 20 Amp CT secondary or 12kA CT primary to prevent false tripping for reverse ground faults.

SYSTEM DATA:

Language =	English	
Sys Fn Links =	0	
Decription =	85-1-G13	
Plant Reference =	CHARLES POLETTI	
Frequency =	60 Hz	

CB CONTROL:

CB Control by =	Disabled	
Rst CB mon L0 by =	CB Close	
CB mon Lo RstDly =	5.000 S	
CB1 Status Input =	52B 3 pole	
CB Status Time =	5.000 S	
CB2 Status Input =	52B 3 pole	

DATE AND TIME:

IRIG-B Sync =	Enabled	
Battery Alarm =	Enabled	
Other Time Settings =	Default	

CONFIGURATION:

Setting Group =	Select via Menu	
Active Settings =	Group 1	
Setting Group 1 =	Enabled	
Setting Group 2 =	Disabled	
Setting Group 3 =	Disabled	
Setting Group 4 =	Disabled	
Distance =	Enabled	# 21Z1,21Z2
Directional E/F =	Disabled	# Not used
Phase Diff =	Enabled	
Overcurrent =	Enabled	# 50HS
Neg Sequence O/C =	Disabled	# Not used
Broken Conductor =	Disabled	# Not used
Earth Fault =	Enabled	# 67N
Sensitive E/F =	Disabled	# Not used
Residual O/V NVD =	Disabled	# Not used
Thermal Overload =	Disabled	# Not used
PowerSwing Block =	Disabled	# Not used
Volt Protection =	Disabled	# Not used
Freq Protection =	Disabled	# Not used
df/dt Protection =	Disabled	# Not used
CB Fail =	Disabled	# Not used
Supervision =	Enabled	
System Checks =	Disabled	
Auto-Reclose =	Disabled	
Input Labels =	Visible	
Output Labels =	Visible	
CT & VT Ratios =	Visible	
Record Control =	Visible	

	Disturb Recorder =	Visible	
	Measure't Setup =	Visible	
	Comms Settings =	Visible	
	Commission Tests =	Visible	
	Setting Values =	Secondary	
	Control Inputs =	Invisible	
	Ctrl I/P Config =	Invisible	
	Ctrl I/P Labels =	Invisible	
	Direct Access =	Disabled	
	InterMiCOM 64 =	Disabled	
	Function Key =	Invisible	
	LCD Contrast =	11	
CT AND VT RATIOS			
	Main VT Primary =	345.0 kV	
	Main VT Sec'y =	115.0 V	
	CB1 CS VT Prim'y =	345.0 kV	
	CB1 CS VT Sec'y =	115.0 V	
	CB2 CS VT Prim'y =	345.0 kV	
	CB2 CS VT Sec'y =	115.0 V	
	Phase CT Primary =	3000 A	
	Phase CT Sec'y =	5.000 A	
	SEF CT Primary =	3000 A	
	SEF CT Secondary =	5.000 A	
	MComp CT Primary =	1.000 A	
	MComp CT Sec'y =	1.000 A	
	CS Input =	A-N	
	CT1 Polarity =	Standard	
	CT2 Polarity =	Standard	
	SEF CT Polarity =	Standard	
	M CT Polarity =	Standard	
	VT Connected =	Yes	
	CB1 CS VT PhShft =	0 deg	
	CB1 CS VT Mag =	1	
	CB2 CS VT PhShft =	0 deg	
	CB2 CS VT Mag =	1	
MEASURE'T SETUP:			
	Default Display =	Plant Reference	
	Local Values =	Primary	
	Remote Values =	Primary	
	Measurement Ref =	VA	
	Measurement Mode =	0	
	Fix Dem Period =	30.00 min	
	Roll Sub Period =	30.00 min	
	Num Sub Periods =	1	
	Distance Unit =	Miles	
	Fault Location =	Distance	
COMMISSION TESTS:			
	Monitor Bit 1 =	1060	# Red LED1
	Monitor Bit 2 =	1062	# Red LED2
	Monitor Bit 3 =	1064	# Red LED3

	Monitor Bit 4 =	1066		# Red LED4
	Monitor Bit 5 =	1068		# Red LED5
	Monitor Bit 6 =	1070		# Red LED6
	Monitor Bit 7 =	1072		# Red LED7
	Monitor Bit 8 =	1074		# Red LED8
CB MONITOR SETUP:	All disabled			# Not required
OPTO CONFIG:				
	Global Nominal V =	110/125V		
	Opto Filter Cntl =	1111111111111111111111111		
	Characteristic =	Standard 60%-80%		
CONTROL INPUTS:		Not used		
Group 1:				
GROUP 1 LINE PARAMETERS:				
	Line Length =	0.35 mi		
	Line Impedance =	0.06	Ohm	
	Line Angle =	84.0	deg	
	kZN Res Comp =	0.33		
	kZN Res Angle =	-2		
	Mutual Comp =	Disabled		
	Phase Sequence =	Standard ABC		
	CB1Tripping Mode =	3 Pole		
	CB2Tripping Mode =	3 Pole		
GROUP 1 DISTANCE SETUP:				
	Setting Mode =	Advanced		
	Phase Chars. =	Quad		
	Zone 1 Ph Status =	Enabled		
	Zone 2 Ph Status =	Enabled		
	Zone 3 Ph Status =	Disabled		
	Zone 4 Ph Status =	Disabled		
	Ground Chars. =	Quad		
	Zone 1 Gnd Stat =	Enabled		
	Zone 2 Gnd Stat. =	Enabled		
	Zone 3 Gnd Stat =	Disabled		
	Zone P Gnd Stat. =	Disabled		
	Zone 4 Gnd Stat. =	Diabled		
	Digital Filter =	Standard		
	CVT Filters =	Disabled		# VT is used
	Load Blinders =	Disabled		# Default
	Dist. Polarizing =	1		
	Dir. Status =	Enabled		
	AidedDeltaStatus =	Disabled		
	Dir. Char Angle =	60.00 deg		# Default
GROUP 1 DIST. ELEMENTS:				
	Z1 Ph. Reach =	50.000	mOhm	
	Z1 Ph. Angle =	84.0	deg	
	R1 Ph. Resistive =	5	Ohm	
	Z1 Tilt Top Line =	-3	deg	
	Z1 Sensit. Iph>1 =	0.25	A	

Z2 Ph. Reach =	100	mOhm	
Z2 Ph. Angle =	84.0	deg	
R2 Ph. Resistive =	5	Ohm	
Z2 Tilt Top Line =	-3	deg	
Z2 Sensit. Iph>2 =	0.25	A	
Z1 Gnd. Reach =	50.000	mOhm	
Z1 Gnd. Angle =	84.0	deg	
Z1 Dynamic Tilt =	Enabled		
Z1 Tilt Top Line =	-3	deg	
kZN1 Res. Comp =	0.33	Ohm	
kZN1 Res. Angle =	-2	deg	
R1 Gnd Resistive =	5	Ohm	
Z1 Sensit Ignd>1 =	0.25	A	
Z2 Gnd. Reach =	100	mOhm	
Z2 Gnd. Angle =	84.0	deg	
Z2 Dynamic Tilt =	Enabled		
Z2 Tilt Top Line =	-3	deg	
kZN2 Res. Comp. =	0.33		
kZN2 Res. Angle =	-2		
R2 Gnd Resistive =	5	Ohm	
Z2 Sensit Ignd>2 =	0.25	A	

GROUP 1 PHASE DIFF:

Phase Diff =	Enabled		
Phase Is1 =	1.000 A		# Minimum
Phase Is2 =	10.00 A		# Minimum
Phase k1 =	30.00%		# Default
Phase k2 =	150.00%		# Default
Phase Char =	DT		# Default
Phase Time Delay =	0 s		# Default
PIT Time =	200.0ms		# Default
Ph CT Corr'tion =	2.5		# Section 2.5
Compensation =	None		# Default
PIT I selection =	Remote		# Default

GROUP 1 SCHEME LOGIC:

Zone1 Tripping =	Phase And Ground		
tZ1 Ph. Delay =	0	s	
tZ1 Gnd. Delay =	0	s	
Zone2 Tripping =	Phase And Ground		
tZ2 Ph. Delay =	350	ms	
tZ2 Gnd. Delay =	600	ms	
Zone3 Tripping =	Disabled		
ZoneP Tripping =	Disabled		
Zone4 Tripping =	Disabled		
Aid. 1 Selection =	Disabled		
Aid. 2 Selection =	Disabled		
SOTF Status =	Enabled PoleDead		
SOTF Delay =	600	ms	
SOTF Tripping =	000010		# Zone 2

TOR Status =	Disabled		
TOC Reset Delay =	200	ms,	# 250ms in 311L, 100ms step
TOC Delay =	200	ms	
Z1 Extension =	Disabled		
LOL Scheme =	Disabled		

GROUP 1 OVERCURRENT:

I>1 Status =	Disabled		
I>2 Status =	Disabled		
I>3 Status =	Enabled		
I>3 Directional =	Non-Directional		# 50HS
I>3 Current Set =	12.00 A		# Section 2.6
I>3 Time Delay =	0 s		
I>4 Status =	Disabled		
I> Char Angle =	30.00 deg		
I> Blocking =	000000		

GROUP 1 EARTH FAULT:

IN>1 Status =	Enabled		
IN>1 Function =	US Inverse		
IN>1 Directional =	Directional Fwd		
IN>1 Current Set =	700.00	mA	# 67N-TOC
IN>1 Time Dial =	3.5		
IN>1 Reset Char =	DT		
IN>1 tRESET =	0	s	
IN>2 Status =	Enabled		# 67N-IOC
IN>2 Function =	DT		
IN>2 Directional =	Non-Directional		
IN>2 Current Set =	20		# Section 2.9
IN>2 Time delay =	0 s		
IN>2 Treset =	0 s		
IN>3 Status =	Disabled		
IN>4 Status =	Disabled		
IN> Blocking =	000001		# Block IN>1
IN> Char Angle =	-60	deg	# Default
IN> Polarisation =	Zero Sequence		
IN> VNpol Set =	1.000	V	# Minimum

GROUP 1 CB FAIL & P.DEAD:

I< Current Set =	250.0mA		# Default
ISEF< Current =	100.0mA		# Default
V< =	10.0 V		# Minimum

GROUP 1 SUPERVISION:

VTS Mode =	Measured Only		
VTS Status =	Blocking		
VTS Reset Mode =	Auto		
VTS Time Delay =	5.000 s		
VTS I> Inhibit =	3.150 A		
VTS I2> Inhibit =	250.0 mA		
I>2nd Harmonic =	10.00%		
WI Inhibit =	Disabled		

Appendix 09 85-1-G13 (Areva P546) Setting Calculation

CTS Mode = Disabled

GROUP 1 INPUT LABELS:

Opto Input 1	Spare
Opto Input 2	Spare
Opto Input 3	KEY DTT
Opto Input 4	Spare
Opto Input 5	52b/1-status
Opto Input 6	52b/2-status
Opto Input 7	89b/F2-status
Opto Input 8	Spare
Opto Input 9	86TT-1/G13-stat
Opto Input 10	86TT-1/G13-alm
Opto Input 11	86-1/G13-status
Opto Input 12	86-1/G13-alm
Opto Input 13	85TSS-1/G13 Mon
Opto Input 14	85TCO-1/G13 Mon
Opto Input 15	Spare
Opto Input 16	Spare
Opto Input 17	Spare
Opto Input 18	Spare
Opto Input 19	Spare
Opto Input 20	Spare
Opto Input 21	Spare
Opto Input 22	Spare
Opto Input 23	Spare
Opto Input 24	Spare

GROUP 1 OUTPUT LABELS:

Relay 1	DTT RCVD
Relay 2	67N TRIP
Relay 3	21(ZONE2) TRIP
Relay 4	21&21G TRIP
Relay 5	50SOTF TRIP
Relay 6	50HS TRIP
Relay 7	Spare
Relay 8	87 TRIP
Relay 9	Spare

GROUP 1 OUTPUT LABELS:

Relay 10	General Alarm
Relay 11	Any Trip (SER)
Relay 12	Spare
Relay 13	Spare
Relay 14	Spare
Relay 15	Spare
Relay 16	Spare
Relay 17	Spare
Relay 18	Spare
Relay 19	Spare
Relay 20	Spare
Relay 21	Spare
Relay 22	Spare

Relay 23	Spare
Relay 24	Spare
Relay 25	Spare
Relay 26	Spare
Relay 27	Spare
Relay 28	Spare
Relay 29	Spare
Relay 30	Spare
Relay 31	Spare
Relay 32	Spare

Appendix 10 85-2-G13 (SEL-311L) Setting Calculation

1. Data

MVA_Base =	100	kV_Base =	345	Z_Base =	1190.25	ohms
CTR =	600	PTR =	3000	CTR/PTR=	0.2	

Line ID	From	To	R1(ohms)	X1(ohms)	R0(ohms)	X0(ohms)
G13	Charles Poletti	AEII GEN	0.01410275	0.1332769	0.038613481	0.32084775

Secondary Ohms = Primary Ohms • (CTR/PTR)

Line ID	From	To	R1(2nd ohm)	X1(2nd ohm)	R0(2nd ohm)	X0(2nd ohm)
G13	Charles Poletti	AEII GEN	0.00	0.03	0.01	0.06

Z1 = Sqrt (R1*R1+X1*X1) Z1Ang = Arctan (X1/R1) Z0 equations are the same.

Line ID	From	To	Z1(2nd ohm)	Z1Ang	Z0(2nd ohm)	Z0Ang
G13	Charles Poletti	AEII GEN	0.03	83.96	0.06	83.14

Note: Line Z1 is less than the minimum 0.05 of Z1MAG setting. Two times of real Z1 and Z0 will be used in Z1MAG and Z0MAG settings.

2. Setting Criteria

2.1 Zone 1 phase distace:

Set Zone 1 phase distace at minimum setting of 0.05 secondary ohm, or 167% of line impedance. It may trip for a fault beyond the protected TL, such as a transformer fault. However, since there is no 345kV breaker at G13 station, such overreach is not a concern.

2.2 Set Zone 2 phase distace at 333% of the line impedance with 0.35 second delay.

2.3 Zone 1 ground distace:

Set Zone 1 ground distace at minimum setting of 0.05 secondary ohm, or 167% of line impedance. It may trip for a fault beyond the protected TL, such as a transformer fault. However, since there is no 345kV breaker at G13 station, such overreach is not a concern.

2.4 Set Zone 2 ground distance at 333% of the line impedance with 0.6 second delay.

2.5 Line differential element

Set 87LPP at the minimum setting of 1 Amp secondary; Set 87L2P and 87LGP at the minimum setting of 0.5 Amp secondary, or 300 Amp Primary, which should be above expected line charging current unbalance. 87LR and 87LANG can be set as default per SEL manual.

2.6 High Set Fault Protection (50HS):

50HS must not operate for reverse faults (local line end) or transformer inrush with appropriate operating margin. It may trip for a fault beyond the protected TL, such as a transformer fault. However, since there is no 345kV breaker at G13 station, such overreach is not a concern.

Both SEL-311L and Areva P546 can filter out 2nd harmonic etc major component of inrush current. Set 50HS at 7,200 Primary Amp or 12 Amp at CT secondary. It will well below the forward fault current but above the reverse fault level. Refer to Appendix 01 Section 2.6 fault current distribution.

2.7 Stub Bus Protection (50SB):

The voltage source of 85-2-G13 (SEL-311L) relay is at the line side of the MOD, so 50SB is required.

50SB is to be enabled only when MOD is open, i.e. supervised by MOD's 89b, see 67P2TC setting.

For normal load current or external fault current through the stub bus, the current will ideally be zero.

Set 50SB pickup at 150% of the maximum full load current by considering all three GSUs with a possibility of one set of CT test switches left shorted.

Total MVA of all three GSUs = 750 ; Maximum full load current (amps) = 1255.11

2.8 Switch-On-To-Fault Protection (50SOTF)

50SOTF will only be armed when the circuit breakers are open and the asscoated line is de-energized. While closing the first circuit breaker to energize the line this function shall only be in service for the first 15 cycles and will reset if no fault is detected. Set 50SOTF pickup the same as 50HS.

2.9 Directional Ground Overcurrent Backup Protection (67N)

67N will be used to provided backup protection for ground faults on the system. 67N pickup shall be higher than the worst unbalance and can be set 1/3 of maximum full load

1/3 of FLC = 1/3 * 1,255 Amp = 418.33 primary amp or 0.7 Amp at CT secondary.

Directional element is not necessary due to the strong utility source. Curve and time dial is set to provide security margin for reverse close-in faults.

The instantaneous -overcurrent (IOC) function can be used to provide close-in ground fault detection and shall not trip for reverse faults or transformer inrush. Set it at 20 Amp CT secondary or 12kA CT primary to prevent false tripping for reverse ground faults.

Group 1 - Set 1:

General Settings:

Relay ID	RID = 85-2-G13	
Terminal ID	TID = CHARLES POLETTI	
CT Ratio	CTR = 600	
Application	APP = 311L	
Advanced Setting Enable	EADVS = N	

Line Current Differential Settings:

Number of 87L Terminals	E87L = 2	
High Speed Tripping	EHST = 1	
Enable High Speed Direct Transfer Trip	EHSDTT = Y	
Enable Disturbance Current Detect	EDD = Y	
Tapped Load Coordination	ETAP = N	
Enable Open CT Logic	EOCTL = N	
CTR at Terminal Connected to Channel X	CTR_X = 240	# 1200/5 CT
Phase 87L (Amp secondary)	87LPP = 1	# Minimum
Negative Sequence 87L (Amp secondary)	87L2P = 0.5	# Minimum
Ground 87L (Amp secondary)	87LGP = 0.5	# Minimum
Ph. Diff. Current Alarm Pickup (Amp secondary)	CTALRM = 0.5	# Minimum
Outer Radius	87LR = 6	# Default
Angle (Degree)	87LANG = 195	# Default

Backup Protection and Line Parameters:

Polarizing (IPOL) CT Ratio	CTRP = 600	# Not used
Phase PT Ratio	PTR = 3000	
Synch Voltage (VS) PT Ratio	PTRS = 3000	# Not used
Pos-Seq Line Impedance Magnitude (Ohms secondary)	Z1MAG = 0.06	# 2x real Z1
Pos-Seq Line Impedance Angle (degrees)	Z1ANG = 84.0	
Zero-Seq Line Impedance Magnitude (Ohms secondary)	Z0MAG = 0.12	# 2x real Z0
Zero-Seq Line Impedance Angle (degrees)	Z0ANG = 83.14	
Line Length (unitless)	LL = 100	
Fault Locator Enable	EFLOC = Y	

Phase Distance:

Enable Mho Phase Distance Elements	E21P = 2	
CCVT Transient Detection Enable	ECCVT = N	# VT is used
Reach Zone 1 (Ohms secondary)	Z1P = 0.05	# Minimum

Reach Zone 2 (Ohms secondary)	Z2P = 0.10	# 333% of line
Phase-Phase Overcurrent Fault Detector Zone 1 (2nd Amp)	50PP1 = 0.5	# Minimum
Phase-Phase Overcurrent Fault Detector Zone 2 (2nd Amp)	50PP2 = 0.5	# Minimum

Fault detectors can be set at the minimum if LOP (Loss Of Potential) is enabled.

<u>Ground Distance Elements:</u>

Enable Mho Ground Distance Elements	E21MG = N	
Enable Quad Ground Distance Elements	E21XG = 2	
XG1 Zone 1 Reactance (Ohms secondary)	XG1 = 0.05	# Minimum
XG2 Zone 2 Reactance (Ohms secondary)	XG2 = 0.1	# 333% of line
Zone 1 Resistance (Ohms secondary)	RG1 = 5.00	
Zone 2 Resistance (Ohms secondary)	RG2 = 5.00	

Zone 1 Phase Current FD (Amps secondary)	50L1 = 0.5	# Minimum
Zone 2 Phase Current FD (Amps secondary)	50L2 = 0.5	# Minimum
Zone 1 Residual Current FD (Amps secondary)	50GZ1 = 0.5	# Minimum
Zone 2 Residual Current FD (Amps secondary)	50GZ2 = 0.5	# Minimum

Fault detectors can be set at the minimum if LOP (Loss Of Potential) is enabled.

Zone 1 ZSC Factor Mag (unitless)	k0M1 = 0.33	
Zone 1 ZSC Factor Ang (degrees)	k0A1 = -1.64	
Zone 2,3,4 ZSC Factor Mag (Unitless)	k0M = 0.33	# As k0M1
Zone 2,3,4 ZSC Factor Ang (degrees)	k0A = -1.64	# As k0A1

$$k0M1 \angle k0A1 = \frac{(Z0MAG \angle Z0ANG) - (Z1MAG \angle Z1ANG)}{3 \cdot (Z1MAG \angle Z1ANG)}$$

<u>Mho Phase Distance Element Time Delay Settings:</u>

Zone 1 Time Delay (cycles in 0.25 increments)	Z1PD = OFF	
Zone 2 Time Delay (cycles in 0.25 increments)	Z2PD = 21	# 0.35 second

<u>Mho Ground Distance Element Time Delay Settings:</u>

Zone 1 Time Delay (cycles in 0.25 increments)	Z1GD = OFF	
Zone 2 Time Delay (cycles in 0.25 increments)	Z2GD = 36	# 0.6 second

<u>Phase Instantaneous Overcurrent Elements:</u>

Enable Phase Overcurrent Elements	E50P = 3	
Phase Instantaneous Overcurrent Level 1 (Amps secondary)	50P1P = 12	# 50HS
Phase Instantaneous Overcurrent Level 2 (Amps secondary)	50P2P = 3.14	# 50SB
Phase Instantaneous Overcurrent Level 3 (Amps secondary)	50P3P = 12	# 50SOTF
Phase Definite-Time Overcurrent Element Level 1 (cycles)	67P1D = 0	# Not used
Phase Definite-Time Overcurrent Element Level 2 (cycles)	67P2D = 0	# Not used
Phase Definite-Time Overcurrent Element Level 3 (cycles)	67P3D = 0	# Not used

<u>Residual Ground Instantaneous Overcurrent Elements:</u>

Enable Residual Ground Overcurrent Elements	E50G = 1	
Residual Ground Inst O/C Level 1 (Amps secondary):	50G1P = 20	# 67N-IOC
Residual Ground Definite-Time Overcurrent Elements:	67G1D = 0	

<u>Negative-Sequence Instantaneous Elements:</u>

Enable Negative-Sequence Overcurrent Element	E50Q = N	# Not required

<u>Phase Time-Overcurrent Elements:</u>			
Enable Phase Time-Overcurrent Elements	E51P =	N	# Not used
<u>Residual Ground Time-Overcurrent Elements:</u>			
Enable Residual Ground Time Overcurrent Elements	E51G =	Y	
Residual Ground Time-Overcurrent Pickup (Amp secondary)	51GP =	0.70	# 67N-TOC
51GC Curve	51GC =	U2	
51GTD Time Dial	52GTD =	3.5	
51GRS Electromechanical Reset Delay	51GRS =	N	
<u>Negative-Sequence Time-Overcurrent Elements:</u>			
Enable Negative-Sequence Time-Overcurrent Elements	E51Q =	N	# Not required
<u>Out-of-Step Settings:</u>			
Enable Out-of-Step Elements	EOOS =	N	# Not required

<u>Load-Encroachment Elements:</u>

As per NERC Task Froce requirement, phase distance settings and other applicable phase and ground distance zone settings must permit loading of the line without trip to 150% of emergency line ampere rating, with 0.85 per unit bus voltage and a load angle

Loadability S = (0.85*kV)*(0.85*kV)/(Zsec*cos(Z1ANG-30)*CTR/PTR =		292325.87	MVA

Where, Zsec is Z2P in this application, kV is 345 and Z1ANG is line angle.

Conclusion: Loadability is more than 150% of maximum generation at AEII, no load encroachment.

Enable Load-Encroachment Element	ELOAD =	N	# Calc above
<u>Directional Elements:</u>			
Enable Directional Elements	E32 =	Y	
Loss-Of_Potential Enable	ELOP =	Y1	
# When ELOP = Y1 and a lop occurs, directional O/C elements are blocked.			
Busbar PT LOP Logic Enable	EBBPT =	N	# N/A
Level 3 Direction	DIR3 =	F	# Default
Level 4 Direction	DIR4 =	F	# Default
Ground Directional Element Priority	ORDER =	Q	
Forward Dir. Z2 Threshold (Ohms secondary)	Z2F =	0.01	# Real Z1/2
Reverse Dir. Z2 Threshold (Ohms secondary)	Z2R =	0.11	# Z2F+0.1
Forward Dir. 3I2 Pickup (Amps secondary)	50QFP =	0.25	# Minimum
Reverse Dir. 3I2 Pickup (Amps secondary)	50QRP =	0.5	# 24% max FLC
Pos-Seq Restraint Factor I2/I1 (unitless)	a2 =	0.1	# Default
Zero-Seq Restraint Factor, I2/I0 (unitless)	k2 =	0.2	# Default
<u>Enable Voltage Elements:</u>			
Enable Voltage Elements	EVOLT =	N	
<u>Synchronism Check Elements</u>			
Enable Synchronism Check Elements	E25 =	N	# Not required
<u>Frequency Elements</u>			
Enable Frequency Elements	E81 =	N	# Not required

Relcosing Relay:

Enable Reclosing Relay Elements	E79 = N	# Not required

Switch-Onto-Fault:

Enable Switch-Onto-Fault Elements	ESOTF = Y	# Section 2.8
Close Enable Time Delay (cycles in 0.25 increments)	CLOEND = OFF	# Not used
52A Eanble Tim Delay (cycles in 0.25 increments)	52AEND = 36	# 0.6 second
SOTF Duration (cycles in 0.25 increments)	SOTFD = 15	# Section 2.8

Commnunications Assisted Tripping Schemes:

Enable Communication Assisted Tripping Schemes	ECOMM = N	# Not used

Zone 1 Extension Settings:

Enable Zone 1 Extension Elements	EZ1EXT = N	# Not used

Demand Metering Settings:

Enable Demand Metering Method	EDEM = THM	
DMTC Time constant	DMTC = 15	
Phase Pickup (Amps secondary)	PDEMP = OFF	# Not used
Residual Ground Pickup (Amps secondary)	GDEMP = OFF	# Not used
Negative-Sequence Pcikup (Amps secondary)	QDEMP = OFF	# Not used

Other Setting:

Minimum Trip Duration Time (cycles in 0.25 increments)	TDURD = 9	# Default
Close Failure Time Delay (cycles in 0.25 increments)	CFD = 0	# Not used
Three-Pole Open Time Delay (cycles in 0.25 increments)	3POD = 0.5	# Default
Open Pole Option	OPO = 52	# BKR status
Load Detection Phase Pickup (Ampes secondary)	50LP = 0.25	# Minimum

SELogic Control Equation Variable Timers:

SELogic Latch Bits Enables	ELAT = N	
SELogic Display Points Enables	EDP = 8	
Enable SELogic Control Variable Timers	ESV = N	

Group 1 - Logic 1:

Trip/Comm.-Assisted Trip Logic:

Direct trip conditions TR = TRIP87+M1P+Z1G+M2PT+Z2GT+67P1T+67P2T+67G1T+51GT

#LED2 Target. 67P1T is 50HS; 67P2T is 50SB; 50P3 is 50SOTF; 67G1T is 67N-IOC; 51GT is 67N-TOC;

Switch-onto-fault trip conditions	TRSOTF = 50P3	# SOTF
Direct transfer trip conditions	DTT = 0	# Not used
Unlatch trip conditions	ULTR = !52A	

Close Logic Equations:

Circuit breaker status	52A = !IN104+!IN105	CB1&2 Status
Close conditions	CL = 0	# Not used
Unlatch close conditions	ULCL = 0	# Not used

Latch Bits Set/Reset Equations: # Not used

Torque Control Equations for Inst./Def.-Time Overcurrent Elemements:

67P1TC Level 1 phase	67P1TC = 1	# nondirectiona
67P2TC Level 1 phase	67P2TC = IN106	# MOD-89b
67P3TC Level 1 phase	67P3TC = 1	# nondirectiona

SOTF is enabled when breaker open 52b =1 and the supervision is in relay internal logic.
SOTF is irrelevant with MOD-89b since there is a possility of switching on a bus fault.

67G1TC Level 1 phase	67G1TC = 1	# nondirectiona
51GTC Residual Ground	51GTC = 1	# nondirectiona

Other Torque Controls are not enabled.

<u>SELogic Control Equation Variables:</u> # ESV = N

<u>Output Contacts:</u>

Output Contact 101	OUT101 = R1X*ROKX	# DTT Trip
Output Contact 102	OUT102 = 67G1T+51GT	# 67N
Output Contact 103	OUT103 = M2PT+Z2GT	# 21 Zone 2
Output Contact 104	OUT104 = M1P+Z1G	# 21 & 21G
Output Contact 105	OUT105 = SOTFT	# 50SOTF
Output Contact 106	OUT106 = 67P1T	# 50HS
Output Contact 107	OUT107 = 67P2T	# 50SB
Output Contact 201	OUT201 = TRIP87	# 87 Trip
Output Contact 202	OUT202 = TRIP+R1X*ROKX	# Any Trip

Output Contact 203 ~ 206, 301 ~ 312 are all 0.

<u>Display Points:</u>

Display Point 1	DP1 = 0	# Not used
Display Point 2	DP2 = 0	# Not used
Display Point 3	DP3 = 0	# Not used
Display Point 4	DP4 = IN104	# 52b/BKR1
Display Point 5	DP5 = IN105	# 52b/BKR2
Display Point 6	DP6 = IN106	# 89b/FQ35L
Display Point 7	DP7 = 0	# Not used
Display Point 8	DP8 = 0	# Not used
Display Point 9 ~16		# Not used

<u>Setting Group Selection Equations:</u>

Select Setting Group 1	SS1 = 1	
Select Setting Group 2 ~ 6 are all 0	SS2~SS6 = 0	# Not used

<u>Other Equations:</u>

Event report trigger conditions ER = /87L+/M2P+/Z2G++/50P2+/51G+/R1X+/LOP
Fault indication FAULT = 87L+M2P+Z2G+50P2+51G+R1X

Block synchronism check elements	BSYNCH = 0	# Not used
Close bus monitor	CLMON = 0	# Not used
Enable for V0 polarized and IN polarized elements	E32V = 1	
Stub Bus Logic Enable	ESTUB = 0	# Not used

50SB is done by setting its torque control 67P2TC as MOD-89b.

<u>Mirrored Bits Transmit Equations:</u> # Not used

<u>87L Transmit Equations:</u>

87L Channel X, Transmit Bit 1	T1X =	IN103	# KEY DTT
All other bits			# Not used

General Settings:

Group Change Delay (cycles in 0.25 increments)	TGR =	0	# Not used
Nominal Frequency (Hz)	NFREQ =	60	
Phase Rotation	PHROT =	ABC	
Date Format	Date_F =	MDY	
Front Panel Timeout (minutes)	FP_TO =	5	# 5 minutes
Display Update Rate (seconds)	SCROLD =	5	# 5 seconds
Length of Event Report (cycles)	LER =	60	
Cycle Length of Prefault in Event Report (cycles)	PRE =	4	
DC Battery LO Voltage Pickup (Vdc)	DCLOP =	OFF	
DC Battery HI Voltage Pickup (Vdc)	DCHIP =	OFF	

Optoisolated Input Timers: IN101D ~ IN106D, IN301D ~ IN308D = 0.5 # 0.5 cycle

Breaker Monitor Settings:

Breaker Monitor Enable EBMON = N # Not used

Synchronized Phasor Settings:

Synchronized Phasor Measurement EPMU = N # Not used

SER:

SER1 = 87L,87L2,87LG,87LA,87LB,87LC,R87L2,R87LG,R87LA,R87LB,R87LC,M1P,Z1G,M2P,M2PT ,Z2G,Z2GT,67P1T,67P2T,67P3T,67G1T,51G,51GT,LOP

SER2 = SV1T, SV2T, IN103, IN104, IN105, IN106, IN301, IN302, IN303, IN304, IN305, IN306, IN307

SER3 = OUT102, OUT103, OUT104, OUT105,OUT106, OUT107

Text:

Local Bit Labels			# Not used
Display-Point Labels	DP1_1 =	NA	
	DP1_0 =	NA	
	DP2_1 =	NA	
	DP2_0 =	NA	
	DP3_1 =	NA	
	DP3_0 =	NA	
	DP4_1 =	BREAKER 1 OPEN	
	DP4_0 =	BREAKER 1 CLOSED	
	DP5_1 =	BREAKER 2 OPEN	
	DP5_0 =	BREAKER 2 CLOSED	
	DP6_1 =	MOD F2 OPEN	
	DP6_0 =	MOD F2 CLOSED	
	DP7_1 =	NA	
	DP7_0 =	NA	
	DP8_1 =	NA	
	DP8_0 =	NA	
Reclosing Relay Labels			# Not used

Appendix 11 87B-BS2 (SEL-387) Setting Calculation

1. Data

MVA_Base =	100	kV_Base =	345	Z_Base =	1190.25	ohms
CTR =	600	PTR =	3000	CTR/PTR=	0.2	

Total MVA of all three GSUs = 750 ; Maximum full load current (amps) = 1255.11

2. Setting Criteria

2.1 Differential Settings:

Maximum Transformer **MVA** =	750	MVA
The nominal transformer Winding 1 terminal voltage **VWDG1** =	345	kV
The nominal transformer Winding 2 terminal voltage **VWDG2** =	345	kV
The nominal transformer Winding 3 terminal voltage **VWDG3** =	345	kV
CT ratio for winding 1---**CTR1**=	600	
CT ratio for winding 2---**CTR2**=	600	
CT ratio for winding 3---**CTR3**=	600	
Winding 1 Current Tap **TAP1** = MVA/(Sqrt(3) x VWDG1 x CTR1) =	2.09	A
Winding 2 Current Tap **TAP2** = MVA/(Sqrt(3) x VWDG2 x CTR2) =	2.09	A
Winding 3 Current Tap **TAP3** = MVA/(Sqrt(3) x VWDG3 x CTR3) =	2.09	A
O87P ≥ 0.1 x 5A / TAPmin = 0.24 Set **O87P=**	0.24	# Per manual
Dual-Slop variable-percentage differential characteristic is used.		
Restraint Slop 1 Percentage (5-100%) **SLP 1** =	25	
Restraint Slope 2 Percentage (OFF, 25–200%) **SLP2** =	50	
Restraint Current Slope 1 Limit ((1–20) multiple of tap) **IRS1** =	6.8	
Unrestrained Element Current PU ((1–20) multiple of tap) **U87P** =	10.2	
Second-Harmonic Blocking Percentage (OFF, 5–100%) **PCT2** =	OFF	
Fifth-Harmonic Blocking Percentage (OFF, 5–100%) **PCT5** =	OFF	
Independent Harmonic Blocking **IHBL =**	N	

2.2 Winding 1 Elems (for event triggering)

2.2.1 Set phase IOC element 50P11P at 7.3 CT secondary amp or 4,393 CT primary amp, i.e. 3.5 times of the maximum full load current (FLC).

2.2.2. Set phase TOC element 51P1P at 2.95 CT secondary amp or 1,770 CT primary amp, i.e. 1.4 times of the maximum FLC.

2.2.3. Set residual IOC element 51N11P at 2.95 CT secondary amp or 1,770 CT primary amp, i.e. 1.4 times of the maximum FLC.

2.2.4. Set residual TOC element 51N1P at 1.65 CT secondary amp or 1,004 CT primary amp, i.e. 80% of the maximum FLC.

Group 1 - Set 1:

Config. Settings:

Relay Identifier	RID =	87B-BS2
Terminal Identifier	TID =	CHARLES POLETTI
Enable Wdg1 in Differential Element	E87W1 =	Y
Enable Wdg2 in Differential Element	E87W2 =	Y
Enable Wdg3 in Differential Element	E87W3 =	Y
Enable Wdg4 in Differential Element	E87W4 =	N
Enable Wdg1 O/C Elements and Dmd. Thresholds	EOC1 =	Y
Enable Wdg2 O/C Elements and Dmd. Thresholds	EOC2 =	N
Enable Wdg3 O/C Elements and Dmd. Thresholds	EOC3 =	N

Enable Wdg4 O/C Elements and Dmd. Thresholds	EOC4 = N	
Enable Combined O/C Elements	EOCC = N	
Enable RTDA Elements	E49A = N	
Enable RTDB Elements	E49B = N	
Enable SELogic Set 1	ESLS1 = Y	
Enable SELogic Set 2	ESLS2 = N	
Enable SELogic Set 3	ESLS3 = N	
General Data:		
Wdg1 CT Connection	W1CT = Y	
Wdg2 CT Connection	W2CT = Y	
Wdg3 CT Connection	W3CT = Y	
Wdg4 CT Connection	W4CT = Y	# Not Used
Wdg1 CT Ratio	CTR1 = 600	
Wdg2 CT Ratio	CTR2 = 600	
Wdg3 CT Ratio	CTR3 = 600	
Wdg4 CT Ratio	CTR4 = 600	# Not Used
Maximum Power Xfmr Capacity	MVA = 750	
Define Interal CT Connection Compensation	ICOM = N	
Wdg 1 Line-to-Line Voltage	VWDG1 = 345	# kV
Wdg 2 Line-to-Line Voltage	VWDG2 = 345	# kV
Wdg 3 Line-to-Line Voltage	VWDG3 = 345	# kV
Wdg 4 Line-to-Line Voltage	VWDG4 = 345	# Not used
Diff Elems:		
Restrained Element Current PU	O87P = 0.24	
Restrain Slope 1 Percentage	SLP1 = 25	
Restrain Slope 2 Percentage	SLP2 = 50	
Restraint Current Slope 1 Limit	IRS1 = 6.8	
Unrestrained Element Current PU	U87P = 10.2	
2nd Harmonic Blocking Percentage	PCT2 = OFF	
5th Hamronic Blocking Percentage	PCT5 = OFF	
5th Harmonic Alarm Threshold	TH5P = OFF	
Independent Harmonic Blocking	IHBL = N	
Restriced Earth Fault:		# Not Used
Winding 1 Elems:		
Phase Def-Time O/C Level 1 PU	50P11P = 7.3	# 3.5xFLC
Phase Level 1 O/C Delay	50P11P = 0.5	# cycle
50P11 Torque Control (SELogic Equation)	50P11TC = 1	
Oher Phase Inst O/C elements		# Not used
Phase Inv-Time O/C PU	51P1P = 2.95	# 1.4xFLC
Phase Inv-Time O/C Curve	51P1C = C2	
Phase Inv-Time O/C Time-Dial	51P1TD = 0.2	
Phase Inv-Time O/C EM Reset	51P1RS = N	
51P1 Torque Control (SELogic Equation)	51P1TC = 1	
Neg-Seq Def-Time O/C		# Not used
Residual Def-Time O/C Level 1 PU	50N11P = 2.95	# 1.4xFLC
Residual Level 1 O/C Delay	50N11D = 0.5	# cycle
50N11 Torque Control (SELogic Equation)	50N11TC = 1	

Other Residual Inst O/C elements		# Not used
Residual Inv-Time O/C PU	51N1P = 1.65	# 80% FLC
Residual Inv-Time O/C Curve	51N1C = C2	
Residual Inv-Time O/C Time-Dial	51N1TD = 0.35	
Residual Inv-Time O/C EM Reset	51N1RS = N	
51N1 Torque Control (SELogic Equation)	51N1TC = 1	
Demand Ammeter Time Constant	DATC1 = 15	# Default
Phase Demand Ammeter Threshold	PDEM1P = 7	# Default
Neg-Seq Demand Ammeter Threshold	QDEM1P = 1	# Default
Residual Demand Ammeter Threshold	NDEM1P = 1	# Default
Winding 2 Elems:		# Not Used
Winding 3 Elems:		# Not Used
Winding 4 Elems:		# Not Used
Combined Elems:		# Not used
RTD A Elems:		# Not used
RTD B Elems:		# Not used
Misc. Timers		# Default
SELogic Set 1:		
Set 1 Variable 1 (SELogic Equation)	S1V1 = 87R	
S1V1 Timer Pickup	S1V1PU = 0	
S1V1 Timer Dropout	S1V1DO = 24	# 0.4 second
Set 1 Variable 2 (SELogic Equation)	S1V2 = 51P1T+51N1T	
S1V2 Timer Pickup	S1V2PU = 0	
S1V2 Timer Dropout	S1V2DO = 0	
Set 1 Variable 3 (SELogic Equation)	S1V3 = S1V2+87R	
S1V3 Timer Pickup	S1V3PU = 60	# 1 second
S1V3 Timer Dropout	S1V3DO = 300	# 5 seconds
Set 1 Variable 4 (SELogic Equation)	S1V4 = 87R+50N11T+50P11T+51P1T+51N1T	# Event trigger
S1V4 Timer Pickup	S1V4PU = 0	
S1V4 Timer Dropout	S1V4DO = 0	
Set 1 Latch Bits		# Not used
SELogic Set 2:		# Not used
SELogic Set 3:		# Not used
Trip Logic:		
	TR1 = 50P11T + 51P1T +50N11T +51N1T	
	TR2 = 87R + 87U	
	TR3 = 0	
	TR4 = 0	
	TR5 = 0	
	ULTR1 = !(51P1 + 51N1)	
	ULTR2 = !(87R + 87U)	
	ULTR3 = 0	
	ULTR4 = 0	
	ULTR5 = 0	
Close Logic:		# Not used
Event Trigger		
	ER = /S1V4	
Output Contact Logic:		
Output Contact 101	OUT101 = TRIP1+TRIP2	# Any Trip
Output Contact 102	OUT102 = 0	# Not used

Output Contact	103	OUT103 = 0	# Not used
Output Contact	104	OUT104 = 0	# Not used
Output Contact	105	OUT105 = S1V3T	# Alarm
Output Contact	106	OUT106 = 0	# Not used
Output Contact	107	OUT107 = 0	# Not used
Output Contact 201 ~ 212 are all 0.			# Not used

<u>Global</u> # Default

<u>SER:</u>
SER1 = 87R,87U,50P11,50P11T,51P1,51P1T,50N11,50N11T,51N1,51N1T
SER2 = S1V1,S1V1T,S1V2,S1V3,OUT105,S1V4
SER3 = 0
SER4 = 0

Appendix 12 87B-1-BS3 (SEL-387) Setting Calculation

1. Data

MVA_Base =	100	kV_Base =	345	Z_Base =	1190.25	ohms
CTR =	600	PTR =	3000	CTR/PTR=	0.2	

Total MVA of all three GSUs = 750 ; Maximum full load current (amps) = 1255.11

2. Setting Criteria

2.1 Differential Settings:

Maximum Transformer **MVA** =	750	MVA
The nominal transformer Winding 1 terminal voltage **VWDG1** =	345	# Not Used
The nominal transformer Winding 2 terminal voltage **VWDG2** =	345	kV
The nominal transformer Winding 3 terminal voltage **VWDG3** =	345	kV
CT ratio for winding 1---**CTR1**=	600	# Not Used
CT ratio for winding 2---**CTR2**=	600	
CT ratio for winding 3---**CTR3**=	600	
Winding 1 Current Tap **TAP1** = MVA/(Sqrt(3) x VWDG1 x CTR1) =	2.09	# Not Used
Winding 2 Current Tap **TAP2** = MVA/(Sqrt(3) x VWDG2 x CTR2) =	2.09	A
Winding 3 Current Tap **TAP3** = MVA/(Sqrt(3) x VWDG3 x CTR3) =	2.09	A
O87P ≥ 0.1 x 5A / TAPmin = 0.24 Set **O87P=**	0.24	# Per manual
Dual-Slop variable-percentage differential characteristic is used.		
Restraint Slop 1 Percentage (5-100%) **SLP 1** =	25	
Restraint Slope 2 Percentage (OFF, 25–200%) **SLP2** =	50	
Restraint Current Slope 1 Limit ((1–20) multiple of tap**) IRS1** =	6.8	
Unrestrained Element Current PU ((1–20) multiple of tap) **U87P** =	10.2	
Second-Harmonic Blocking Percentage (OFF, 5–100%) **PCT2** =	OFF	
Fifth-Harmonic Blocking Percentage (OFF, 5–100%) **PCT5** =	OFF	
Independent Harmonic Blocking **IHBL =**	N	

2.2 Winding 2 Elems (for event triggering)

2.2.1 Set phase IOC element 50P21P at 7.3 CT secondary amp or 4,380 CT primary amp, i.e. 3.5 times of the maximum full load current (FLC).

2.2.2. Set phase TOC element 51P2P at 2.95 CT secondary amp or 1,770 CT primary amp, i.e. 1.4 times of the maximum FLC.

2.2.3. Set residual IOC element 51N21P at 2.95 CT secondary amp or 1,770 CT primary amp, i.e. 1.4 times of the maximum FLC.

2.2.4. Set residual TOC element 51N2P at 1.65 CT secondary amp or 990 CT primary amp, i.e. 79% of the maximum FLC.

Group 1 - Set 1:

Config. Settings:

Relay Identifier	RID =	87B-1-BS3	
Terminal Identifier	TID =	CHARLES POLETTI	
Enable Wdg1 in Differential Element	E87W1 =	N	# Not Used
Enable Wdg2 in Differential Element	E87W2 =	Y	
Enable Wdg3 in Differential Element	E87W3 =	Y	
Enable Wdg4 in Differential Element	E87W4 =	N	
Enable Wdg1 O/C Elements and Dmd. Thresholds	EOC1 =	N	
Enable Wdg2 O/C Elements and Dmd. Thresholds	EOC2 =	Y	
Enable Wdg3 O/C Elements and Dmd. Thresholds	EOC3 =	N	

Enable Wdg4 O/C Elements and Dmd. Thresholds	EOC4 =	N	
Enable Combined O/C Elements	EOCC =	N	
Enable RTDA Elements	E49A =	N	
Enable RTDB Elements	E49B =	N	
Enable SELogic Set 1	ESLS1 =	Y	
Enable SELogic Set 2	ESLS2 =	N	
Enable SELogic Set 3	ESLS3 =	N	
General Data:			
Wdg1 CT Connection	W1CT =	Y	# Not Used
Wdg2 CT Connection	W2CT =	Y	
Wdg3 CT Connection	W3CT =	Y	
Wdg4 CT Connection	W4CT =	Y	# Not Used
Wdg1 CT Ratio	CTR1 =	600	# Not Used
Wdg2 CT Ratio	CTR2 =	600	
Wdg3 CT Ratio	CTR3 =	600	
Wdg4 CT Ratio	CTR4 =	600	# Not Used
Maximum Power Xfmr Capacity	MVA =	750	
Define Interal CT Connection Compensation	ICOM =	N	
Wdg 1 Line-to-Line Voltage	VWDG1 =	345	# Not Used
Wdg 2 Line-to-Line Voltage	VWDG2 =	345	# kV
Wdg 3 Line-to-Line Voltage	VWDG3 =	345	# kV
Wdg 4 Line-to-Line Voltage	VWDG4 =	345	# Not used
Diff Elems:			
Restrained Element Current PU	O87P =	0.24	
Restrain Slope 1 Percentage	SLP1 =	25	
Restrain Slope 2 Percentage	SLP2 =	50	
Restraint Current Slope 1 Limit	IRS1 =	6.8	
Unrestrained Element Current PU	U87P =	10.2	
2nd Harmonic Blocking Percentage	PCT2 =	OFF	
5th Hamronic Blocking Percentage	PCT5 =	OFF	
5th Harmonic Alarm Threshold	TH5P =	OFF	
Independent Harmonic Blocking	IHBL =	N	
Restriced Earth Fault:			# Not Used
Winding 1 Elems:			# Not Used
Winding 2 Elems:			
Phase Def-Time O/C Level 1 PU	50P21P =	7.3	# 3.5xFLC
Phase Level 1 O/C Delay	50P21P =	0.5	# cycle
50P21 Torque Control (SELogic Equation)	50P21TC =	1	
Oher Phase Inst O/C elements			# Not used
Phase Inv-Time O/C PU	51P2P =	2.95	# 1.4xFLC
Phase Inv-Time O/C Curve	51P2C =	C2	
Phase Inv-Time O/C Time-Dial	51P2TD =	0.2	
Phase Inv-Time O/C EM Reset	51P2RS =	N	
51P2 Torque Control (SELogic Equation)	51P2TC =	1	
Neg-Seq Def-Time O/C			# Not used
Residual Def-Time O/C Level 1 PU	50N21P =	2.95	# 1.4xFLC
Residual Level 1 O/C Delay	50N21D =	0.5	# cycle

50N21 Torque Control (SELogic Equation)	50N21TC = 1	
Other Residual Inst O/C elements		# Not used
Residual Inv-Time O/C PU	51N2P = 1.65	# 80% FLC
Residual Inv-Time O/C Curve	51N2C = C2	
Residual Inv-Time O/C Time-Dial	51N2TD = 0.35	
Residual Inv-Time O/C EM Reset	51N2RS = N	
51N2 Torque Control (SELogic Equation)	51N2TC = 1	
Demand Ammeter Time Constant	DATC2 = 15	# Default
Phase Demand Ammeter Threshold	PDEM2P = 7	# Default
Neg-Seq Demand Ammeter Threshold	QDEM2P = 1	# Default
Residual Demand Ammeter Threshold	NDEM2P = 1	# Default
Winding 3 Elems:		# Not Used
Winding 4 Elems:		# Not Used
Combined Elems:		# Not used
RTD A Elems:		# Not used
RTD B Elems:		# Not used
Misc. Timers		# Default
SELogic Set 1:		
Set 1 Variable 1 (SELogic Equation)	S1V1 = TRIP2	
S1V1 Timer Pickup	S1V1PU = 0	
S1V1 Timer Dropout	S1V1DO = 24	# 0.4 second
Set 1 Variable 2 (SELogic Equation)	S1V2 = 51P2T	
S1V2 Timer Pickup	S1V2PU = 0	
S1V2 Timer Dropout	S1V2DO = 24	# 0.4 second
Set 1 Variable 3 (SELogic Equation)	S1V3 = 51N2T	
S1V3 Timer Pickup	S1V3PU = 0	
S1V3 Timer Dropout	S1V3DO = 24	# 0.4 second
Set 1 Variable 4 (SELogic Equation)	S1V4 = 87R+50N21T+50P21T+51P2T+51N2T	# Event trigger
S1V4 Timer Pickup	S1V4PU = 0	
S1V4 Timer Dropout	S1V4DO = 0	
Set 1 Latch Bits		# Not used
SELogic Set 2:		# Not used
SELogic Set 3:		# Not used
Trip Logic:		
	TR1 = 50P21T + 51P2T +50N21T +51N2T	
	TR2 = 87R + 87U	
	TR3 = 0	
	TR4 = 0	
	TR5 = 0	
	ULTR1 = !(51P2 + 51N2)	
	ULTR2 = !(87R + 87U)	
	ULTR3 = 0	
	ULTR4 = 0	
	ULTR5 = 0	
Close Logic:		# Not used
Event Trigger		
	ER = /S1V4	
Output Contact Logic:		
Output Contact 101	OUT101 = TRIP1+TRIP2	# Any Trip
Output Contact 102	OUT102 = 0	# Not used

Output Contact 103	OUT103 = 0	# Not used
Output Contact 104	OUT104 = 0	# Not used
Output Contact 105	OUT105 = S1V1T	# Alarm
Output Contact 106	OUT106 = S1V2T	# Alarm
Output Contact 107	OUT107 = S1V3T	# Alarm
Output Contact 201 ~ 212 are all 0.		# Not used

Global # Default

SER:
SER1 = 87R,87U,50P21,50P21T,51P2,51P2T,50N21,50N21T,51N2,51N2T
SER2 = S1V1,S1V1T,S1V2,S1V3,OUT105,S1V4
SER3 = 0
SER4 = 0

Appendix 13 87B-2-BS3 (GE-B30) Setting Calculation

1. Data

MVA_Base =	100	kV_Base =	345	Z_Base =	1190.25	ohms
CTR =	600	PTR =	3000	CTR/PTR=	0.2	

Total MVA of all three GSUs = 750 ; Maximum full load current (amps) = 1255.11

2. Setting Criteria

2.1 Differential Settings: refer to "MottHaven_345kV_87B_100906.doc" for setting criteria.

Pickup	=	0.170 pu	# 40% of FLC
Low Slope	=	25%	
Low Bpnt	=	1.70 pu	# 4x of FLC
High Slope	=	50%	
High Bpnt	=	6.80 pu	# 16x of FLC

2.2 Overcurrent Elements (for event triggering)

2.2.1 Set phase IOC element at 1.46 pu or CT primary amp 4,380, i.e. 3.5 times of the maximum full load

2.2.2. Set phase TOC element at 0.59 pu or CT primary amp 1,770 , i.e. 1.4 times of the maximum FLC.

2.2.3. Set ground IOC element at 0.6 pu or CT primary amp 1,770 , i.e. 1.4 times of the maximum FLC.

2.2.4. Set ground TOC element at 0.33 pu or CT primary amp 990 , i.e. 79% of the maximum FLC.

<u>Device Definition:</u> # Default

<u>Product Setup:</u>

<u>Security:</u> # Default

<u>Display Properties:</u> # Default

<u>Clear Relay Records:</u> # All OFF

<u>Communications:</u> # Default

<u>Modbus User Map:</u> # Not used

<u>Real Time Clock:</u>

IRIG-B Signal Type	=	DC Shift
All other settings	=	Default

Appendix 13 87B-2-BS3 (GE-B30) Setting Calculation

User-Programmable Fault Report:

Prefault Trigger	=	ON	
Fault Trigger	=	Bus Diff Op On (VO1)	
Analog Channel 1	=	SRC1	Ia Mag
Analog Channel 2	=	SRC1	Ib Mag
Analog Channel 3	=	SRC1	Ic Mag
Analog Channel 4	=	SRC2	Ia Mag
Analog Channel 5	=	SRC2	Ib Mag
Analog Channel 6	=	SRC2	Ic Mag
Analog Channel 7	=	SRC1	Ia Angle
Analog Channel 8	=	SRC1	Ib Angle
Analog Channel 9	=	SRC1	Ic Angle
Analog Channel 10	=	SRC2	Ia Angle
Analog Channel 11	=	SRC2	Ib Angle
Analog Channel 12	=	SRC2	Ic Angle
Analog Channel 13	=	Bus 1 Diff A Mag	
Analog Channel 14	=	Bus 1 Diff A Ang	
Analog Channel 15	=	Bus 1 Diff B Mag	
Analog Channel 16	=	Bus 1 Diff B Ang	
Analog Channel 17	=	Bus 1 Diff C Mag	
Analog Channel 18	=	Bus 1 Diff C Ang	
Analog Channel 19	=	Bus 1 Rest A Mag	
Analog Channel 20	=	Bus 1 Rest A Ang	
Analog Channel 21	=	Bus 1 Rest B Mag	
Analog Channel 22	=	Bus 1 Rest B Ang	
Analog Channel 23	=	Bus 1 Rest C Mag	
Analog Channel 24	=	Bus 1 Rest C Ang	

Oscillography:

SETTING	=	PARAMETER
Number Of Records	=	6
Trigger Mode	=	Automatic Overwrite
Trigger Position	=	50%
Trigger Source	=	Trig Oscill On (VO4)
AC Input Waveforms	=	32 samples/cycle
Digital Channel 1	=	OFF
Digital Channel 2	=	Bus Diff Op On (VO1)
Digital Channel 3	=	Not Used On (VO2)
Digital Channel 4	=	Alarm On (VO3)
Digital Channel 5	=	Trig Oscill On (VO4)
Digital Channel 6	=	CT Trouble On (VO5)
Digital Channel 7	=	BUS 1 BIASED PKP A
Digital Channel 8	=	BUS 1 BIASED OP A
Digital Channel 9	=	BUS 1 BIASED PKP B
Digital Channel 10	=	BUS 1 BIASED OP B
Digital Channel 11	=	BUS 1 BIASED PKP C
Digital Channel 12	=	BUS 1 BIASED OP C
Digital Channel 13	=	BUS 1 DIR A
Digital Channel 14	=	BUS 1 DIR B
Digital Channel 15	=	BUS 1 DIR C
Digital Channel 16	=	BUS 1 SAT A

Digital Channel 17	=	BUS 1 SAT B	
Digital Channel 18	=	BUS 1 SAT C	
Digital Channel 19	=	BUS 1 UNBIASED OP A	
Digital Channel 20	=	BUS 1 UNBIASED OP B	
Digital Channel 21	=	BUS 1 UNBIASED OP C	
Digital Channel 22	=	PHASE TOC1 PKP A	
Digital Channel 23	=	PHASE TOC1 OP A	
Digital Channel 24	=	PHASE TOC1 PKP B	
Digital Channel 25	=	PHASE TOC1 OP B	
Digital Channel 26	=	PHASE TOC1 PKP C	
Digital Channel 27	=	PHASE TOC1 OP C	
Digital Channel 28	=	NEUTRAL TOC1 PKP	
Digital Channel 29	=	NEUTRAL TOC1 OP	
Digital Channel 30	=	NEUTRAL IOC1 PKP	
Digital Channel 31	=	NEUTRAL IOC1 OP	
Digital Channel 32	=	PHASE IOC1 PKP A	
Digital Channel 33	=	PHASE IOC1 PKP B	
Digital Channel 34	=	PHASE IOC1 PKP C	
Digital Channel 35	=	Trip_LED On (VO9)	
Digital Channel 36	=	51 On (VO8)	
Digital Channel 37	=	87I On (VO7)	
Digital Channel 38	=	OFF	
Digital Channel 39	=	OFF	
Digital Channel 40	=	OFF	
Digital Channel 41	=	OFF	
Digital Channel 42	=	OFF	
Digital Channel 43	=	OFF	
Digital Channel 44	=	OFF	
Digital Channel 45	=	OFF	
Digital Channel 46	=	OFF	
Digital Channel 47	=	OFF	
Digital Channel 48	=	OFF	
Digital Channel 49	=	OFF	
Digital Channel 50	=	OFF	
Digital Channel 51	=	OFF	
Digital Channel 52	=	OFF	
Digital Channel 53	=	OFF	
Digital Channel 54	=	OFF	
Digital Channel 55	=	OFF	
Digital Channel 56	=	OFF	
Digital Channel 57	=	OFF	
Digital Channel 58	=	OFF	
Digital Channel 59	=	OFF	
Digital Channel 60	=	OFF	
Digital Channel 61	=	OFF	
Digital Channel 62	=	OFF	
Digital Channel 63	=	OFF	
Analog Channel 1	=	SRC1	Ia Mag
Analog Channel 2	=	SRC1	Ib Mag
Analog Channel 3	=	SRC1	Ic Mag

Analog Channel 4	=	SRC1	Ia Angle
Analog Channel 5	=	SRC1	Ib Angle
Analog Channel 6	=	SRC1	Ic Angle
Analog Channel 7	=	SRC2	Ia Mag
Analog Channel 8	=	SRC2	Ib Mag
Analog Channel 9	=	SRC2	Ic Mag
Analog Channel 10	=	Bus 1 Diff A Mag	
Analog Channel 11	=	Bus 1 Diff B Mag	
Analog Channel 12	=	Bus 1 Diff C Mag	
Analog Channel 13	=	SRC2	Ia Angle
Analog Channel 14	=	SRC2	Ib Angle
Analog Channel 15	=	SRC2	Ic Angle
Analog Channel 16	=	SRC1	Frequency

<u>User-Programmable Leds:</u>

<u>LED Test:</u>

Function	=	Enabled
Control	=	CONTROL PUSHBUTTON 1 ON

<u>Trip and Alarms Leds:</u>

Trip LED Input	=	Trip_LED On (VO9)
Alarm LED Input	=	Alarm On (VO3)

LED 1	=	Bus Diff Op On (VO1)	Latched
LED 2	=	51 On (VO8)	Latched
LED 3	=	87I On (VO7)	Latched
LED 4	=	OFF	Self-Reset
LED 5	=	BUS 1 BIASED OP A	Latched
LED 6	=	BUS 1 BIASED OP B	Latched
LED 7	=	BUS 1 BIASED OP C	Latched
LED 8	=	OFF	Self-Reset
LED 9	=	PHASE TOC1 OP A	Latched
LED 10	=	PHASE TOC1 OP B	Latched
LED 11	=	PHASE TOC1 OP C	Latched
LED 12	=	OFF	Self-Reset
LED 13	=	NEUTRAL TOC1 OP	Latched
LED 14	=	OFF	Self-Reset
LED 15	=	CT Trouble On (VO5)	Latched
LED 16	=	OFF	Self-Reset
LED 17	=	BUS 1 UNBIASED OP A	Latched
LED 18	=	BUS 1 UNBIASED OP B	Latched
LED 19	=	BUS 1 UNBIASED OP C	Latched
LED 20	=	OFF	Self-Reset
LED 21	=	OFF	Self-Reset
LED 22	=	OFF	Self-Reset
LED 23	=	OFF	Self-Reset
LED 24	=	OFF	Self-Reset
LED 25	=	BUS 1 BIASED PKP A	Self-Reset
LED 26	=	BUS 1 BIASED PKP B	Self-Reset
LED 27	=	BUS 1 BIASED PKP C	Self-Reset
LED 28	=	OFF	Self-Reset

LED 29	=	PHASE TOC1 PKP A	Self-Reset
LED 30	=	PHASE TOC1 PKP B	Self-Reset
LED 31	=	PHASE TOC1 PKP C	Self-Reset
LED 32	=	OFF	Self-Reset
LED 33	=	NEUTRAL TOC1 PKP	Self-Reset
LED 34	=	OFF	Self-Reset
LED 35	=	OFF	Self-Reset
LED 36	=	BUS 1 DIR A	Self-Reset
LED 37	=	BUS 1 DIR B	Self-Reset
LED 38	=	BUS 1 DIR C	Self-Reset
LED 39	=	OFF	Self-Reset
LED 40	=	BUS 1 SAT A	Self-Reset
LED 41	=	BUS 1 SAT B	Self-Reset
LED 42	=	BUS 1 SAT C	Self-Reset
LED 43	=	OFF	Self-Reset
LED 44	=	OFF	Self-Reset
LED 45	=	OFF	Self-Reset
LED 46	=	OFF	Self-Reset
LED 47	=	OFF	Self-Reset
LED 48	=	OFF	Self-Reset

User-Programmable Self Tests:

Remote Device Off Function	=	Enabled
Pri Ethernet Fail Function	=	Disabled
Battery Fail Function	=	Enabled
SNTP Fail Function	=	Enabled
IRIG B Fail Function	=	Enabled

Control Pushbuttons:

PARAMETER	CPB 1	CPB 2	CPB 3
Function	Disabled	Disabled	Enabled
Events	Disabled	Disabled	Enabled

Flex States: # All OFF

User-definable displays: # Not used

Direct I/O: # Not used

Teleprotection: # Not used

Installation:

Relay Name = 87B-2/BS3

System Setup:

AC Inputs

Current:

PARAMETER		CT F1	CT F5
Phase CT Primary	=	3000 A	3000 A
Phase CT Secondary	=	5 A	5 A
Ground CT Primary	=	3000 A	3000 A
Ground CT Secondary	=	5 A	5 A

Power System:

Nominal Frequency	=	60 Hz
Phase Rotation	=	ABC
Frequency And Phase Reference	=	SRC 1 (SRC 1)
Frequency Tracking Function	=	Enabled

Signal Sources: PARAMETER SOURCE 1 SOURCE 2

Appendix 13 87B-2-BS3 (GE-B30) Setting Calculation

	Name	=	SRC 1	SRC 2	
	Phase CT	=	F1	F5	
	Ground CT	=	None	None	
	Phase VT	=	None	None	
	Aux VT	=	None	None	
Breakers:					# Not used
Switches					# Not used
FlexCurves:					# Not used
Bus:	PARAMETER		BUS ZONE 1		
	Source A	=	SRC 1 (SRC 1)		
	Status A	=	ON		
	Source B	=	SRC 2 (SRC 2)		
	Status B	=	ON		
	Source C	=	SRC 1 (SRC 1)		
	Status C	=	OFF		
	Source D	=	SRC 1 (SRC 1)		
	Status D	=	OFF		
	Source E	=	SRC 1 (SRC 1)		
	Status E	=	OFF		
	Source F	=	SRC 1 (SRC 1)		
	Status F	=	OFF		
FlexLogic:				# See 87B-2-BS3-logic-r0.pdf	
Grouped Elements:					
Group 1:					
Bus Differential:					
	Operating Characteristc Graph	=	View		
	Function	=	Enabled		
	Pickup	=	0.170 pu		# 40% of FLC
	Low Slope	=	25%		
	Low Bpnt	=	1.70 pu		# 4x of FLC
	High Slope	=	50%		
	High Bpnt	=	6.80 pu		# 16x of FLC
	High Set	=	10.20 pu		# 24x of FLC
	Seal-In	=	0.400 s		
	Block	=	OFF		
	Target	=	Latched		
	Events	=	Enabled		
Phase Current:					
Phase TOC:					
	Function	=	Enabled		
	Signal Source	=	SRC 1 (SRC 1)		
	Input	=	RMS		
	Pickup	=	0.590 pu		# 1.4x of FLC
	Curve	=	IEC Curve B		
	TD Multiplier	=	0.2		
	Reset	=	Timed		
	Voltage Restraint	=	Disabled		
	Block A	=	OFF		
	Block B	=	OFF		
	Block C	=	OFF		

	Target	=	Latched	
	Events	=	Enabled	
Phase IOC:				
	Function	=	Enabled	
	Source	=	SRC 1 (SRC 1)	
	Pickup	=	1.460 pu	# 3.5x of FLC
	Delay	=	0.01 s	
	Reset Delay	=	0.00 s	
	Block A	=	OFF	
	Block B	=	OFF	
	Block C	=	OFF	
	Target	=	Self-reset	
	Events	=	Enabled	
Neutral Current:				
Neutral TOC:				
	Function	=	Enabled	
	Source	=	SRC 1 (SRC 1)	
	Input	=	RMS	
	Pickup	=	0.330 pu	# 80% of FLC
	Curve	=	IEC Curve B	
	TD Multiplier	=	0.35	
	Reset	=	Timed	
	Block	=	OFF	
	Target	=	Latched	
	Events	=	Enabled	
Neutral IOC:				
	Function	=	Enabled	
	Source	=	SRC 1 (SRC 1)	
	Pickup	=	0.600 pu	# 1.4x of FLC
	Delay	=	0.01 s	
	Reset Delay	=	0.00 s	
	Block	=	OFF	
	Target	=	Self-reset	
	Events	=	Enabled	
Ground Current:				
Ground TOC				# Not used
Ground IOC				# Not used
Breaker Failure:				# Not used
Control Elements:				
Trip Bus:				# Not used
Setting Groups:				# Not used
Selector Switches:				# Not used
Digital Elements:				# Not used
Digital Counters:				# Not used
Monitoring Elements:				
Breaker Flashover:				# Not used
CT Trouble:				
	Function	=	Enabled	
	Pickup	=	0.084 pu	
	Delay	=	10.0 s	

Target	=	Disabled
Events	=	Enabled

Inputs/Outputs:

Contact inputs: # Not used

Contact Inputs Thresholds:

Cont Ip 1, Cont Ip 2, Cont Ip 3, Cont Ip 4(H5A, H5C, H6A, H6C)	=	84 Vdc
Cont Ip 5, Cont Ip 6, Cont Ip 7, Cont Ip 8(H7A, H7C, H8A, H8C)	=	84 Vdc
Cont Ip 9, Cont Ip 10, Cont Ip 11, Cont Ip 12(L5A, L5C, L6A, L6C)	=	84 Vdc
Cont Ip 13, Cont Ip 14, Cont Ip 15, Cont Ip 16(L7A, L7C, L8A, L8C)	=	84 Vdc

Virtual Inputs: # Not used

Contact Outputs:

[H1] Contact Output 1 ID	=	87 Trip
[H1] Contact Output 1 Operate	=	Bus Diff Op On (VO1)
[H1] Contact Output 1 Seal-In	=	Bus Diff Op On (VO1)
[H1] Contact Output 1 Events	=	Enabled
[H2] Contact Output 2 ID	=	51 TRIP (SP)
[H2] Contact Output 2 Operate	=	OFF
[H2] Contact Output 2 Seal-In	=	OFF
[H2] Contact Output 2 Events	=	Disabled
[H3] Contact Output 3 ID	=	NOT USED
[H3] Contact Output 3 Operate	=	OFF
[H3] Contact Output 3 Seal-In	=	OFF
[H3] Contact Output 3 Events	=	Disabled
[H4] Contact Output 4 ID	=	NOT USED
[H4] Contact Output 4 Operate	=	OFF
[H4] Contact Output 4 Seal-In	=	OFF
[H4] Contact Output 4 Events	=	Disabled
[L1] Contact Output 5 ID	=	Any Trip
[L1] Contact Output 5 Operate	=	FOR TESTING On (VO11)
[L1] Contact Output 5 Seal-In	=	OFF
[L1] Contact Output 5 Events	=	Enabled
[L2] Contact Output 6 ID	=	50 51P Trip
[L2] Contact Output 6 Operate	=	50 51P TRIP On (VO2)
[L2] Contact Output 6 Seal-In	=	OFF
[L2] Contact Output 6 Events	=	Enabled
[L3] Contact Output 7 ID	=	50 51N Trip
[L3] Contact Output 7 Operate	=	50 51N TRIP On (VO12)
[L3] Contact Output 7 Seal-In	=	OFF
[L3] Contact Output 7 Events	=	Enabled
[L4] Contact Output 8 ID	=	NOT USED
[L4] Contact Output 8 Operate	=	OFF
[L4] Contact Output 8 Seal-In	=	OFF
[L4] Contact Output 8 Events	=	Disabled

Virtual Outputs:

Virtual Output 1 ID	=	Bus Diff Op
Virtual Output 1 Events	=	Enabled
Virtual Output 2 ID	=	50 51P TRIP
Virtual Output 2 Events	=	Enabled
Virtual Output 3 ID	=	Alarm
Virtual Output 3 Events	=	Enabled
Virtual Output 4 ID	=	Trig Oscill
Virtual Output 4 Events	=	Enabled
Virtual Output 5 ID	=	CT Trouble
Virtual Output 5 Events	=	Enabled
Virtual Output 6 ID	=	Virt Op 6
Virtual Output 6 Events	=	Disabled
Virtual Output 7 ID	=	87I
Virtual Output 7 Events	=	Enabled
Virtual Output 8 ID	=	51
Virtual Output 8 Events	=	Enabled
Virtual Output 9 ID	=	Trip_LED
Virtual Output 9 Events	=	Enabled
Virtual Output 10 ID	=	Biased_pkp
Virtual Output 10 Events	=	Enabled
Virtual Output 11 ID	=	FOR TESTING
Virtual Output 11 Events	=	Enabled
Virtual Output 12 ID	=	50 51N TRIP
Virtual Output 12 Events	=	Enabled

Remote Devices:	# Not used
Remote Inputs:	# Not used
Remote Outputs DNA Bit Pairs	# Not used
Remote Outputs UserSt Bit Pairs:	# Not used
Resetting:	# Not used
Direct Inputs:	# Not used
Direct Outputs:	# Not used
Teleprotection:	# Not used
IEC 61850 GOOSE Analogs Inputs	# Not used

Appendix 14 87-51-1-R1 (SEL-387) Setting Calculation

1. Data

MVA_Base =	100	kV_Base =	345	
CTR =	240			
MVA rating of Reactor R1 =	150	; Maximum full load current (amps) =	251.02	

2. Setting Criteria

2.1 Differential Settings:

Maximum Transformer **MVA** =	150	MVA
The nominal transformer Winding 1 terminal voltage **VWDG1** =	345	kV
The nominal transformer Winding 2 terminal voltage **VWDG2** =	345	kV
CT ratio for winding 1---**CTR1**=	240	
CT ratio for winding 2---**CTR2**=	240	
Winding 1 Current Tap **TAP1** = MVA/(Sqrt(3) x VWDG1 x CTR1) =	1.05	A
Winding 2 Current Tap **TAP2** = MVA/(Sqrt(3) x VWDG2 x CTR2) =	1.05	A
O87P ≥ 0.1 x 5A / TAPmin = 0.48 Set **O87P=**	0.50	# Per manual
Dual-Slop variable-percentage differential characteristic is used.		
Restraint Slop 1 Percentage (5-100%) **SLP 1** =	25	
Restraint Slope 2 Percentage (OFF, 25–200%) **SLP2** =	50	
Restraint Current Slope 1 Limit ((1–20) multiple of tap**)** **IRS1** =	3	
Unrestrained Element Current PU ((1–20) multiple of tap) **U87P** =	10	
Second-Harmonic Blocking Percentage (OFF, 5–100%) **PCT2** =	10	# Inrush inhibit
Fifth-Harmonic Blocking Percentage (OFF, 5–100%) **PCT5** =	OFF	
Independent Harmonic Blocking **IHBL =**	N	

2.2 Winding 1 Elems

2.2.1 Set phase IOC element 50P12P at 0.25 CT secondary amp (minimum) for unlatch trip setting ULTR.

2.2.2. Set phase TOC element 51P1P at 2 CT secondary amp or 480 CT primary amp, i.e. 1.91 times of the maximum FLC. 2nd harmonic (2HB1+2HB2+2HB3) is used to block operation to prevent inrush false trip. Curve and time dial are set to make the curve to match the existing setting curve.

2.2.3 Set residual IOC element 50N12P at 0.25 CT secondary amp (minimum) for unlatch trip setting ULTR.

2.2.4. Set residual TOC element 51N1P at 1 CT secondary amp or 240 CT primary amp, i.e. 95.6% of the maximum FLC. 2nd harmonic (2HB1+2HB2+2HB3) is used to block operation to prevent inrush false trip. Curve and time dial are set to make the curve to match the existing setting curve.

2.3 Winding 2 Elems

2.3.1 Set phase IOC element 50P22P at 0.25 CT secondary amp (minimum) for unlatch trip setting ULTR.

2.3.2. Set phase TOC element 51P2P at 2 CT secondary amp or 480 CT primary amp, i.e. 1.91 times of the maximum FLC. Curve and time dial are set to make the curve to match the existing setting curve.

2.3.3 Set residual IOC element 50N12P at 0.25 CT secondary amp (minimum) for unlatch trip setting ULTR.

2.3.4. Set residual TOC element 51N1P at 1 CT secondary amp or 240 CT primary amp, i.e. 95.6% of the maximum FLC. Curve and time dial are set to make the curve to match the existing setting curve.

<u>Group 1 - Set 1:</u>
<u>Config. Settings:</u>

Appendix 14 87-51-1-R1 (SEL-387) Setting Calculation

Relay Identifier	RID = 87-51-1-R1	
Terminal Identifier	TID = CHARLES POLETTI	
Enable Wdg1 in Differential Element	E87W1 = Y	
Enable Wdg2 in Differential Element	E87W2 = Y	
Enable Wdg3 in Differential Element	E87W3 = N	
Enable Wdg4 in Differential Element	E87W4 = N	
Enable Wdg1 O/C Elements and Dmd. Thresholds	EOC1 = Y	
Enable Wdg2 O/C Elements and Dmd. Thresholds	EOC2 = Y	
Enable Wdg3 O/C Elements and Dmd. Thresholds	EOC3 = N	
Enable Wdg4 O/C Elements and Dmd. Thresholds	EOC4 = N	
Enable Combined O/C Elements	EOCC = N	
Enable RTDA Elements	E49A = N	
Enable RTDB Elements	E49B = N	
Enable SELogic Set 1	ESLS1 = Y	
Enable SELogic Set 2	ESLS2 = N	
Enable SELogic Set 3	ESLS3 = N	
General Data:		
Wdg1 CT Connection	W1CT = Y	
Wdg2 CT Connection	W2CT = Y	
Wdg3 CT Connection	W3CT = Y	# Not Used
Wdg4 CT Connection	W4CT = Y	# Not Used
Wdg1 CT Ratio	CTR1 = 240	
Wdg2 CT Ratio	CTR2 = 240	
Wdg3 CT Ratio	CTR3 = 240	# Not Used
Wdg4 CT Ratio	CTR4 = 240	# Not Used
Maximum Power Xfmr Capacity	MVA = 150	
Define Interal CT Connection Compensation	ICOM = Y	
Wdg1 CT Conn. Compensation	W1CTC = 12	
Wdg2 CT Conn. Compensation	W2CTC = 12	
Wdg 1 Line-to-Line Voltage	VWDG1 = 345	# kV
Wdg 2 Line-to-Line Voltage	VWDG2 = 345	# kV
Wdg 3 Line-to-Line Voltage	VWDG3 = 345	# Not Used
Wdg 4 Line-to-Line Voltage	VWDG4 = 345	# Not used
Diff Elems:		
Restrained Element Current PU	O87P = 0.50	
Restrain Slope 1 Percentage	SLP1 = 25	
Restrain Slope 2 Percentage	SLP2 = 50	
Restraint Current Slope 1 Limit	IRS1 = 3	
Unrestrained Element Current PU	U87P = 10	
2nd Harmonic Blocking Percentage	PCT2 = 10	
5th Hamronic Blocking Percentage	PCT5 = OFF	
5th Harmonic Alarm Threshold	TH5P = OFF	
Independent Harmonic Blocking	IHBL = N	
Restriced Earth Fault:		
Winding 1 Elems:		
Phase Def-Time O/C Level 1 PU	50P11P = OFF	
Phase Level 1 O/C Delay	50P11P = 5	# Not used

50P11 Torque Control (SELogic Equation)	50P11TC = 1	# Not used
Phase Def-Time O/C Level 2 PU	50P12P = 0.25	# Minimum
50P12 Torque Control (SELogic Equation)	50P12TC = 1	
Oher Phase Inst O/C elements		# Not used
Phase Inv-Time O/C PU	51P1P = 2	# 1.91xFLC
Phase Inv-Time O/C Curve	51P1C = U1	
Phase Inv-Time O/C Time-Dial	51P1TD = 0.5	
Phase Inv-Time O/C EM Reset	51P1RS = N	
51P1 Torque Control (SELogic Equation)	51P1TC = !(2HB1 + 2HB2 + 2HB3)	
Neg-Seq Def-Time O/C		# Not used
Residual Def-Time O/C Level 1 PU	50N11P = OFF	
Residual Level 1 O/C Delay	50N11D = 5	# Not used
50N11 Torque Control (SELogic Equation)	50N11TC = 1	# Not used
Residual Def-Time O/C Level 1 PU	50N12P = 0.25	# Minimum
50N12 Torque Control (SELogic Equation)	50N12TC = 1	
Other Residual Inst O/C elements		# Not used
Residual Inv-Time O/C PU	51N1P = 1	# 95.6% FLC
Residual Inv-Time O/C Curve	51N1C = U1	
Residual Inv-Time O/C Time-Dial	51N1TD = 0.5	
Residual Inv-Time O/C EM Reset	51N1RS = N	
51N2 Torque Control (SELogic Equation)	51N2TC = !(2HB1 + 2HB2 + 2HB3)	
Demand Ammeter Time Constant	DATC1 = 15	# Default
Phase Demand Ammeter Threshold	PDEM1P = 7	# Default
Neg-Seq Demand Ammeter Threshold	QDEM1P = 1	# Default
Residual Demand Ammeter Threshold	NDEM1P = 1	# Default
Winding 2 Elems:		
Phase Def-Time O/C Level 1 PU	50P21P = OFF	# Not used
Phase Level 1 O/C Delay	50P21P = 5	# Not used
50P21 Torque Control (SELogic Equation)	50P21TC = 1	# Not used
Phase Def-Time O/C Level 2 PU	50P22P = 0.25	# Minimum
50P22 Torque Control (SELogic Equation)	50P22TC = 1	
Oher Phase Inst O/C elements		# Not used
Phase Inv-Time O/C PU	51P2P = 2	# 1.91xFLC
Phase Inv-Time O/C Curve	51P2C = U1	
Phase Inv-Time O/C Time-Dial	51P2TD = 0.5	
Phase Inv-Time O/C EM Reset	51P2RS = N	
51P2 Torque Control (SELogic Equation)	51P2TC = 1	
Neg-Seq Def-Time O/C		# Not used
Residual Def-Time O/C Level 1 PU	50N21P = OFF	# Not used
Residual Level 1 O/C Delay	50N21D = 5	# Not used
50N21 Torque Control (SELogic Equation)	50N21TC = 1	# Not used
Residual Def-Time O/C Level 1 PU	50N22P = 0.25	# Minimum
50N22 Torque Control (SELogic Equation)	50N22TC = 1	
Other Residual Inst O/C elements		# Not used
Residual Inv-Time O/C PU	51N2P = 1	# 95.6% FLC
Residual Inv-Time O/C Curve	51N2C = U1	
Residual Inv-Time O/C Time-Dial	51N2TD = 0.5	
Residual Inv-Time O/C EM Reset	51N2RS = N	
51N2 Torque Control (SELogic Equation)	51N2TC = 1	
Demand Ammeter Time Constant	DATC2 = 15	# Default

Phase Demand Ammeter Threshold	PDEM2P = 7	# Default
Neg-Seq Demand Ammeter Threshold	QDEM2P = 1	# Default
Residual Demand Ammeter Threshold	NDEM2P = 1	# Default
Winding 3 Elems:		# Not Used
Winding 4 Elems:		# Not Used
Combined Elems:		# Not used
RTD A Elems:		# Not used
RTD B Elems:		# Not used
Misc. Timers		# Default
SELogic Set 1:		
	S1V1 = IN106	# 63SPR Ttrip
	S1V1PU = 0	
	S1V1DO = 9	
	Other SV = OFF	# Not used
SELogic Set 2:		# Not used
SELogic Set 3:		# Not used
Trip Logic:		
	TR1 = 51P1T+51P2T	
	TR2 = 51N1T+51N2T	
	TR3 = 0	
	TR4 = 0	
	TR5 = 87R + 87U	
	ULTR1 = !(50P12 + 50P22)	
	ULTR2 = !(50N12 + 50N22)	
	ULTR3 = 0	
	ULTR4 = 0	
	ULTR5 = !(87U + 87R)	
Close Logic:		# Not used
Event Trigger		

ER = /51P1 + /51N1 + /51P2 + /51N2 + /87U + /87R

Output Contact Logic:			
Output Contact 101	# Any Trip	OUT101=TRIP1+TRIP2 +TRIP5+S1V1T	
Output Contact 102		OUT102 = 0	# Not used
Output Contact 103		OUT103 = TRIP5	# 87 Trip
Output Contact 104		OUT104 = TRIP1	# 51P Trip
Output Contact 105		OUT105 = TRIP2	# 51N Trip
Output Contact 106		OUT106 = S1V1T	# Not used
Output Contact 107		OUT107 = 0	# Not used
Output Contact 201 ~ 212 are all 0.			# Not used
Global			# Default

SER:

SER1 = IN101,IN102,IN103,IN104,IN105,IN106

SER2 = OUT101,OUT102,OUT103,OUT104,OUT105,OUT106,OUT107

SER3 = 51P1,51P1T,51N1,51N1T,51P2,51P2T,51N2,51N2T

SER4 = 87R1,87R2,87R3,87U1,87U2,87U3

Appendix 15 87-51-2-R1 (GE-T60) Setting Calculation

1. Data

MVA_Base =	100	kV_Base =	345	
CTR =	240			
MVA rating of Reactor R1 =	150	; Maximum full load current (amps) =		251.02

2. Setting Criteria

2.1 Differential Settings:

Differential Pickup in per unit =	0.50	# APP14-2.1
Differential Slope 1 in % =	25%	# APP14-2.1
Differential Break 1 in per unit =	2	
Differential Break 2 in per unit =	3	# APP14-2.1
Differential Slope 2 in % =	50%	# APP14-2.1
Inrush Inhibit Function =	Adapt. 2nd	# APP14-2.1
Inrush Inhibit Mode =	Per Phase	# APP14-2.1
Inrush Inhibit Level =	10%	# APP14-2.1
Instantaneous Differential Pickup in per unit =	10	# APP14-2.1

2.2 Winding 1 Elements

2.2.1. Set phase TOC element at 0.4 pu, or 2 CT secondary amp or 480 CT primary amp, i.e. 1.91 times of the maximum FLC. 2nd harmonic (XFMR PCNT DIFF 2ND A, XFMR PCNT DIFF 2ND B, XFMR PCNT DIFF 2ND C) is used to block operation to prevent inrush false trip. Curve and time dial are set to make the curve to match the existing setting curve.

2.2.2. Set residual TOC element at 0.2 pu or 1 CT secondary amp or 240 CT primary amp, i.e. 95.6% of the maximum FLC. 2nd harmonic (XFMR PCNT DIFF 2ND A, XFMR PCNT DIFF 2ND B, XFMR PCNT DIFF 2ND C) is used to block operation to prevent inrush false trip. Curve and time dial are set to make the curve to match the existing setting curve.

2.3 Winding 2 Elements

2.3.1. Set phase TOC element at 0.4 pu, or 2 CT secondary amp or 480 CT primary amp, i.e. 1.91 times of the maximum FLC. Curve and time dial are set to make the curve to match the existing setting curve.

2.3.2. Set residual TOC element at 0.2 pu or 1 CT secondary amp or 240 CT primary amp, i.e. 95.6% of the maximum FLC. Curve and time dial are set to make the curve to match the existing setting curve.

<u>Device Definition:</u>	# Default
<u>Product Setup:</u>	
<u>Security:</u>	# Default
<u>Display Properties:</u>	# Default
<u>Clear Relay Records:</u>	# All OFF
<u>Communications:</u>	# Default
<u>Modbus User Map:</u>	# Not used
<u>Real Time Clock:</u>	

IRIG-B Signal Type	=	DC Shift	
All other settings	=	Default	

<u>User-Programmable Fault Report:</u>

PARAMETER		FAULT REPORT 1	
Function	=	Enabled	
Prefault Trigger	=	Osc Trigger On (VO3)	
Fault Trigger	=	FR-Trigger On (VO5)	
Analog Channel 1	=	SRC1	Ia Mag
Analog Channel 2	=	SRC1	Ib Mag

Analog Channel 3	=	SRC1	Ic Mag
Analog Channel 4	=	SRC2	Ia Mag
Analog Channel 5	=	SRC2	Ib Mag
Analog Channel 6	=	SRC2	Ic Mag
Analog Channel 7	=	SRC1	Ia Angle
Analog Channel 8	=	SRC1	Ib Angle
Analog Channel 9	=	SRC1	Ic Angle
Analog Channel 10	=	SRC2	Ia Angle
Analog Channel 11	=	SRC2	Ib Angle
Analog Channel 12	=	SRC2	Ic Angle
Analog Channel 13	=	Xfmr Iad Mag	
Analog Channel 14	=	Xfmr Ibd Mag	
Analog Channel 15	=	Xfmr Icd Mag	
Analog Channel 16	=	Xfmr Iad Angle	
Analog Channel 17	=	Xfmr Ibd Angle	
Analog Channel 18	=	Xfmr Icd Angle	
Analog Channel 19	=	Xfmr Harm2 Iad Mag	
Analog Channel 20	=	Xfmr Harm2 Ibd Mag	
Analog Channel 21	=	Xfmr Harm2 Icd Mag	
Analog Channel 22	=	Xfmr Harm2 Iad Angle	
Analog Channel 23	=	Xfmr Harm2 Ibd Angle	
Analog Channel 24	=	Xfmr Harm2 Icd Angle	
Analog Channel 25	=	Xfmr Harm5 Iad Mag	
Analog Channel 26	=	Xfmr Harm5 Ibd Mag	
Analog Channel 27	=	Xfmr Harm5 Icd Mag	
Analog Channel 28	=	Xfmr Harm5 Iad Angle	
Analog Channel 29	=	Xfmr Harm5 Ibd Angle	
Analog Channel 30	=	Xfmr Harm5 Icd Angle	
Analog Channel 31	=	SRC1	Frequency
Analog Channel 32	=	SRC1	Q

<u>Oscillography:</u>

SETTING		PARAMETER
Number Of Records	=	5
Trigger Mode	=	Automatic Overwrite
Trigger Position	=	30%
Trigger Source	=	Osc Trigger On (VO3)
AC Input Waveforms	=	32 samples/cycle
Digital Channel 1	=	87Trip On (VO1)
Digital Channel 2	=	Cont Ip 1 Off(H5a)
Digital Channel 3	=	XFMR INST DIFF OP
Digital Channel 4	=	XFMR PCNT DIFF OP
Digital Channel 5	=	XFMR INST DIFF OP A
Digital Channel 6	=	XFMR INST DIFF OP B
Digital Channel 7	=	XFMR INST DIFF OP C
Digital Channel 8	=	XFMR PCNT DIFF 2ND A
Digital Channel 9	=	XFMR PCNT DIFF 2ND B
Digital Channel 10	=	XFMR PCNT DIFF 2ND C
Digital Channel 11	=	XFMR PCNT DIFF OP A
Digital Channel 12	=	XFMR PCNT DIFF OP B

Digital Channel 13	=	XFMR PCNT DIFF OP C
Digital Channel 14	=	XFMR PCNT DIFF 5TH A
Digital Channel 15	=	XFMR PCNT DIFF 5TH B
Digital Channel 16	=	XFMR PCNT DIFF 5TH C
Digital Channel 17	=	OFF
Digital Channel 18	=	OFF
Digital Channel 19	=	OFF
Digital Channel 20	=	OFF
Digital Channel 21	=	OFF
Digital Channel 22	=	OFF
Digital Channel 23	=	OFF
Digital Channel 24	=	OFF
Digital Channel 25	=	OFF
Digital Channel 26	=	OFF
Digital Channel 27	=	OFF
Digital Channel 28	=	OFF
Digital Channel 29	=	OFF
Digital Channel 30	=	OFF
Digital Channel 31	=	OFF
Digital Channel 32	=	OFF
Digital Channel 33	=	OFF
Digital Channel 34	=	OFF
Digital Channel 35	=	OFF
Digital Channel 36	=	OFF
Digital Channel 37	=	OFF
Digital Channel 38	=	OFF
Digital Channel 39	=	OFF
Digital Channel 40	=	OFF
Digital Channel 41	=	OFF
Digital Channel 42	=	OFF
Digital Channel 43	=	OFF
Digital Channel 44	=	OFF
Digital Channel 45	=	OFF
Digital Channel 46	=	OFF
Digital Channel 47	=	OFF
Digital Channel 48	=	OFF
Digital Channel 49	=	OFF
Digital Channel 50	=	OFF
Digital Channel 51	=	OFF
Digital Channel 52	=	OFF
Digital Channel 53	=	OFF
Digital Channel 54	=	OFF
Digital Channel 55	=	OFF
Digital Channel 56	=	OFF
Digital Channel 57	=	OFF
Digital Channel 58	=	OFF
Digital Channel 59	=	OFF
Digital Channel 60	=	OFF
Digital Channel 61	=	OFF
Digital Channel 62	=	OFF

	Digital Channel 63	=	OFF	
	Analog Channel 1	=	Xfmr Iad Mag	
	Analog Channel 2	=	Xfmr Iar Mag	
	Analog Channel 3	=	Xfmr Harm2 Iad Mag	
	Analog Channel 4	=	Xfmr Ibd Mag	
	Analog Channel 5	=	Xfmr Ibr Mag	
	Analog Channel 6	=	Xfmr Harm2 Ibd Mag	
	Analog Channel 7	=	Xfmr Icd Mag	
	Analog Channel 8	=	Xfmr Icr Mag	
	Analog Channel 9	=	Xfmr Harm2 Icd Mag	
	Analog Channel 10	=	Xfmr Harm5 Iad Mag	
	Analog Channel 11	=	Xfmr Harm5 Ibd Mag	
	Analog Channel 12	=	Xfmr Harm5 Icd Mag	
	Analog Channel 13	=	Off	
	Analog Channel 14	=	Off	
	Analog Channel 15	=	Off	
	Analog Channel 16	=	Tracking Frequency	
<u>Data Logger:</u>				# Default
<u>Demand:</u>				# Default
<u>User-Programmable Leds:</u>				
<u>LED Test:</u>				
	Function	=	Enabled	
	Control	=	CONTROL PUSHBUTTON 1 ON	
<u>Trip and Alarms Leds:</u>				
	Trip LED Input	=	87Trip On (VO1)	
	Alarm LED Input	=	51Trip On (VO2)	
	LED 1	=	87Trip On (VO1)	Latched
	LED 2	=	51Trip On (VO2)	Latched
	LED 3	=	XFMR INST DIFF OP	Latched
	LED 4	=	XFMR PCNT DIFF OP	Latched
	LED 5	=	XFMR INST DIFF OP A	Latched
	LED 6	=	XFMR INST DIFF OP B	Latched
	LED 7	=	XFMR INST DIFF OP C	Latched
	LED 8	=	XFMR PCNT DIFF OP A	Latched
	LED 9	=	XFMR PCNT DIFF OP B	Latched
	LED 10	=	XFMR PCNT DIFF OP C	Latched
	LED 11	=	PHASE TOC1 OP	Latched
	LED 12	=	PHASE TOC2 OP	Latched
	LED 13	=	NEUTRAL TOC1 OP	Latched
	LED 14	=	NEUTRAL TOC2 OP	Latched
	LED 15	=	PHASE TOC1 OP A	Latched
	LED 16	=	PHASE TOC1 OP B	Latched
	LED 17	=	PHASE TOC1 OP C	Latched
	LED 18	=	PHASE TOC2 OP A	Latched
	LED 19	=	PHASE TOC2 OP B	Latched
	LED 20	=	PHASE TOC2 OP C	Latched
	LED 21	=	OFF	Self-Reset
	LED 22	=	OFF	Self-Reset
	LED 23	=	OFF	Self-Reset

LED 24	=	OFF	Self-Reset
LED 25	=	OFF	Self-Reset
LED 26	=	OFF	Self-Reset
LED 27	=	OFF	Self-Reset
LED 28	=	OFF	Self-Reset
LED 29	=	OFF	Self-Reset
LED 30	=	OFF	Self-Reset
LED 31	=	OFF	Self-Reset
LED 32	=	OFF	Self-Reset
LED 33	=	OFF	Self-Reset
LED 34	=	OFF	Self-Reset
LED 35	=	OFF	Self-Reset
LED 36	=	OFF	Self-Reset
LED 37	=	OFF	Self-Reset
LED 38	=	OFF	Self-Reset
LED 39	=	OFF	Self-Reset
LED 40	=	OFF	Self-Reset
LED 41	=	OFF	Self-Reset
LED 42	=	OFF	Self-Reset
LED 43	=	OFF	Self-Reset
LED 44	=	OFF	Self-Reset
LED 45	=	OFF	Self-Reset
LED 46	=	OFF	Self-Reset
LED 47	=	OFF	Self-Reset
LED 48	=	OFF	Self-Reset

User-Programmable Self Tests:

Remote Device Off Function	=	Enabled
Pri Ethernet Fail Function	=	Disabled
Battery Fail Function	=	Enabled
SNTP Fail Function	=	Enabled
IRIG B Fail Function	=	Enabled

Control Pushbuttons:

PARAMETER	CPB 1	CPB 2	CPB 3
Function	Enabled	Disabled	Enabled
Events	Disabled	Disabled	Enabled

Flex States: # All OFF

User-definable displays: # Not used

Direct I/O: # Not used

Teleprotection: # Not used

Installation:

Relay Name = 87-51-2-R1

System Setup:

AC Inputs

Current:

PARAMETER		CT F1	CT F5
Phase CT Primary	=	1200 A	1200 A
Phase CT Secondary	=	5 A	5 A
Ground CT Primary	=	1200 A	1200 A
Ground CT Secondary	=	5 A	5 A

Power System:

Appendix 15 87-51-2-R1 (GE-T60) Setting Calculation

	Nominal Frequency	=	60 Hz		
	Phase Rotation	=	ABC		
	Frequency And Phase Reference	=	SRC 1 (SRC 1)		
	Frequency Tracking Function	=	Enabled		
Signal Sources:	PARAMETER		SOURCE 1	SOURCE 2	
	Name	=	SRC 1	SRC 2	
	Phase CT	=	F1	F5	
	Ground CT	=	None	None	
	Phase VT	=	None	None	
	Aux VT	=	None	None	
Transformer:					
General:	SETTING		PARAMETER		
	Number Of Windings	=	2		
	Reference Winding Selection	=	Automatic Selection		
	Phase Compensation	=	Internal (software)		
	Load Loss At Rated Load	=	225 kW		
	Rated Winding Temperature Rise	=	65°C (oil)		
	No Load Loss	=	75 kW		
	Type Of Cooling	=	OA		
	Top-oil Rise Over Ambient	=	35 °C		
	Thermal Capacity	=	100.00 kWh/°C		
	Winding Thermal Time Constant	=	2.00 min		
Windings:	PARAMETER		WINDING 1		WINDING 2
	Source	=	SRC 1 (SRC 1)		SRC 2(SRC 2)
	Rated MVA	=	150.000 MVA		150.000 MVA
	Nominal Phs-phs Voltage	=	345.000 kV		345.000 kV
	Connection	=	Wye		Wye
	Grounding	=	Within zone		Within zone
	Angle Wrt Winding 1	=	0.0 deg		0.0 deg
	Resistance	=	10.0000 ohms		10.0000 ohms
Thermal Inputs:					# Not used
Breakers:					# Not used
Switches					# Not used
FlexCurves:					# Not used
FlexLogic:				# See 87-51-2-R1-logic-r0.pdf	
Grouped Elements:					
Group 1:					
Distance:					# Not used
Power Swing Detect:					# Not used
Load Encroachment:					# Not used
Transformer:					
Percent Differential	SETTING		PARAMETER		
	Function	=	Enabled		
	Pickup	=	0.50		
	Slope 1	=	25%		
	Break 1	=	2.00		
	Break 2	=	3.00		
	Slope 2	=	50%		
	Inrush Inhibit Function	=	Adapt. 2nd		
	Inrush Inhibit Mode	=	Per Phase		

Appendix 15 87-51-2-R1 (GE-T60) Setting Calculation

	Inrush Inhibit Level	=	10%	
	Overexcitation Inhibit Function	=	Disabled	
	Overexcitation Inhibit Level	=	10.0 % fo	
	Block	=	OFF	
	Target	=	Self-reset	
	Events	=	Enabled	
Instantaneous Differential	SETTING		PARAMETER	
	Function	=	Enabled	
	Pickup	=	10	
	Block	=	OFF	
	Target	=	Self-reset	
	Events	=	Enabled	
Hottest Spot				# Not Used
Aging Factor				# Not Used
Loss of Life				# Not Used
Phase Current:				
Phase TOC:	PARAMETER		PHASE TOC1	PHASE TOC2
	Function	=	Enabled	Enabled
	Signal Source	=	SRC 1 (SRC 1)	SRC 2 (SRC2)
	Input	=	Phasor	Phasor
	Pickup	=	0.400 pu	0.400 pu
	Curve	=	IEEE Mod Inv	IEEE Mod Inv
	TD Multiplier	=	0.5	0.5
	Reset	=	Instantaneous	Instantaneous
	Voltage Restraint	=	Disabled	Disabled
	Block A	=	XFMR PCNT DIFF 2ND A	OFF
	Block B	=	XFMR PCNT DIFF 2ND B	OFF
	Block C	=	XFMR PCNT DIFF 2ND C	OFF
	Target	=	Self-reset	Self-reset
	Events	=	Enabled	Enabled
Neutral Current:				
Neutral TOC:	PARAMETER		NEUTRAL TOC1	Neutral TOC2
	Function	=	Enabled	Enabled
	Source	=	SRC 1 (SRC 1)	SRC 2 (SRC2)
	Input	=	Phasor	Phasor
	Pickup	=	0.200 pu	0.200 pu
	Curve	=	IEEE Mod Inv	IEEE Mod Inv
	TD Multiplier	=	0.5	0.5
	Reset	=	Instantaneous	Instantaneous
	Block	=	Hamornic BlK On (VO4)	OFF
	Target	=	Self-reset	Self-reset
	Events	=	Enabled	Enabled
Ground Current:				
Ground TOC				# Not used
Ground IOC				# Not used
Breaker Failure:				# Not used
Control Elements:				
Trip Bus:				# Not used
Setting Groups:				# Not used
Selector Switches:				# Not used

Appendix 15 87-51-2-R1 (GE-T60) Setting Calculation

Underfrequency:		# Not used
Overfrequency:		# Not used
Synchrocheck:		# Not used
Digital Elements:		# Not used
Digital Counters:		# Not used
Monitoring Elements:		# Not used
Pilot Schemes:		# Not used
Inputs/Outputs:		
Contact inputs:		# Not used
Contact Inputs Thresholds:		
Cont Ip 1, Cont Ip 2, Cont Ip 3, Cont Ip 4(H5A, H5C, H6A, H6C)	=	84 Vdc
Cont Ip5, Cont Ip 6, Cont Ip 7, Cont Ip 8(H7A, H7C, H8A, H8C)	=	84 Vdc
Cont Ip 9, Cont Ip 10, Cont Ip 11, Cont Ip 12(M5A, M5C, M6A, M6C)	=	84 Vdc
Cont Ip 13, Cont Ip 14, Cont Ip 15, Cont Ip 16(M7A, M7C, M8A, M8C)	=	84 Vdc
Virtual Inputs:		# Not used
Contact Outputs:		

[H1] Contact Output 1 ID		ANY TRIP
[H1] Contact Output 1 Operate	=	FR-Trigger On (VO5)
[H1] Contact Output 1 Seal-In	=	OFF
[H1] Contact Output 1 Events	=	Enabled
[H2] Contact Output 2 ID		DS-R1 OPEN
[H2] Contact Output 2 Operate	=	52b/DS-R1 On(H8A)
[H2] Contact Output 2 Seal-In	=	OFF
[H2] Contact Output 2 Events	=	Enabled
[H3] Contact Output 3 ID		DS-R1 CLOSE
[H3] Contact Output 3 Operate	=	52b/DS-R1 Off(H8A)
[H3] Contact Output 3 Seal-In	=	OFF
[H3] Contact Output 3 Events	=	Enabled
[H4] Contact Output 4 ID		CB-R1 TRIP
[H4] Contact Output 4 Operate	=	52b/CB-R1 On(H7C)
[H4] Contact Output 4 Seal-In	=	OFF
[H4] Contact Output 4 Events	=	Enabled
[M1] Contact Output 5 ID		87 TRIP
[M1] Contact Output 5 Operate	=	87Trip On (VO1)
[M1] Contact Output 5 Seal-In	=	OFF
[M1] Contact Output 5 Events	=	Enabled
[M2] Contact Output 6 ID		51P TRIP
[M2] Contact Output 6 Operate	=	51P Trip On (VO2)
[M2] Contact Output 6 Seal-In	=	OFF
[M2] Contact Output 6 Events	=	Enabled
[M3] Contact Output 7 ID		51N TRIP
[M3] Contact Output 7 Operate	=	51N Trip On (VO6)
[M3] Contact Output 7 Seal-In	=	OFF
[M3] Contact Output 7 Events	=	Enabled

[M4] Contact Output 8 ID		CB-R1 CLOSE
[M4] Contact Output 8 Operate	=	52b/CB-R1 Off(H7C)
[M4] Contact Output 8 Seal-In	=	OFF
[M4] Contact Output 8 Events	=	Enabled

Virtual Outputs:

SETTING		PARAMETER
Virtual Output 1 ID	=	87Trip
Virtual Output 1 Events	=	Enabled
Virtual Output 2 ID	=	51P Trip
Virtual Output 2 Events	=	Enabled
Virtual Output 3 ID	=	Osc Trigger
Virtual Output 3 Events	=	Enabled
Virtual Output 4 ID	=	Hamornic BlK
Virtual Output 4 Events	=	Enabled
Virtual Output 5 ID	=	FR-Trigger
Virtual Output 5 Events	=	Enabled
Virtual Output 6 ID	=	51N Trip
Virtual Output 6 Events	=	Enabled
Virtual Output 7 ID	=	Virt Op 7
Virtual Output 7 Events	=	Disabled
Virtual Output 8 ID	=	Virt Op 8
Virtual Output 8 Events	=	Disabled
Virtual Output 9 ID	=	Virt Op 9
Virtual Output 9 Events	=	Disabled
Virtual Output 10 ID	=	Virt Op 10
Virtual Output 10 Events	=	Disabled
Virtual Output 11 ID	=	Virt Op 11
Virtual Output 11 Events	=	Disabled
Virtual Output 12 ID	=	Virt Op 12
Virtual Output 12 Events	=	Disabled
Virtual Output 13 ID	=	Virt Op 13
Virtual Output 13 Events	=	Disabled
Virtual Output 14 ID	=	Virt Op 14
Virtual Output 14 Events	=	Disabled
Virtual Output 15 ID	=	Virt Op 15

Virtual Output 15 Events	=	Disabled
Virtual Output 16 ID	=	Virt Op 16
Virtual Output 16 Events	=	Disabled

Remote Devices:	# Not used
Remote Inputs:	# Not used
Remote Outputs DNA Bit Pairs	# Not used
Remote Outputs UserSt Bit Pairs:	# Not used
Resetting:	# Not used
Direct Inputs:	# Not used
Direct Outputs:	# Not used
Teleprotection:	# Not used
IEC 61850 GOOSE Analogs Inputs	# Not used

Appendix 16 87-51-1-R2 (SEL-387) Setting Calculation

1. Data

MVA_Base =	100	kV_Base =	345		
CTR =	240				
MVA rating of Reactor R1 =		150	; Maximum full load current (amps) =		251.02

2. Setting Criteria

2.1 Differential Settings:

Maximum Transformer **MVA** =	150	MVA	
The nominal transformer Winding 1 terminal voltage **VWDG1** =	345	kV	
The nominal transformer Winding 2 terminal voltage **VWDG2** =	345	kV	
CT ratio for winding 1---**CTR1**=	240		
CT ratio for winding 2---**CTR2**=	240		
Winding 1 Current Tap **TAP1** = MVA/(Sqrt(3) x VWDG1 x CTR1) =	1.05	A	
Winding 2 Current Tap **TAP2** = MVA/(Sqrt(3) x VWDG2 x CTR2) =	1.05	A	
O87P ≥ 0.1 x 5A / TAPmin = 0.48 Set **O87P=**	0.50	# Per manual	
Dual-Slop variable-percentage differential characteristic is used.			
Restraint Slop 1 Percentage (5-100%) **SLP 1** =	25		
Restraint Slope 2 Percentage (OFF, 25–200%) **SLP2** =	50		
Restraint Current Slope 1 Limit ((1–20) multiple of tap**)** **IRS1** =	3		
Unrestrained Element Current PU ((1–20) multiple of tap) **U87P** =	10		
Second-Harmonic Blocking Percentage (OFF, 5–100%) **PCT2** =	10	# Inrush inhibit	
Fifth-Harmonic Blocking Percentage (OFF, 5–100%) **PCT5** =	OFF		
Independent Harmonic Blocking **IHBL =**	N		

2.2 Winding 1 Elements

2.2.1 Set phase IOC element 50P12P at 0.25 CT secondary amp (minimum) for unlatch trip setting ULTR.

2.2.2. Set phase TOC element 51P1P at 2 CT secondary amp or 480 CT primary amp, i.e. 1.91 times of the maximum FLC. 2nd harmonic (2HB1+2HB2+2HB3) is used to block operation to prevent inrush false trip. Curve and time dial are set to make the curve to match the existing setting curve.

2.2.3 Set residual IOC element 50N12P at 0.25 CT secondary amp (minimum) for unlatch trip setting ULTR.

2.2.4. Set residual TOC element 51N1P at 1 CT secondary amp or 240 CT primary amp, i.e. 95.6% of the maximum FLC. 2nd harmonic (2HB1+2HB2+2HB3) is used to block operation to prevent inrush false trip. Curve and time dial are set to make the curve to match the existing setting curve.

2.3 Winding 2 Elements

2.3.1 Set phase IOC element 50P22P at 0.25 CT secondary amp (minimum) for unlatch trip setting ULTR.

2.3.2. Set phase TOC element 51P2P at 2 CT secondary amp or 480 CT primary amp, i.e. 1.91 times of the maximum FLC. Curve and time dial are set to make the curve to match the existing setting curve.

2.3.3 Set residual IOC element 50N12P at 0.25 CT secondary amp (minimum) for unlatch trip setting ULTR.

2.3.4. Set residual TOC element 51N1P at 1 CT secondary amp or 240 CT primary amp, i.e. 95.6% of the maximum FLC. Curve and time dial are set to make the curve to match the existing setting curve.

Group 1 - Set 1:

Config. Settings:

Appendix 16 87-51-1-R2 (SEL-387) Setting Calculation

Relay Identifier	RID =	87-51-1-R2	
Terminal Identifier	TID =	CHARLES POLETTI	
Enable Wdg1 in Differential Element	E87W1 =	Y	
Enable Wdg2 in Differential Element	E87W2 =	Y	
Enable Wdg3 in Differential Element	E87W3 =	N	
Enable Wdg4 in Differential Element	E87W4 =	N	
Enable Wdg1 O/C Elements and Dmd. Thresholds	EOC1 =	Y	
Enable Wdg2 O/C Elements and Dmd. Thresholds	EOC2 =	Y	
Enable Wdg3 O/C Elements and Dmd. Thresholds	EOC3 =	N	
Enable Wdg4 O/C Elements and Dmd. Thresholds	EOC4 =	N	
Enable Combined O/C Elements	EOCC =	N	
Enable RTDA Elements	E49A =	N	
Enable RTDB Elements	E49B =	N	
Enable SELogic Set 1	ESLS1 =	Y	
Enable SELogic Set 2	ESLS2 =	N	
Enable SELogic Set 3	ESLS3 =	N	
General Data:			
Wdg1 CT Connection	W1CT =	Y	
Wdg2 CT Connection	W2CT =	Y	
Wdg3 CT Connection	W3CT =	Y	# Not Used
Wdg4 CT Connection	W4CT =	Y	# Not Used
Wdg1 CT Ratio	CTR1 =	240	
Wdg2 CT Ratio	CTR2 =	240	
Wdg3 CT Ratio	CTR3 =	240	# Not Used
Wdg4 CT Ratio	CTR4 =	240	# Not Used
Maximum Power Xfmr Capacity	MVA =	150	
Define Interal CT Connection Compensation	ICOM =	Y	
Wdg1 CT Conn. Compensation	W1CTC =	12	
Wdg2 CT Conn. Compensation	W2CTC =	12	
Wdg 1 Line-to-Line Voltage	VWDG1 =	345	# kV
Wdg 2 Line-to-Line Voltage	VWDG2 =	345	# kV
Wdg 3 Line-to-Line Voltage	VWDG3 =	345	# Not Used
Wdg 4 Line-to-Line Voltage	VWDG4 =	345	# Not used
Diff Elems:			
Restrained Element Current PU	O87P =	0.50	
Restrain Slope 1 Percentage	SLP1 =	25	
Restrain Slope 2 Percentage	SLP2 =	50	
Restraint Current Slope 1 Limit	IRS1 =	3	
Unrestrained Element Current PU	U87P =	10	
2nd Harmonic Blocking Percentage	PCT2 =	10	
5th Hamronic Blocking Percentage	PCT5 =	OFF	
5th Harmonic Alarm Threshold	TH5P =	OFF	
Independent Harmonic Blocking	IHBL =	N	
Restriced Earth Fault:			
Winding 1 Elems:			
Phase Def-Time O/C Level 1 PU	50P11P =	OFF	
Phase Level 1 O/C Delay	50P11P =	5	# Not used

50P11 Torque Control (SELogic Equation)	50P11TC = 1	# Not used
Phase Def-Time O/C Level 2 PU	50P12P = 0.25	# Minimum
50P12 Torque Control (SELogic Equation)	50P12TC = 1	
Oher Phase Inst O/C elements		# Not used
Phase Inv-Time O/C PU	51P1P = 2	# 1.91xFLC
Phase Inv-Time O/C Curve	51P1C = U1	
Phase Inv-Time O/C Time-Dial	51P1TD = 0.5	
Phase Inv-Time O/C EM Reset	51P1RS = N	
51P1 Torque Control (SELogic Equation)	51P1TC = !(2HB1 + 2HB2 + 2HB3)	
Neg-Seq Def-Time O/C		# Not used
Residual Def-Time O/C Level 1 PU	50N11P = OFF	
Residual Level 1 O/C Delay	50N11D = 5	# Not used
50N11 Torque Control (SELogic Equation)	50N11TC = 1	# Not used
Residual Def-Time O/C Level 1 PU	50N12P = 0.25	# Minimum
50N12 Torque Control (SELogic Equation)	50N12TC = 1	
Other Residual Inst O/C elements		# Not used
Residual Inv-Time O/C PU	51N1P = 1	# 95.6% FLC
Residual Inv-Time O/C Curve	51N1C = U1	
Residual Inv-Time O/C Time-Dial	51N1TD = 0.5	
Residual Inv-Time O/C EM Reset	51N1RS = N	
51N2 Torque Control (SELogic Equation)	51N2TC = !(2HB1 + 2HB2 + 2HB3)	
Demand Ammeter Time Constant	DATC1 = 15	# Default
Phase Demand Ammeter Threshold	PDEM1P = 7	# Default
Neg-Seq Demand Ammeter Threshold	QDEM1P = 1	# Default
Residual Demand Ammeter Threshold	NDEM1P = 1	# Default
<u>Winding 2 Elems:</u>		
Phase Def-Time O/C Level 1 PU	50P21P = OFF	# Not used
Phase Level 1 O/C Delay	50P21P = 5	# Not used
50P21 Torque Control (SELogic Equation)	50P21TC = 1	# Not used
Phase Def-Time O/C Level 2 PU	50P22P = 0.25	# Minimum
50P22 Torque Control (SELogic Equation)	50P22TC = 1	
Oher Phase Inst O/C elements		# Not used
Phase Inv-Time O/C PU	51P2P = 2	# 1.91xFLC
Phase Inv-Time O/C Curve	51P2C = U1	
Phase Inv-Time O/C Time-Dial	51P2TD = 0.5	
Phase Inv-Time O/C EM Reset	51P2RS = N	
51P2 Torque Control (SELogic Equation)	51P2TC = 1	
Neg-Seq Def-Time O/C		# Not used
Residual Def-Time O/C Level 1 PU	50N21P = OFF	# Not used
Residual Level 1 O/C Delay	50N21D = 5	# Not used
50N21 Torque Control (SELogic Equation)	50N21TC = 1	# Not used
Residual Def-Time O/C Level 1 PU	50N22P = 0.25	# Minimum
50N22 Torque Control (SELogic Equation)	50N22TC = 1	
Other Residual Inst O/C elements		# Not used
Residual Inv-Time O/C PU	51N2P = 1	# 95.6% FLC
Residual Inv-Time O/C Curve	51N2C = U1	
Residual Inv-Time O/C Time-Dial	51N2TD = 0.5	
Residual Inv-Time O/C EM Reset	51N2RS = N	
51N2 Torque Control (SELogic Equation)	51N2TC = 1	
Demand Ammeter Time Constant	DATC2 = 15	# Default

Appendix 16 87-51-1-R2 (SEL-387) Setting Calculation

Phase Demand Ammeter Threshold		PDEM2P = 7	# Default
Neg-Seq Demand Ammeter Threshold		QDEM2P = 1	# Default
Residual Demand Ammeter Threshold		NDEM2P = 1	# Default
Winding 3 Elems:			# Not Used
Winding 4 Elems:			# Not Used
Combined Elems:			# Not used
RTD A Elems:			# Not used
RTD B Elems:			# Not used
Misc. Timers			# Default
SELogic Set 1:			
		S1V1 = IN106	# 63SPR Ttrip
		S1V1PU = 0	
		S1V1DO = 9	
		Other SV = OFF	# Not used
SELogic Set 2:			# Not used
SELogic Set 3:			# Not used
Trip Logic:			
		TR1 = 51P1T+51P2T	
		TR2 = 51N1T+51N2T	
		TR3 = 0	
		TR4 = 0	
		TR5 = 87R + 87U	
		ULTR1 = !(50P12 + 50P22)	
		ULTR2 = !(50N12 + 50N22)	
		ULTR3 = 0	
		ULTR4 = 0	
		ULTR5 = !(87U + 87R)	
Close Logic:			# Not used
Event Trigger			
Output Contact Logic:			
Output Contact 101	# Any Trip	OUT101=TRIP1+TRIP2 +TRIP5+S1V1T	
Output Contact 102		OUT102 = 0	# Not used
Output Contact 102		OUT102 = 51GT+67G1T	# Not used
Output Contact 103		OUT103 = TRIP5	# 87 Trip
Output Contact 104		OUT104 = TRIP1	# 51P Trip
Output Contact 105		OUT105 = TRIP2	# 51N Trip
Output Contact 106		OUT106 = S1V1T	# Not used
Output Contact 107		OUT107 = 0	# Not used
Output Contact 201 ~ 212 are all 0.			# Not used
Global			# Default

SER:
SER1 = M1P, Z1G, M2P, M2PT, Z2G, Z2GT, 67P2T, SOTFT, 67G1T, 51G, 51GT, 3P27, LOP
SER1 = IN101,IN102,IN103,IN104,IN105,IN106

Appendix 17 87-51-2-R2 (GE-T60) Setting Calculation

1. Data

MVA_Base =	100	kV_Base =	345
CTR =	240		

MVA rating of Reactor R1 = 150 ; Maximum full load current (amps) = 251.02

2. Setting Criteria

2.1 Differential Settings:

Differential Pickup in per unit =	0.50	# APP14-2.1
Differential Slope 1 in % =	25%	# APP14-2.1
Differential Break 1 in per unit =	2	
Differential Break 2 in per unit =	3	# APP14-2.1
Differential Slope 2 in % =	50%	# APP14-2.1
Inrush Inhibit Function =	Adapt. 2nd	# APP14-2.1
Inrush Inhibit Mode =	Per Phase	# APP14-2.1
Inrush Inhibit Level =	10%	# APP14-2.1
Instantaneous Differential Pickup in per unit =	10	# APP14-2.1

2.2 Winding 1 Elements

2.2.1. Set phase TOC element at 0.4 pu, or 2 CT secondary amp or 480 CT primary amp, i.e. 1.91 times of the maximum FLC. 2nd harmonic (XFMR PCNT DIFF 2ND A, XFMR PCNT DIFF 2ND B, XFMR PCNT DIFF 2ND C) is used to block operation to prevent inrush false trip. Curve and time dial are set to make the curve to match the existing setting curve.

2.2.2. Set residual TOC element at 0.2 pu or 1 CT secondary amp or 240 CT primary amp, i.e. 95.6% of the maximum FLC. 2nd harmonic (XFMR PCNT DIFF 2ND A, XFMR PCNT DIFF 2ND B, XFMR PCNT DIFF 2ND C) is used to block operation to prevent inrush false trip. Curve and time dial are set to make the curve to match the existing setting curve.

2.3 Winding 2 Elements

2.3.1. Set phase TOC element at 0.4 pu, or 2 CT secondary amp or 480 CT primary amp, i.e. 1.91 times of the maximum FLC. Curve and time dial are set to make the curve to match the existing setting curve.

2.3.2. Set residual TOC element at 0.2 pu or 1 CT secondary amp or 240 CT primary amp, i.e. 95.6% of the maximum FLC. Curve and time dial are set to make the curve to match the existing setting curve.

Device Definition: # Default

Product Setup:

Security: # Default

Display Properties: # Default

Clear Relay Records: # All OFF

Communications: # Default

Modbus User Map: # Not used

Real Time Clock:

IRIG-B Signal Type	=	DC Shift
All other settings	=	Default

User-Programmable Fault Report:

PARAMETER		FAULT REPORT 1
Function	=	Enabled
Prefault Trigger	=	Osc Trigger On (VO3)
Fault Trigger	=	FR-Trigger On (VO5)
Analog Channel 1	=	SRC1 Ia Mag
Analog Channel 2	=	SRC1 Ib Mag

Analog Channel 3	=	SRC1	Ic Mag
Analog Channel 4	=	SRC2	Ia Mag
Analog Channel 5	=	SRC2	Ib Mag
Analog Channel 6	=	SRC2	Ic Mag
Analog Channel 7	=	SRC1	Ia Angle
Analog Channel 8	=	SRC1	Ib Angle
Analog Channel 9	=	SRC1	Ic Angle
Analog Channel 10	=	SRC2	Ia Angle
Analog Channel 11	=	SRC2	Ib Angle
Analog Channel 12	=	SRC2	Ic Angle
Analog Channel 13	=	Xfmr Iad Mag	
Analog Channel 14	=	Xfmr Ibd Mag	
Analog Channel 15	=	Xfmr Icd Mag	
Analog Channel 16	=	Xfmr Iad Angle	
Analog Channel 17	=	Xfmr Ibd Angle	
Analog Channel 18	=	Xfmr Icd Angle	
Analog Channel 19	=	Xfmr Harm2 Iad Mag	
Analog Channel 20	=	Xfmr Harm2 Ibd Mag	
Analog Channel 21	=	Xfmr Harm2 Icd Mag	
Analog Channel 22	=	Xfmr Harm2 Iad Angle	
Analog Channel 23	=	Xfmr Harm2 Ibd Angle	
Analog Channel 24	=	Xfmr Harm2 Icd Angle	
Analog Channel 25	=	Xfmr Harm5 Iad Mag	
Analog Channel 26	=	Xfmr Harm5 Ibd Mag	
Analog Channel 27	=	Xfmr Harm5 Icd Mag	
Analog Channel 28	=	Xfmr Harm5 Iad Angle	
Analog Channel 29	=	Xfmr Harm5 Ibd Angle	
Analog Channel 30	=	Xfmr Harm5 Icd Angle	
Analog Channel 31	=	SRC1	Frequency
Analog Channel 32	=	SRC1	Q

Oscillography:

SETTING		PARAMETER
Number Of Records	=	5
Trigger Mode	=	Automatic Overwrite
Trigger Position	=	30%
Trigger Source	=	Osc Trigger On (VO3)
AC Input Waveforms	=	32 samples/cycle
Digital Channel 1	=	87Trip On (VO1)
Digital Channel 2	=	Cont Ip 1 Off(H5a)
Digital Channel 3	=	XFMR INST DIFF OP
Digital Channel 4	=	XFMR PCNT DIFF OP
Digital Channel 5	=	XFMR INST DIFF OP A
Digital Channel 6	=	XFMR INST DIFF OP B
Digital Channel 7	=	XFMR INST DIFF OP C
Digital Channel 8	=	XFMR PCNT DIFF 2ND A
Digital Channel 9	=	XFMR PCNT DIFF 2ND B
Digital Channel 10	=	XFMR PCNT DIFF 2ND C
Digital Channel 11	=	XFMR PCNT DIFF OP A
Digital Channel 12	=	XFMR PCNT DIFF OP B

Digital Channel 13	=	XFMR PCNT DIFF OP C
Digital Channel 14	=	XFMR PCNT DIFF 5TH A
Digital Channel 15	=	XFMR PCNT DIFF 5TH B
Digital Channel 16	=	XFMR PCNT DIFF 5TH C
Digital Channel 17	=	OFF
Digital Channel 18	=	OFF
Digital Channel 19	=	OFF
Digital Channel 20	=	OFF
Digital Channel 21	=	OFF
Digital Channel 22	=	OFF
Digital Channel 23	=	OFF
Digital Channel 24	=	OFF
Digital Channel 25	=	OFF
Digital Channel 26	=	OFF
Digital Channel 27	=	OFF
Digital Channel 28	=	OFF
Digital Channel 29	=	OFF
Digital Channel 30	=	OFF
Digital Channel 31	=	OFF
Digital Channel 32	=	OFF
Digital Channel 33	=	OFF
Digital Channel 34	=	OFF
Digital Channel 35	=	OFF
Digital Channel 36	=	OFF
Digital Channel 37	=	OFF
Digital Channel 38	=	OFF
Digital Channel 39	=	OFF
Digital Channel 40	=	OFF
Digital Channel 41	=	OFF
Digital Channel 42	=	OFF
Digital Channel 43	=	OFF
Digital Channel 44	=	OFF
Digital Channel 45	=	OFF
Digital Channel 46	=	OFF
Digital Channel 47	=	OFF
Digital Channel 48	=	OFF
Digital Channel 49	=	OFF
Digital Channel 50	=	OFF
Digital Channel 51	=	OFF
Digital Channel 52	=	OFF
Digital Channel 53	=	OFF
Digital Channel 54	=	OFF
Digital Channel 55	=	OFF
Digital Channel 56	=	OFF
Digital Channel 57	=	OFF
Digital Channel 58	=	OFF
Digital Channel 59	=	OFF
Digital Channel 60	=	OFF
Digital Channel 61	=	OFF
Digital Channel 62	=	OFF

Digital Channel 63	=	OFF	
Analog Channel 1	=	Xfmr Iad Mag	
Analog Channel 2	=	Xfmr Iar Mag	
Analog Channel 3	=	Xfmr Harm2 Iad Mag	
Analog Channel 4	=	Xfmr Ibd Mag	
Analog Channel 5	=	Xfmr Ibr Mag	
Analog Channel 6	=	Xfmr Harm2 Ibd Mag	
Analog Channel 7	=	Xfmr Icd Mag	
Analog Channel 8	=	Xfmr Icr Mag	
Analog Channel 9	=	Xfmr Harm2 Icd Mag	
Analog Channel 10	=	Xfmr Harm5 Iad Mag	
Analog Channel 11	=	Xfmr Harm5 Ibd Mag	
Analog Channel 12	=	Xfmr Harm5 Icd Mag	
Analog Channel 13	=	Off	
Analog Channel 14	=	Off	
Analog Channel 15	=	Off	
Analog Channel 16	=	Tracking Frequency	

Data Logger: # Default

Demand: # Default

User-Programmable Leds:

LED Test:

Function	=	Enabled	
Control	=	CONTROL PUSHBUTTON 1 ON	

Trip and Alarms Leds:

Trip LED Input	=	87Trip On (VO1)	
Alarm LED Input	=	51Trip On (VO2)	
LED 1	=	87Trip On (VO1)	Latched
LED 2	=	51Trip On (VO2)	Latched
LED 3	=	XFMR INST DIFF OP	Latched
LED 4	=	XFMR PCNT DIFF OP	Latched
LED 5	=	XFMR INST DIFF OP A	Latched
LED 6	=	XFMR INST DIFF OP B	Latched
LED 7	=	XFMR INST DIFF OP C	Latched
LED 8	=	XFMR PCNT DIFF OP A	Latched
LED 9	=	XFMR PCNT DIFF OP B	Latched
LED 10	=	XFMR PCNT DIFF OP C	Latched
LED 11	=	PHASE TOC1 OP	Latched
LED 12	=	PHASE TOC2 OP	Latched
LED 13	=	NEUTRAL TOC1 OP	Latched
LED 14	=	NEUTRAL TOC2 OP	Latched
LED 15	=	PHASE TOC1 OP A	Latched
LED 16	=	PHASE TOC1 OP B	Latched
LED 17	=	PHASE TOC1 OP C	Latched
LED 18	=	PHASE TOC2 OP A	Latched
LED 19	=	PHASE TOC2 OP B	Latched
LED 20	=	PHASE TOC2 OP C	Latched
LED 21	=	OFF	Self-Reset
LED 22	=	OFF	Self-Reset
LED 23	=	OFF	Self-Reset

LED 24	=	OFF	Self-Reset
LED 25	=	OFF	Self-Reset
LED 26	=	OFF	Self-Reset
LED 27	=	OFF	Self-Reset
LED 28	=	OFF	Self-Reset
LED 29	=	OFF	Self-Reset
LED 30	=	OFF	Self-Reset
LED 31	=	OFF	Self-Reset
LED 32	=	OFF	Self-Reset
LED 33	=	OFF	Self-Reset
LED 34	=	OFF	Self-Reset
LED 35	=	OFF	Self-Reset
LED 36	=	OFF	Self-Reset
LED 37	=	OFF	Self-Reset
LED 38	=	OFF	Self-Reset
LED 39	=	OFF	Self-Reset
LED 40	=	OFF	Self-Reset
LED 41	=	OFF	Self-Reset
LED 42	=	OFF	Self-Reset
LED 43	=	OFF	Self-Reset
LED 44	=	OFF	Self-Reset
LED 45	=	OFF	Self-Reset
LED 46	=	OFF	Self-Reset
LED 47	=	OFF	Self-Reset
LED 48	=	OFF	Self-Reset

User-Programmable Self Tests:

Remote Device Off Function	=	Enabled
Pri Ethernet Fail Function	=	Disabled
Battery Fail Function	=	Enabled
SNTP Fail Function	=	Enabled
IRIG B Fail Function	=	Enabled

Control Pushbuttons:

PARAMETER	CPB 1	CPB 2	CPB 3
Function	Enabled	Disabled	Enabled
Events	Disabled	Disabled	Enabled

Flex States: # All OFF

User-definable displays: # Not used

Direct I/O: # Not used

Teleprotection: # Not used

Installation:

Relay Name = 87-51-2-R2

System Setup:

AC Inputs

Current:

PARAMETER		CT F1	CT F5
Phase CT Primary	=	1200 A	1200 A
Phase CT Secondary	=	5 A	5 A
Ground CT Primary	=	1200 A	1200 A
Ground CT Secondary	=	5 A	5 A

Power System:

Appendix 17 87-51-2-R2 (GE-T60) Setting Calculation

	Nominal Frequency	=	60 Hz		
	Phase Rotation	=	ABC		
	Frequency And Phase Reference	=	SRC 1 (SRC 1)		
	Frequency Tracking Function	=	Enabled		
Signal Sources:	PARAMETER		SOURCE 1	SOURCE 2	
	Name	=	SRC 1	SRC 2	
	Phase CT	=	F1	F5	
	Ground CT	=	None	None	
	Phase VT	=	None	None	
	Aux VT	=	None	None	
Transformer:					
General:	SETTING		PARAMETER		
	Number Of Windings	=	2		
	Reference Winding Selection	=	Automatic Selection		
	Phase Compensation	=	Internal (software)		
	Load Loss At Rated Load	=	225 kW		
	Rated Winding Temperature Rise	=	65°C (oil)		
	No Load Loss	=	75 kW		
	Type Of Cooling	=	OA		
	Top-oil Rise Over Ambient	=	35 °C		
	Thermal Capacity	=	100.00 kWh/°C		
	Winding Thermal Time Constant	=	2.00 min		
Windings:	PARAMETER		WINDING 1		WINDING 2
	Source	=	SRC 1 (SRC 1)		SRC 2(SRC 2)
	Rated MVA	=	150.000 MVA		150.000 MVA
	Nominal Phs-phs Voltage	=	345.000 kV		345.000 kV
	Connection	=	Wye		Wye
	Grounding	=	Within zone		Within zone
	Angle Wrt Winding 1	=	0.0 deg		0.0 deg
	Resistance	=	10.0000 ohms		10.0000 ohms
Thermal Inputs:					# Not used
Breakers:					# Not used
Switches					# Not used
FlexCurves:					# Not used
FlexLogic:				# See 87-51-2-R1-logic-r0.pdf	
Grouped Elements:					
Group 1:					
Distance:					# Not used
Power Swing Detect:					# Not used
Load Encroachment:					# Not used
Transformer:					
Percent Differential	SETTING		PARAMETER		
	Function	=	Enabled		
	Pickup	=	0.50		
	Slope 1	=	25%		
	Break 1	=	2.00		
	Break 2	=	3.00		
	Slope 2	=	50%		
	Inrush Inhibit Function	=	Adapt. 2nd		
	Inrush Inhibit Mode	=	Per Phase		

	Inrush Inhibit Level	=	10%	
	Overexcitation Inhibit Function	=	Disabled	
	Overexcitation Inhibit Level	=	10.0 % fo	
	Block	=	OFF	
	Target	=	Self-reset	
	Events	=	Enabled	
Instantaneous Differential	SETTING		PARAMETER	
	Function	=	Enabled	
	Pickup	=	10	
	Block	=	OFF	
	Target	=	Self-reset	
	Events	=	Enabled	
Hottest Spot				# Not Used
Aging Factor				# Not Used
Loss of Life				# Not Used
Phase Current:				
Phase TOC:	PARAMETER		PHASE TOC1	PHASE TOC2
	Function	=	Enabled	Enabled
	Signal Source	=	SRC 1 (SRC 1)	SRC 2 (SRC2)
	Input	=	Phasor	Phasor
	Pickup	=	0.400 pu	0.400 pu
	Curve	=	IEEE Mod Inv	IEEE Mod Inv
	TD Multiplier	=	0.5	0.5
	Reset	=	Instantaneous	Instantaneous
	Voltage Restraint	=	Disabled	Disabled
	Block A	=	XFMR PCNT DIFF 2ND A	OFF
	Block B	=	XFMR PCNT DIFF 2ND B	OFF
	Block C	=	XFMR PCNT DIFF 2ND C	OFF
	Target	=	Self-reset	Self-reset
	Events	=	Enabled	Enabled
Neutral Current:				
Neutral TOC:	PARAMETER		NEUTRAL TOC1	Neutral TOC2
	Function	=	Enabled	Enabled
	Source	=	SRC 1 (SRC 1)	SRC 2 (SRC2)
	Input	=	Phasor	Phasor
	Pickup	=	0.200 pu	0.200 pu
	Curve	=	IEEE Mod Inv	IEEE Mod Inv
	TD Multiplier	=	0.5	0.5
	Reset	=	Instantaneous	Instantaneous
	Block	=	Hamornic BlK On (VO4)	OFF
	Target	=	Self-reset	Self-reset
	Events	=	Enabled	Enabled
Ground Current:				
Ground TOC				# Not used
Ground IOC				# Not used
Breaker Failure:				# Not used
Control Elements:				
Trip Bus:				# Not used
Setting Groups:				# Not used
Selector Switches:				# Not used

Appendix 17 87-51-2-R2 (GE-T60) Setting Calculation

Underfrequency:		# Not used
Overfrequency:		# Not used
Synchrocheck:		# Not used
Digital Elements:		# Not used
Digital Counters:		# Not used
Monitoring Elements:		# Not used
Pilot Schemes:		# Not used
Inputs/Outputs:		
Contact inputs:		# Not used
Contact Inputs Thresholds:		
Cont Ip 1, Cont Ip 2, Cont Ip 3, Cont Ip 4(H5A, H5C, H6A, H6C)	=	84 Vdc
Cont Ip5, Cont Ip 6, Cont Ip 7, Cont Ip 8(H7A, H7C, H8A, H8C)	=	84 Vdc
Cont Ip 9, Cont Ip 10, Cont Ip 11, Cont Ip 12(M5A, M5C, M6A, M6C)	=	84 Vdc
Cont Ip 13, Cont Ip 14, Cont Ip 15, Cont Ip 16(M7A, M7C, M8A, M8C)	=	84 Vdc
Virtual Inputs:		# Not used
Contact Outputs:		

[H1] Contact Output 1 ID		ANY TRIP
[H1] Contact Output 1 Operate	=	FR-Trigger On (VO5)
[H1] Contact Output 1 Seal-In	=	OFF
[H1] Contact Output 1 Events	=	Enabled
[H2] Contact Output 2 ID		DS-R2 OPEN
[H2] Contact Output 2 Operate	=	52b/DS-R2 On(H8A)
[H2] Contact Output 2 Seal-In	=	OFF
[H2] Contact Output 2 Events	=	Enabled
[H3] Contact Output 3 ID		DS-R2 CLOSE
[H3] Contact Output 3 Operate	=	52b/DS-R2 Off(H8A)
[H3] Contact Output 3 Seal-In	=	OFF
[H3] Contact Output 3 Events	=	Enabled
[H4] Contact Output 4 ID		CB-R2 TRIP
[H4] Contact Output 4 Operate	=	52b/CB-R2 On(H7C)
[H4] Contact Output 4 Seal-In	=	OFF
[H4] Contact Output 4 Events	=	Enabled
[M1] Contact Output 5 ID		87 TRIP
[M1] Contact Output 5 Operate	=	87Trip On (VO1)
[M1] Contact Output 5 Seal-In	=	OFF
[M1] Contact Output 5 Events	=	Enabled
[M2] Contact Output 6 ID		51P TRIP
[M2] Contact Output 6 Operate	=	51P Trip On (VO2)
[M2] Contact Output 6 Seal-In	=	OFF
[M2] Contact Output 6 Events	=	Enabled
[M3] Contact Output 7 ID		51N TRIP
[M3] Contact Output 7 Operate	=	51N Trip On (VO6)
[M3] Contact Output 7 Seal-In	=	OFF
[M3] Contact Output 7 Events	=	Enabled

[M4] Contact Output 8 ID		CB-R2 CLOSE
[M4] Contact Output 8 Operate	=	52b/CB-R2 Off(H7C)
[M4] Contact Output 8 Seal-In	=	OFF
[M4] Contact Output 8 Events	=	Enabled

Virtual Outputs:

SETTING		PARAMETER
Virtual Output 1 ID	=	87Trip
Virtual Output 1 Events	=	Enabled
Virtual Output 2 ID	=	51P Trip
Virtual Output 2 Events	=	Enabled
Virtual Output 3 ID	=	Osc Trigger
Virtual Output 3 Events	=	Enabled
Virtual Output 4 ID	=	Hamornic BlK
Virtual Output 4 Events	=	Enabled
Virtual Output 5 ID	=	FR-Trigger
Virtual Output 5 Events	=	Enabled
Virtual Output 6 ID	=	51N Trip
Virtual Output 6 Events	=	Enabled
Virtual Output 7 ID	=	Virt Op 7
Virtual Output 7 Events	=	Disabled
Virtual Output 8 ID	=	Virt Op 8
Virtual Output 8 Events	=	Disabled
Virtual Output 9 ID	=	Virt Op 9
Virtual Output 9 Events	=	Disabled
Virtual Output 10 ID	=	Virt Op 10
Virtual Output 10 Events	=	Disabled
Virtual Output 11 ID	=	Virt Op 11
Virtual Output 11 Events	=	Disabled
Virtual Output 12 ID	=	Virt Op 12
Virtual Output 12 Events	=	Disabled
Virtual Output 13 ID	=	Virt Op 13
Virtual Output 13 Events	=	Disabled
Virtual Output 14 ID	=	Virt Op 14
Virtual Output 14 Events	=	Disabled
Virtual Output 15 ID	=	Virt Op 15

Virtual Output 15 Events	=	Disabled
Virtual Output 16 ID	=	Virt Op 16
Virtual Output 16 Events	=	Disabled

Remote Devices:	# Not used
Remote Inputs:	# Not used
Remote Outputs DNA Bit Pairs	# Not used
Remote Outputs UserSt Bit Pairs:	# Not used
Resetting:	# Not used
Direct Inputs:	# Not used
Direct Outputs:	# Not used
Teleprotection:	# Not used
IEC 61850 GOOSE Analogs Inputs	# Not used

Appendix 18 50-62-1-BKR1 (Areva P141) Setting Calculation

1. Data

MVA_Base =	100	kV_Base =	345	Z_Base =	1190.25	ohms
CTR =	600	PTR =	3000	CTR/PTR=	0.2	

Total MVA of all three GSUs = 750 ; Maximum full load current (amps) = 1255.11

2. Setting Criteria

2.1. Set phase IOC element, i.e. phase fault detector, above load if possible but not more than 2/3 of the minimum phase to phase fault at remote bus with the largest source out. For the minimum phase to phase fault at Farragut station under minimum condition which is considered as the largest unit (STG1) of the three units out of service, the contributions from Charlie Poletti are 1,454 Amp via Q35M line and 1,349 Amp via Q35L line. Since each breaker failure relay will normally see only half of the fault contribution per feeder. The IOC1 element shall be set at 0.15 pu or 0.75 CT secondary amp or 450 CT primary amp, or 1/3 of 1,349 Amp or 35.8% of maximum full load. Fault detector picking up on load is considered acceptable here per IEEE standard.

2.2. Set residual IOC element, i.e. ground fault detector, above maximum expected unbalance , but not more than 2/3 of the minimum ground fault at remote bus with the largest source out. For the minimum line to ground fault at Farragut station under minimum condition with is considered as the largest unit (STG1) of the three units out of serivce, the fault contributions from Chaerlie Poletti are 2,021 Amp via Q35L and 2,129 Amp via Q35M. Since each breaker failure relay will normally see only half of the fault contribution on each feeder, set residual IOC element at 0.1 pu or 0.5 CT secondary amp, 300 CT primary amp, or 24% of maximum full load, which is less than 1/3 of minimum phase to ground fault at Farragut.

2.3 Breaker failure timer of 130 ms is used for 3 phase fault and 160 ms is used for unbalanced fault per ConEd standard. Existing Poletti settings show that 120 ms breaker failure time is used regardless fault type.

SYSTEM DATA:

Language = English
Sys Fn Links = 0
Decription = 50-62-1-BKR1
Plant Reference = CHARLES POLETTI
Frequency = 60 Hz

CB CONTROL:

CB Control by = Disabled
Reset Lockout by = CB Close
Man Close RstDly = 5.000 s
CB2 Status Input = 52A

DATE AND TIME:

IRIG-B Sync = Enabled
Battery Alarm = Enabled
Other Time Settings = Default

CONFIGURATION:

Setting Group = Select via Menu
Active Settings = Group 1
Setting Group 1 = Enabled
Setting Group 2 = Disabled
Setting Group 3 = Disabled
Setting Group 4 = Disabled
System Config = Invisible

Appendix 18 50-62-1-BKR1 (Areva P141) Setting Calculation

Overcurrent =	Enabled	# 50FD-P
Neg Sequence O/C =	Enabled	# Unbalance
Broken Conductor =	Disabled	# Not used
Earth Fault 1 =	Disabled	# Not used
Earth Fault 2 =	Enabled	# 50FD-G
Sensitive E/F Prot'n =	Disabled	# Not used
Residual O/V NVD =	Disabled	# Not used
Thermal Overload =	Disabled	# Not used
Neg Sequence O/V =	Disabled	# Not used
Cold Load Pickup =	Disabled	# Not used
Selective Logic =	Disabled	# Not used
Admit Protection =	Disabled	# Not used
Volt Protection =	Disabled	# Not used
Freq Protection =	Disabled	# Not used
df/dt Protection =	Disabled	# Not used
CB Fail =	Enabled	
Supervision =	Enabled	
Fault Locator =	Disabled	
Input Labels =	Visible	
Output Labels =	Visible	
CT & VT Ratios =	Visible	
Record Control =	Invisible	
Disturb Recorder =	Visible	
Measure't Setup =	Visible	
Comms Settings =	Visible	
Commission Tests =	Visible	
Setting Values =	Secondary	
Control Inputs =	Invisible	
Ctrl I/P Config =	Invisible	
Ctrl I/P Labels =	Invisible	
Direct Access =	Disabled	
LCD Contrast =	11	

CT AND VT RATIOS

Main VT Primary =	110.0 V	# Not used
Main VT Sec'y =	110.0 V	# Not used
Phase CT Primary =	3000 A	
Phase CT Sec'y =	5.000 A	
E/F CT Primary =	3000 A	
E/F CT Secondary =	5.000 A	
SEF CT Primary =	1.000 A	
SEF CT Secondary =	1.000 A	

DISTURB RECORDER: See setting file for detail

MEASURE'T SETUP:

Default Display =	Description
Local Values =	Primary
Remote Values =	Primary
Measurement Ref =	VA
Measurement Mode =	0
Fix Dem Period =	30.00 min
Roll Sub Period =	30.00 min

	Num Sub Periods =	1		
COMMISSION TESTS:				
	Monitor Bit 1 =	64		
	Monitor Bit 2 =	65		
	Monitor Bit 3 =	66		
	Monitor Bit 4 =	67		
	Monitor Bit 5 =	68		
	Monitor Bit 6 =	69		
	Monitor Bit 7 =	70		
	Monitor Bit 8 =	71		
CB MONITOR SETUP:				
	Broken I^ =	2.000		
	I^ Maintenance =	Alarm Disabled		
	I^ Lockout =	Alarm Disabled		
	No. CB Ops Maint =	Alarm Disabled		
	No. CB Ops Lock =	Alarm Disabled		
	CB Time Maint =	Alarm Disabled		
	CB Time Lockout =	Alarm Disabled		
	Fault Freq Lock =	Alarm Disabled		
OPTO CONFIG:				
	Global Nominal V =	110/125V		
	Opto Filter Cntl =	11111111		
	Characteristic =	Standard 60%-80%		
Group 1:				
GROUP 1 OVERCURRENT:				
	I>1 Function =	DT		
	I>1 Direction =	Non-Directional		
	I>1 Current Set =	0.75		# 50FD-P
	I>1 Time Delay =	0		
	I>1 tRESET =	0	s	
	I>2 Status =	Disabled		
	I>3 Status =	Disabled		
	I>4 Status =	Disabled		
	I> Blocking =	000000000		
	I> Char Angle =	45	deg	# Default
	VC0 Status =	Disabled		
GROUP 1 NEG SEQ O/C				
	I2>1 Status =	Enabled		
	I2>1 Function =	DT		
	I2>1 Directional =	Non-Directional		
	I2>1 Current Set =	500.0mA		
	I2>1 Time Delay =	0 s		
	I2>1 Treset =	0 s		
	I2>2 Status =	Disabled		
	I2>3 Status =	Disabled		
	I2>4 Status =	Disabled		
	I2> Blocking =	00000000		
	I2> Char Angle =	-60.00 deg		
	I2> V2pol Set =	5.000 V		
GROUP 1 EARTH FAULT 2				

IN2> Input = Derived
IN2>1 Function = DT
IN2>1 Direction = Non-Directional
IN2>1 Current = 500.0mA # 50FD-G
IN2>1 Time Delay = 0 s
IN2>1 tRESET = 0 s
IN2>2 Function = Disabled
IN2>3 Status = Disabled
IN2>4 Status = Disabled
IN2> Blocking = 00000000
IN2> = POL
IN2> Char Angle = -45.00 deg
IN2> Pol = Zero Sequence
IN2> VNpol Set = 5.000 V

GROUP 1 CB FAIL & I<:

CB Fail 1 Status = Enabled
GB Fail 1 Timer = 0 s
CB Fail 2 Status = Enabled
CB Fail 2 Timer = 130.0 ms
Volt Prot Reset = I < only
Ext Prot Reset = I < only
I< Current Set = 500.0 mA
IN< Current Set = 500.0 mA
ISEF< Current = 20.00 mA
Remove I> Start = Disabled
Remove IN> Start = Disabled

GROUP 1 SUPERVISION:

VTS Status = Indication
VTS Reset Mode = Manual
VTS Time Delay = 5.000 s
VTS I> Inhibit = 50.0 A
VTS I2> Inhibit = 250.0 mA
CTS Mode = Disabled

GROUP 1 INPUT LABELS:

Opto Input 1 Input L1
Opto Input 2 Input L2
Opto Input 3 30-TC2/1 ALM
Opto Input 4 86BF-1/1 TRIP
Opto Input 5 30-86BF-1/1 ALM
Opto Input 6 BF Initiation
Opto Input 7 Input L7
Opto Input 8 Input L8

GROUP 1 OUTPUT LABELS:

Relay 1 Trip 86BF
Relay 2 ReTrip BkrTC2
Relay 3 Any Trip
Relay 4 Output R4
Relay 5 Output R5
Relay 6 Output R6
Relay 7 Output R7

Appendix 19 50-62-2-BKR1 (GE-C60) Setting Calculation

1. Data

MVA_Base =	100	kV_Base =	345	Z_Base =	1190.25	ohms
CTR =	600	PTR =	3000	CTR/PTR=	0.2	

Total MVA of all three GSUs = 750 ; Maximum full load current (amps) = 1255.11

2. Setting Criteria

2.1. Set phase IOC element, i.e. phase fault detector, above load if possible but not more than 2/3 of the minimum phase to phase fault at remote bus with the largest source out. For the minimum phase to phase fault at Farragut station under minimum condition which is considered as the largest unit (STG1) of the three units out of service, the contributions from Charlie Poletti are 1,454 Amp via Q35M line and 1,349 Amp via Q35L line. Since each breaker failure relay will normally see only half of the fault contribution per feeder. The IOC1 element shall be set at 0.15 pu or 0.75 CT secondary amp or 450 CT primary amp, or 1/3 of 1,349 Amp or 35.8% of maximum full load. Fault detector picking up on load is considered acceptable here per IEEE standard.

2.2. Set residual IOC element, i.e. ground fault detector, above maximum expected unbalance , but not more than 2/3 of the minimum ground fault at remote bus with the largest source out. For the minimum line to ground fault at Farragut station under minimum condition with is considered as the largest unit (STG1) of the three units out of serivce, the fault contributions from Chaerlie Poletti are 2,021 Amp via Q35L and 2,129 Amp via Q35M. Since each breaker failure relay will normally see only half of the fault contribution on each feeder, set residual IOC element at 0.1 pu or 0.5 CT secondary amp, 300 CT primary amp, or 24% of maximum full load, which is less than 1/3 of minimum phase to ground fault at Farragut.

2.3 Breaker failure timer of 130 ms is used for 3 phase fault and 160 ms is used for unbalanced fault per ConEd standard. Existing Poletti settings show that 120 ms breaker failure time is used regardless fault type.

Device Definition:				# Default
Product Setup:				
Security:				# Default
Display Properties:				# Default
Clear Relay Records:				# All OFF
Communications:				# Default
Modbus User Map:				# Not used
Real Time Clock:				
	IRIG-B Signal Type	=	DC Shift	
	All other settings	=	Default	
Fault Report:	SETTING		PARAMETER	
	Fault Report 1 Source	=	SRC 1 (SRC 1)	
	Fault Report 1 Trigger	=	Trig Oscill On (VO4)	
	Fault Report 1 Positive Seq (Z1) Mag	=	0.49 ohms	# See data
	Fault Report 1 Positive Seq (Z1) Angle	=	78 deg	# at Appendix
	Fault Report 1 Zero Seq (Z0) Mag	=	1.50 ohms	# 01 or 05
	Fault Report 1 Zero Seq (Z0) Angle	=	54 deg	# Section 1
	Fault Report 1 Line Length Units	=	mile	
	Fault Report 1 Line Length	=	7.74	
	Fault Report 1 VT Substitution	=	None	
	Fault Report 1 System Z0 Mag	=	0.49 ohms	
	Fault Report 1 System Z0 Angle	=	78 deg	
Oscillography:				
	SETTING		PARAMETER	

Appendix 19 50-62-2-BKR1 (GE-C60) Setting Calculation

Number Of Records	=	6
Trigger Mode	=	Automatic Overwrite
Trigger Position	=	30%
Trigger Source	=	Trig Oscill On (VO4)
AC Input Waveforms	=	32 samples/cycle
Digital Channel 1	=	OFF
Digital Channel 2	=	OFF
Digital Channel 3	=	OFF
Digital Channel 4	=	OFF
Digital Channel 5	=	OFF
Digital Channel 6	=	86BF TRIP On (VO1)
Digital Channel 7	=	RETRIP BKR On (VO2)
Digital Channel 8	=	UNIT ALARM On (VO3)
Digital Channel 9	=	OFF
Digital Channel 10	=	NEUTRAL IOC1 PKP
Digital Channel 11	=	NEUTRAL IOC1 OP
Digital Channel 12	=	PHASE IOC1 PKP A
Digital Channel 13	=	PHASE IOC1 OP A
Digital Channel 14	=	PHASE IOC1 PKP B
Digital Channel 15	=	PHASE IOC1 OP B
Digital Channel 16	=	PHASE IOC1 PKP C
Digital Channel 17	=	PHASE IOC1 OP C
Digital Channel 18	=	Bkr Fail Int On(H7c)
Digital Channel 19	=	BKR FAIL 1 TRIP OP
Digital Channel 20	=	BKR FAIL 2 TRIP OP
Digital Channel 21	=	BKR FAIL 1 T2 OP
Digital Channel 22	=	BKR FAIL 2 T2 OP
Digital Channel 23	=	86BF TRIP On (VO1)
Digital Channel 24	=	RETRIP BKR On (VO2)
Digital Channel 25	=	BKR FAIL 1 RETRIPA
Digital Channel 26	=	BKR FAIL 1 RETRIPB
Digital Channel 27	=	BKR FAIL 1 RETRIPC
Digital Channel 28	=	OFF
Digital Channel 29	=	OFF
Digital Channel 30	=	OFF
Digital Channel 31	=	OFF
Digital Channel 32	=	OFF
Digital Channel 33	=	OFF
Digital Channel 34	=	OFF
Digital Channel 35	=	OFF
Digital Channel 36	=	OFF
Digital Channel 37	=	OFF
Digital Channel 38	=	OFF
Digital Channel 39	=	OFF
Digital Channel 40	=	OFF
Digital Channel 41	=	OFF
Digital Channel 42	=	OFF
Digital Channel 43	=	OFF
Digital Channel 44	=	OFF
Digital Channel 45	=	OFF

Digital Channel 46	=	OFF		
Digital Channel 47	=	OFF		
Digital Channel 48	=	OFF		
Digital Channel 49	=	OFF		
Digital Channel 50	=	OFF		
Digital Channel 51	=	OFF		
Digital Channel 52	=	OFF		
Digital Channel 53	=	OFF		
Digital Channel 54	=	OFF		
Digital Channel 55	=	OFF		
Digital Channel 56	=	OFF		
Digital Channel 57	=	OFF		
Digital Channel 58	=	OFF		
Digital Channel 59	=	OFF		
Digital Channel 60	=	OFF		
Digital Channel 61	=	OFF		
Digital Channel 62	=	OFF		
Digital Channel 63	=	OFF		
Analog Channel 1	=	SRC1	Ia Mag	
Analog Channel 2	=	SRC2	Ia Mag	
Analog Channel 3	=	SRC1	Ib Mag	
Analog Channel 4	=	SRC2	Ib Mag	
Analog Channel 5	=	SRC1	Ic Mag	
Analog Channel 6	=	SRC2	Ic Mag	
Analog Channel 7	=	SRC1	In Mag	
Analog Channel 8	=	SRC2	In Mag	
Analog Channel 9	=	SRC1	Ia Angle	
Analog Channel 10	=	SRC2	Ia Angle	
Analog Channel 11	=	SRC1	Ib Angle	
Analog Channel 12	=	SRC2	Ib Angle	
Analog Channel 13	=	SRC1	Ic Angle	
Analog Channel 14	=	SRC2	Ic Angle	
Analog Channel 15	=	Off		
Analog Channel 16	=	Off		

<u>Data Logger:</u> # Default

<u>Demand:</u> # Default

<u>User-Programmable Leds:</u>

<u>LED Test:</u>

Function	=	Enabled
Control	=	CONTROL PUSHBUTTON 1 ON

<u>Trip and Alarms Leds:</u>

Trip LED Input	=	86BF TRIP On (VO1)	
Alarm LED Input	=	UNIT ALARM On (VO3)	
LED 1	=	86BF TRIP On (VO1)	Latched
LED 2	=	BKR FAIL 1 TRIP OP	Latched
LED 3	=	BKR FAIL 2 TRIP OP	Latched
LED 4	=	Retrip LED On (VO9)	Latched
LED 5	=	OFF	Latched
LED 6	=	OFF	Self-Reset

LED 7	=	OFF	Self-Reset
LED 8	=	OFF	Self-Reset
LED 9	=	Phase A Trip On (VO10)	Latched
LED 10	=	Phase B Trip On (VO11)	Latched
LED 11	=	Phase C Trip On (VO12)	Latched
LED 12	=	Ground Trip On (VO13)	Latched
LED 13	=	OFF	Self-Reset
LED 14	=	OFF	Self-Reset
LED 15	=	OFF	Self-Reset
LED 16	=	OFF	Self-Reset
LED 17	=	OFF	Self-Reset
LED 18	=	OFF	Self-Reset
LED 19	=	OFF	Self-Reset
LED 20	=	OFF	Self-Reset
LED 21	=	OFF	Self-Reset
LED 22	=	Bkr Fail Int On(M7a)	Self-Reset
LED 23	=	BKR FAIL 1 T2 OP	Self-Reset
LED 24	=	BKR FAIL 2 T2 OP	Self-Reset
LED 25	=	OFF	Self-Reset
LED 26	=	OFF	Self-Reset
LED 27	=	OFF	Self-Reset
LED 28	=	OFF	Self-Reset
LED 29	=	OFF	Self-Reset
LED 30	=	OFF	Self-Reset
LED 31	=	OFF	Self-Reset
LED 32	=	OFF	Self-Reset
LED 33	=	OFF	Self-Reset
LED 34	=	OFF	Self-Reset
LED 35	=	OFF	Self-Reset
LED 36	=	OFF	Self-Reset
LED 37	=	OFF	Self-Reset
LED 38	=	OFF	Self-Reset
LED 39	=	OFF	Self-Reset
LED 40	=	OFF	Self-Reset
LED 41	=	OFF	Self-Reset
LED 42	=	OFF	Self-Reset
LED 43	=	OFF	Self-Reset
LED 44	=	OFF	Self-Reset
LED 45	=	OFF	Self-Reset
LED 46	=	OFF	Self-Reset
LED 47	=	OFF	Self-Reset
LED 48	=	OFF	Self-Reset

<u>User-Programmable Self Tests:</u>

Remote Device Off Function	=	Enabled
Pri Ethernet Fail Function	=	Enabled
Battery Fail Function	=	Enabled
SNTP Fail Function	=	Enabled
IRIG B Fail Function	=	Enabled

<u>Control Pushbuttons:</u>

PARAMETER	CPB 1	CPB 2	CPB 3

Function	Enabled	Disabled	Disabled		
Events	Disabled	Disabled	Disabled		
Flex States:					# All OFF
User-definable displays:					# Not used
Direct I/O:					# Not used
Teleprotection:					# Not used
Installation:					
	Relay Name	=	50/62-2 Breaker 1		
System Setup:					
AC Inputs					
Current:	PARAMETER		CT F1		
	Phase CT Primary	=	3000 A		
	Phase CT Secondary	=	5 A		
	Ground CT Primary	=	3000 A		
	Ground CT Secondary	=	5 A		
Voltage:					# Not used
Power System:					
	Nominal Frequency	=	60 Hz		
	Phase Rotation	=	ABC		
	Frequency And Phase Reference	=	SRC 1 (SRC 1)		
	Frequency Tracking Function	=	Enabled		
Signal Sources:	PARAMETER		SOURCE 1	SOURCE 2	
	Name	=	SRC 1	SRC 2	
	Phase CT	=	F1	None	
	Ground CT	=	None	None	
	Phase VT	=	None	None	
	Aux VT	=	None	None	
Breakers:	SETTING		PARAMETER		
	Breaker 1 Function	=	Disabled		
	Breaker 1 Push Button Control	=	Disabled		
	Breaker 1 Name	=	Bkr 1		
	Breaker 1 Mode	=	3-Pole		
	Breaker 1 Open	=	OFF		
	Breaker 1 Block Open	=	OFF		
	Breaker 1 Close	=	OFF		
	Breaker 1 Block Close	=	OFF		
	Breaker 1 Phase A/3-Pole Closed	=	OFF		
	Breaker 1 Phase A/3-Pole Opened	=	OFF		
	Breaker 1 Phase B Closed	=	OFF		
	Breaker 1 Phase B Opened	=	OFF		
	Breaker 1 Phase C Closed	=	OFF		
	Breaker 1 Phase C Opened	=	OFF		
	Breaker 1 Toperate	=	0.070 s		
	Breaker 1 External Alarm	=	OFF		
	Breaker 1 Alarm Delay	=	0.000 s		
	Breaker 1 Manual Close Recal Time	=	0.000 s		
	Breaker 1 Out Of Service	=	OFF		
	Breaker 1 Events	=	Disabled		
	Breaker 2 Function	=	Disabled		

Appendix 19 50-62-2-BKR1 (GE-C60) Setting Calculation

Breaker 2 Push Button Control	=	Disabled	
Breaker 2 Name	=	Bkr 2	
Breaker 2 Mode	=	3-Pole	
Breaker 2 Open	=	OFF	
Breaker 2 Block Open	=	OFF	
Breaker 2 Close	=	OFF	
Breaker 2 Block Close	=	OFF	
Breaker 2 Phase A/3-Pole Closed	=	OFF	
Breaker 2 Phase A/3-Pole Opened	=	OFF	
Breaker 2 Phase B Closed	=	OFF	
Breaker 2 Phase B Opened	=	OFF	
Breaker 2 Phase C Closed	=	OFF	
Breaker 2 Phase C Opened	=	OFF	
Breaker 2 Toperate	=	0.070 s	
Breaker 2 External Alarm	=	OFF	
Breaker 2 Alarm Delay	=	0.000 s	
Breaker 2 Manual Close Recal Time	=	0.000 s	
Breaker 2 Out Of Service	=	OFF	
Breaker 2 Events	=	Disabled	
Switches			# Not used
FlexCurves:			# Not used
FlexLogic:			# See 50-62-2-BKR1-r0.pdf
Grouped Elements:			
Group 1:			
Phase Current:			
Phase TOC:			# Not used
Phase IOC:			
Function	=	Enabled	
Source	=	SRC 1 (SRC 1)	
Pickup	=	0.15 pu	
Delay	=	0.00 s	
Reset Delay	=	0.00 s	
Block A	=	OFF	
Block B	=	OFF	
Block C	=	OFF	
Target	=	Self-reset	
Events	=	Enabled	
Neutral Current:			
Neutral TOC:			# Not used
Neutral IOC:			
Function	=	Enabled	
Source	=	SRC 1 (SRC 1)	
Pickup	=	0.100 pu	
Delay	=	0.00 s	
Reset Delay	=	0.00 s	
Block	=	OFF	
Target	=	Self-reset	
Events	=	Enabled	
Ground Current:			
Ground TOC			# Not used

Appendix 19 50-62-2-BKR1 (GE-C60) Setting Calculation

Ground IOC				# Not used
Breaker Failure:	PARAMETER		BF1	BF2
	Function	=	Enabled	Enabled
	Mode	=	3-Pole	3-Pole
	Source	=	SRC 1 (SRC 1)	SRC 1 (SRC1)
	Current Supervision	=	Yes	Yes
	Use Seal-In	=	No	No
	Three Pole Initiate	=	Bkr Fail Int On(M7a);	
	Block	=	NEUTRAL IOC1 PKP	OFF
	Phase Current Supv Pickup	=	0.15 pu	# 50FD-P
	Neutral Current Supv Pickup	=	0.100 pu	# 50FD-G
	Use Timer 1	=	No	No
	Timer 1 Pickup Delay	=	0.000 s	0.000 s
	Use Timer 2	=	Yes	Yes
	Timer 2 Pickup Delay	=	0.130 s	0.160 s
	Use Timer 3	=	No	No
	Timer 3 Pickup Delay	=	0.000 s	0.000 s
	Breaker Pos1 Phase A/3P	=	OFF	OFF
	Breaker Pos2 Phase A/3P	=	OFF	OFF
	Breaker Test On	=	OFF	OFF
	Phase Current HiSet Pickup	=	0.15 pu	0.15 pu
	Neutral Current HiSet Pickup	=	0.100 pu	0.100 pu
	Phase Current LoSet Pickup	=	0.15 pu	0.15 pu
	Neutral Current LoSet Pickup	=	0.100 pu	0.100 pu
	LoSet Time Delay	=	0.000 s	0.000 s
	Trip Dropout Delay	=	0.000 s	0.000 s
	Target	=	Latched	Latched
	Events	=	Enabled	Enabled
	Phase A Initiate	=	OFF	OFF
	Phase B Initiate	=	OFF	OFF
	Phase C Initiate	=	OFF	OFF
	Breaker Pos1 Phase B	=	OFF	OFF
	Breaker Pos1 Phase C	=	OFF	OFF
	Breaker Pos2 Phase B	=	OFF	OFF
	Breaker Pos2 Phase C	=	OFF	OFF
Voltage Elements:				# Not used
Power:				# Not used
Control Elements:				
Trip Bus:				# Not used
Setting Groups:				# Not used
Selector Switches:				# Not used
Synchrocheck:				# Not used
Digital Elements:				# Not used
Digital Counters:				# Not used
Monitoring Elements:				# Not used
Autoreclose 1P				# Not used
Inputs/Outputs:				
Contact inputs:	SETTING		PARAMETER	
	[H5A] Contact Input 1 ID	=	CSM-2 (E13)	
	[H5A] Contact Input 1 Debounce Time	=	2.0 ms	

[H5A] Contact Input 1 Events	=	Enabled
[H5C] Contact Input 2 ID	=	CSM-2 (TIE)
[H5C] Contact Input 2 Debounce Time	=	2.0 ms
[H5C] Contact Input 2 Events	=	Enabled
[H6A] Contact Input 3 ID	=	Bkr TC1 Mont
[H6A] Contact Input 3 Debounce Time	=	2.0 ms
[H6A] Contact Input 3 Events	=	Enabled
[H6C] Contact Input 4 ID	=	86BF-2 Oper
[H6C] Contact Input 4 Debounce Time	=	2.0 ms
[H6C] Contact Input 4 Events	=	Enabled
[H7A] Contact Input 5 ID	=	86BF-2 Mont
[H7A] Contact Input 5 Debounce Time	=	2.0 ms
[H7A] Contact Input 5 Events	=	Enabled
[H7C] Contact Input 6 ID	=	43L/R
[H7C] Contact Input 6 Debounce Time	=	2.0 ms
[H7C] Contact Input 6 Events	=	Enabled
[H8A] Contact Input 7 ID	=	CSM-2 (OFF)
[H8A] Contact Input 7 Debounce Time	=	2.0 ms
[H8A] Contact Input 7 Events	=	Enabled
[H8C] Contact Input 8 ID	=	CSM-2 (FARR)
[H8C] Contact Input 8 Debounce Time	=	2.0 ms
[H8C] Contact Input 8 Events	=	Enabled
[M5A] Contact Input 9 ID	=	11LTSR-2A
[M5A] Contact Input 9 Debounce Time	=	2.0 ms
[M5A] Contact Input 9 Events	=	Enabled
[M5C] Contact Input 10 ID	=	11LTSR-2B
[M5C] Contact Input 10 Debounce Time	=	2.0 ms
[M5C] Contact Input 10 Events	=	Enabled
[M6A] Contact Input 11 ID	=	Cont Ip 11
[M6A] Contact Input 11 Debounce Time	=	2.0 ms
[M6A] Contact Input 11 Events	=	Disabled
[M6C] Contact Input 12 ID	=	spare
[M6C] Contact Input 12 Debounce Time	=	2.0 ms
[M6C] Contact Input 12 Events	=	Disabled
[M7A] Contact Input 13 ID	=	Bkr Fail Int
[M7A] Contact Input 13 Debounce Time	=	2.0 ms
[M7A] Contact Input 13 Events	=	Enabled

[M7C] Contact Input 14 ID	=	Cont Ip 14
[M7C] Contact Input 14 Debounce Time	=	2.0 ms
[M7C] Contact Input 14 Events	=	Disabled
[M8A] Contact Input 15 ID	=	Cont Ip 15
[M8A] Contact Input 15 Debounce Time	=	2.0 ms
[M8A] Contact Input 15 Events	=	Disabled
[M8C] Contact Input 16 ID	=	Cont Ip 16
[M8C] Contact Input 16 Debounce Time	=	2.0 ms
[M8C] Contact Input 16 Events	=	Disabled

Contact Inputs Thresholds:

Cont Ip 1, Cont Ip 2, Cont Ip 3, Cont Ip 4(H5A, H5C, H6A, H6C)	=	84 Vdc
Cont Ip5, Cont Ip 6, Cont Ip 7, Cont Ip 8(H7A, H7C, H8A, H8C)	=	84 Vdc
Cont Ip 9, Cont Ip 10, Cont Ip 11, Cont Ip 12(M5A, M5C, M6A, M6C)	=	84 Vdc
Cont Ip 13, Cont Ip 14, Cont Ip 15, Cont Ip 16(M7A, M7C, M8A, M8C)	=	84 Vdc

Virtual Inputs:

SETTING		PARAMETER	
Virtual Input 1 Function	=	Enabled	
Virtual Input 1 ID	=	Bkr Trip	
Virtual Input 1 Type	=	Self-Reset	
Virtual Input 1 Events	=	Enabled	
Virtual Input 2 Function	=	Enabled	
Virtual Input 2 ID	=	Bkr Close	
Virtual Input 2 Type	=	Self-Reset	
Virtual Input 2 Events	=	Enabled	
Other Virtual Inputs (from VI03 to VI64)			# Not used

Contact Outputs:

[H1] Contact Output 1 ID	=	Any Trip
[H1] Contact Output 1 Operate	=	TRIP LED On (VO6)
[H1] Contact Output 1 Seal-In	=	OFF
[H1] Contact Output 1 Events	=	Enabled
[H2] Contact Output 2 ID	=	spare
[H2] Contact Output 2 Operate	=	OFF
[H2] Contact Output 2 Seal-In	=	OFF
[H2] Contact Output 2 Events	=	Disabled
[H3] Contact Output 3 ID	=	Not Used
[H3] Contact Output 3 Operate	=	OFF
[H3] Contact Output 3 Seal-In	=	OFF
[H3] Contact Output 3 Events	=	Disabled
[H4] Contact Output 4 ID	=	NOT USED
[H4] Contact Output 4 Operate	=	OFF
[H4] Contact Output 4 Seal-In	=	OFF
[H4] Contact Output 4 Events	=	Disabled
[M1] Contact Output 5 ID	=	BF TRIP
[M1] Contact Output 5 Operate	=	86BF TRIP On (VO1)

[M1] Contact Output 5 Seal-In	=	86BF TRIP On (VO1)
[M1] Contact Output 5 Events	=	Enabled
[M2] Contact Output 6 ID	=	RETRIP BKR
[M2] Contact Output 6 Operate	=	RETRIP BKR On (VO2)
[M2] Contact Output 6 Seal-In	=	RETRIP BKR On (VO2)
[M2] Contact Output 6 Events	=	Enabled
[M3] Contact Output 7 ID	=	Bkr Trip
[M3] Contact Output 7 Operate	=	Bkr Trip On (VO7)
[M3] Contact Output 7 Seal-In	=	OFF
[M3] Contact Output 7 Events	=	Enabled
[M4] Contact Output 8 ID	=	Bkr Close
[M4] Contact Output 8 Operate	=	Bkr Close On (VO8)
[M4] Contact Output 8 Seal-In	=	OFF
[M4] Contact Output 8 Events	=	Enabled
<u>Virtual Outputs:</u> SETTING		PARAMETER
Virtual Output 1 ID	=	86BF TRIP
Virtual Output 1 Events	=	Enabled
Virtual Output 2 ID	=	RETRIP BKR
Virtual Output 2 Events	=	Enabled
Virtual Output 3 ID	=	UNIT ALARM
Virtual Output 3 Events	=	Enabled
Virtual Output 4 ID	=	Trig Oscill
Virtual Output 4 Events	=	Enabled
Virtual Output 5 ID	=	ALARM NC
Virtual Output 5 Events	=	Enabled
Virtual Output 6 ID	=	TRIP LED
Virtual Output 6 Events	=	Enabled
Virtual Output 7 ID	=	Bkr Trip
Virtual Output 7 Events	=	Enabled
Virtual Output 8 ID	=	Bkr Close
Virtual Output 8 Events	=	Enabled
Virtual Output 9 ID	=	Retrip LED
Virtual Output 9 Events	=	Enabled
Virtual Output 10 ID	=	Phase A Trip
Virtual Output 10 Events	=	Enabled
Virtual Output 11 ID	=	Phase B Trip
Virtual Output 11 Events	=	Enabled

Virtual Output 12 ID	=	Phase C Trip	
Virtual Output 12 Events	=	Enabled	
Virtual Output 13 ID	=	Ground Trip	
Virtual Output 13 Events	=	Enabled	
Other Virtual Outputs (from VO14 to VO96)			# Not used
Remote Devices:			# Not used
Remote Inputs:			# Not used
Remote Outputs DNA Bit Pairs			# Not used
Remote Outputs UserSt Bit Pairs:			# Not used
Resetting:			# Not used
Direct Inputs:			# Not used
Direct Outputs:			# Not used
Teleprotection:			# Not used
IEC 61850 GOOSE Analogs Inputs			# Not used

Appendix 20 50-62-1-BKR2 (Areva P141) Setting Calculation

1. Data

MVA_Base =	100	kV_Base =	345	Z_Base =	1190.25	ohms
CTR =	600	PTR =	3000	CTR/PTR=	0.2	

Total MVA of all three GSUs = 750 ; Maximum full load current (amps) = 1255.11

2. Setting Criteria

2.1. Set phase IOC element, i.e. phase fault detector, above load if possible but not more than 2/3 of the minimum phase to phase fault at remote bus with the largest source out. For the minimum phase to phase fault at Farragut station under minimum condition which is considered as the largest unit (STG1) of the three units out of service, the contributions from Charlie Poletti are 1,454 Amp via Q35M line and 1,349 Amp via Q35L line. Since each breaker failure relay will normally see only half of the fault contribution per feeder. The IOC1 element shall be set at 0.15 pu or 0.75 CT secondary amp or 450 CT primary amp, or 1/3 of 1,349 Amp or 35.8% of maximum full load. Fault detector picking up on load is considered acceptable here per IEEE standard.

2.2. Set residual IOC element, i.e. ground fault detector, above maximum expected unbalance , but not more than 2/3 of the minimum ground fault at remote bus with the largest source out. For the minimum line to ground fault at Farragut station under minimum condition with is considered as the largest unit (STG1) of the three units out of serivce, the fault contributions from Chaerlie Poletti are 2,021 Amp via Q35L and 2,129 Amp via Q35M. Since each breaker failure relay will normally see only half of the fault contribution on each feeder, set residual IOC element at 0.1 pu or 0.5 CT secondary amp, 300 CT primary amp, or 24% of maximum full load, which is less than 1/3 of minimum phase to ground fault at Farragut.

2.3 Breaker failure timer of 130 ms is used for 3 phase fault and 160 ms is used for unbalanced fault per ConEd standard. Existing Poletti settings show that 120 ms breaker failure time is used regardless fault type.

SYSTEM DATA:

Language = English
Sys Fn Links = 0
Decription = 50-62-1-BKR2
Plant Reference = CHARLES POLETTI
Frequency = 60 Hz

CB CONTROL:

CB Control by = Disabled
Reset Lockout by = CB Close
Man Close RstDly = 5.000 s
CB2 Status Input = 52A

DATE AND TIME:

IRIG-B Sync = Enabled
Battery Alarm = Enabled
Other Time Settings = Default

CONFIGURATION:

Setting Group = Select via Menu
Active Settings = Group 1
Setting Group 1 = Enabled
Setting Group 2 = Disabled
Setting Group 3 = Disabled
Setting Group 4 = Disabled
System Config = Invisible

Appendix 20 50-62-1-BKR2 (Areva P141) Setting Calculation

Overcurrent =	Enabled	# 50FD-P
Neg Sequence O/C =	Enabled	# Unbalance
Broken Conductor =	Disabled	# Not used
Earth Fault 1 =	Disabled	# Not used
Earth Fault 2 =	Enabled	# 50FD-G
Sensitive E/F Prot'n =	Disabled	# Not used
Residual O/V NVD =	Disabled	# Not used
Thermal Overload =	Disabled	# Not used
Neg Sequence O/V =	Disabled	# Not used
Cold Load Pickup =	Disabled	# Not used
Selective Logic =	Disabled	# Not used
Admit Protection =	Disabled	# Not used
Volt Protection =	Disabled	# Not used
Freq Protection =	Disabled	# Not used
df/dt Protection =	Disabled	# Not used
CB Fail =	Enabled	
Supervision =	Enabled	
Fault Locator =	Disabled	
Input Labels =	Visible	
Output Labels =	Visible	
CT & VT Ratios =	Visible	
Record Control =	Invisible	
Disturb Recorder =	Visible	
Measure't Setup =	Visible	
Comms Settings =	Visible	
Commission Tests =	Visible	
Setting Values =	Secondary	
Control Inputs =	Invisible	
Ctrl I/P Config =	Invisible	
Ctrl I/P Labels =	Invisible	
Direct Access =	Disabled	
LCD Contrast =	11	

<u>CT AND VT RATIOS</u>

Main VT Primary =	110.0 V	# Not used
Main VT Sec'y =	110.0 V	# Not used
Phase CT Primary =	3000 A	
Phase CT Sec'y =	5.000 A	
E/F CT Primary =	3000 A	
E/F CT Secondary =	5.000 A	
SEF CT Primary =	1.000 A	
SEF CT Secondary =	1.000 A	

<u>DISTURB RECORDER:</u> See setting file for detail

<u>MEASURE'T SETUP:</u>

Default Display =	Description
Local Values =	Primary
Remote Values =	Primary
Measurement Ref =	VA
Measurement Mode =	0
Fix Dem Period =	30.00 min
Roll Sub Period =	30.00 min

Num Sub Periods = 1

COMMISSION TESTS:

Monitor Bit 1 = 64
Monitor Bit 2 = 65
Monitor Bit 3 = 66
Monitor Bit 4 = 67
Monitor Bit 5 = 68
Monitor Bit 6 = 69
Monitor Bit 7 = 70
Monitor Bit 8 = 71

CB MONITOR SETUP:

Broken I^ = 2.000
I^ Maintenance = Alarm Disabled
I^ Lockout = Alarm Disabled
No. CB Ops Maint = Alarm Disabled
No. CB Ops Lock = Alarm Disabled
CB Time Maint = Alarm Disabled
CB Time Lockout = Alarm Disabled
Fault Freq Lock = Alarm Disabled

OPTO CONFIG:

Global Nominal V = 110/125V
Opto Filter Cntl = 11111111
Characteristic = Standard 60%-80%

Group 1:

GROUP 1 OVERCURRENT:

I>1 Function = DT
I>1 Direction = Non-Directional
I>1 Current Set = 0.75 # 50FD-P
I>1 Time Delay = 0
I>1 tRESET = 0 s
I>2 Status = Disabled
I>3 Status = Disabled
I>4 Status = Disabled
I> Blocking = 000000000
I> Char Angle = 45 deg # Default
VC0 Status = Disabled

GROUP 1 NEG SEQ O/C

I2>1 Status = Enabled
I2>1 Function = DT
I2>1 Directional = Non-Directional
I2>1 Current Set = 500.0mA
I2>1 Time Delay = 0 s
I2>1 Treset = 0 s
I2>2 Status = Disabled
I2>3 Status = Disabled
I2>4 Status = Disabled
I2> Blocking = 00000000
I2> Char Angle = -60.00 deg
I2> V2pol Set = 5.000 V

GROUP 1 EARTH FAULT 2

IN2> Input = Derived
IN2>1 Function = DT
IN2>1 Direction = Non-Directional
IN2>1 Current = 500.0mA # 50FD-G
IN2>1 Time Delay = 0 s
IN2>1 tRESET = 0 s
IN2>2 Function = Disabled
IN2>3 Status = Disabled
IN2>4 Status = Disabled
IN2> Blocking = 00000000
IN2> = POL
IN2> Char Angle = -45.00 deg
IN2> Pol = Zero Sequence
IN2> VNpol Set = 5.000 V

GROUP 1 CB FAIL & I<:

CB Fail 1 Status = Enabled
GB Fail 1 Timer = 0 s
CB Fail 2 Status = Enabled
CB Fail 2 Timer = 130.0 ms
Volt Prot Reset = I < only
Ext Prot Reset = I < only
I< Current Set = 500.0 mA
IN< Current Set = 500.0 mA
ISEF< Current = 20.00 mA
Remove I> Start = Disabled
Remove IN> Start = Disabled

GROUP 1 SUPERVISION:

VTS Status = Indication
VTS Reset Mode = Manual
VTS Time Delay = 5.000 s
VTS I> Inhibit = 50.0 A
VTS I2> Inhibit = 250.0 mA
CTS Mode = Disabled

GROUP 1 INPUT LABELS:

Opto Input 1 Input L1
Opto Input 2 Input L2
Opto Input 3 30-TC2/1 ALM
Opto Input 4 86BF-1/1 TRIP
Opto Input 5 30-86BF-1/1 ALM
Opto Input 6 BF Initiation
Opto Input 7 Input L7
Opto Input 8 Input L8

GROUP 1 OUTPUT LABELS:

Relay 1 Trip 86BF
Relay 2 ReTrip BkrTC2
Relay 3 Any Trip
Relay 4 Output R4
Relay 5 Output R5
Relay 6 Output R6
Relay 7 Output R7

Appendix 21 50-62-2-BKR1 (GE-C60) Setting Calculation

1. Data

MVA_Base =	100	kV_Base =	345	Z_Base =	1190.25	ohms
CTR =	600	PTR =	3000	CTR/PTR=	0.2	

Total MVA of all three GSUs = 750 ; Maximum full load current (amps) = 1255.11

2. Setting Criteria

2.1. Set phase IOC element, i.e. phase fault detector, above load if possible but not more than 2/3 of the minimum phase to phase fault at remote bus with the largest source out. For the minimum phase to phase fault at Farragut station under minimum condition which is considered as the largest unit (STG1) of the three units out of service, the contributions from Charlie Poletti are 1,454 Amp via Q35M line and 1,349 Amp via Q35L line. Since each breaker failure relay will normally see only half of the fault contribution per feeder. The IOC1 element shall be set at 0.15 pu or 0.75 CT secondary amp or 450 CT primary amp, or 1/3 of 1,349 Amp or 35.8% of maximum full load. Fault detector picking up on load is considered acceptable here per IEEE standard.

2.2. Set residual IOC element, i.e. ground fault detector, above maximum expected unbalance , but not more than 2/3 of the minimum ground fault at remote bus with the largest source out. For the minimum line to ground fault at Farragut station under minimum condition with is considered as the largest unit (STG1) of the three units out of serivce, the fault contributions from Chaerlie Poletti are 2,021 Amp via Q35L and 2,129 Amp via Q35M. Since each breaker failure relay will normally see only half of the fault contribution on each feeder, set residual IOC element at 0.1 pu or 0.5 CT secondary amp, 300 CT primary amp, or 24% of maximum full load, which is less than 1/3 of minimum phase to ground fault at Farragut.

2.3 Breaker failure timer of 130 ms is used for 3 phase fault and 160 ms is used for unbalanced fault per ConEd standard. Existing Poletti settings show that 120 ms breaker failure time is used regardless fault type.

Device Definition:	# Default
Product Setup:	
Security:	# Default
Display Properties:	# Default
Clear Relay Records:	# All OFF
Communications:	# Default
Modbus User Map:	# Not used

Real Time Clock:

IRIG-B Signal Type	=	DC Shift
All other settings	=	Default

Fault Report:

SETTING		PARAMETER
Fault Report 1 Source	=	SRC 1 (SRC 1)
Fault Report 1 Trigger	=	Trig Oscill On (VO4)
Fault Report 1 Positive Seq (Z1) Mag	=	0.49 ohms
Fault Report 1 Positive Seq (Z1) Angle	=	78 deg
Fault Report 1 Zero Seq (Z0) Mag	=	1.50 ohms
Fault Report 1 Zero Seq (Z0) Angle	=	54 deg
Fault Report 1 Line Length Units	=	mile
Fault Report 1 Line Length	=	7.74
Fault Report 1 VT Substitution	=	None
Fault Report 1 System Z0 Mag	=	0.49 ohms
Fault Report 1 System Z0 Angle	=	78 deg

Oscillography:

SETTING		PARAMETER

Appendix 21 50-62-2-BKR1 (GE-C60) Setting Calculation

Number Of Records	=	6
Trigger Mode	=	Automatic Overwrite
Trigger Position	=	30%
Trigger Source	=	Trig Oscill On (VO4)
AC Input Waveforms	=	32 samples/cycle
Digital Channel 1	=	OFF
Digital Channel 2	=	OFF
Digital Channel 3	=	OFF
Digital Channel 4	=	OFF
Digital Channel 5	=	OFF
Digital Channel 6	=	86BF TRIP On (VO1)
Digital Channel 7	=	RETRIP BKR On (VO2)
Digital Channel 8	=	UNIT ALARM On (VO3)
Digital Channel 9	=	OFF
Digital Channel 10	=	NEUTRAL IOC1 PKP
Digital Channel 11	=	NEUTRAL IOC1 OP
Digital Channel 12	=	PHASE IOC1 PKP A
Digital Channel 13	=	PHASE IOC1 OP A
Digital Channel 14	=	PHASE IOC1 PKP B
Digital Channel 15	=	PHASE IOC1 OP B
Digital Channel 16	=	PHASE IOC1 PKP C
Digital Channel 17	=	PHASE IOC1 OP C
Digital Channel 18	=	Bkr Fail Int On(H7c)
Digital Channel 19	=	BKR FAIL 1 TRIP OP
Digital Channel 20	=	BKR FAIL 2 TRIP OP
Digital Channel 21	=	BKR FAIL 1 T2 OP
Digital Channel 22	=	BKR FAIL 2 T2 OP
Digital Channel 23	=	86BF TRIP On (VO1)
Digital Channel 24	=	RETRIP BKR On (VO2)
Digital Channel 25	=	BKR FAIL 1 RETRIPA
Digital Channel 26	=	BKR FAIL 1 RETRIPB
Digital Channel 27	=	BKR FAIL 1 RETRIPC
Digital Channel 28	=	OFF
Digital Channel 29	=	OFF
Digital Channel 30	=	OFF
Digital Channel 31	=	OFF
Digital Channel 32	=	OFF
Digital Channel 33	=	OFF
Digital Channel 34	=	OFF
Digital Channel 35	=	OFF
Digital Channel 36	=	OFF
Digital Channel 37	=	OFF
Digital Channel 38	=	OFF
Digital Channel 39	=	OFF
Digital Channel 40	=	OFF
Digital Channel 41	=	OFF
Digital Channel 42	=	OFF
Digital Channel 43	=	OFF
Digital Channel 44	=	OFF
Digital Channel 45	=	OFF

Digital Channel 46	=	OFF		
Digital Channel 47	=	OFF		
Digital Channel 48	=	OFF		
Digital Channel 49	=	OFF		
Digital Channel 50	=	OFF		
Digital Channel 51	=	OFF		
Digital Channel 52	=	OFF		
Digital Channel 53	=	OFF		
Digital Channel 54	=	OFF		
Digital Channel 55	=	OFF		
Digital Channel 56	=	OFF		
Digital Channel 57	=	OFF		
Digital Channel 58	=	OFF		
Digital Channel 59	=	OFF		
Digital Channel 60	=	OFF		
Digital Channel 61	=	OFF		
Digital Channel 62	=	OFF		
Digital Channel 63	=	OFF		
Analog Channel 1	=	SRC1	Ia Mag	
Analog Channel 2	=	SRC2	Ia Mag	
Analog Channel 3	=	SRC1	Ib Mag	
Analog Channel 4	=	SRC2	Ib Mag	
Analog Channel 5	=	SRC1	Ic Mag	
Analog Channel 6	=	SRC2	Ic Mag	
Analog Channel 7	=	SRC1	In Mag	
Analog Channel 8	=	SRC2	In Mag	
Analog Channel 9	=	SRC1	Ia Angle	
Analog Channel 10	=	SRC2	Ia Angle	
Analog Channel 11	=	SRC1	Ib Angle	
Analog Channel 12	=	SRC2	Ib Angle	
Analog Channel 13	=	SRC1	Ic Angle	
Analog Channel 14	=	SRC2	Ic Angle	
Analog Channel 15	=	Off		
Analog Channel 16	=	Off		

<u>Data Logger:</u> # Default

<u>Demand:</u> # Default

<u>User-Programmable Leds:</u>

<u>LED Test:</u>

Function	=	Enabled
Control	=	CONTROL PUSHBUTTON 1 ON

<u>Trip and Alarms Leds:</u>

Trip LED Input	=	86BF TRIP On (VO1)	
Alarm LED Input	=	UNIT ALARM On (VO3)	
LED 1	=	86BF TRIP On (VO1)	Latched
LED 2	=	BKR FAIL 1 TRIP OP	Latched
LED 3	=	BKR FAIL 2 TRIP OP	Latched
LED 4	=	Retrip LED On (VO9)	Latched
LED 5	=	OFF	Latched
LED 6	=	OFF	Self-Reset

LED 7	=	OFF	Self-Reset
LED 8	=	OFF	Self-Reset
LED 9	=	Phase A Trip On (VO10)	Latched
LED 10	=	Phase B Trip On (VO11)	Latched
LED 11	=	Phase C Trip On (VO12)	Latched
LED 12	=	Ground Trip On (VO13)	Latched
LED 13	=	OFF	Self-Reset
LED 14	=	OFF	Self-Reset
LED 15	=	OFF	Self-Reset
LED 16	=	OFF	Self-Reset
LED 17	=	OFF	Self-Reset
LED 18	=	OFF	Self-Reset
LED 19	=	OFF	Self-Reset
LED 20	=	OFF	Self-Reset
LED 21	=	OFF	Self-Reset
LED 22	=	Bkr Fail Int On(M7a)	Self-Reset
LED 23	=	BKR FAIL 1 T2 OP	Self-Reset
LED 24	=	BKR FAIL 2 T2 OP	Self-Reset
LED 25	=	OFF	Self-Reset
LED 26	=	OFF	Self-Reset
LED 27	=	OFF	Self-Reset
LED 28	=	OFF	Self-Reset
LED 29	=	OFF	Self-Reset
LED 30	=	OFF	Self-Reset
LED 31	=	OFF	Self-Reset
LED 32	=	OFF	Self-Reset
LED 33	=	OFF	Self-Reset
LED 34	=	OFF	Self-Reset
LED 35	=	OFF	Self-Reset
LED 36	=	OFF	Self-Reset
LED 37	=	OFF	Self-Reset
LED 38	=	OFF	Self-Reset
LED 39	=	OFF	Self-Reset
LED 40	=	OFF	Self-Reset
LED 41	=	OFF	Self-Reset
LED 42	=	OFF	Self-Reset
LED 43	=	OFF	Self-Reset
LED 44	=	OFF	Self-Reset
LED 45	=	OFF	Self-Reset
LED 46	=	OFF	Self-Reset
LED 47	=	OFF	Self-Reset
LED 48	=	OFF	Self-Reset

User-Programmable Self Tests:

Remote Device Off Function	=	Enabled
Pri Ethernet Fail Function	=	Enabled
Battery Fail Function	=	Enabled
SNTP Fail Function	=	Enabled
IRIG B Fail Function	=	Enabled

Control Pushbuttons:

PARAMETER	CPB 1	CPB 2	CPB 3

Function	Enabled	Disabled	Disabled	
Events	Disabled	Disabled	Disabled	
Flex States:				# All OFF
User-definable displays:				# Not used
Direct I/O:				# Not used
Teleprotection:				# Not used
Installation:				

	Relay Name	=	50/62-2 Breaker 2		
System Setup:					
AC Inputs					
Current:	PARAMETER		CT F1		
	Phase CT Primary	=	3000 A		
	Phase CT Secondary	=	5 A		
	Ground CT Primary	=	3000 A		
	Ground CT Secondary	=	5 A		
Voltage:					# Not used
Power System:					
	Nominal Frequency	=	60 Hz		
	Phase Rotation	=	ABC		
	Frequency And Phase Reference	=	SRC 1 (SRC 1)		
	Frequency Tracking Function	=	Enabled		
Signal Sources:	PARAMETER		SOURCE 1	SOURCE 2	
	Name	=	SRC 1	SRC 2	
	Phase CT	=	F1	None	
	Ground CT	=	None	None	
	Phase VT	=	None	None	
	Aux VT	=	None	None	
Breakers:	SETTING		PARAMETER		
	Breaker 1 Function	=	Disabled		
	Breaker 1 Push Button Control	=	Disabled		
	Breaker 1 Name	=	Bkr 1		
	Breaker 1 Mode	=	3-Pole		
	Breaker 1 Open	=	OFF		
	Breaker 1 Block Open	=	OFF		
	Breaker 1 Close	=	OFF		
	Breaker 1 Block Close	=	OFF		
	Breaker 1 Phase A/3-Pole Closed	=	OFF		
	Breaker 1 Phase A/3-Pole Opened	=	OFF		
	Breaker 1 Phase B Closed	=	OFF		
	Breaker 1 Phase B Opened	=	OFF		
	Breaker 1 Phase C Closed	=	OFF		
	Breaker 1 Phase C Opened	=	OFF		
	Breaker 1 Toperate	=	0.070 s		
	Breaker 1 External Alarm	=	OFF		
	Breaker 1 Alarm Delay	=	0.000 s		
	Breaker 1 Manual Close Recal Time	=	0.000 s		
	Breaker 1 Out Of Service	=	OFF		
	Breaker 1 Events	=	Disabled		
	Breaker 2 Function	=	Disabled		

Breaker 2 Push Button Control	=	Disabled	
Breaker 2 Name	=	Bkr 2	
Breaker 2 Mode	=	3-Pole	
Breaker 2 Open	=	OFF	
Breaker 2 Block Open	=	OFF	
Breaker 2 Close	=	OFF	
Breaker 2 Block Close	=	OFF	
Breaker 2 Phase A/3-Pole Closed	=	OFF	
Breaker 2 Phase A/3-Pole Opened	=	OFF	
Breaker 2 Phase B Closed	=	OFF	
Breaker 2 Phase B Opened	=	OFF	
Breaker 2 Phase C Closed	=	OFF	
Breaker 2 Phase C Opened	=	OFF	
Breaker 2 Toperate	=	0.070 s	
Breaker 2 External Alarm	=	OFF	
Breaker 2 Alarm Delay	=	0.000 s	
Breaker 2 Manual Close Recal Time	=	0.000 s	
Breaker 2 Out Of Service	=	OFF	
Breaker 2 Events	=	Disabled	

Switches — # Not used

FlexCurves: — # Not used

FlexLogic: — # See 50-62-2-BKR1-r0.pdf

Grouped Elements:

Group 1:

Phase Current:

Phase TOC: — # Not used

Phase IOC:

Function	=	Enabled
Source	=	SRC 1 (SRC 1)
Pickup	=	0.15 pu
Delay	=	0.00 s
Reset Delay	=	0.00 s
Block A	=	OFF
Block B	=	OFF
Block C	=	OFF
Target	=	Self-reset
Events	=	Enabled

Neutral Current:

Neutral TOC: — # Not used

Neutral IOC:

Function	=	Enabled
Source	=	SRC 1 (SRC 1)
Pickup	=	0.100 pu
Delay	=	0.00 s
Reset Delay	=	0.00 s
Block	=	OFF
Target	=	Self-reset
Events	=	Enabled

Ground Current:

Ground TOC — # Not used

Ground IOC				# Not used
Breaker Failure:	PARAMETER		BF1	BF2
	Function	=	Enabled	Enabled
	Mode	=	3-Pole	3-Pole
	Source	=	SRC 1 (SRC 1)	SRC 1 (SRC1)
	Current Supervision	=	Yes	Yes
	Use Seal-In	=	No	No
	Three Pole Initiate	=	Bkr Fail Int On(M7a);	
	Block	=	NEUTRAL IOC1 PKP	OFF
	Phase Current Supv Pickup	=	0.15 pu	# 50FD-P
	Neutral Current Supv Pickup	=	0.100 pu	# 50FD-G
	Use Timer 1	=	No	No
	Timer 1 Pickup Delay	=	0.000 s	0.000 s
	Use Timer 2	=	Yes	Yes
	Timer 2 Pickup Delay	=	0.130 s	0.160 s
	Use Timer 3	=	No	No
	Timer 3 Pickup Delay	=	0.000 s	0.000 s
	Breaker Pos1 Phase A/3P	=	OFF	OFF
	Breaker Pos2 Phase A/3P	=	OFF	OFF
	Breaker Test On	=	OFF	OFF
	Phase Current HiSet Pickup	=	0.15 pu	0.15 pu
	Neutral Current HiSet Pickup	=	0.100 pu	0.100 pu
	Phase Current LoSet Pickup	=	0.15 pu	0.15 pu
	Neutral Current LoSet Pickup	=	0.100 pu	0.100 pu
	LoSet Time Delay	=	0.000 s	0.000 s
	Trip Dropout Delay	=	0.000 s	0.000 s
	Target	=	Latched	Latched
	Events	=	Enabled	Enabled
	Phase A Initiate	=	OFF	OFF
	Phase B Initiate	=	OFF	OFF
	Phase C Initiate	=	OFF	OFF
	Breaker Pos1 Phase B	=	OFF	OFF
	Breaker Pos1 Phase C	=	OFF	OFF
	Breaker Pos2 Phase B	=	OFF	OFF
	Breaker Pos2 Phase C	=	OFF	OFF
Voltage Elements:				# Not used
Power:				# Not used
Control Elements:				
Trip Bus:				# Not used
Setting Groups:				# Not used
Selector Switches:				# Not used
Synchrocheck:				# Not used
Digital Elements:				# Not used
Digital Counters:				# Not used
Monitoring Elements:				# Not used
Autoreclose 1P				# Not used
Inputs/Outputs:				
Contact inputs:	SETTING		PARAMETER	
	[H5A] Contact Input 1 ID	=	Spare	
	[H5A] Contact Input 1 Debounce Time	=	2.0 ms	

[H5A] Contact Input 1 Events	=	Disabled
[H5C] Contact Input 2 ID	=	Spare
[H5C] Contact Input 2 Debounce Time	=	2.0 ms
[H5C] Contact Input 2 Events	=	Disabled
[H6A] Contact Input 3 ID	=	Bkr TC1 Mont
[H6A] Contact Input 3 Debounce Time	=	2.0 ms
[H6A] Contact Input 3 Events	=	Enabled
[H6C] Contact Input 4 ID	=	86BF-2 Oper
[H6C] Contact Input 4 Debounce Time	=	2.0 ms
[H6C] Contact Input 4 Events	=	Enabled
[H7A] Contact Input 5 ID	=	86BF-2 Mont
[H7A] Contact Input 5 Debounce Time	=	2.0 ms
[H7A] Contact Input 5 Events	=	Enabled
[H7C] Contact Input 6 ID	=	43L/R
[H7C] Contact Input 6 Debounce Time	=	2.0 ms
[H7C] Contact Input 6 Events	=	Enabled
[H8A] Contact Input 7 ID	=	Spare
[H8A] Contact Input 7 Debounce Time	=	2.0 ms
[H8A] Contact Input 7 Events	=	Disabled
[H8C] Contact Input 8 ID	=	Spare
[H8C] Contact Input 8 Debounce Time	=	2.0 ms
[H8C] Contact Input 8 Events	=	Disabled
[M5A] Contact Input 9 ID	=	Spare
[M5A] Contact Input 9 Debounce Time	=	2.0 ms
[M5A] Contact Input 9 Events	=	Disabled
[M5C] Contact Input 10 ID	=	Spare
[M5C] Contact Input 10 Debounce Time	=	2.0 ms
[M5C] Contact Input 10 Events	=	Disabled
[M6A] Contact Input 11 ID	=	Cont Ip 11
[M6A] Contact Input 11 Debounce Time	=	2.0 ms
[M6A] Contact Input 11 Events	=	Disabled
[M6C] Contact Input 12 ID	=	spare
[M6C] Contact Input 12 Debounce Time	=	2.0 ms
[M6C] Contact Input 12 Events	=	Disabled
[M7A] Contact Input 13 ID	=	Bkr Fail Int
[M7A] Contact Input 13 Debounce Time	=	2.0 ms
[M7A] Contact Input 13 Events	=	Enabled

[M7C] Contact Input 14 ID	=	Cont Ip 14
[M7C] Contact Input 14 Debounce Time	=	2.0 ms
[M7C] Contact Input 14 Events	=	Disabled
[M8A] Contact Input 15 ID	=	Cont Ip 15
[M8A] Contact Input 15 Debounce Time	=	2.0 ms
[M8A] Contact Input 15 Events	=	Disabled
[M8C] Contact Input 16 ID	=	Cont Ip 16
[M8C] Contact Input 16 Debounce Time	=	2.0 ms
[M8C] Contact Input 16 Events	=	Disabled

Contact Inputs Thresholds:

Cont Ip 1, Cont Ip 2, Cont Ip 3, Cont Ip 4(H5A, H5C, H6A, H6C)	=	84 Vdc
Cont Ip5, Cont Ip 6, Cont Ip 7, Cont Ip 8(H7A, H7C, H8A, H8C)	=	84 Vdc
Cont Ip 9, Cont Ip 10, Cont Ip 11, Cont Ip 12(M5A, M5C, M6A, M6C)	=	84 Vdc
Cont Ip 13, Cont Ip 14, Cont Ip 15, Cont Ip 16(M7A, M7C, M8A, M8C)	=	84 Vdc

Virtual Inputs:

SETTING		PARAMETER	
Virtual Input 1 Function	=	Enabled	
Virtual Input 1 ID	=	Bkr Trip	
Virtual Input 1 Type	=	Self-Reset	
Virtual Input 1 Events	=	Enabled	
Virtual Input 2 Function	=	Enabled	
Virtual Input 2 ID	=	Bkr Close	
Virtual Input 2 Type	=	Self-Reset	
Virtual Input 2 Events	=	Enabled	
Other Virtual Inputs (from VI03 to VI64)			# Not used

Contact Outputs:

[H1] Contact Output 1 ID	=	Any Trip
[H1] Contact Output 1 Operate	=	TRIP LED On (VO6)
[H1] Contact Output 1 Seal-In	=	OFF
[H1] Contact Output 1 Events	=	Enabled
[H2] Contact Output 2 ID	=	spare
[H2] Contact Output 2 Operate	=	OFF
[H2] Contact Output 2 Seal-In	=	OFF
[H2] Contact Output 2 Events	=	Disabled
[H3] Contact Output 3 ID	=	Not Used
[H3] Contact Output 3 Operate	=	OFF
[H3] Contact Output 3 Seal-In	=	OFF
[H3] Contact Output 3 Events	=	Disabled
[H4] Contact Output 4 ID	=	NOT USED
[H4] Contact Output 4 Operate	=	OFF
[H4] Contact Output 4 Seal-In	=	OFF
[H4] Contact Output 4 Events	=	Disabled
[M1] Contact Output 5 ID	=	BF TRIP
[M1] Contact Output 5 Operate	=	86BF TRIP On (VO1)

	[M1] Contact Output 5 Seal-In	=	86BF TRIP On (VO1)
	[M1] Contact Output 5 Events	=	Enabled
	[M2] Contact Output 6 ID	=	RETRIP BKR
	[M2] Contact Output 6 Operate	=	RETRIP BKR On (VO2)
	[M2] Contact Output 6 Seal-In	=	RETRIP BKR On (VO2)
	[M2] Contact Output 6 Events	=	Enabled
	[M3] Contact Output 7 ID	=	Bkr Trip
	[M3] Contact Output 7 Operate	=	Bkr Trip On (VO7)
	[M3] Contact Output 7 Seal-In	=	OFF
	[M3] Contact Output 7 Events	=	Enabled
	[M4] Contact Output 8 ID	=	Bkr Close
	[M4] Contact Output 8 Operate	=	Bkr Close On (VO8)
	[M4] Contact Output 8 Seal-In	=	OFF
	[M4] Contact Output 8 Events	=	Enabled
Virtual Outputs:	SETTING		PARAMETER
	Virtual Output 1 ID	=	86BF TRIP
	Virtual Output 1 Events	=	Enabled
	Virtual Output 2 ID	=	RETRIP BKR
	Virtual Output 2 Events	=	Enabled
	Virtual Output 3 ID	=	UNIT ALARM
	Virtual Output 3 Events	=	Enabled
	Virtual Output 4 ID	=	Trig Oscill
	Virtual Output 4 Events	=	Enabled
	Virtual Output 5 ID	=	ALARM NC
	Virtual Output 5 Events	=	Enabled
	Virtual Output 6 ID	=	TRIP LED
	Virtual Output 6 Events	=	Enabled
	Virtual Output 7 ID	=	Bkr Trip
	Virtual Output 7 Events	=	Enabled
	Virtual Output 8 ID	=	Bkr Close
	Virtual Output 8 Events	=	Enabled
	Virtual Output 9 ID	=	Retrip LED
	Virtual Output 9 Events	=	Enabled
	Virtual Output 10 ID	=	Phase A Trip
	Virtual Output 10 Events	=	Enabled
	Virtual Output 11 ID	=	Phase B Trip
	Virtual Output 11 Events	=	Enabled

Virtual Output 12 ID	=	Phase C Trip	
Virtual Output 12 Events	=	Enabled	
Virtual Output 13 ID	=	Ground Trip	
Virtual Output 13 Events	=	Enabled	
Other Virtual Outputs (from VO14 to VO96)			# Not used
Remote Devices:			# Not used
Remote Inputs:			# Not used
Remote Outputs DNA Bit Pairs			# Not used
Remote Outputs UserSt Bit Pairs:			# Not used
Resetting:			# Not used
Direct Inputs:			# Not used
Direct Outputs:			# Not used
Teleprotection:			# Not used
IEC 61850 GOOSE Analogs Inputs			# Not used

Appendix 22 50-62-1-BKR3 (Areva P141) Setting Calculation

1. Data

MVA_Base =	100	kV_Base =	345	Z_Base =	1190.25	ohms
CTR =	600	PTR =	3000	CTR/PTR=	0.2	

Total MVA of all three GSUs = 750 ; Maximum full load current (amps) = 1255.11

2. Setting Criteria

2.1. Set phase IOC element, i.e. phase fault detector, above load if possible but not more than 2/3 of the minimum phase to phase fault at remote bus with the largest source out. For the minimum phase to phase fault at Farragut station under minimum condition which is considered as the largest unit (STG1) of the three units out of service, the contributions from Charlie Poletti are 1,454 Amp via Q35M line and 1,349 Amp via Q35L line. Since each breaker failure relay will normally see only half of the fault contribution per feeder. The IOC1 element shall be set at 0.15 pu or 0.75 CT secondary amp or 450 CT primary amp, or 1/3 of 1,349 Amp or 35.8% of maximum full load. Fault detector picking up on load is considered acceptable here per IEEE standard.

2.2. Set residual IOC element, i.e. ground fault detector, above maximum expected unbalance , but not more than 2/3 of the minimum ground fault at remote bus with the largest source out. For the minimum line to ground fault at Farragut station under minimum condition with is considered as the largest unit (STG1) of the three units out of serivce, the fault contributions from Chaerlie Poletti are 2,021 Amp via Q35L and 2,129 Amp via Q35M. Since each breaker failure relay will normally see only half of the fault contribution on each feeder, set residual IOC element at 0.1 pu or 0.5 CT secondary amp, 300 CT primary amp, or 24% of maximum full load, which is less than 1/3 of minimum phase to ground fault at Farragut.

2.3 Breaker failure timer of 130 ms is used for 3 phase fault and 160 ms is used for unbalanced fault per ConEd standard. Existing Poletti settings show that 120 ms breaker failure time is used regardless fault type.

SYSTEM DATA:

Language = English
Sys Fn Links = 0
Decription = 50-62-1-BKR3
Plant Reference = CHARLES POLETTI
Frequency = 60 Hz

CB CONTROL:

CB Control by = Disabled
Reset Lockout by = CB Close
Man Close RstDly = 5.000 s
CB2 Status Input = 52A

DATE AND TIME:

IRIG-B Sync = Enabled
Battery Alarm = Enabled
Other Time Settings = Default

CONFIGURATION:

Setting Group = Select via Menu
Active Settings = Group 1
Setting Group 1 = Enabled
Setting Group 2 = Disabled
Setting Group 3 = Disabled
Setting Group 4 = Disabled
System Config = Invisible

Appendix 22 50-62-1-BKR3 (Areva P141) Setting Calculation

Overcurrent =	Enabled	# 50FD-P
Neg Sequence O/C =	Enabled	# Unbalance
Broken Conductor =	Disabled	# Not used
Earth Fault 1 =	Disabled	# Not used
Earth Fault 2 =	Enabled	# 50FD-G
Sensitive E/F Prot'n =	Disabled	# Not used
Residual O/V NVD =	Disabled	# Not used
Thermal Overload =	Disabled	# Not used
Neg Sequence O/V =	Disabled	# Not used
Cold Load Pickup =	Disabled	# Not used
Selective Logic =	Disabled	# Not used
Admit Protection =	Disabled	# Not used
Volt Protection =	Disabled	# Not used
Freq Protection =	Disabled	# Not used
df/dt Protection =	Disabled	# Not used
CB Fail =	Enabled	
Supervision =	Enabled	
Fault Locator =	Disabled	
Input Labels =	Visible	
Output Labels =	Visible	
CT & VT Ratios =	Visible	
Record Control =	Invisible	
Disturb Recorder =	Visible	
Measure't Setup =	Visible	
Comms Settings =	Visible	
Commission Tests =	Visible	
Setting Values =	Secondary	
Control Inputs =	Invisible	
Ctrl I/P Config =	Invisible	
Ctrl I/P Labels =	Invisible	
Direct Access =	Disabled	
LCD Contrast =	11	

CT AND VT RATIOS

Main VT Primary =	110.0 V	# Not used
Main VT Sec'y =	110.0 V	# Not used
Phase CT Primary =	3000 A	
Phase CT Sec'y =	5.000 A	
E/F CT Primary =	3000 A	
E/F CT Secondary =	5.000 A	
SEF CT Primary =	1.000 A	
SEF CT Secondary =	1.000 A	

DISTURB RECORDER: See setting file for detail

MEASURE'T SETUP:

Default Display =	Description
Local Values =	Primary
Remote Values =	Primary
Measurement Ref =	VA
Measurement Mode =	0
Fix Dem Period =	30.00 min
Roll Sub Period =	30.00 min

Num Sub Periods = 1

COMMISSION TESTS:

Monitor Bit 1 = 64
Monitor Bit 2 = 65
Monitor Bit 3 = 66
Monitor Bit 4 = 67
Monitor Bit 5 = 68
Monitor Bit 6 = 69
Monitor Bit 7 = 70
Monitor Bit 8 = 71

CB MONITOR SETUP:

Broken I^ = 2.000
I^ Maintenance = Alarm Disabled
I^ Lockout = Alarm Disabled
No. CB Ops Maint = Alarm Disabled
No. CB Ops Lock = Alarm Disabled
CB Time Maint = Alarm Disabled
CB Time Lockout = Alarm Disabled
Fault Freq Lock = Alarm Disabled

OPTO CONFIG:

Global Nominal V = 110/125V
Opto Filter Cntl = 11111111
Characteristic = Standard 60%-80%

Group 1:

GROUP 1 OVERCURRENT:

I>1 Function = DT
I>1 Direction = Non-Directional
I>1 Current Set = 0.75 # 50FD-P
I>1 Time Delay = 0
I>1 tRESET = 0 s
I>2 Status = Disabled
I>3 Status = Disabled
I>4 Status = Disabled
I> Blocking = 000000000
I> Char Angle = 45 deg # Default
VC0 Status = Disabled

GROUP 1 NEG SEQ O/C

I2>1 Status = Enabled
I2>1 Function = DT
I2>1 Directional = Non-Directional
I2>1 Current Set = 500.0mA
I2>1 Time Delay = 0 s
I2>1 Treset = 0 s
I2>2 Status = Disabled
I2>3 Status = Disabled
I2>4 Status = Disabled
I2> Blocking = 00000000
I2> Char Angle = -60.00 deg
I2> V2pol Set = 5.000 V

GROUP 1 EARTH FAULT 2

Appendix 22 50-62-1-BKR3 (Areva P141) Setting Calculation

IN2> Input = Derived
IN2>1 Function = DT
IN2>1 Direction = Non-Directional
IN2>1 Current = 500.0mA # 50FD-G
IN2>1 Time Delay = 0 s
IN2>1 tRESET = 0 s
IN2>2 Function = Disabled
IN2>3 Status = Disabled
IN2>4 Status = Disabled
IN2> Blocking = 00000000
IN2> = POL
IN2> Char Angle = -45.00 deg
IN2> Pol = Zero Sequence
IN2> VNpol Set = 5.000 V

<u>GROUP 1 CB FAIL & I<:</u>

CB Fail 1 Status = Enabled
GB Fail 1 Timer = 0 s
CB Fail 2 Status = Enabled
CB Fail 2 Timer = 130.0 ms
Volt Prot Reset = I < only
Ext Prot Reset = I < only
I< Current Set = 500.0 mA
IN< Current Set = 500.0 mA
ISEF< Current = 20.00 mA
Remove I> Start = Disabled
Remove IN> Start = Disabled

<u>GROUP 1 SUPERVISION:</u>

VTS Status = Indication
VTS Reset Mode = Manual
VTS Time Delay = 5.000 s
VTS I> Inhibit = 50.0 A
VTS I2> Inhibit = 250.0 mA
CTS Mode = Disabled

<u>GROUP 1 INPUT LABELS:</u>

Opto Input 1 Input L1
Opto Input 2 Input L2
Opto Input 3 30-TC2/1 ALM
Opto Input 4 86BF-1/1 TRIP
Opto Input 5 30-86BF-1/1 ALM
Opto Input 6 BF Initiation
Opto Input 7 Input L7
Opto Input 8 Input L8

<u>GROUP 1 OUTPUT LABELS:</u>

Relay 1 Trip 86BF
Relay 2 ReTrip BkrTC2
Relay 3 Any Trip
Relay 4 Output R4
Relay 5 Output R5
Relay 6 Output R6
Relay 7 Output R7

Appendix 23 50-62-2-BKR3 (GE-C60) Setting Calculation

1. Data

MVA_Base =	100	kV_Base =	345	Z_Base =	1190.25	ohms
CTR =	600	PTR =	3000	CTR/PTR=	0.2	

Total MVA of all three GSUs = 750 ; Maximum full load current (amps) = 1255.11

2. Setting Criteria

2.1. Set phase IOC element, i.e. phase fault detector, above load if possible but not more than 2/3 of the minimum phase to phase fault at remote bus with the largest source out. For the minimum phase to phase fault at Farragut station under minimum condition which is considered as the largest unit (STG1) of the three units out of service, the contributions from Charlie Poletti are 1,454 Amp via Q35M line and 1,349 Amp via Q35L line. Since each breaker failure relay will normally see only half of the fault contribution per feeder. The IOC1 element shall be set at 0.15 pu or 0.75 CT secondary amp or 450 CT primary amp, or 1/3 of 1,349 Amp or 35.8% of maximum full load. Fault detector picking up on load is considered acceptable here per IEEE standard.

2.2. Set residual IOC element, i.e. ground fault detector, above maximum expected unbalance , but not more than 2/3 of the minimum ground fault at remote bus with the largest source out. For the minimum line to ground fault at Farragut station under minimum condition with is considered as the largest unit (STG1) of the three units out of serivce, the fault contributions from Chaerlie Poletti are 2,021 Amp via Q35L and 2,129 Amp via Q35M. Since each breaker failure relay will normally see only half of the fault contribution on each feeder, set residual IOC element at 0.1 pu or 0.5 CT secondary amp, 300 CT primary amp, or 24% of maximum full load, which is less than 1/3 of minimum phase to ground fault at Farragut.

2.3 Breaker failure timer of 130 ms is used for 3 phase fault and 160 ms is used for unbalanced fault per ConEd standard. Existing Poletti settings show that 120 ms breaker failure time is used regardless fault type.

Device Definition:				# Default
Product Setup:				
Security:				# Default
Display Properties:				# Default
Clear Relay Records:				# All OFF
Communications:				# Default
Modbus User Map:				# Not used
Real Time Clock:				
	IRIG-B Signal Type	=	DC Shift	
	All other settings	=	Default	
Fault Report:	SETTING		PARAMETER	
	Fault Report 1 Source	=	SRC 1 (SRC 1)	
	Fault Report 1 Trigger	=	Trig Oscill On (VO4)	
	Fault Report 1 Positive Seq (Z1) Mag	=	0.49 ohms	
	Fault Report 1 Positive Seq (Z1) Angle	=	78 deg	
	Fault Report 1 Zero Seq (Z0) Mag	=	1.50 ohms	
	Fault Report 1 Zero Seq (Z0) Angle	=	54 deg	
	Fault Report 1 Line Length Units	=	mile	
	Fault Report 1 Line Length	=	7.74	
	Fault Report 1 VT Substitution	=	None	
	Fault Report 1 System Z0 Mag	=	0.49 ohms	
	Fault Report 1 System Z0 Angle	=	78 deg	
Oscillography:				

Appendix 23 50-62-2-BKR3 (GE-C60) Setting Calculation

SETTING		PARAMETER
Number Of Records	=	6
Trigger Mode	=	Automatic Overwrite
Trigger Position	=	30%
Trigger Source	=	Trig Oscill On (VO4)
AC Input Waveforms	=	32 samples/cycle
Digital Channel 1	=	OFF
Digital Channel 2	=	OFF
Digital Channel 3	=	OFF
Digital Channel 4	=	OFF
Digital Channel 5	=	OFF
Digital Channel 6	=	86BF TRIP On (VO1)
Digital Channel 7	=	RETRIP BKR On (VO2)
Digital Channel 8	=	UNIT ALARM On (VO3)
Digital Channel 9	=	OFF
Digital Channel 10	=	NEUTRAL IOC1 PKP
Digital Channel 11	=	NEUTRAL IOC1 OP
Digital Channel 12	=	PHASE IOC1 PKP A
Digital Channel 13	=	PHASE IOC1 OP A
Digital Channel 14	=	PHASE IOC1 PKP B
Digital Channel 15	=	PHASE IOC1 OP B
Digital Channel 16	=	PHASE IOC1 PKP C
Digital Channel 17	=	PHASE IOC1 OP C
Digital Channel 18	=	Bkr Fail Int On(H7c)
Digital Channel 19	=	BKR FAIL 1 TRIP OP
Digital Channel 20	=	BKR FAIL 2 TRIP OP
Digital Channel 21	=	BKR FAIL 1 T2 OP
Digital Channel 22	=	BKR FAIL 2 T2 OP
Digital Channel 23	=	86BF TRIP On (VO1)
Digital Channel 24	=	RETRIP BKR On (VO2)
Digital Channel 25	=	BKR FAIL 1 RETRIPA
Digital Channel 26	=	BKR FAIL 1 RETRIPB
Digital Channel 27	=	BKR FAIL 1 RETRIPC
Digital Channel 28	=	OFF
Digital Channel 29	=	OFF
Digital Channel 30	=	OFF
Digital Channel 31	=	OFF
Digital Channel 32	=	OFF
Digital Channel 33	=	OFF
Digital Channel 34	=	OFF
Digital Channel 35	=	OFF
Digital Channel 36	=	OFF
Digital Channel 37	=	OFF
Digital Channel 38	=	OFF
Digital Channel 39	=	OFF
Digital Channel 40	=	OFF
Digital Channel 41	=	OFF
Digital Channel 42	=	OFF
Digital Channel 43	=	OFF
Digital Channel 44	=	OFF

Digital Channel 45	=	OFF		
Digital Channel 46	=	OFF		
Digital Channel 47	=	OFF		
Digital Channel 48	=	OFF		
Digital Channel 49	=	OFF		
Digital Channel 50	=	OFF		
Digital Channel 51	=	OFF		
Digital Channel 52	=	OFF		
Digital Channel 53	=	OFF		
Digital Channel 54	=	OFF		
Digital Channel 55	=	OFF		
Digital Channel 56	=	OFF		
Digital Channel 57	=	OFF		
Digital Channel 58	=	OFF		
Digital Channel 59	=	OFF		
Digital Channel 60	=	OFF		
Digital Channel 61	=	OFF		
Digital Channel 62	=	OFF		
Digital Channel 63	=	OFF		
Analog Channel 1	=	SRC1	Ia Mag	
Analog Channel 2	=	SRC2	Ia Mag	
Analog Channel 3	=	SRC1	Ib Mag	
Analog Channel 4	=	SRC2	Ib Mag	
Analog Channel 5	=	SRC1	Ic Mag	
Analog Channel 6	=	SRC2	Ic Mag	
Analog Channel 7	=	SRC1	In Mag	
Analog Channel 8	=	SRC2	In Mag	
Analog Channel 9	=	SRC1	Ia Angle	
Analog Channel 10	=	SRC2	Ia Angle	
Analog Channel 11	=	SRC1	Ib Angle	
Analog Channel 12	=	SRC2	Ib Angle	
Analog Channel 13	=	SRC1	Ic Angle	
Analog Channel 14	=	SRC2	Ic Angle	
Analog Channel 15	=	Off		
Analog Channel 16	=	Off		

<u>Data Logger:</u> # Default

<u>Demand:</u> # Default

<u>User-Programmable Leds:</u>

<u>LED Test:</u>

Function	=	Enabled	
Control	=	CONTROL PUSHBUTTON 1 ON	

<u>Trip and Alarms Leds:</u>

Trip LED Input	=	86BF TRIP On (VO1)	
Alarm LED Input	=	UNIT ALARM On (VO3)	
LED 1	=	86BF TRIP On (VO1)	Latched
LED 2	=	BKR FAIL 1 TRIP OP	Latched
LED 3	=	BKR FAIL 2 TRIP OP	Latched
LED 4	=	Retrip LED On (VO9)	Latched
LED 5	=	OFF	Latched

LED 6	=	OFF	Self-Reset
LED 7	=	OFF	Self-Reset
LED 8	=	OFF	Self-Reset
LED 9	=	Phase A Trip On (VO10)	Latched
LED 10	=	Phase B Trip On (VO11)	Latched
LED 11	=	Phase C Trip On (VO12)	Latched
LED 12	=	Ground Trip On (VO13)	Latched
LED 13	=	OFF	Self-Reset
LED 14	=	OFF	Self-Reset
LED 15	=	OFF	Self-Reset
LED 16	=	OFF	Self-Reset
LED 17	=	OFF	Self-Reset
LED 18	=	OFF	Self-Reset
LED 19	=	OFF	Self-Reset
LED 20	=	OFF	Self-Reset
LED 21	=	OFF	Self-Reset
LED 22	=	Bkr Fail Int On(H7c)	Self-Reset
LED 23	=	BKR FAIL 1 T2 OP	Self-Reset
LED 24	=	BKR FAIL 2 T2 OP	Self-Reset
LED 25	=	OFF	Self-Reset
LED 26	=	OFF	Self-Reset
LED 27	=	OFF	Self-Reset
LED 28	=	OFF	Self-Reset
LED 29	=	OFF	Self-Reset
LED 30	=	OFF	Self-Reset
LED 31	=	OFF	Self-Reset
LED 32	=	OFF	Self-Reset
LED 33	=	OFF	Self-Reset
LED 34	=	OFF	Self-Reset
LED 35	=	OFF	Self-Reset
LED 36	=	OFF	Self-Reset
LED 37	=	OFF	Self-Reset
LED 38	=	OFF	Self-Reset
LED 39	=	OFF	Self-Reset
LED 40	=	OFF	Self-Reset
LED 41	=	OFF	Self-Reset
LED 42	=	OFF	Self-Reset
LED 43	=	OFF	Self-Reset
LED 44	=	OFF	Self-Reset
LED 45	=	OFF	Self-Reset
LED 46	=	OFF	Self-Reset
LED 47	=	OFF	Self-Reset
LED 48	=	OFF	Self-Reset

<u>User-Programmable Self Tests:</u>

Remote Device Off Function	=	Enabled
Pri Ethernet Fail Function	=	Enabled
Battery Fail Function	=	Enabled
SNTP Fail Function	=	Enabled
IRIG B Fail Function	=	Enabled

<u>Control Pushbuttons:</u>

Appendix 23 50-62-2-BKR3 (GE-C60) Setting Calculation

PARAMETER	CPB 1	CPB 2	CPB 3
Function	Enabled	Disabled	Disabled
Events	Disabled	Disabled	Disabled

Flex States: # All OFF
User-definable displays: # Not used
Direct I/O: # Not used
Teleprotection: # Not used
Installation:

Relay Name = 50/62-2 Breaker 3

System Setup:
AC Inputs

Current:	PARAMETER		CT F1
	Phase CT Primary	=	3000 A
	Phase CT Secondary	=	5 A
	Ground CT Primary	=	3000 A
	Ground CT Secondary	=	5 A

Voltage: # Not used

Power System:

Nominal Frequency	=	60 Hz
Phase Rotation	=	ABC
Frequency And Phase Reference	=	SRC 1 (SRC 1)
Frequency Tracking Function	=	Enabled

Signal Sources:	PARAMETER		SOURCE 1	SOURCE 2
	Name	=	SRC 1	SRC 2
	Phase CT	=	F1	None
	Ground CT	=	None	None
	Phase VT	=	None	None
	Aux VT	=	None	None

Breakers:	SETTING		PARAMETER
	Breaker 1 Function	=	Disabled
	Breaker 1 Push Button Control	=	Disabled
	Breaker 1 Name	=	Bkr 1
	Breaker 1 Mode	=	3-Pole
	Breaker 1 Open	=	OFF
	Breaker 1 Block Open	=	OFF
	Breaker 1 Close	=	OFF
	Breaker 1 Block Close	=	OFF
	Breaker 1 Phase A/3-Pole Closed	=	OFF
	Breaker 1 Phase A/3-Pole Opened	=	OFF
	Breaker 1 Phase B Closed	=	OFF
	Breaker 1 Phase B Opened	=	OFF
	Breaker 1 Phase C Closed	=	OFF
	Breaker 1 Phase C Opened	=	OFF
	Breaker 1 Toperate	=	0.070 s
	Breaker 1 External Alarm	=	OFF
	Breaker 1 Alarm Delay	=	0.000 s
	Breaker 1 Manual Close Recal Time	=	0.000 s
	Breaker 1 Out Of Service	=	OFF
	Breaker 1 Events	=	Disabled

Breaker 2 Function	=	Disabled	
Breaker 2 Push Button Control	=	Disabled	
Breaker 2 Name	=	Bkr 2	
Breaker 2 Mode	=	3-Pole	
Breaker 2 Open	=	OFF	
Breaker 2 Block Open	=	OFF	
Breaker 2 Close	=	OFF	
Breaker 2 Block Close	=	OFF	
Breaker 2 Phase A/3-Pole Closed	=	OFF	
Breaker 2 Phase A/3-Pole Opened	=	OFF	
Breaker 2 Phase B Closed	=	OFF	
Breaker 2 Phase B Opened	=	OFF	
Breaker 2 Phase C Closed	=	OFF	
Breaker 2 Phase C Opened	=	OFF	
Breaker 2 Toperate	=	0.070 s	
Breaker 2 External Alarm	=	OFF	
Breaker 2 Alarm Delay	=	0.000 s	
Breaker 2 Manual Close Recal Time	=	0.000 s	
Breaker 2 Out Of Service	=	OFF	
Breaker 2 Events	=	Disabled	
Switches			# Not used
FlexCurves:			# Not used
FlexLogic:			# See 50-62-2-BKR1-r0.pdf
Grouped Elements:			
Group 1:			
Phase Current:			
Phase TOC:			# Not used
Phase IOC:			
Function	=	Enabled	
Source	=	SRC 1 (SRC 1)	
Pickup	=	0.15 pu	
Delay	=	0.00 s	
Reset Delay	=	0.00 s	
Block A	=	OFF	
Block B	=	OFF	
Block C	=	OFF	
Target	=	Self-reset	
Events	=	Enabled	
Neutral Current:			
Neutral TOC:			# Not used
Neutral IOC:			
Function	=	Enabled	
Source	=	SRC 1 (SRC 1)	
Pickup	=	0.100 pu	
Delay	=	0.00 s	
Reset Delay	=	0.00 s	
Block	=	OFF	
Target	=	Self-reset	
Events	=	Enabled	
Ground Current:			

Ground TOC				# Not used
Ground IOC				# Not used
Breaker Failure:	PARAMETER		BF1	BF2
	Function	=	Enabled	Enabled
	Mode	=	3-Pole	3-Pole
	Source	=	SRC 1 (SRC 1)	SRC 1 (SRC1)
	Current Supervision	=	Yes	Yes
	Use Seal-In	=	No	No
	Three Pole Initiate	=	Bkr Fail Int On(H7c);	Cont Ip 2 On(H5c)
	Block	=	NEUTRAL IOC1 PKP	OFF
	Phase Current Supv Pickup	=	0.15 pu	# 50FD-P
	Neutral Current Supv Pickup	=	0.100 pu	# 50FD-G
	Use Timer 1	=	No	No
	Timer 1 Pickup Delay	=	0.000 s	0.000 s
	Use Timer 2	=	Yes	Yes
	Timer 2 Pickup Delay	=	0.130 s	0.160 s
	Use Timer 3	=	No	No
	Timer 3 Pickup Delay	=	0.000 s	0.000 s
	Breaker Pos1 Phase A/3P	=	OFF	OFF
	Breaker Pos2 Phase A/3P	=	OFF	OFF
	Breaker Test On	=	OFF	OFF
	Phase Current HiSet Pickup	=	0.15 pu	0.15 pu
	Neutral Current HiSet Pickup	=	0.100 pu	0.100 pu
	Phase Current LoSet Pickup	=	0.15 pu	0.15 pu
	Neutral Current LoSet Pickup	=	0.100 pu	0.100 pu
	LoSet Time Delay	=	0.000 s	0.000 s
	Trip Dropout Delay	=	0.000 s	0.000 s
	Target	=	Latched	Latched
	Events	=	Enabled	Enabled
	Phase A Initiate	=	OFF	OFF
	Phase B Initiate	=	OFF	OFF
	Phase C Initiate	=	OFF	OFF
	Breaker Pos1 Phase B	=	OFF	OFF
	Breaker Pos1 Phase C	=	OFF	OFF
	Breaker Pos2 Phase B	=	OFF	OFF
	Breaker Pos2 Phase C	=	OFF	OFF
Voltage Elements:				# Not used
Power:				# Not used
Control Elements:				
Trip Bus:				# Not used
Setting Groups:				# Not used
Selector Switches:				# Not used
Synchrocheck:				# Not used
Digital Elements:				# Not used
Digital Counters:				# Not used
Monitoring Elements:				# Not used
Autoreclose 1P				# Not used
Inputs/Outputs:				
Contact inputs:	SETTING		PARAMETER	
	[H5A] Contact Input 1 ID	=	Spare	

[H5A] Contact Input 1 Debounce Time	=	2.0 ms
[H5A] Contact Input 1 Events	=	Disabled
[H5C] Contact Input 2 ID	=	Spare
[H5C] Contact Input 2 Debounce Time	=	2.0 ms
[H5C] Contact Input 2 Events	=	Disabled
[H6A] Contact Input 3 ID	=	Bkr TC1 Mont
[H6A] Contact Input 3 Debounce Time	=	2.0 ms
[H6A] Contact Input 3 Events	=	Enabled
[H6C] Contact Input 4 ID	=	86BF-2 Oper
[H6C] Contact Input 4 Debounce Time	=	2.0 ms
[H6C] Contact Input 4 Events	=	Enabled
[H7A] Contact Input 5 ID	=	86BF-2 Mont
[H7A] Contact Input 5 Debounce Time	=	2.0 ms
[H7A] Contact Input 5 Events	=	Enabled
[H7C] Contact Input 6 ID	=	43L/R
[H7C] Contact Input 6 Debounce Time	=	2.0 ms
[H7C] Contact Input 6 Events	=	Enabled
[H8A] Contact Input 7 ID	=	Spare
[H8A] Contact Input 7 Debounce Time	=	2.0 ms
[H8A] Contact Input 7 Events	=	Disabled
[H8C] Contact Input 8 ID	=	Spare
[H8C] Contact Input 8 Debounce Time	=	2.0 ms
[H8C] Contact Input 8 Events	=	Disabled
[M5A] Contact Input 9 ID	=	Spare
[M5A] Contact Input 9 Debounce Time	=	2.0 ms
[M5A] Contact Input 9 Events	=	Disabled
[M5C] Contact Input 10 ID	=	Spare
[M5C] Contact Input 10 Debounce Time	=	2.0 ms
[M5C] Contact Input 10 Events	=	Disabled
[M6A] Contact Input 11 ID	=	Cont Ip 11
[M6A] Contact Input 11 Debounce Time	=	2.0 ms
[M6A] Contact Input 11 Events	=	Disabled
[M6C] Contact Input 12 ID	=	spare
[M6C] Contact Input 12 Debounce Time	=	2.0 ms
[M6C] Contact Input 12 Events	=	Disabled
[M7A] Contact Input 13 ID	=	Bkr Fail Int
[M7A] Contact Input 13 Debounce Time	=	2.0 ms
[M7A] Contact Input 13 Events	=	Enabled

[M7C] Contact Input 14 ID	=	Cont Ip 14		
[M7C] Contact Input 14 Debounce Time	=	2.0 ms		
[M7C] Contact Input 14 Events	=	Disabled		
[M8A] Contact Input 15 ID	=	Cont Ip 15		
[M8A] Contact Input 15 Debounce Time	=	2.0 ms		
[M8A] Contact Input 15 Events	=	Disabled		
[M8C] Contact Input 16 ID	=	Cont Ip 16		
[M8C] Contact Input 16 Debounce Time	=	2.0 ms		
[M8C] Contact Input 16 Events	=	Disabled		
Contact Inputs Thresholds:				
Cont Ip 1, Cont Ip 2, Cont Ip 3, Cont Ip 4(H5A, H5C, H6A, H6C)			=	84 Vdc
Cont Ip5, Cont Ip 6, Cont Ip 7, Cont Ip 8(H7A, H7C, H8A, H8C)			=	84 Vdc
Cont Ip 9, Cont Ip 10, Cont Ip 11, Cont Ip 12(M5A, M5C, M6A, M6C)			=	84 Vdc
Cont Ip 13, Cont Ip 14, Cont Ip 15, Cont Ip 16(M7A, M7C, M8A, M8C)			=	84 Vdc
Virtual Inputs: SETTING		PARAMETER		
Virtual Input 1 Function	=	Enabled		
Virtual Input 1 ID	=	Bkr Trip		
Virtual Input 1 Type	=	Self-Reset		
Virtual Input 1 Events	=	Enabled		
Virtual Input 2 Function	=	Enabled		
Virtual Input 2 ID	=	Bkr Close		
Virtual Input 2 Type	=	Self-Reset		
Virtual Input 2 Events	=	Enabled		
Other Virtual Inputs (from VI03 to VI64)				# Not used
Contact Outputs:				
[H1] Contact Output 1 ID	=	Any Trip		
[H1] Contact Output 1 Operate	=	TRIP LED On (VO6)		
[H1] Contact Output 1 Seal-In	=	OFF		
[H1] Contact Output 1 Events	=	Enabled		
[H2] Contact Output 2 ID	=	spare		
[H2] Contact Output 2 Operate	=	OFF		
[H2] Contact Output 2 Seal-In	=	OFF		
[H2] Contact Output 2 Events	=	Disabled		
[H3] Contact Output 3 ID	=	Not Used		
[H3] Contact Output 3 Operate	=	OFF		
[H3] Contact Output 3 Seal-In	=	OFF		
[H3] Contact Output 3 Events	=	Disabled		
[H4] Contact Output 4 ID	=	NOT USED		
[H4] Contact Output 4 Operate	=	OFF		
[H4] Contact Output 4 Seal-In	=	OFF		
[H4] Contact Output 4 Events	=	Disabled		
[M1] Contact Output 5 ID	=	BF TRIP		

	[M1] Contact Output 5 Operate	=	86BF TRIP On (VO1)
	[M1] Contact Output 5 Seal-In	=	86BF TRIP On (VO1)
	[M1] Contact Output 5 Events	=	Enabled
	[M2] Contact Output 6 ID	=	RETRIP BKR
	[M2] Contact Output 6 Operate	=	RETRIP BKR On (VO2)
	[M2] Contact Output 6 Seal-In	=	RETRIP BKR On (VO2)
	[M2] Contact Output 6 Events	=	Enabled
	[M3] Contact Output 7 ID	=	Bkr Trip
	[M3] Contact Output 7 Operate	=	Bkr Trip On (VO7)
	[M3] Contact Output 7 Seal-In	=	OFF
	[M3] Contact Output 7 Events	=	Enabled
	[M4] Contact Output 8 ID	=	Bkr Close
	[M4] Contact Output 8 Operate	=	Bkr Close On (VO8)
	[M4] Contact Output 8 Seal-In	=	OFF
	[M4] Contact Output 8 Events	=	Enabled
<u>Virtual Outputs:</u>	SETTING		PARAMETER
	Virtual Output 1 ID	=	86BF TRIP
	Virtual Output 1 Events	=	Enabled
	Virtual Output 2 ID	=	RETRIP BKR
	Virtual Output 2 Events	=	Enabled
	Virtual Output 3 ID	=	UNIT ALARM
	Virtual Output 3 Events	=	Enabled
	Virtual Output 4 ID	=	Trig Oscill
	Virtual Output 4 Events	=	Enabled
	Virtual Output 5 ID	=	ALARM NC
	Virtual Output 5 Events	=	Enabled
	Virtual Output 6 ID	=	TRIP LED
	Virtual Output 6 Events	=	Enabled
	Virtual Output 7 ID	=	Bkr Trip
	Virtual Output 7 Events	=	Enabled
	Virtual Output 8 ID	=	Bkr Close
	Virtual Output 8 Events	=	Enabled
	Virtual Output 9 ID	=	Retrip LED
	Virtual Output 9 Events	=	Enabled
	Virtual Output 10 ID	=	Phase A Trip
	Virtual Output 10 Events	=	Enabled
	Virtual Output 11 ID	=	Phase B Trip

Virtual Output 11 Events	=	Enabled	
Virtual Output 12 ID	=	Phase C Trip	
Virtual Output 12 Events	=	Enabled	
Virtual Output 13 ID	=	Ground Trip	
Virtual Output 13 Events	=	Enabled	
Other Virtual Outputs (from VO14 to VO96)			# Not used
Remote Devices:			# Not used
Remote Inputs:			# Not used
Remote Outputs DNA Bit Pairs			# Not used
Remote Outputs UserSt Bit Pairs:			# Not used
Resetting:			# Not used
Direct Inputs:			# Not used
Direct Outputs:			# Not used
Teleprotection:			# Not used
IEC 61850 GOOSE Analogs Inputs			# Not used

Appendix 24 50-62-1-BKR5 (Areva P141) Setting Calculation

1. Data

MVA_Base =	100	kV_Base =	345	Z_Base =	1190.25	ohms
CTR =	600	PTR =	3000	CTR/PTR=	0.2	

Total MVA of all three GSUs = 750 ; Maximum full load current (amps) = 1255.11

2. Setting Criteria

2.1. Set phase IOC element, i.e. phase fault detector, above load if possible but not more than 2/3 of the minimum phase to phase fault at remote bus with the largest source out. For the minimum phase to phase fault at Farragut station under minimum condition which is considered as the largest unit (STG1) of the three units out of service, the contributions from Charlie Poletti are 1,454 Amp via Q35M line and 1,349 Amp via Q35L line. Since each breaker failure relay will normally see only half of the fault contribution per feeder. The IOC1 element shall be set at 0.15 pu or 0.75 CT secondary amp or 450 CT primary amp, or 1/3 of 1,349 Amp or 35.8% of maximum full load. Fault detector picking up on load is considered acceptable here per IEEE standard.

2.2. Set residual IOC element, i.e. ground fault detector, above maximum expected unbalance , but not more than 2/3 of the minimum ground fault at remote bus with the largest source out. For the minimum line to ground fault at Farragut station under minimum condition with is considered as the largest unit (STG1) of the three units out of serivce, the fault contributions from Chaerlie Poletti are 2,021 Amp via Q35L and 2,129 Amp via Q35M. Since each breaker failure relay will normally see only half of the fault contribution on each feeder, set residual IOC element at 0.1 pu or 0.5 CT secondary amp, 300 CT primary amp, or 24% of maximum full load, which is less than 1/3 of minimum phase to ground fault at Farragut.

2.3 Breaker failure timer of 130 ms is used for 3 phase fault and 160 ms is used for unbalanced fault per ConEd standard. Existing Poletti settings show that 120 ms breaker failure time is used regardless fault type.

<u>SYSTEM DATA:</u>

Language = English
Sys Fn Links = 0
Decription = 50-62-1-BKR5
Plant Reference = CHARLES POLETTI
Frequency = 60 Hz

<u>CB CONTROL:</u>

CB Control by = Disabled
Reset Lockout by = CB Close
Man Close RstDly = 5.000 s
CB2 Status Input = 52A

<u>DATE AND TIME:</u>

IRIG-B Sync = Enabled
Battery Alarm = Enabled
Other Time Settings = Default

<u>CONFIGURATION:</u>

Setting Group = Select via Menu
Active Settings = Group 1
Setting Group 1 = Enabled
Setting Group 2 = Disabled
Setting Group 3 = Disabled
Setting Group 4 = Disabled
System Config = Invisible

Appendix 24 50-62-1-BKR5 (Areva P141) Setting Calculation

Overcurrent =	Enabled	# 50FD-P
Neg Sequence O/C =	Enabled	# Unbalance
Broken Conductor =	Disabled	# Not used
Earth Fault 1 =	Disabled	# Not used
Earth Fault 2 =	Enabled	# 50FD-G
Sensitive E/F Prot'n =	Disabled	# Not used
Residual O/V NVD =	Disabled	# Not used
Thermal Overload =	Disabled	# Not used
Neg Sequence O/V =	Disabled	# Not used
Cold Load Pickup =	Disabled	# Not used
Selective Logic =	Disabled	# Not used
Admit Protection =	Disabled	# Not used
Volt Protection =	Disabled	# Not used
Freq Protection =	Disabled	# Not used
df/dt Protection =	Disabled	# Not used
CB Fail =	Enabled	
Supervision =	Enabled	
Fault Locator =	Disabled	
Input Labels =	Visible	
Output Labels =	Visible	
CT & VT Ratios =	Visible	
Record Control =	Invisible	
Disturb Recorder =	Visible	
Measure't Setup =	Visible	
Comms Settings =	Visible	
Commission Tests =	Visible	
Setting Values =	Secondary	
Control Inputs =	Invisible	
Ctrl I/P Config =	Invisible	
Ctrl I/P Labels =	Invisible	
Direct Access =	Disabled	
LCD Contrast =	11	

CT AND VT RATIOS

Main VT Primary =	110.0 V	# Not used
Main VT Sec'y =	110.0 V	# Not used
Phase CT Primary =	3000 A	
Phase CT Sec'y =	5.000 A	
E/F CT Primary =	3000 A	
E/F CT Secondary =	5.000 A	
SEF CT Primary =	1.000 A	
SEF CT Secondary =	1.000 A	

DISTURB RECORDER: See setting file for detail

MEASURE'T SETUP:

Default Display =	Description
Local Values =	Primary
Remote Values =	Primary
Measurement Ref =	VA
Measurement Mode =	0
Fix Dem Period =	30.00 min
Roll Sub Period =	30.00 min

Num Sub Periods = 1

COMMISSION TESTS:

Monitor Bit 1 =	64	
Monitor Bit 2 =	65	
Monitor Bit 3 =	66	
Monitor Bit 4 =	67	
Monitor Bit 5 =	68	
Monitor Bit 6 =	69	
Monitor Bit 7 =	70	
Monitor Bit 8 =	71	

CB MONITOR SETUP:

Broken I^ =	2.000	
I^ Maintenance =	Alarm Disabled	
I^ Lockout =	Alarm Disabled	
No. CB Ops Maint =	Alarm Disabled	
No. CB Ops Lock =	Alarm Disabled	
CB Time Maint =	Alarm Disabled	
CB Time Lockout =	Alarm Disabled	
Fault Freq Lock =	Alarm Disabled	

OPTO CONFIG:

Global Nominal V =	110/125V	
Opto Filter Cntl =	11111111	
Characteristic =	Standard 60%-80%	

Group 1:

GROUP 1 OVERCURRENT:

I>1 Function =	DT		
I>1 Direction =	Non-Directional		
I>1 Current Set =	0.75		# 50FD-P
I>1 Time Delay =	0		
I>1 tRESET =	0	s	
I>2 Status =	Disabled		
I>3 Status =	Disabled		
I>4 Status =	Disabled		
I> Blocking =	000000000		
I> Char Angle =	45	deg	# Default
VC0 Status =	Disabled		

GROUP 1 NEG SEQ O/C

I2>1 Status =	Enabled
I2>1 Function =	DT
I2>1 Directional =	Non-Directional
I2>1 Current Set =	500.0mA
I2>1 Time Delay =	0 s
I2>1 Treset =	0 s
I2>2 Status =	Disabled
I2>3 Status =	Disabled
I2>4 Status =	Disabled
I2> Blocking =	00000000
I2> Char Angle =	-60.00 deg
I2> V2pol Set =	5.000 V

GROUP 1 EARTH FAULT 2

IN2> Input = Derived
IN2>1 Function = DT
IN2>1 Direction = Non-Directional
IN2>1 Current = 500.0mA # 50FD-G
IN2>1 Time Delay = 0 s
IN2>1 tRESET = 0 s
IN2>2 Function = Disabled
IN2>3 Status = Disabled
IN2>4 Status = Disabled
IN2> Blocking = 00000000
IN2> = POL
IN2> Char Angle = -45.00 deg
IN2> Pol = Zero Sequence
IN2> VNpol Set = 5.000 V

GROUP 1 CB FAIL & I<:

CB Fail 1 Status = Enabled
GB Fail 1 Timer = 0 s
CB Fail 2 Status = Enabled
CB Fail 2 Timer = 130.0 ms
Volt Prot Reset = I < only
Ext Prot Reset = I < only
I< Current Set = 500.0 mA
IN< Current Set = 500.0 mA
ISEF< Current = 20.00 mA
Remove I> Start = Disabled
Remove IN> Start = Disabled

GROUP 1 SUPERVISION:

VTS Status = Indication
VTS Reset Mode = Manual
VTS Time Delay = 5.000 s
VTS I> Inhibit = 50.0 A
VTS I2> Inhibit = 250.0 mA
CTS Mode = Disabled

GROUP 1 INPUT LABELS:

Opto Input 1 Input L1
Opto Input 2 Input L2
Opto Input 3 30-TC2/1 ALM
Opto Input 4 86BF-1/1 TRIP
Opto Input 5 30-86BF-1/1 ALM
Opto Input 6 BF Initiation
Opto Input 7 Input L7
Opto Input 8 Input L8

GROUP 1 OUTPUT LABELS:

Relay 1 Trip 86BF
Relay 2 ReTrip BkrTC2
Relay 3 Any Trip
Relay 4 Output R4
Relay 5 Output R5
Relay 6 Output R6
Relay 7 Output R7

Appendix 25 50-62-2-BKR5 (GE-C60) Setting Calculation

1. Data

MVA_Base =	100	kV_Base =	345	Z_Base =	1190.25	ohms
CTR =	600	PTR =	3000	CTR/PTR=	0.2	

Total MVA of all three GSUs = 750 ; Maximum full load current (amps) = 1255.11

2. Setting Criteria

2.1. Set phase IOC element, i.e. phase fault detector, above load if possible but not more than 2/3 of the minimum phase to phase fault at remote bus with the largest source out. For the minimum phase to phase fault at Farragut station under minimum condition which is considered as the largest unit (STG1) of the three units out of service, the contributions from Charlie Poletti are 1,454 Amp via Q35M line and 1,349 Amp via Q35L line. Since each breaker failure relay will normally see only half of the fault contribution per feeder. The IOC1 element shall be set at 0.15 pu or 0.75 CT secondary amp or 450 CT primary amp, or 1/3 of 1,349 Amp or 35.8% of maximum full load. Fault detector picking up on load is considered acceptable here per IEEE standard.

2.2. Set residual IOC element, i.e. ground fault detector, above maximum expected unbalance , but not more than 2/3 of the minimum ground fault at remote bus with the largest source out. For the minimum line to ground fault at Farragut station under minimum condition with is considered as the largest unit (STG1) of the three units out of serivce, the fault contributions from Chaerlie Poletti are 2,021 Amp via Q35L and 2,129 Amp via Q35M. Since each breaker failure relay will normally see only half of the fault contribution on each feeder, set residual IOC element at 0.1 pu or 0.5 CT secondary amp, 300 CT primary amp, or 24% of maximum full load, which is less than 1/3 of minimum phase to ground fault at Farragut.

2.3 Breaker failure timer of 130 ms is used for 3 phase fault and 160 ms is used for unbalanced fault per ConEd standard. Existing Poletti settings show that 120 ms breaker failure time is used regardless fault type.

Device Definition:			# Default
Product Setup:			
Security:			# Default
Display Properties:			# Default
Clear Relay Records:			# All OFF
Communications:			# Default
Modbus User Map:			# Not used
Real Time Clock:			
IRIG-B Signal Type	=	DC Shift	
All other settings	=	Default	
Fault Report: SETTING		PARAMETER	
Fault Report 1 Source	=	SRC 1 (SRC 1)	
Fault Report 1 Trigger	=	Trig Oscill On (VO4)	
Fault Report 1 Positive Seq (Z1) Mag	=	0.49 ohms	
Fault Report 1 Positive Seq (Z1) Angle	=	78 deg	
Fault Report 1 Zero Seq (Z0) Mag	=	1.50 ohms	
Fault Report 1 Zero Seq (Z0) Angle	=	54 deg	
Fault Report 1 Line Length Units	=	mile	
Fault Report 1 Line Length	=	7.74	
Fault Report 1 VT Substitution	=	None	
Fault Report 1 System Z0 Mag	=	0.49 ohms	
Fault Report 1 System Z0 Angle	=	78 deg	
Oscillography:			

Appendix 25 50-62-2-BKR5 (GE-C60) Setting Calculation

SETTING		PARAMETER
Number Of Records	=	6
Trigger Mode	=	Automatic Overwrite
Trigger Position	=	30%
Trigger Source	=	Trig Oscill On (VO4)
AC Input Waveforms	=	32 samples/cycle
Digital Channel 1	=	OFF
Digital Channel 2	=	OFF
Digital Channel 3	=	OFF
Digital Channel 4	=	OFF
Digital Channel 5	=	OFF
Digital Channel 6	=	86BF TRIP On (VO1)
Digital Channel 7	=	RETRIP BKR On (VO2)
Digital Channel 8	=	UNIT ALARM On (VO3)
Digital Channel 9	=	OFF
Digital Channel 10	=	NEUTRAL IOC1 PKP
Digital Channel 11	=	NEUTRAL IOC1 OP
Digital Channel 12	=	PHASE IOC1 PKP A
Digital Channel 13	=	PHASE IOC1 OP A
Digital Channel 14	=	PHASE IOC1 PKP B
Digital Channel 15	=	PHASE IOC1 OP B
Digital Channel 16	=	PHASE IOC1 PKP C
Digital Channel 17	=	PHASE IOC1 OP C
Digital Channel 18	=	Bkr Fail Int On(H7c)
Digital Channel 19	=	BKR FAIL 1 TRIP OP
Digital Channel 20	=	BKR FAIL 2 TRIP OP
Digital Channel 21	=	BKR FAIL 1 T2 OP
Digital Channel 22	=	BKR FAIL 2 T2 OP
Digital Channel 23	=	86BF TRIP On (VO1)
Digital Channel 24	=	RETRIP BKR On (VO2)
Digital Channel 25	=	BKR FAIL 1 RETRIPA
Digital Channel 26	=	BKR FAIL 1 RETRIPB
Digital Channel 27	=	BKR FAIL 1 RETRIPC
Digital Channel 28	=	OFF
Digital Channel 29	=	OFF
Digital Channel 30	=	OFF
Digital Channel 31	=	OFF
Digital Channel 32	=	OFF
Digital Channel 33	=	OFF
Digital Channel 34	=	OFF
Digital Channel 35	=	OFF
Digital Channel 36	=	OFF
Digital Channel 37	=	OFF
Digital Channel 38	=	OFF
Digital Channel 39	=	OFF
Digital Channel 40	=	OFF
Digital Channel 41	=	OFF
Digital Channel 42	=	OFF
Digital Channel 43	=	OFF
Digital Channel 44	=	OFF

Digital Channel 45	=	OFF		
Digital Channel 46	=	OFF		
Digital Channel 47	=	OFF		
Digital Channel 48	=	OFF		
Digital Channel 49	=	OFF		
Digital Channel 50	=	OFF		
Digital Channel 51	=	OFF		
Digital Channel 52	=	OFF		
Digital Channel 53	=	OFF		
Digital Channel 54	=	OFF		
Digital Channel 55	=	OFF		
Digital Channel 56	=	OFF		
Digital Channel 57	=	OFF		
Digital Channel 58	=	OFF		
Digital Channel 59	=	OFF		
Digital Channel 60	=	OFF		
Digital Channel 61	=	OFF		
Digital Channel 62	=	OFF		
Digital Channel 63	=	OFF		
Analog Channel 1	=	SRC1	Ia Mag	
Analog Channel 2	=	SRC2	Ia Mag	
Analog Channel 3	=	SRC1	Ib Mag	
Analog Channel 4	=	SRC2	Ib Mag	
Analog Channel 5	=	SRC1	Ic Mag	
Analog Channel 6	=	SRC2	Ic Mag	
Analog Channel 7	=	SRC1	In Mag	
Analog Channel 8	=	SRC2	In Mag	
Analog Channel 9	=	SRC1	Ia Angle	
Analog Channel 10	=	SRC2	Ia Angle	
Analog Channel 11	=	SRC1	Ib Angle	
Analog Channel 12	=	SRC2	Ib Angle	
Analog Channel 13	=	SRC1	Ic Angle	
Analog Channel 14	=	SRC2	Ic Angle	
Analog Channel 15	=	Off		
Analog Channel 16	=	Off		

<u>Data Logger:</u> # Default

<u>Demand:</u> # Default

<u>User-Programmable Leds:</u>

<u>LED Test:</u>

Function	=	Enabled
Control	=	CONTROL PUSHBUTTON 1 ON

<u>Trip and Alarms Leds:</u>

Trip LED Input	=	86BF TRIP On (VO1)	
Alarm LED Input	=	UNIT ALARM On (VO3)	
LED 1	=	86BF TRIP On (VO1)	Latched
LED 2	=	BKR FAIL 1 TRIP OP	Latched
LED 3	=	BKR FAIL 2 TRIP OP	Latched
LED 4	=	Retrip LED On (VO9)	Latched
LED 5	=	OFF	Latched

LED 6	=	OFF	Self-Reset
LED 7	=	OFF	Self-Reset
LED 8	=	OFF	Self-Reset
LED 9	=	Phase A Trip On (VO10)	Latched
LED 10	=	Phase B Trip On (VO11)	Latched
LED 11	=	Phase C Trip On (VO12)	Latched
LED 12	=	Ground Trip On (VO13)	Latched
LED 13	=	OFF	Self-Reset
LED 14	=	OFF	Self-Reset
LED 15	=	OFF	Self-Reset
LED 16	=	OFF	Self-Reset
LED 17	=	OFF	Self-Reset
LED 18	=	OFF	Self-Reset
LED 19	=	OFF	Self-Reset
LED 20	=	OFF	Self-Reset
LED 21	=	OFF	Self-Reset
LED 22	=	Bkr Fail Int On(H7c)	Self-Reset
LED 23	=	BKR FAIL 1 T2 OP	Self-Reset
LED 24	=	BKR FAIL 2 T2 OP	Self-Reset
LED 25	=	OFF	Self-Reset
LED 26	=	OFF	Self-Reset
LED 27	=	OFF	Self-Reset
LED 28	=	OFF	Self-Reset
LED 29	=	OFF	Self-Reset
LED 30	=	OFF	Self-Reset
LED 31	=	OFF	Self-Reset
LED 32	=	OFF	Self-Reset
LED 33	=	OFF	Self-Reset
LED 34	=	OFF	Self-Reset
LED 35	=	OFF	Self-Reset
LED 36	=	OFF	Self-Reset
LED 37	=	OFF	Self-Reset
LED 38	=	OFF	Self-Reset
LED 39	=	OFF	Self-Reset
LED 40	=	OFF	Self-Reset
LED 41	=	OFF	Self-Reset
LED 42	=	OFF	Self-Reset
LED 43	=	OFF	Self-Reset
LED 44	=	OFF	Self-Reset
LED 45	=	OFF	Self-Reset
LED 46	=	OFF	Self-Reset
LED 47	=	OFF	Self-Reset
LED 48	=	OFF	Self-Reset

User-Programmable Self Tests:

Remote Device Off Function	=	Enabled
Pri Ethernet Fail Function	=	Enabled
Battery Fail Function	=	Enabled
SNTP Fail Function	=	Enabled
IRIG B Fail Function	=	Enabled

Control Pushbuttons:

PARAMETER	CPB 1	CPB 2	CPB 3
Function	Enabled	Disabled	Disabled
Events	Disabled	Disabled	Disabled

Flex States: # All OFF
User-definable displays: # Not used
Direct I/O: # Not used
Teleprotection: # Not used
Installation:

	Relay Name	=	50/62-2 Breaker 5	

System Setup:
AC Inputs

Current:	PARAMETER		CT F1	
	Phase CT Primary	=	3000 A	
	Phase CT Secondary	=	5 A	
	Ground CT Primary	=	3000 A	
	Ground CT Secondary	=	5 A	
Voltage:				# Not used
Power System:				
	Nominal Frequency	=	60 Hz	
	Phase Rotation	=	ABC	
	Frequency And Phase Reference	=	SRC 1 (SRC 1)	
	Frequency Tracking Function	=	Enabled	

Signal Sources:	PARAMETER		SOURCE 1	SOURCE 2
	Name	=	SRC 1	SRC 2
	Phase CT	=	F1	None
	Ground CT	=	None	None
	Phase VT	=	None	None
	Aux VT	=	None	None

Breakers:	SETTING		PARAMETER
	Breaker 1 Function	=	Disabled
	Breaker 1 Push Button Control	=	Disabled
	Breaker 1 Name	=	Bkr 1
	Breaker 1 Mode	=	3-Pole
	Breaker 1 Open	=	OFF
	Breaker 1 Block Open	=	OFF
	Breaker 1 Close	=	OFF
	Breaker 1 Block Close	=	OFF
	Breaker 1 Phase A/3-Pole Closed	=	OFF
	Breaker 1 Phase A/3-Pole Opened	=	OFF
	Breaker 1 Phase B Closed	=	OFF
	Breaker 1 Phase B Opened	=	OFF
	Breaker 1 Phase C Closed	=	OFF
	Breaker 1 Phase C Opened	=	OFF
	Breaker 1 Toperate	=	0.070 s
	Breaker 1 External Alarm	=	OFF
	Breaker 1 Alarm Delay	=	0.000 s
	Breaker 1 Manual Close Recal Time	=	0.000 s
	Breaker 1 Out Of Service	=	OFF
	Breaker 1 Events	=	Disabled

Appendix 25 50-62-2-BKR5 (GE-C60) Setting Calculation

Breaker 2 Function	=	Disabled	
Breaker 2 Push Button Control	=	Disabled	
Breaker 2 Name	=	Bkr 2	
Breaker 2 Mode	=	3-Pole	
Breaker 2 Open	=	OFF	
Breaker 2 Block Open	=	OFF	
Breaker 2 Close	=	OFF	
Breaker 2 Block Close	=	OFF	
Breaker 2 Phase A/3-Pole Closed	=	OFF	
Breaker 2 Phase A/3-Pole Opened	=	OFF	
Breaker 2 Phase B Closed	=	OFF	
Breaker 2 Phase B Opened	=	OFF	
Breaker 2 Phase C Closed	=	OFF	
Breaker 2 Phase C Opened	=	OFF	
Breaker 2 Toperate	=	0.070 s	
Breaker 2 External Alarm	=	OFF	
Breaker 2 Alarm Delay	=	0.000 s	
Breaker 2 Manual Close Recal Time	=	0.000 s	
Breaker 2 Out Of Service	=	OFF	
Breaker 2 Events	=	Disabled	

Switches # Not used

FlexCurves: # Not used

FlexLogic: # See 50-62-2-BKR1-r0.pdf

Grouped Elements:

Group 1:

Phase Current:

Phase TOC: # Not used

Phase IOC:

Function	=	Enabled
Source	=	SRC 1 (SRC 1)
Pickup	=	0.15 pu
Delay	=	0.00 s
Reset Delay	=	0.00 s
Block A	=	OFF
Block B	=	OFF
Block C	=	OFF
Target	=	Self-reset
Events	=	Enabled

Neutral Current:

Neutral TOC: # Not used

Neutral IOC:

Function	=	Enabled
Source	=	SRC 1 (SRC 1)
Pickup	=	0.100 pu
Delay	=	0.00 s
Reset Delay	=	0.00 s
Block	=	OFF
Target	=	Self-reset
Events	=	Enabled

Ground Current:

Ground TOC				# Not used
Ground IOC				# Not used
Breaker Failure:	PARAMETER		BF1	BF2
	Function	=	Enabled	Enabled
	Mode	=	3-Pole	3-Pole
	Source	=	SRC 1 (SRC 1)	SRC 1 (SRC1)
	Current Supervision	=	Yes	Yes
	Use Seal-In	=	No	No
	Three Pole Initiate	=	Bkr Fail Int On(H7c);	Cont Ip 2 On(H5c)
	Block	=	NEUTRAL IOC1 PKP	OFF
	Phase Current Supv Pickup	=	0.15 pu	# 50FD-P
	Neutral Current Supv Pickup	=	0.100 pu	# 50FD-G
	Use Timer 1	=	No	No
	Timer 1 Pickup Delay	=	0.000 s	0.000 s
	Use Timer 2	=	Yes	Yes
	Timer 2 Pickup Delay	=	0.130 s	0.160 s
	Use Timer 3	=	No	No
	Timer 3 Pickup Delay	=	0.000 s	0.000 s
	Breaker Pos1 Phase A/3P	=	OFF	OFF
	Breaker Pos2 Phase A/3P	=	OFF	OFF
	Breaker Test On	=	OFF	OFF
	Phase Current HiSet Pickup	=	0.15 pu	0.15 pu
	Neutral Current HiSet Pickup	=	0.100 pu	0.100 pu
	Phase Current LoSet Pickup	=	0.15 pu	0.15 pu
	Neutral Current LoSet Pickup	=	0.100 pu	0.100 pu
	LoSet Time Delay	=	0.000 s	0.000 s
	Trip Dropout Delay	=	0.000 s	0.000 s
	Target	=	Latched	Latched
	Events	=	Enabled	Enabled
	Phase A Initiate	=	OFF	OFF
	Phase B Initiate	=	OFF	OFF
	Phase C Initiate	=	OFF	OFF
	Breaker Pos1 Phase B	=	OFF	OFF
	Breaker Pos1 Phase C	=	OFF	OFF
	Breaker Pos2 Phase B	=	OFF	OFF
	Breaker Pos2 Phase C	=	OFF	OFF
Voltage Elements:				# Not used
Power:				# Not used
Control Elements:				
Trip Bus:				# Not used
Setting Groups:				# Not used
Selector Switches:				# Not used
Synchrocheck:				# Not used
Digital Elements:				# Not used
Digital Counters:				# Not used
Monitoring Elements:				# Not used
Autoreclose 1P				# Not used
Inputs/Outputs:				
Contact inputs:	SETTING		PARAMETER	
	[H5A] Contact Input 1 ID	=	CSM-2 (E13)	

[H5A] Contact Input 1 Debounce Time	=	2.0 ms
[H5A] Contact Input 1 Events	=	Enabled
[H5C] Contact Input 2 ID	=	CSM-2 (TIE)
[H5C] Contact Input 2 Debounce Time	=	2.0 ms
[H5C] Contact Input 2 Events	=	Enabled
[H6A] Contact Input 3 ID	=	Bkr TC1 Mont
[H6A] Contact Input 3 Debounce Time	=	2.0 ms
[H6A] Contact Input 3 Events	=	Enabled
[H6C] Contact Input 4 ID	=	86BF-2 Oper
[H6C] Contact Input 4 Debounce Time	=	2.0 ms
[H6C] Contact Input 4 Events	=	Enabled
[H7A] Contact Input 5 ID	=	86BF-2 Mont
[H7A] Contact Input 5 Debounce Time	=	2.0 ms
[H7A] Contact Input 5 Events	=	Enabled
[H7C] Contact Input 6 ID	=	43L/R
[H7C] Contact Input 6 Debounce Time	=	2.0 ms
[H7C] Contact Input 6 Events	=	Enabled
[H8A] Contact Input 7 ID	=	CSM-2 (OFF)
[H8A] Contact Input 7 Debounce Time	=	2.0 ms
[H8A] Contact Input 7 Events	=	Enabled
[H8C] Contact Input 8 ID	=	CSM-2 (FARR)
[H8C] Contact Input 8 Debounce Time	=	2.0 ms
[H8C] Contact Input 8 Events	=	Enabled
[M5A] Contact Input 9 ID	=	11LTSR-2A
[M5A] Contact Input 9 Debounce Time	=	2.0 ms
[M5A] Contact Input 9 Events	=	Enabled
[M5C] Contact Input 10 ID	=	11LTSR-2B
[M5C] Contact Input 10 Debounce Time	=	2.0 ms
[M5C] Contact Input 10 Events	=	Enabled
[M6A] Contact Input 11 ID	=	Cont Ip 11
[M6A] Contact Input 11 Debounce Time	=	2.0 ms
[M6A] Contact Input 11 Events	=	Disabled
[M6C] Contact Input 12 ID	=	spare
[M6C] Contact Input 12 Debounce Time	=	2.0 ms
[M6C] Contact Input 12 Events	=	Disabled
[M7A] Contact Input 13 ID	=	Bkr Fail Int
[M7A] Contact Input 13 Debounce Time	=	2.0 ms
[M7A] Contact Input 13 Events	=	Enabled

[M7C] Contact Input 14 ID	=	Cont Ip 14		
[M7C] Contact Input 14 Debounce Time	=	2.0 ms		
[M7C] Contact Input 14 Events	=	Disabled		
[M8A] Contact Input 15 ID	=	Cont Ip 15		
[M8A] Contact Input 15 Debounce Time	=	2.0 ms		
[M8A] Contact Input 15 Events	=	Disabled		
[M8C] Contact Input 16 ID	=	Cont Ip 16		
[M8C] Contact Input 16 Debounce Time	=	2.0 ms		
[M8C] Contact Input 16 Events	=	Disabled		
Contact Inputs Thresholds:				
Cont Ip 1, Cont Ip 2, Cont Ip 3, Cont Ip 4(H5A, H5C, H6A, H6C)			=	84 Vdc
Cont Ip5, Cont Ip 6, Cont Ip 7, Cont Ip 8(H7A, H7C, H8A, H8C)			=	84 Vdc
Cont Ip 9, Cont Ip 10, Cont Ip 11, Cont Ip 12(M5A, M5C, M6A, M6C)			=	84 Vdc
Cont Ip 13, Cont Ip 14, Cont Ip 15, Cont Ip 16(M7A, M7C, M8A, M8C)			=	84 Vdc
Virtual Inputs: SETTING		PARAMETER		
Virtual Input 1 Function	=	Enabled		
Virtual Input 1 ID	=	Bkr Trip		
Virtual Input 1 Type	=	Self-Reset		
Virtual Input 1 Events	=	Enabled		
Virtual Input 2 Function	=	Enabled		
Virtual Input 2 ID	=	Bkr Close		
Virtual Input 2 Type	=	Self-Reset		
Virtual Input 2 Events	=	Enabled		
Other Virtual Inputs (from VI03 to VI64)				# Not used
Contact Outputs:				
[H1] Contact Output 1 ID	=	Any Trip		
[H1] Contact Output 1 Operate	=	TRIP LED On (VO6)		
[H1] Contact Output 1 Seal-In	=	OFF		
[H1] Contact Output 1 Events	=	Enabled		
[H2] Contact Output 2 ID	=	spare		
[H2] Contact Output 2 Operate	=	OFF		
[H2] Contact Output 2 Seal-In	=	OFF		
[H2] Contact Output 2 Events	=	Disabled		
[H3] Contact Output 3 ID	=	Not Used		
[H3] Contact Output 3 Operate	=	OFF		
[H3] Contact Output 3 Seal-In	=	OFF		
[H3] Contact Output 3 Events	=	Disabled		
[H4] Contact Output 4 ID	=	NOT USED		
[H4] Contact Output 4 Operate	=	OFF		
[H4] Contact Output 4 Seal-In	=	OFF		
[H4] Contact Output 4 Events	=	Disabled		
[M1] Contact Output 5 ID	=	BF TRIP		

	[M1] Contact Output 5 Operate	=	86BF TRIP On (VO1)
	[M1] Contact Output 5 Seal-In	=	86BF TRIP On (VO1)
	[M1] Contact Output 5 Events	=	Enabled
	[M2] Contact Output 6 ID	=	RETRIP BKR
	[M2] Contact Output 6 Operate	=	RETRIP BKR On (VO2)
	[M2] Contact Output 6 Seal-In	=	RETRIP BKR On (VO2)
	[M2] Contact Output 6 Events	=	Enabled
	[M3] Contact Output 7 ID	=	Bkr Trip
	[M3] Contact Output 7 Operate	=	Bkr Trip On (VO7)
	[M3] Contact Output 7 Seal-In	=	OFF
	[M3] Contact Output 7 Events	=	Enabled
	[M4] Contact Output 8 ID	=	Bkr Close
	[M4] Contact Output 8 Operate	=	Bkr Close On (VO8)
	[M4] Contact Output 8 Seal-In	=	OFF
	[M4] Contact Output 8 Events	=	Enabled
<u>Virtual Outputs:</u>	SETTING		PARAMETER
	Virtual Output 1 ID	=	86BF TRIP
	Virtual Output 1 Events	=	Enabled
	Virtual Output 2 ID	=	RETRIP BKR
	Virtual Output 2 Events	=	Enabled
	Virtual Output 3 ID	=	JNIT ALARM
	Virtual Output 3 Events	=	Enabled
	Virtual Output 4 ID	=	Trig Oscill
	Virtual Output 4 Events	=	Enabled
	Virtual Output 5 ID	=	ALARM NC
	Virtual Output 5 Events	=	Enabled
	Virtual Output 6 ID	=	TRIP LED
	Virtual Output 6 Events	=	Enabled
	Virtual Output 7 ID	=	Bkr Trip
	Virtual Output 7 Events	=	Enabled
	Virtual Output 8 ID	=	Bkr Close
	Virtual Output 8 Events	=	Enabled
	Virtual Output 9 ID	=	Retrip LED
	Virtual Output 9 Events	=	Enabled
	Virtual Output 10 ID	=	Phase A Trip
	Virtual Output 10 Events	=	Enabled
	Virtual Output 11 ID	=	Phase B Trip

Virtual Output 11 Events	=	Enabled	
Virtual Output 12 ID	=	Phase C Trip	
Virtual Output 12 Events	=	Enabled	
Virtual Output 13 ID	=	Ground Trip	
Virtual Output 13 Events	=	Enabled	
Other Virtual Outputs (from VO14 to VO96)			# Not used
Remote Devices:			# Not used
Remote Inputs:			# Not used
Remote Outputs DNA Bit Pairs			# Not used
Remote Outputs UserSt Bit Pairs:			# Not used
Resetting:			# Not used
Direct Inputs:			# Not used
Direct Outputs:			# Not used
Teleprotection:			# Not used
IEC 61850 GOOSE Analogs Inputs			# Not used

Appendix 26 CT Evaluation

345kV CT (3000:5, C800) Steady State Evaluation

NO.	CALCULATION	DATA	UNIT	BASIS (DATA SOURCE)
	The maximum fault current If in primary amperes	37994	A	Per Aspen 1LG (Twice lead)
	The corresponding primary circuit **X/R** ratio, i.e. tan(angle)	4.96	N/A	Calculated per fault angle
	Fault angle	78.6	degree	PER ASPEN
	CT Voltage Rating	800		Per One
	CT Ratio	3000	: 5	Breaker Drawing
	Actual CT Ratio	3000	: 5	PER ONE-LINE Drawing 001-Sheet 1
1	The CT secondary maximum fault current Imax-ct-secondary	**63.32**	A	
	Check that CT secondary current does not exceed 100A for maximum fault condition	CT OK		
2	Effective C-Rating = CT Tap/Max CT Ratio * (C-Rating)	800.00		
	Burden Maximum Allow = Eff C-Rating/(2*Imax-ct-secondary)	6.32		C-Rating is two times of the excitation voltage Refer (IEEE C37-110 1996)
	CT winding 600 turns at 0.00207 ohms/turn	1.242	ohms	0.00207ohms/turn per Breaker DWG
	CT leads One Way length In Feet	400	feet	Per Physical layout or cable list
	Single Phase Fault, Y/N?	Y		
	CT lead Wiring Size (AWG)	10	AWG	Per Physical layout or cable list
	Ohms/1000ft of CT Lead	1.00	ohms/1000ft	
	CT leads burden	0.80	ohms	1 Ph or Netural CT: Two Way ; 3 Ph: One-Way
	Relay burden	0.01	ohms	NEGILIBLE PER SEL PAPER 6142.PDF
	Actual CT burden in total	2.05	ohms	
	Compare actual CT burden in total and maximum allowed Burden	CT OK		
	CT Steady State Saturation Evaluation Final Conclusion	**CT OK**		

Note 1: Equation per IEEE C37-110 2007

Note 2. During normal operation, i.e. the ring bus is complete, the fault current through one CT will be half of the fault level used.

3. The fault current used in CT evaluation is the maximum CT primary current with addition of Astoria Energy II generating plant.

Note It is the largest part of the fault current which relay will see, instead of the total fault current.

Appendix 26 CT Evaluation

345kV CT (3000:5, C800) Transient State Evaluation

NO.	CALCULATION	DATA	UNIT	BASIS (DATA SOURCE)
1	The maximum fault current If in primary amperes	37994	A	Per Aspen 1LG (Twice lead)
2	The corresponding primary circuit **X/R** ratio, i.e. tan(angle)	**4.96**	N/A	Calculated per fault angle
	Fault angle	78.6	degree	PER ASPEN
3	CT Voltage Rating	800		Per One
	CT Ratio	3000	: 5	Breaker Drawing
	Actual CT Ratio	3000	: 5	PER ONE-LINE Drawing 001-Sheet 1
4	Maximum fault current in per unit of actual CT rating **If**	**12.66**	pu	
	CT Standard Burden	8	ohms	
	Actual CT Standard Burden	8.00	ohms	
	CT winding 600 turns at 0.00207 ohms/turn	1.242	ohms	0.00207ohms/turn per Breaker DWG
	CT leads One Way length In Feet	400	feet	Per Physical layout or cable list
	Single Phase Fault or Netural CT, "Y" or "N"?	Y		
	CT lead Wiring Size (AWG)	10	AWG	Per Physical layout or cable list
	Ohms/1000ft of CT Lead	1.00	ohms/kft	
	CT leads burden	0.80	ohms	1 Ph or Netural CT: Two Way ; 3 Ph: One-Way
	Relay burden	0.01	ohms	NEGILIBLE PER SEL PAPER 6142.PDF
	Actual CT burden in total	2.05	ohms	
	Actual CT burden in per unit of the actual CT standard burden **Zb**	**0.26**	pu	
5	|X/R+1| * If * Zb =	**19.36**	N/A	
6	20 > = |X/R+1| * If * Zb ?	**CT OK**	N/A	CONCLUSION

Note 1: Equation per SEL paper 6027.pdf

Note 2. During normal operation, i.e. the ring bus is complete, the fault current through one CT will be half of the fault level used.

3. The fault current used in CT evaluation is the maximum CT primary current with addition of Astoria Energy II generating plant.
Note It is the largest part of the fault current which relay will see, instead of the total fault current.

CHARLES POLETTI SUBSTATION

Appendix 27 - Short Circuit Study Results

Appendix 27 - 1 Summary of fault being displayed:
Prefault voltage: From a linear network solution
Generator impedance: Subtransient
MOV iteration: [Off]
Ignore shunts with + seq value: [Yes]
Ignore loads: [Yes]
Ignore line G+jB: [Yes]

```
==============================================================================================================
 1. Bus Fault on:         0 CharlesPolet 345. kV 3LG
                                        FAULT CURRENT (A @ DEG)
          + SEQ                  - SEQ           0 SEQ           A PHASE          B PHASE          C PHASE
        46291.0@ -83.0        0.0@   0.0        0.0@   0.0    46291.0@ -83.0    46291.0@ 157.0    46291.0@  37.0
                                        THEVENIN IMPEDANCE (OHM)
       0.31934+j4.32648   0.36693+j4.34665   1.70682+j4.92127

          SHORT CIRCUIT MVA= 27888.7       X/R RATIO= 13.5481     R0/X1= 0.3945    X0/X1= 1.13748
----------------------------------------------------------------------------------------------------
BUS      0 CharlesPolet   345.KV  AREA   7  ZONE  10   TIER   0      (PREFAULT V=1.008@   2.8 PU)
                              + SEQ              - SEQ                0 SEQ                  A PHASE         B PHASE         C PHASE
VOLTAGE (KV, L-G)          >     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0
BRANCH CURRENT (A) TO      >
    0 AEII          345.  2L    4266.3@ 121.2       0.0@   0.0       0.0@   0.0    4266.3@ 121.2    4266.3@   1.2    4266.3@-118.8
   16 E15ST 48      345.  1L   21007.8@  94.6       0.0@   0.0       0.0@   0.0   21007.8@  94.6   21007.8@ -25.4   21007.8@-145.4
    0 E15ST 47      345.  1L   21426.8@  94.7       0.0@   0.0       0.0@   0.0   21426.8@  94.7   21426.8@ -25.3   21426.8@-145.3

CURRENT TO FAULT (A)       >    46291.0@ -83.0       0.0@   0.0       0.0@   0.0   46291.0@ -83.0   46291.0@ 157.0   46291.0@  37.0
THEVENIN IMPEDANCE (OHM)   >    4.33825@  85.8   4.36211@  85.2   5.20885@  70.9
----------------------------------------------------------------------------------------------------
```

CHARLES POLETTI SUBSTATION

Appendix 27 - Short Circuit Study Results

Appendix 27 – 2 Summary of fault being displayed:
Prefault voltage: From a linear network solution
Generator impedance: Subtransient
MOV iteration: [Off]
Ignore shunts with + seq value: [Yes]
Ignore loads: [Yes]
Ignore line G+jB: [Yes]

```
=====================================================================================================================
 2. Bus Fault on:      0 CharlesPolet 345. kV 2LG Type=B-C
                              FAULT CURRENT (A @ DEG)
        + SEQ            - SEQ         0 SEQ        A PHASE       B PHASE      C PHASE
     29889.4@ -80.5   16393.4@  93.0   13728.5@ 107.3    0.0@   0.0   48112.2@ 162.3   41677.2@  36.3
                              THEVENIN IMPEDANCE (OHM)
    0.31934+j4.32648   0.36693+j4.34665   1.70682+j4.92127

        SHORT CIRCUIT MVA= 28986.0     X/R RATIO= 8.44801    R0/X1= 0.3945    X0/X1= 1.13748
---------------------------------------------------------------------------------------------------
BUS     0 CharlesPolet   345.KV  AREA   7  ZONE  10   TIER   0     (PREFAULT V=1.008@   2.8 PU)
                          + SEQ          - SEQ          0 SEQ            A PHASE       B PHASE       C PHASE
VOLTAGE (KV, L-G)      >    71.510@  -1.8   71.510@  -1.8   71.510@  -1.8  214.529@  -1.8    0.000@   0.0    0.000@   0.0
BRANCH CURRENT (A) TO     >
   0 AEII        345.  2L    3072.8@ 136.4    1522.3@ -88.6    3134.8@ -90.5    3367.0@-131.1    4472.4@ -19.2    5781.2@-111.1
  16 E15ST 48     345.  1L   13611.1@  95.6    7362.0@ -86.9    5344.4@ -67.6    1675.0@  48.5   21616.4@ -17.6   18275.5@-148.5
   0 E15ST 47     345.  1L   13881.8@  95.8    7509.8@ -86.7    5441.5@ -67.6    1692.0@  49.3   22025.3@ -17.5   18659.0@-148.4

CURRENT TO FAULT (A)      >   29889.4@ -80.5   16393.4@  93.0   13728.5@ 107.3      0.0@   0.0   48112.2@ 162.3   41677.2@  36.3
THEVENIN IMPEDANCE (OHM)   >    4.33825@  85.8   4.36211@  85.2   5.20885@  70.9
---------------------------------------------------------------------------------------------------
```

Appendix 27 – 3 Summary of fault being displayed:
Prefault voltage: From a linear network solution
Generator impedance: Subtransient
MOV iteration: [Off]
Ignore shunts with + seq value: [Yes]
Ignore loads: [Yes]
Ignore line G+jB: [Yes]

```
========================================================================================================================
 3. Bus Fault on:          0 CharlesPolet 345. kV 1LG Type=A
                                  FAULT CURRENT (A @ DEG)
          + SEQ            - SEQ         0 SEQ        A PHASE        B PHASE        C PHASE
      14548.7@ -77.2   14548.7@ -77.2   14548.7@ -77.2   43646.1@ -77.2      0.0@   0.0      0.0@   0.0
                                  THEVENIN IMPEDANCE (OHM)
     0.31934+j4.32648   0.36693+j4.34665   1.70682+j4.92127

          SHORT CIRCUIT MVA= 26295.3      X/R RATIO= 5.68069    R0/X1= 0.3945    X0/X1= 1.13748
------------------------------------------------------------------------------------------------------------------------
BUS      0 CharlesPolet   345.KV  AREA   7  ZONE  10   TIER   0      (PREFAULT V=1.008@   2.8 PU)
                              + SEQ          - SEQ          0 SEQ           A PHASE       B PHASE       C PHASE
VOLTAGE (KV, L-G)        >   138.170@   0.2    63.463@-172.1    75.782@ 173.6    0.000@   0.0   192.662@-123.0   222.409@ 122.9
BRANCH CURRENT (A) TO     >
   0 AEII         345.  2L    2249.0@ 162.1    1351.0@ 101.1    3322.1@  85.0    5730.3@ 111.6    4038.9@  76.5    2147.1@  18.3
  16 E15ST 48      345.  1L    6703.6@  94.5    6533.5@ 102.9    5663.7@ 107.9   18813.5@ 101.4    2000.9@-103.9    1075.1@-162.1
   0 E15ST 47      345.  1L    6835.9@  94.6    6664.8@ 103.0    5766.6@ 107.8   19180.7@ 101.5    2038.0@-103.1    1072.1@-161.4

CURRENT TO FAULT (A)      >   14548.7@ -77.2   14548.7@ -77.2   14548.7@ -77.2   43646.1@ -77.2      0.0@   0.0      0.0@   0.0
THEVENIN IMPEDANCE (OHM)   >    4.33825@  85.8   4.36211@  85.2   5.20885@  70.9
------------------------------------------------------------------------------------------------------------------------
```

Appendix 27 - 4 Summary of fault being displayed:
Prefault voltage: From a linear network solution
Generator impedance: Subtransient
MOV iteration: [Off]
Ignore shunts with + seq value: [Yes]
Ignore loads: [Yes]
Ignore line G+jB: [Yes]

```
==========================================================================================================================
 4. Bus Fault on:        0 CharlesPolet 345. kV LL Type=B-C
                                  FAULT CURRENT (A @ DEG)
          + SEQ            - SEQ          0 SEQ        A PHASE        B PHASE        C PHASE
      23082.3@ -82.7   23082.3@  97.3    0.0@   0.0    0.0@   0.0   39979.8@-172.7   39979.8@   7.3
                                  THEVENIN IMPEDANCE (OHM)
     0.31934+j4.32648   0.36693+j4.34665   1.70682+j4.92127

          SHORT CIRCUIT MVA= 24086.4     X/R RATIO= 12.638    R0/X1= 0.3945    X0/X1= 1.13748
----------------------------------------------------------------------------------------------------------
BUS     0 CharlesPolet   345.KV  AREA   7  ZONE  10   TIER   0      (PREFAULT V=1.008@   2.8 PU)
                                 + SEQ            - SEQ            0 SEQ           A PHASE        B PHASE        C PHASE
VOLTAGE (KV, L-G)        >    100.688@   2.5   100.688@   2.5    0.000@   0.0   201.375@   2.5   100.688@-177.5   100.688@-177.5
BRANCH CURRENT (A) TO      >
   0 AEII         345.  2L    2556.2@ 144.1    2143.5@ -84.3      0.0@   0.0    1963.9@-161.2    4675.9@  29.4    2768.5@-143.2
  16 E15ST 48      345.  1L   10601.7@  92.2   10365.8@ -82.6      0.0@   0.0     972.8@  18.8   17668.5@   4.4   18612.2@-174.8
   0 E15ST 47      345.  1L   10812.1@  92.4   10574.0@ -82.5      0.0@   0.0     991.1@  18.9   18021.6@   4.6   18983.6@-174.7

CURRENT TO FAULT (A)      >    23082.3@ -82.7   23082.3@  97.3      0.0@   0.0      0.0@   0.0   39979.8@-172.7   39979.8@   7.3
THEVENIN IMPEDANCE (OHM)   >    4.33825@  85.8   4.36211@  85.2   5.20885@  70.9
----------------------------------------------------------------------------------------------------------
```

Appendix 27 - 5 Summary of fault being displayed:
Prefault voltage: From a linear network solution
Generator impedance: Subtransient
MOV iteration: [Off]
Ignore shunts with + seq value: [Yes]
Ignore loads: [Yes]
Ignore line G+jB: [Yes]

```
==================================================================================================================================
 5. Close-In Fault on:  0 CharlesPolet 345.kV - 0 AEII 345.kV 2L 3LG
                                  FAULT CURRENT (A @ DEG)
           + SEQ                - SEQ          0 SEQ        A PHASE        B PHASE        C PHASE
       46291.0@ -83.0       0.0@   0.0      0.0@   0.0   46291.0@ -83.0   46291.0@ 157.0   46291.0@  37.0
                                  THEVENIN IMPEDANCE (OHM)
      0.31934+j4.32648   0.36693+j4.34665   1.70682+j4.92127

           SHORT CIRCUIT MVA= 27888.7      X/R RATIO= 13.5481    R0/X1= 0.3945    X0/X1= 1.13748
--------------------------------------------------------------------------------------------------------------------
BUS    0 CharlesPolet   345.KV  AREA   7  ZONE  10   TIER   0     (PREFAULT V=1.008@   2.8 PU)
                              + SEQ           - SEQ           0 SEQ           A PHASE       B PHASE       C PHASE
VOLTAGE (KV, L-G)        >    0.000@   0.0    0.000@   0.0    0.000@   0.0    0.000@   0.0    0.000@   0.0    0.000@   0.0
BRANCH CURRENT (A) TO    >
  0 AEII        345.  2L    4266.3@ 121.2      0.0@   0.0      0.0@   0.0    4266.3@ 121.2    4266.3@   1.2    4266.3@-118.8
 16 E15ST 48    345.  1L   21007.8@  94.6      0.0@   0.0      0.0@   0.0   21007.8@  94.6   21007.8@ -25.4   21007.8@-145.4
  0 E15ST 47    345.  1L   21426.8@  94.7      0.0@   0.0      0.0@   0.0   21426.8@  94.7   21426.8@ -25.3   21426.8@-145.3

CURRENT TO FAULT (A)     >   46291.0@ -83.0      0.0@   0.0      0.0@   0.0   46291.0@ -83.0   46291.0@ 157.0   46291.0@  37.0
THEVENIN IMPEDANCE (OHM)  >   4.33825@  85.8   4.36211@  85.2   5.20885@  70.9
--------------------------------------------------------------------------------------------------------------------
MONITORED BRANCH:    0 CharlesPolet   345.KV ->    0 AEII        345.KV  2L

                              + SEQ           - SEQ           0 SEQ           A PHASE       B PHASE       C PHASE
RELAY CURRENT (A)          42434.6@ -85.4      0.0@   0.0      0.0@   0.0   42434.6@ -85.4   42434.6@ 154.6   42434.6@  34.6

BUS VOLTAGES (KV, L-G)
  0 CharlesPolet  345.kV    0.000@   0.0    0.000@   0.0    0.000@   0.0    0.000@   0.0    0.000@   0.0    0.000@   0.0
  0 AEII          345.kV    0.561@  26.0    0.000@   0.0    0.000@   0.0    0.561@  26.0    0.561@ -94.0    0.561@ 146.0
      3Io=     0.0@   0.0 A     Va/Ia=   2.01e-015@  85.4 Ohm     (Va-Vb)/(Ia-Ib)=   2.01e-015@  85.4 Ohm
      (Zo-Z1)/3Z1 = 0.4866 @ -1.9
--------------------------------------------------------------------------------------------------------------------
```

Appendix 27 - 6 Summary of fault being displayed:
Prefault voltage: From a linear network solution
Generator impedance: Subtransient
MOV iteration: [Off]
Ignore shunts with + seq value: [Yes]
Ignore loads: [Yes]
Ignore line G+jB: [Yes]

```
==========================================================================================================
 6. Close-In Fault on:  0 CharlesPolet 345.kV - 0 AEII 345.kV 2L 2LG  Type=B-C
                                FAULT CURRENT (A @ DEG)
          + SEQ              - SEQ          0 SEQ          A PHASE          B PHASE          C PHASE
        29889.4@ -80.5    16393.4@  93.0    13728.5@ 107.3        0.0@   0.0    48112.2@ 162.3    41677.2@  36.3
                                THEVENIN IMPEDANCE (OHM)
       0.31934+j4.32648   0.36693+j4.34665   1.70682+j4.92127

          SHORT CIRCUIT MVA= 28986.0       X/R RATIO= 8.44801     R0/X1= 0.3945    X0/X1= 1.13748
------------------------------------------------------------------------------------------------------------
BUS      0 CharlesPolet   345.KV  AREA   7  ZONE  10   TIER   0      (PREFAULT V=1.008@   2.8 PU)
                              + SEQ            - SEQ            0 SEQ            A PHASE        B PHASE        C PHASE
VOLTAGE (KV, L-G)         >    71.510@  -1.8    71.510@  -1.8    71.510@  -1.8   214.529@  -1.8     0.000@   0.0     0.000@   0.0
BRANCH CURRENT (A) TO      >
    0 AEII         345.  2L    3072.8@ 136.4    1522.3@ -88.6    3134.8@ -90.5    3367.0@-131.1    4472.4@ -19.2    5781.2@-111.1
   16 E15ST 48      345.  1L   13611.1@  95.6    7362.0@ -86.9    5344.4@ -67.6    1675.0@  48.5   21616.4@ -17.6   18275.5@-148.5
    0 E15ST 47      345.  1L   13881.8@  95.8    7509.8@ -86.7    5441.5@ -67.6    1692.0@  49.3   22025.3@ -17.5   18659.0@-148.4

CURRENT TO FAULT (A)      >   29889.4@ -80.5   16393.4@  93.0   13728.5@ 107.3       0.0@   0.0   48112.2@ 162.3   41677.2@  36.3
THEVENIN IMPEDANCE (OHM)   >    4.33825@  85.8    4.36211@  85.2    5.20885@  70.9
------------------------------------------------------------------------------------------------------------
MONITORED BRANCH:     0 CharlesPolet   345.KV ->     0 AEII          345.KV  2L

                              + SEQ            - SEQ            0 SEQ            A PHASE        B PHASE        C PHASE
RELAY CURRENT (A)            27492.9@ -84.3   14871.8@  93.2   10785.9@ 112.4    3367.0@-131.1   43641.7@ 162.5   36934.5@  31.5

BUS VOLTAGES (KV, L-G)
    0 CharlesPolet   345.kV     71.510@  -1.8    71.510@  -1.8    71.510@  -1.8   214.529@  -1.8     0.000@   0.0     0.000@   0.0
    0 AEII           345.kV     71.806@  -1.6    71.310@  -1.8    70.500@  -1.7   213.615@  -1.7     0.955@-151.5     1.344@ 161.9
       3Io=  32357.6@ 112.4 A      Va/Ia=       63.7@ 129.3 Ohm      (Va-Vb)/(Ia-Ib)=       5.06@  19.9 Ohm
       (Zo-Z1)/3Z1 = 0.4866 @ -1.9
------------------------------------------------------------------------------------------------------------
```

Appendix 27 - 7 Summary of fault being displayed:
Prefault voltage: From a linear network solution
Generator impedance: Subtransient
MOV iteration: [Off]
Ignore shunts with + seq value: [Yes]
Ignore loads: [Yes]
Ignore line G+jB: [Yes]

```
=====================================================================================================================================
 7. Close-In Fault on:  0 CharlesPolet 345.kV - 0 AEII 345.kV 2L 1LG  Type=A
                                   FAULT CURRENT (A @ DEG)
          + SEQ                - SEQ            0 SEQ            A PHASE           B PHASE          C PHASE
       14548.7@ -77.2    14548.7@ -77.2    14548.7@ -77.2    43646.1@ -77.2        0.0@   0.0        0.0@   0.0
                                   THEVENIN IMPEDANCE (OHM)
      0.31934+j4.32648   0.36693+j4.34665   1.70682+j4.92127

          SHORT CIRCUIT MVA= 26295.3      X/R RATIO= 5.68069    R0/X1= 0.3945    X0/X1= 1.13748
-------------------------------------------------------------------------------------------------------------
BUS     0 CharlesPolet   345.KV  AREA   7  ZONE  10   TIER  0      (PREFAULT V=1.008@   2.8 PU)
                              + SEQ            - SEQ              0 SEQ                A PHASE         B PHASE         C PHASE
VOLTAGE (KV, L-G)        >   138.170@   0.2    63.463@-172.1    75.782@ 173.6    0.000@   0.0   192.662@-123.0   222.409@ 122.9
BRANCH CURRENT (A) TO      >
   0 AEII         345.  2L    2249.0@ 162.1    1351.0@ 101.1    3322.1@  85.0    5730.3@ 111.6    4038.9@  76.5    2147.1@  18.3
  16 E15ST 48      345.  1L    6703.6@  94.5    6533.5@ 102.9    5663.7@ 107.9   18813.5@ 101.4    2000.9@-103.9    1075.1@-162.1
   0 E15ST 47      345.  1L    6835.9@  94.6    6664.8@ 103.0    5766.6@ 107.8   19180.7@ 101.5    2038.0@-103.1    1072.1@-161.4

CURRENT TO FAULT (A)      >    14548.7@ -77.2   14548.7@ -77.2   14548.7@ -77.2   43646.1@ -77.2       0.0@   0.0       0.0@   0.0
THEVENIN IMPEDANCE (OHM)   >    4.33825@  85.8   4.36211@  85.2   5.20885@  70.9
-------------------------------------------------------------------------------------------------------------
MONITORED BRANCH:     0 CharlesPolet   345.KV ->     0 AEII         345.KV  2L

                              + SEQ            - SEQ              0 SEQ                A PHASE         B PHASE         C PHASE
RELAY CURRENT (A)            13539.4@ -85.4   13198.3@ -77.1   11430.3@ -72.1   37994.2@ -78.6    4038.9@  76.5    2147.1@  18.3

BUS VOLTAGES (KV, L-G)
   0 CharlesPolet   345.kV    138.170@   0.2    63.463@-172.1    75.782@ 173.6    0.000@   0.0   192.662@-123.0   222.409@ 122.9
   0 AEII           345.kV    138.287@   0.3    63.285@-172.1    74.712@ 173.7    1.348@   3.4   192.306@-122.7   221.693@ 122.8
        3Io=   34290.8@ -72.1 A      Va/Ia=   1.14e-015@  88.0 Ohm      (Va-Vb)/(Ia-Ib)=        4.62@ 137.9 Ohm
        (Zo-Z1)/3Z1 = 0.4866 @ -1.9
-------------------------------------------------------------------------------------------------------------
```

Appendix 27 - 8 Summary of fault being displayed:
Prefault voltage: From a linear network solution
Generator impedance: Subtransient
MOV iteration: [Off]
Ignore shunts with + seq value: [Yes]
Ignore loads: [Yes]
Ignore line G+jB: [Yes]

```
=====================================================================================================================
 8. Close-In Fault on:  0 CharlesPolet 345.kV - 0 AEII 345.kV 2L LL  Type=B-C
                              FAULT CURRENT (A @ DEG)
        + SEQ              - SEQ         0 SEQ       A PHASE       B PHASE       C PHASE
     23082.3@ -82.7   23082.3@  97.3      0.0@   0.0      0.0@   0.0   39979.8@-172.7   39979.8@   7.3
                              THEVENIN IMPEDANCE (OHM)
    0.31934+j4.32648   0.36693+j4.34665   1.70682+j4.92127

        SHORT CIRCUIT MVA= 24086.4      X/R RATIO= 12.638    R0/X1= 0.3945    X0/X1= 1.13748
------------------------------------------------------------------------------------------------------------
BUS     0 CharlesPolet   345.KV  AREA   7  ZONE  10   TIER   0      (PREFAULT V=1.008@   2.8 PU)
                             + SEQ          - SEQ          0 SEQ              A PHASE       B PHASE       C PHASE
VOLTAGE (KV, L-G)        >   100.688@   2.5   100.688@   2.5    0.000@   0.0   201.375@   2.5   100.688@-177.5   100.688@-177.5
BRANCH CURRENT (A) TO      >
   0 AEII         345.  2L    2556.2@ 144.1    2143.5@ -84.3      0.0@   0.0     1963.9@-161.2    4675.9@  29.4    2768.5@-143.2
  16 E15ST 48     345.  1L   10601.7@  92.2   10365.8@ -82.6      0.0@   0.0      972.8@  18.8   17668.5@   4.4   18612.2@-174.8
   0 E15ST 47     345.  1L   10812.1@  92.4   10574.0@ -82.5      0.0@   0.0      991.1@  18.9   18021.6@   4.6   18983.6@-174.7

CURRENT TO FAULT (A)      >   23082.3@ -82.7   23082.3@  97.3      0.0@   0.0      0.0@   0.0   39979.8@-172.7   39979.8@   7.3
THEVENIN IMPEDANCE (OHM)   >   4.33825@  85.8   4.36211@  85.2   5.20885@  70.9
------------------------------------------------------------------------------------------------------------
MONITORED BRANCH:     0 CharlesPolet   345.KV ->     0 AEII          345.KV  2L

                             + SEQ          - SEQ          0 SEQ              A PHASE       B PHASE       C PHASE
RELAY CURRENT (A)          21413.7@ -87.7   20939.8@  97.5      0.0@   0.0    1963.9@-161.2   35690.0@-175.5   37595.7@   5.2

BUS VOLTAGES (KV, L-G)
   0 CharlesPolet   345.kV   100.688@   2.5   100.688@   2.5    0.000@   0.0   201.375@   2.5   100.688@-177.5   100.688@-177.5
   0 AEII           345.kV   100.920@   2.6   100.406@   2.5    0.000@   0.0   201.325@   2.6   100.462@-177.2   100.866@-177.7
        3Io=      0.0@ -92.3 A      Va/Ia=        103@ 163.6 Ohm      (Va-Vb)/(Ia-Ib)=       8.94@  -1.2 Ohm
        (Zo-Z1)/3Z1 = 0.4866 @ -1.9
------------------------------------------------------------------------------------------------------------
```

Appendix 27 - 9 Summary of fault being displayed:
Prefault voltage: From a linear network solution
Generator impedance: Subtransient
MOV iteration: [Off]
Ignore shunts with + seq value: [Yes]
Ignore loads: [Yes]
Ignore line G+jB: [Yes]

```
==========================================================================================================================================
 9. Close-In Fault on:  0 CharlesPolet 345.kV - 0 E15ST 47 345.kV 1L 3LG
                                   FAULT CURRENT (A @ DEG)
          + SEQ              - SEQ          0 SEQ         A PHASE         B PHASE         C PHASE
       46291.0@ -83.0      0.0@   0.0      0.0@   0.0   46291.0@ -83.0   46291.0@ 157.0   46291.0@  37.0
                                   THEVENIN IMPEDANCE (OHM)
      0.31934+j4.32648   0.36693+j4.34665   1.70682+j4.92127

          SHORT CIRCUIT MVA= 27888.7      X/R RATIO= 13.5481    R0/X1= 0.3945    X0/X1= 1.13748
------------------------------------------------------------------------------------------------------------------------------
BUS     0 CharlesPolet   345.KV  AREA   7  ZONE  10   TIER   0      (PREFAULT V=1.008@   2.8 PU)
                                  + SEQ            - SEQ            0 SEQ              A PHASE        B PHASE        C PHASE
VOLTAGE (KV, L-G)        >     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0
BRANCH CURRENT (A) TO      >
    0 AEII         345.  2L    4266.3@ 121.2       0.0@   0.0       0.0@   0.0    4266.3@ 121.2    4266.3@   1.2    4266.3@-118.8
   16 E15ST 48      345.  1L   21007.8@  94.6       0.0@   0.0       0.0@   0.0   21007.8@  94.6   21007.8@ -25.4   21007.8@-145.4
    0 E15ST 47      345.  1L   21426.8@  94.7       0.0@   0.0       0.0@   0.0   21426.8@  94.7   21426.8@ -25.3   21426.8@-145.3

CURRENT TO FAULT (A)      >    46291.0@ -83.0       0.0@   0.0       0.0@   0.0   46291.0@ -83.0   46291.0@ 157.0   46291.0@  37.0
THEVENIN IMPEDANCE (OHM)   >    4.33825@  85.8   4.36211@  85.2   5.20885@  70.9
------------------------------------------------------------------------------------------------------------------------------
MONITORED BRANCH:     0 CharlesPolet   345.KV ->     0 E15ST 47       345.KV  1L

                                  + SEQ            - SEQ            0 SEQ              A PHASE        B PHASE        C PHASE
RELAY CURRENT (A)            24895.8@ -81.0       0.0@   0.0       0.0@   0.0   24895.8@ -81.0   24895.8@ 159.0   24895.8@  39.0

BUS VOLTAGES (KV, L-G)
    0 CharlesPolet   345.kV     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0
    0 E15ST 47       345.kV    41.664@  -6.9     0.000@   0.0     0.000@   0.0    41.664@  -6.9    41.664@-126.9    41.664@ 113.1
          3Io=      0.0@   0.0 A     Va/Ia=   3.42e-015@  81.0 Ohm      (Va-Vb)/(Ia-Ib)=   3.42e-015@  81.0 Ohm
          (Zo-Z1)/3Z1 = 0.7127 @-33.1
------------------------------------------------------------------------------------------------------------------------------
```

CHARLES POLETTI SUBSTATION

Appendix 27 - Short Circuit Study Results

Appendix 27 - 10 Summary of fault being displayed:
Prefault voltage: From a linear network solution
Generator impedance: Subtransient
MOV iteration: [Off]
Ignore shunts with + seq value: [Yes]
Ignore loads: [Yes]
Ignore line G+jB: [Yes]

```
====================================================================================================
 10. Close-In Fault on:  0 CharlesPolet 345.kV - 0 E15ST 47 345.kV 1L 2LG  Type=B-C
                                  FAULT CURRENT (A @ DEG)
          + SEQ              - SEQ         0 SEQ         A PHASE        B PHASE        C PHASE
        29889.4@ -80.5    16393.4@  93.0    13728.5@ 107.3        0.0@   0.0    48112.2@ 162.3    41677.2@  36.3
                                  THEVENIN IMPEDANCE (OHM)
       0.31934+j4.32648   0.36693+j4.34665   1.70682+j4.92127

          SHORT CIRCUIT MVA= 28986.0      X/R RATIO= 8.44801    R0/X1= 0.3945    X0/X1= 1.13748
-----------------------------------------------------------------------------------------------
BUS      0 CharlesPolet   345.KV  AREA   7  ZONE  10   TIER   0      (PREFAULT V=1.008@   2.8 PU)
                                  + SEQ          - SEQ          0 SEQ            A PHASE       B PHASE       C PHASE
VOLTAGE (KV, L-G)        >    71.510@  -1.8    71.510@  -1.8    71.510@  -1.8   214.529@  -1.8    0.000@   0.0    0.000@   0.0
BRANCH CURRENT (A) TO     >
   0 AEII        345.  2L    3072.8@ 136.4    1522.3@ -88.6    3134.8@ -90.5    3367.0@-131.1    4472.4@ -19.2    5781.2@-111.1
  16 E15ST 48    345.  1L   13611.1@  95.6    7362.0@ -86.9    5344.4@ -67.6    1675.0@  48.5   21616.4@ -17.6   18275.5@-148.5
   0 E15ST 47    345.  1L   13881.8@  95.8    7509.8@ -86.7    5441.5@ -67.6    1692.0@  49.3   22025.3@ -17.5   18659.0@-148.4

CURRENT TO FAULT (A)      >   29889.4@ -80.5   16393.4@  93.0   13728.5@ 107.3       0.0@   0.0   48112.2@ 162.3   41677.2@  36.3
THEVENIN IMPEDANCE (OHM)  >    4.33825@  85.8    4.36211@  85.2    5.20885@  70.9
-----------------------------------------------------------------------------------------------
MONITORED BRANCH:     0 CharlesPolet   345.KV ->     0 E15ST 47       345.KV  1L

                                  + SEQ          - SEQ          0 SEQ            A PHASE       B PHASE       C PHASE
RELAY CURRENT (A)            16063.6@ -77.2    8883.7@  92.8    8322.0@ 104.0    1692.0@  49.3   26087.2@ 162.1   23135.2@  40.2

BUS VOLTAGES (KV, L-G)
   0 CharlesPolet   345.kV     71.510@  -1.8    71.510@  -1.8    71.510@  -1.8   214.529@  -1.8    0.000@   0.0    0.000@   0.0
   0 E15ST 47       345.kV     98.453@  -2.9    57.028@  -0.1    40.399@   6.2   195.513@  -0.2   50.727@-145.4   54.158@ 127.9
       3Io=  24966.1@ 104.0 A      Va/Ia=        127@ -51.1 Ohm      (Va-Vb)/(Ia-Ib)=        8.01@  12.7 Ohm
       (Zo-Z1)/3Z1 = 0.7127 @-33.1
-----------------------------------------------------------------------------------------------
```

CHARLES POLETTI SUBSTATION

Appendix 27 - 11 Summary of fault being displayed:
Prefault voltage: From a linear network solution
Generator impedance: Subtransient
MOV iteration: [Off]
Ignore shunts with + seq value: [Yes]
Ignore loads: [Yes]
Ignore line G+jB: [Yes]

```
=====================================================================================================================
 11. Close-In Fault on:  0 CharlesPolet 345.kV - 0 E15ST 47 345.kV 1L 1LG  Type=A
                              FAULT CURRENT (A @ DEG)
        + SEQ              - SEQ          0 SEQ          A PHASE        B PHASE       C PHASE
     14548.7@ -77.2   14548.7@ -77.2   14548.7@ -77.2   43646.1@ -77.2     0.0@   0.0     0.0@   0.0
                              THEVENIN IMPEDANCE (OHM)
     0.31934+j4.32648   0.36693+j4.34665   1.70682+j4.92127

        SHORT CIRCUIT MVA= 26295.3     X/R RATIO= 5.68069    R0/X1= 0.3945    X0/X1= 1.13748
-----------------------------------------------------------------------------------------------------------------
BUS    0 CharlesPolet   345.KV  AREA   7  ZONE  10   TIER   0     (PREFAULT V=1.008@   2.8 PU)
                              + SEQ          - SEQ          0 SEQ          A PHASE       B PHASE       C PHASE
VOLTAGE (KV, L-G)        >   138.170@   0.2   63.463@-172.1   75.782@ 173.6    0.000@   0.0  192.662@-123.0  222.409@ 122.9
BRANCH CURRENT (A) TO     >
   0 AEII         345.  2L    2249.0@ 162.1    1351.0@ 101.1    3322.1@  85.0    5730.3@ 111.6    4038.9@  76.5    2147.1@  18.3
  16 E15ST 48      345.  1L    6703.6@  94.5    6533.5@ 102.9    5663.7@ 107.9   18813.5@ 101.4    2000.9@-103.9    1075.1@-162.1
   0 E15ST 47      345.  1L    6835.9@  94.6    6664.8@ 103.0    5766.6@ 107.8   19180.7@ 101.5    2038.0@-103.1    1072.1@-161.4

CURRENT TO FAULT (A)      >   14548.7@ -77.2   14548.7@ -77.2   14548.7@ -77.2   43646.1@ -77.2     0.0@   0.0     0.0@   0.0
THEVENIN IMPEDANCE (OHM)  >   4.33825@  85.8   4.36211@  85.2   5.20885@  70.9
-----------------------------------------------------------------------------------------------------------------
MONITORED BRANCH:    0 CharlesPolet   345.KV ->    0 E15ST 47      345.KV  1L

                              + SEQ          - SEQ          0 SEQ          A PHASE       B PHASE       C PHASE
RELAY CURRENT (A)            7841.6@ -70.1    7884.0@ -77.4    8819.2@ -80.5   24474.0@ -76.2    2038.1@-103.1    1072.1@-161.4

BUS VOLTAGES (KV, L-G)
   0 CharlesPolet   345.kV    138.170@   0.2    63.463@-172.1    75.782@ 173.6    0.000@   0.0   192.662@-123.0   222.409@ 122.9
   0 E15ST 47       345.kV    151.367@  -0.5    50.611@-170.4    42.813@-178.3   59.688@ -10.6   191.723@-117.1   203.958@ 119.3
     3Io=   26457.6@ -80.5 A     Va/Ia=   1.77e-015@  85.7 Ohm     (Va-Vb)/(Ia-Ib)=        8.5@ 130.8 Ohm
     (Zo-Z1)/3Z1 = 0.7127 @-33.1
-----------------------------------------------------------------------------------------------------------------
```

Appendix 27 - 12 Summary of fault being displayed:
Prefault voltage: From a linear network solution
Generator impedance: Subtransient
MOV iteration: [Off]
Ignore shunts with + seq value: [Yes]
Ignore loads: [Yes]
Ignore line G+jB: [Yes]

```
==========================================================================================================================
 12. Close-In Fault on:  0 CharlesPolet 345.kV - 0 E15ST 47 345.kV 1L LL  Type=B-C
                                  FAULT CURRENT (A @ DEG)
          + SEQ              - SEQ          0 SEQ          A PHASE         B PHASE         C PHASE
        23082.3@ -82.7   23082.3@  97.3      0.0@   0.0      0.0@   0.0   39979.8@-172.7    39979.8@   7.3
                                  THEVENIN IMPEDANCE (OHM)
       0.31934+j4.32648   0.36693+j4.34665   1.70682+j4.92127

          SHORT CIRCUIT MVA= 24086.4      X/R RATIO= 12.638     R0/X1= 0.3945     X0/X1= 1.13748
--------------------------------------------------------------------------------------------------------------------------
BUS     0 CharlesPolet   345.KV   AREA   7  ZONE  10   TIER   0      (PREFAULT V=1.008@   2.8 PU)
                                  + SEQ          - SEQ              0 SEQ            A PHASE         B PHASE         C PHASE
VOLTAGE (KV, L-G)        >    100.688@   2.5   100.688@   2.5    0.000@   0.0   201.375@   2.5   100.688@-177.5   100.688@-177.5
BRANCH CURRENT (A) TO      >
   0 AEII         345.  2L    2556.2@ 144.1    2143.5@ -84.3      0.0@   0.0    1963.9@-161.2    4675.9@  29.4    2768.5@-143.2
  16 E15ST 48      345.  1L   10601.7@  92.2   10365.8@ -82.6      0.0@   0.0     972.8@  18.8   17668.5@   4.4   18612.2@-174.8
   0 E15ST 47      345.  1L   10812.1@  92.4   10574.0@ -82.5      0.0@   0.0     991.1@  18.9   18021.6@   4.6   18983.6@-174.7

CURRENT TO FAULT (A)      >    23082.3@ -82.7   23082.3@  97.3      0.0@   0.0      0.0@   0.0   39979.8@-172.7   39979.8@   7.3
THEVENIN IMPEDANCE (OHM)   >    4.33825@  85.8    4.36211@  85.2    5.20885@  70.9
--------------------------------------------------------------------------------------------------------------------------
MONITORED BRANCH:     0 CharlesPolet   345.KV ->      0 E15ST 47       345.KV  1L

                                  + SEQ          - SEQ              0 SEQ              A PHASE         B PHASE         C PHASE
RELAY CURRENT (A)            12344.9@ -78.4   12508.5@  97.1      0.0@   0.0     991.1@  18.9   21995.9@-170.4   21018.4@   9.1

BUS VOLTAGES (KV, L-G)
   0 CharlesPolet   345.kV    100.688@   2.5   100.688@   2.5    0.000@   0.0   201.375@   2.5   100.688@-177.5   100.688@-177.5
   0 E15ST 47       345.kV    121.347@   0.5    80.297@   4.2    0.000@   0.0   201.543@   1.9   111.981@-159.5   101.778@ 161.5
        3Io=      0.0@-100.7 A      Va/Ia=        203@ -16.4 Ohm      (Va-Vb)/(Ia-Ib)=        13.1@  -7.5 Ohm
        (Zo-Z1)/3Z1 = 0.7127 @-33.1
--------------------------------------------------------------------------------------------------------------------------
```

CHARLES POLETTI SUBSTATION

Appendix 27 - 13 Summary of fault being displayed:
Prefault voltage: From a linear network solution
Generator impedance: Subtransient
MOV iteration: [Off]
Ignore shunts with + seq value: [Yes]
Ignore loads: [Yes]
Ignore line G+jB: [Yes]

```
==========================================================================================================
 13. Close-In Fault on:  0 CharlesPolet 345.kV - 16 E15ST 48 345.kV 1L 3LG
                                   FAULT CURRENT (A @ DEG)
       + SEQ              - SEQ          0 SEQ         A PHASE          B PHASE          C PHASE
    46291.0@ -83.0      0.0@  0.0      0.0@  0.0   46291.0@ -83.0   46291.0@ 157.0   46291.0@  37.0
                                   THEVENIN IMPEDANCE (OHM)
   0.31934+j4.32648   0.36693+j4.34665   1.70682+j4.92127

       SHORT CIRCUIT MVA= 27888.7      X/R RATIO= 13.5481    R0/X1= 0.3945    X0/X1= 1.13748
-----------------------------------------------------------------------------------------------------------
BUS     0 CharlesPolet   345.KV  AREA   7  ZONE  10   TIER   0      (PREFAULT V=1.008@   2.8 PU)
                                 + SEQ          - SEQ          0 SEQ          A PHASE        B PHASE        C PHASE
VOLTAGE (KV, L-G)         >     0.000@   0.0    0.000@   0.0    0.000@   0.0    0.000@   0.0    0.000@   0.0    0.000@   0.0
BRANCH CURRENT (A) TO     >
   0 AEII         345.  2L    4266.3@ 121.2      0.0@   0.0      0.0@   0.0    4266.3@ 121.2    4266.3@   1.2    4266.3@-118.8
  16 E15ST 48     345.  1L   21007.8@  94.6      0.0@   0.0      0.0@   0.0   21007.8@  94.6   21007.8@ -25.4   21007.8@-145.4
   0 E15ST 47     345.  1L   21426.8@  94.7      0.0@   0.0      0.0@   0.0   21426.8@  94.7   21426.8@ -25.3   21426.8@-145.3

CURRENT TO FAULT (A)      >   46291.0@ -83.0      0.0@   0.0      0.0@   0.0   46291.0@ -83.0   46291.0@ 157.0   46291.0@  37.0
THEVENIN IMPEDANCE (OHM)  >   4.33825@  85.8   4.36211@  85.2   5.20885@  70.9
-----------------------------------------------------------------------------------------------------------
MONITORED BRANCH:     0 CharlesPolet   345.KV ->    16 E15ST 48       345.KV  1L

                                 + SEQ          - SEQ          0 SEQ          A PHASE        B PHASE        C PHASE
RELAY CURRENT (A)              25317.9@ -81.0      0.0@   0.0      0.0@   0.0   25317.9@ -81.0   25317.9@ 159.0   25317.9@  39.0

BUS VOLTAGES (KV, L-G)
   0 CharlesPolet   345.kV      0.000@   0.0    0.000@   0.0    0.000@   0.0    0.000@   0.0    0.000@   0.0    0.000@   0.0
  16 E15ST 48       345.kV     40.849@  -7.1    0.000@   0.0    0.000@   0.0   40.849@  -7.1   40.849@-127.1   40.849@ 112.9
       3Io=      0.0@  0.0 A     Va/Ia=   3.37e-015@  81.0 Ohm      (Va-Vb)/(Ia-Ib)=   3.37e-015@  81.0 Ohm
       (Zo-Z1)/3Z1 = 0.7127 @-33.1
-----------------------------------------------------------------------------------------------------------
```

Appendix 27 - 14 Summary of fault being displayed:
Prefault voltage: From a linear network solution
Generator impedance: Subtransient
MOV iteration: [Off]
Ignore shunts with + seq value: [Yes]
Ignore loads: [Yes]
Ignore line G+jB: [Yes]

```
==================================================================================================================================
 14. Close-In Fault on:  0 CharlesPolet 345.kV - 16 E15ST 48 345.kV 1L 2LG  Type=B-C
                         FAULT CURRENT (A @ DEG)
      + SEQ            - SEQ          0 SEQ         A PHASE        B PHASE        C PHASE
   29889.4@ -80.5   16393.4@  93.0   13728.5@ 107.3      0.0@   0.0   48112.2@ 162.3   41677.2@  36.3
                         THEVENIN IMPEDANCE (OHM)
   0.31934+j4.32648   0.36693+j4.34665   1.70682+j4.92127

      SHORT CIRCUIT MVA= 28986.0      X/R RATIO= 8.44801    R0/X1= 0.3945    X0/X1= 1.13748
------------------------------------------------------------------------------------------------
BUS      0 CharlesPolet   345.KV  AREA   7  ZONE  10   TIER  0      (PREFAULT V=1.008@   2.8 PU)
                         + SEQ          - SEQ           0 SEQ              A PHASE       B PHASE       C PHASE
VOLTAGE (KV, L-G)       >     71.510@  -1.8    71.510@  -1.8    71.510@  -1.8   214.529@  -1.8    0.000@   0.0    0.000@   0.0
BRANCH CURRENT (A) TO    >
    0 AEII         345.  2L    3072.8@ 136.4    1522.3@ -88.6    3134.8@ -90.5    3367.0@-131.1    4472.4@ -19.2    5781.2@-111.1
   16 E15ST 48     345.  1L   13611.1@  95.6    7362.0@ -86.9    5344.4@ -67.6    1675.0@  48.5   21616.4@ -17.6   18275.5@-148.5
    0 E15ST 47     345.  1L   13881.8@  95.8    7509.8@ -86.7    5441.5@ -67.6    1692.0@  49.3   22025.3@ -17.5   18659.0@-148.4

CURRENT TO FAULT (A)     >   29889.4@ -80.5   16393.4@  93.0   13728.5@ 107.3       0.0@   0.0   48112.2@ 162.3   41677.2@  36.3
THEVENIN IMPEDANCE (OHM)  >   4.33825@  85.8   4.36211@  85.2   5.20885@  70.9
------------------------------------------------------------------------------------------------
MONITORED BRANCH:     0 CharlesPolet   345.KV ->    16 E15ST 48       345.KV  1L

                         + SEQ          - SEQ           0 SEQ              A PHASE       B PHASE       C PHASE
RELAY CURRENT (A)          16336.8@ -77.2    9031.5@  92.9    8419.0@ 104.1    1675.0@  48.5   26495.9@ 162.2   23519.6@  40.1

BUS VOLTAGES (KV, L-G)
    0 CharlesPolet   345.kV     71.510@  -1.8    71.510@  -1.8    71.510@  -1.8   214.529@  -1.8    0.000@   0.0    0.000@   0.0
   16 E15ST 48       345.kV     97.923@  -3.0    57.318@  -0.1    40.930@   5.9   195.824@  -0.3   49.862@-145.5   53.064@ 127.9
         3Io=   25257.1@ 104.1 A      Va/Ia=        128@ -50.3 Ohm      (Va-Vb)/(Ia-Ib)=       7.88@  12.7 Ohm
         (Zo-Z1)/3Z1 = 0.7127 @-33.1
------------------------------------------------------------------------------------------------
```

Appendix 27 - 15 Summary of fault being displayed:
Prefault voltage: From a linear network solution
Generator impedance: Subtransient
MOV iteration: [Off]
Ignore shunts with + seq value: [Yes]
Ignore loads: [Yes]
Ignore line G+jB: [Yes]

```
================================================================================================================================
 15. Close-In Fault on:  0 CharlesPolet 345.kV - 16 E15ST 48 345.kV 1L 1LG  Type=A
                                   FAULT CURRENT (A @ DEG)
        + SEQ              - SEQ          0 SEQ          A PHASE          B PHASE          C PHASE
     14548.7@ -77.2   14548.7@ -77.2   14548.7@ -77.2   43646.1@ -77.2       0.0@   0.0       0.0@   0.0
                                   THEVENIN IMPEDANCE (OHM)
     0.31934+j4.32648   0.36693+j4.34665   1.70682+j4.92127

        SHORT CIRCUIT MVA= 26295.3      X/R RATIO= 5.68069    R0/X1= 0.3945    X0/X1= 1.13748
--------------------------------------------------------------------------------------------------------------------------------
BUS     0 CharlesPolet   345.KV  AREA   7  ZONE  10   TIER   0      (PREFAULT V=1.008@   2.8 PU)
                                  + SEQ           - SEQ           0 SEQ            A PHASE        B PHASE        C PHASE
VOLTAGE (KV, L-G)         >   138.170@   0.2    63.463@-172.1    75.782@ 173.6     0.000@   0.0   192.662@-123.0   222.409@ 122.9
BRANCH CURRENT (A) TO     >
   0 AEII         345.  2L    2249.0@ 162.1    1351.0@ 101.1    3322.1@  85.0    5730.3@ 111.6    4038.9@  76.5    2147.1@  18.3
  16 E15ST 48     345.  1L    6703.6@  94.5    6533.5@ 102.9    5663.7@ 107.9   18813.5@ 101.4    2000.9@-103.9    1075.1@-162.1
   0 E15ST 47     345.  1L    6835.9@  94.6    6664.8@ 103.0    5766.6@ 107.8   19180.7@ 101.5    2038.0@-103.1    1072.1@-161.4

CURRENT TO FAULT (A)      >   14548.7@ -77.2   14548.7@ -77.2   14548.7@ -77.2   43646.1@ -77.2       0.0@   0.0       0.0@   0.0
THEVENIN IMPEDANCE (OHM)  >   4.33825@  85.8   4.36211@  85.2   5.20885@  70.9
--------------------------------------------------------------------------------------------------------------------------------
MONITORED BRANCH:     0 CharlesPolet   345.KV ->    16 E15ST 48       345.KV  1L

                                  + SEQ           - SEQ           0 SEQ            A PHASE        B PHASE        C PHASE
RELAY CURRENT (A)              7973.9@ -70.3    8015.2@ -77.3    8922.0@ -80.5   24842.1@ -76.2    2000.9@-103.9    1075.1@-162.1

BUS VOLTAGES (KV, L-G)
   0 CharlesPolet   345.kV    138.170@   0.2    63.463@-172.1    75.782@ 173.6     0.000@   0.0   192.662@-123.0   222.409@ 122.9
  16 E15ST 48       345.kV    151.108@  -0.5    50.868@-170.4    43.375@-178.6    58.593@ -10.6   191.639@-117.2   204.325@ 119.3
        3Io=   26766.1@ -80.5 A      Va/Ia=   1.74e-015@  85.7 Ohm      (Va-Vb)/(Ia-Ib)=       8.34@ 130.8 Ohm
        (Zo-Z1)/3Z1 = 0.7127 @-33.1
--------------------------------------------------------------------------------------------------------------------------------
```

Appendix 27 - 16 Summary of fault being displayed:
Prefault voltage: From a linear network solution
Generator impedance: Subtransient
MOV iteration: [Off]
Ignore shunts with + seq value: [Yes]
Ignore loads: [Yes]
Ignore line G+jB: [Yes]

```
==============================================================================================================
 16. Close-In Fault on:  0 CharlesPolet 345.kV - 16 E15ST 48 345.kV 1L LL  Type=B-C
                                  FAULT CURRENT (A @ DEG)
      + SEQ            - SEQ        0 SEQ       A PHASE      B PHASE      C PHASE
   23082.3@ -82.7  23082.3@  97.3   0.0@  0.0   0.0@  0.0  39979.8@-172.7  39979.8@   7.3
                                  THEVENIN IMPEDANCE (OHM)
  0.31934+j4.32648  0.36693+j4.34665  1.70682+j4.92127

      SHORT CIRCUIT MVA= 24086.4    X/R RATIO= 12.638   R0/X1= 0.3945   X0/X1= 1.13748
--------------------------------------------------------------------------------------------------
BUS     0 CharlesPolet   345.KV  AREA   7  ZONE  10   TIER  0     (PREFAULT V=1.008@   2.8 PU)
                              + SEQ        - SEQ         0 SEQ         A PHASE      B PHASE      C PHASE
VOLTAGE (KV, L-G)       >   100.688@   2.5  100.688@   2.5   0.000@   0.0  201.375@   2.5  100.688@-177.5  100.688@-177.5
BRANCH CURRENT (A) TO    >
  0 AEII       345.  2L    2556.2@ 144.1   2143.5@ -84.3     0.0@   0.0   1963.9@-161.2   4675.9@  29.4   2768.5@-143.2
 16 E15ST 48   345.  1L   10601.7@  92.2  10365.8@ -82.6     0.0@   0.0    972.8@  18.8  17668.5@   4.4  18612.2@-174.8
  0 E15ST 47   345.  1L   10812.1@  92.4  10574.0@ -82.5     0.0@   0.0    991.1@  18.9  18021.6@   4.6  18983.6@-174.7

CURRENT TO FAULT (A)     >  23082.3@ -82.7  23082.3@  97.3     0.0@   0.0     0.0@   0.0  39979.8@-172.7  39979.8@   7.3
THEVENIN IMPEDANCE (OHM)  >   4.33825@  85.8  4.36211@  85.2  5.20885@  70.9
--------------------------------------------------------------------------------------------------
MONITORED BRANCH:    0 CharlesPolet   345.KV ->    16 E15ST 48      345.KV  1L

                              + SEQ        - SEQ         0 SEQ         A PHASE      B PHASE      C PHASE
RELAY CURRENT (A)          12557.1@ -78.4  12716.5@  97.2     0.0@   0.0    972.8@  18.8  22351.8@-170.4  21392.2@   9.2

BUS VOLTAGES (KV, L-G)
  0 CharlesPolet  345.kV   100.688@   2.5  100.688@   2.5   0.000@   0.0  201.375@   2.5  100.688@-177.5  100.688@-177.5
 16 E15ST 48      345.kV   120.934@   0.5   80.705@   4.2   0.000@   0.0  201.539@   1.9  111.747@-159.9  101.537@ 161.9
      3Io=     0.0@-100.7 A     Va/Ia=       207@ -16.4 Ohm     (Va-Vb)/(Ia-Ib)=        13@  -7.5 Ohm
      (Zo-Z1)/3Z1 = 0.7127 @-33.1
--------------------------------------------------------------------------------------------------
```

Appendix 28 Relay Coordination between Charles Poletti Station and Farragut Station

CTR = 400 PTR = 3000

Case	3I0 Mag (Amp)	3I0 Angle	V0 Mag (kV)	V0 Angle	kVA Product	VA @ Relay	Per Unit of Pickup VA	Relay	Pickup VA	Time Dial	Time (Sec)	Q35L-67N Time (Sec)	Q35M-67N Time (Sec)	CTI (Sec)
1	55651	-82.2	61.22	176	9709533.869	8091.28	80.91	67N-1/F4E 67N-2/F4E	100	3	0.15	0.66	0.67	0.51
FDR45	Case 1: 1LG fault at relay (67N-1/F4E or 67N-2/F4E) close-in with the largest source (Line 41) out of service and maximum contribution from Charlie Poletti station.													
2	55293	-82.1	61.69	175.7	9743211.971	8119.34	81.19	67N-1/F4E 67N-2/F4E	100	3	0.15	-	0.52	0.37
FDR45	Case 2: 1LG fault at relay (67N-1/F4E or 67N-2/F4E) close-in with the largest source (Line 41) out of service and maximum contribution from Charlie Poletti station. Line Q35L at Charlie Poletti is out of service.													
3	55294	-82.1	61.71	175.7	9746547.004	8122.12	81.22	67N-1/F4E 67N-2/F4E	100	3	0.15	0.52	-	0.37
FDR45	Case 3: 1LG fault at relay (67N-1/F4E or 67N-2/F4E) close-in with the largest source (Line 41) out of service and maximum contribution from Charlie Poletti station. Line Q35M at Charlie Poletti is out of service.													
4	55820	-82.4	61.22	176	9727783.122	8106.49	81.06	67N-1/F8W 67N-2/F8W	100	3	0.15	0.66	0.67	0.51
FDR46	Case 4: 1LG fault at relay (67N-1/F8W or 67N-2/F8W) close-in with the largest source (Line 41) out of service and maximum contribution from Charlie Poletti station.													
5	55500	-82.2	61.69	175.7	9774192.486	8145.16	81.45	67N-1/F8W 67N-2/F8W	100	3	0.15	-	0.52	0.37
FDR46	Case 5: 1LG fault at relay (67N-1/F8W or 67N-2/F8W) close-in with the largest source (Line 41) out of service and maximum contribution from Charlie Poletti station. Line Q35L at Charlie Poletti is out of service.													
6	55500	-82.2	61.71	175.7	9777361.295	8147.80	81.48	67N-1/F8W 67N-2/F8W	100	3	0.15	0.52	-	0.37
FDR46	Case 6: 1LG fault at relay (67N-1/F8W or 67N-2/F8W)close-in with the largest source (Line 41) out of service and maximum contribution from Charlie Poletti station. Line Q35M at Charlie Poletti is out of service.													
7	53026	-82.6	61.22	176	9230084.493	7691.74	38.46	67N-1/F2E 67N-2/F2E	200	2.5	0.2	0.66	0.67	0.46
FDR61	Case 7: 1LG fault at relay (67N-1/F2E or 67N-2/F2E) close-in with the largest source (Line 41) out of service and maximum contribution from Charlie Poletti station.													
8	52690	-82.4	61.69	175.7	9268800.459	7724.00	38.62	67N-1/F2E 67N-2/F2E	200	2.5	0.2	-	0.52	0.32

Appendix 28 Relay Coordination between Charles Poletti Station and Farragut Station

CTR = 400 PTR = 3000

FDR61	Case 8: 1LG fault at relay (67N-1/F2E or 67N-2/F2E) close-in with the largest source (Line 41) out of service and maximum contribution from Charlie Poletti station. Line Q35L at Charlie Poletti is out of service.													
9	52667	-82.4	61.71	175.7	9267758.133	7723.13	38.62	67N-1/F2E 67N-2/F2E	200	2.5	0.2	0.52	-	0.32
FDR61	Case 9: 1LG fault at relay (67N-1/F2E or 67N-2/F2E) close-in with the largest source (Line 41) out of service and maximum contribution from Charlie Poletti station. Line Q35M at Charlie Poletti is out of service.													
10	53886	-82.6	61.22	176	9379782.239	7816.49	39.08	67N-1/F4W 67N-2/F4W	200	2.5	0.2	0.66	0.67	0.46
FDR62	Case 10: 1LG fault at relay (67N-1/F4W or 67N-2/F4W) close-in with the largest source (Line 41) out of service and maximum contribution from Charlie Poletti station.													
11	53556	-82.5	61.69	175.7	9415751.46	7846.46	39.23	67N-1/F4W 67N-2/F4W	200	2.5	0.2	-	0.52	0.32
FDR62	Case 11: 1LG fault at relay (67N-1/F4W or 67N-2/F4W) close-in with the largest source (Line 41) out of service and maximum contribution from Charlie Poletti station. Line Q35L at Charlie Poletti is out of service.													
12	53533	-82.5	61.71	175.7	9414759.09	7845.63	39.23	67N-1/F4W 67N-2/F4W	200	2.5	0.2	0.52	-	0.32
FDR62	Case 12: 1LG fault at relay (67N-1/F4W or 67N-2/F4W) close-in with the largest source (Line 41) out of service and maximum contribution from Charlie Poletti station. Line Q35M at Charlie Poletti is out of service.													
13	52970	-82.6	61.22	176	9220336.733	7683.61	38.42	67N-1/FBT 67N-2/FBT	200	2.5	0.2	0.66	0.67	0.46
FDR63	Case 13: 1LG fault at relay (67N-1/FBT or 67N-2/FBT) close-in with the largest source (Line 41) out of service and maximum contribution from Charlie Poletti station.													
14	52634	-82.4	61.69	175.7	9258949.39	7715.79	38.58	67N-1/FBT 67N-2/FBT	200	2.5	0.2	-	0.52	0.32
FDR63	Case 14: 1LG fault at relay (67N-1/FBT or 67N-2/FBT) close-in with the largest source (Line 41) out of service and maximum contribution from Charlie Poletti station. Line Q35L at Charlie Poletti is out of service.													
15	52610	-82.4	61.71	175.7	9257727.901	7714.77	38.57	67N-1/FBT 67N-2/FBT	200	2.5	0.2	0.52	-	0.32
FDR63	Case 15: 1LG fault at relay (67N-1/FBT or 67N-2/FBT) close-in with the largest source (Line 41) out of service and maximum contribution from Charlie Poletti station. Line Q35M at Charlie Poletti is out of service.													
16	55224	-81.9	61.22	176	9651488.993	8042.91	26.81	67N-1/B7E 67N-2/B7E	300	3	0.29	0.66	0.67	0.37

Appendix 28 Relay Coordination between Charles Poletti Station and Farragut Station

CTR = 400 PTR = 3000

B47	Case 16: 1LG fault at relay (67N-1/B7E or 67N-2/B7E) close-in with the largest source (Line 41) out of service and maximum contribution from Charlie Poletti station.													
17	58244	-82	61.69	175.7	10268944.91	8557.45	28.52	67N-1/B7E 67N-2/B7E	300	2.5	0.27	-	0.52	0.25
B47	Case 17: 1LG fault at relay (67N-1/B7E or 67N-2/B7E) close-in with the largest source (Line 41) out of service and maximum contribution from Charlie Poletti station. Line Q35L at Charlie Poletti is out of service.													
18	55868	-82	61.22	176	9758521.651	8132.10	27.11	67N-1/F2W 67N-2/F2W	300	3	0.29	0.66	0.67	0.37
FDR48	Case 18: 1LG fault at relay close-in with the largest source (Line 41) out of service and maximum contribution from Charlie Poletti station.													
19	58950	-82.1	61.71	175.7	10390981.77	8659.15	28.86	67N-1/F2W 67N-2/F2W	300	3	0.27	0.52	-	0.25
FDR48	Case 19: 1LG fault at relay (67N-1/B7E or 67N-2/B7E) close-in with the largest source (Line 41) out of service and maximum contribution from Charlie Poletti station. Line Q35M at Charlie Poletti is out of service.													
20	15788	-70.4	34.95	-173.6	1584719.7	1320.60	4.40	67N-1/B7E 67N-2/B7E	300	3	1.7	-	0.47	1.23
B47	Case 20: 1LG fault at relay (Q35M-67N @ Charlie Poletti) close-in with the AEII (G13) station in of service, which is normal.													
21	17522	-75.4	38.79	-178.6	1952008.096	1626.67	5.42	67N-1/B7E 67N-2/B7E	300	2.5	1.4	-	0.47	0.93
B47	Case 21: 1LG fault at relay (Q35M-67N @ Charlie Poletti) close-in with the AEII (G13) station out of service.													
22	15839	-70.4	34.95	-173.6	1589838.822	1324.87	4.42	67N-1/F2W 67N-2/F2W	300	3	1.7	0.45	-	1.25
FDR48	Case 22: 1LG fault at relay (Q35L-67N @ Charlie Poletti) close-in with the AEII (G13) station in of service, which is normal.													
23	17579	-75.4	38.79	-178.6	1958358.082	1631.97	5.44	67N-1/F2W 67N-2/F2W	300	3	1.4	0.46	-	0.94
FDR48	Case 23: 1LG fault at relay (Q35L-67N @ Charlie Poletti) close-in with the AEII (G13) station out of service.													

Appendix 28 Relay Coordination between Charles Poletti Station and Farragut Station

CTR = 400 PTR = 3000

Case	3I0 Mag (Amp)	3I0 Angle	V0 Mag (kV)	V0 Angle	kVA Product	VA @ Relay	Per Unit of Pickup VA	Relay	Pickup VA	Time Dial	Time (Sec)	G13-67N Time (Sec)		CTI (Sec)
24	15788	-70.4	34.95	-173.6	1584719.7	1320.60	4.40	67N-1/F2W 67N-2/F2W	300	3	1.7	0	-	1.7
FDR48	Case 14: 1LG fault at relay (G13-67N @ Charlie Poletti) close-in.													
25	15839	-70.4	34.95	-173.6	1589838.822	1324.87	4.42	67N-1/F2W 67N-2/F2W	300	3	1.7	0	-	1.7
Case	Case 25: 1LG fault at relay (G13-67N @ Charlie Poletti) close-in.													

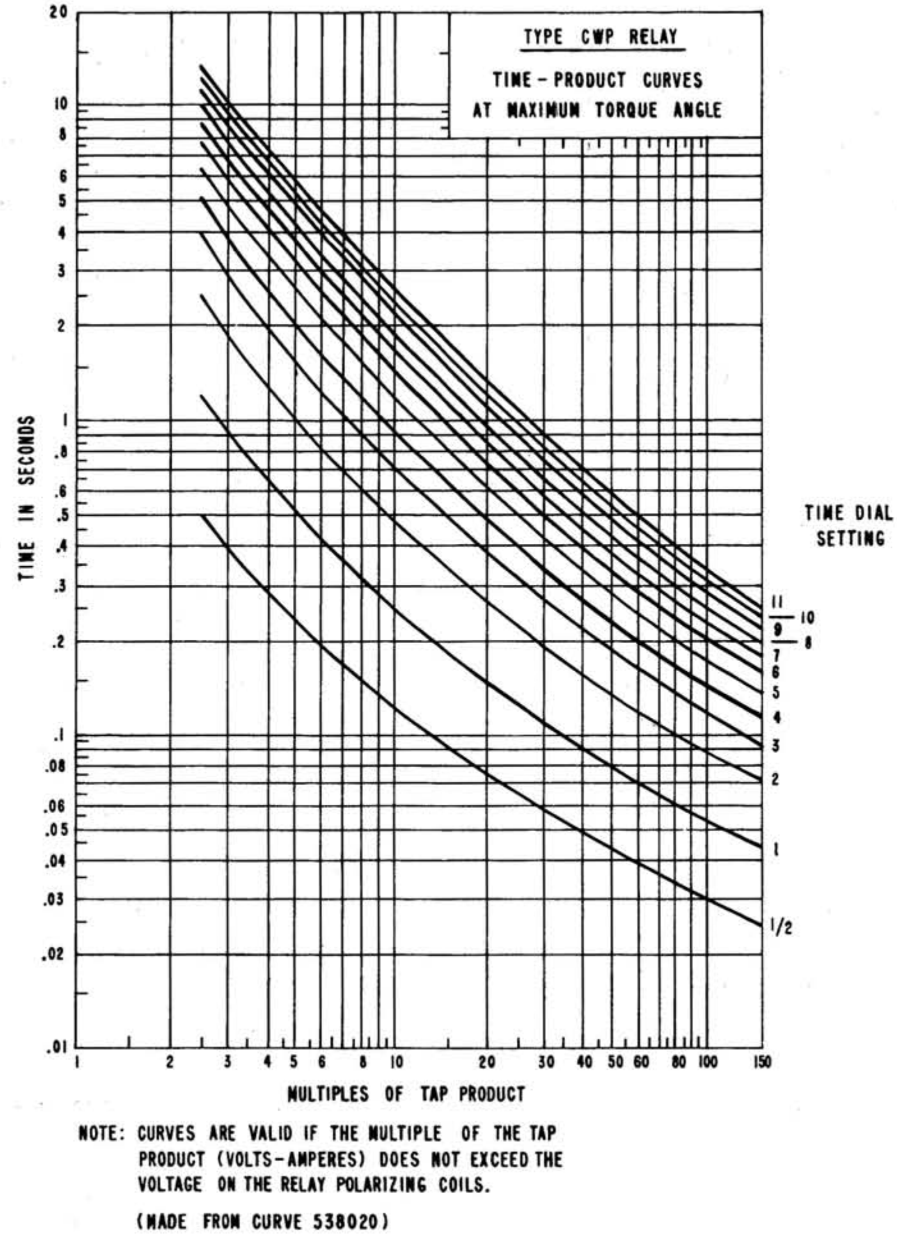
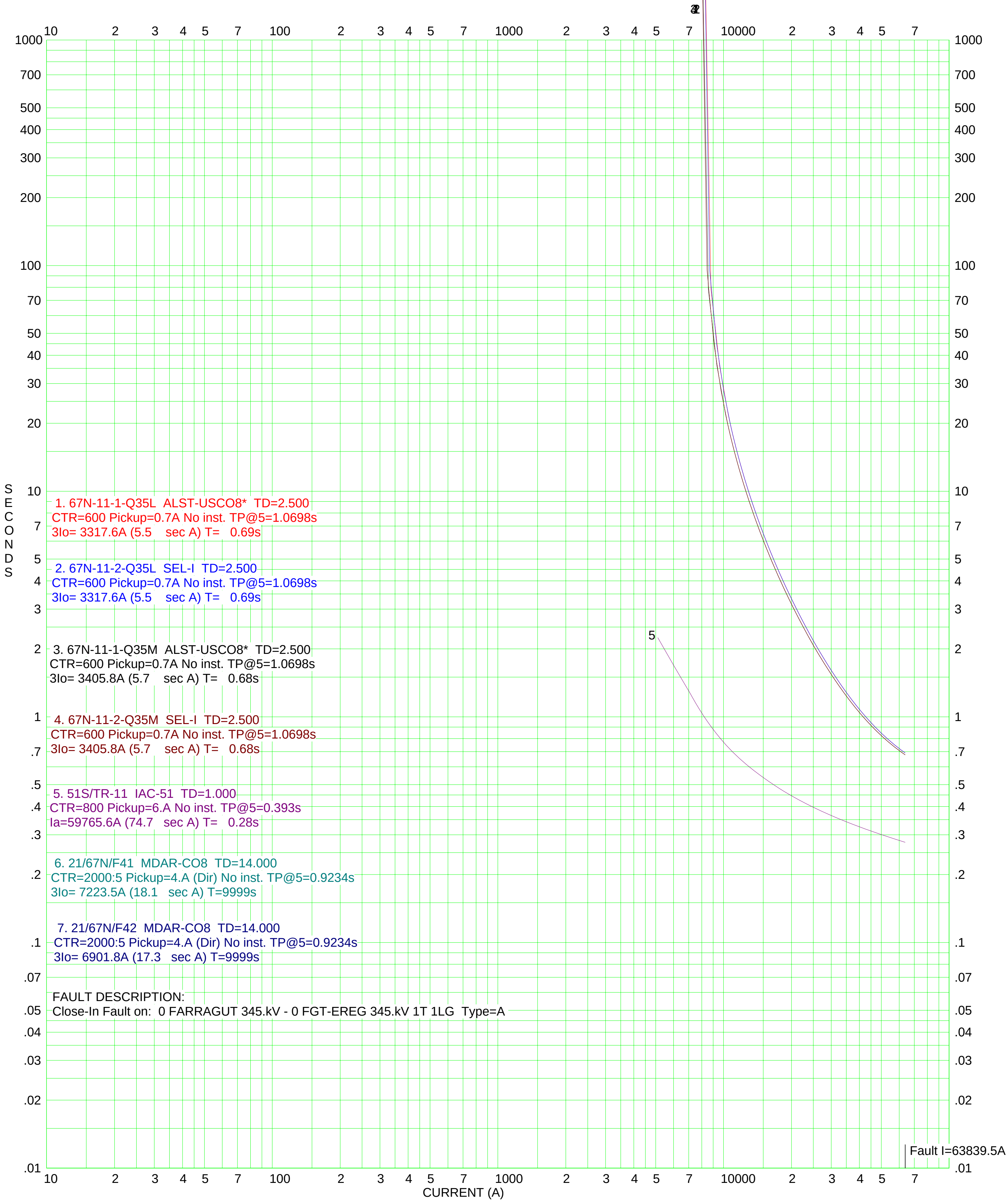
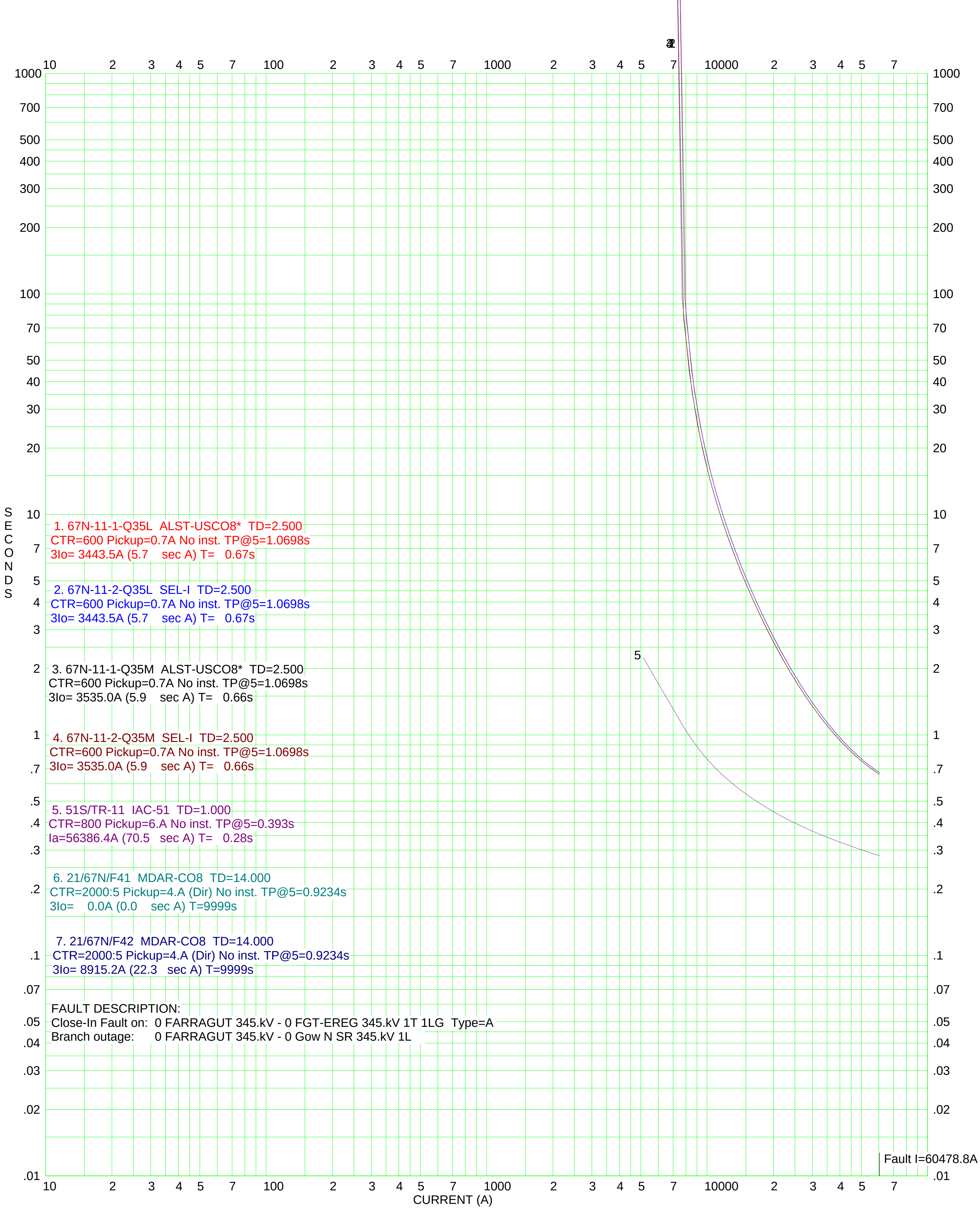


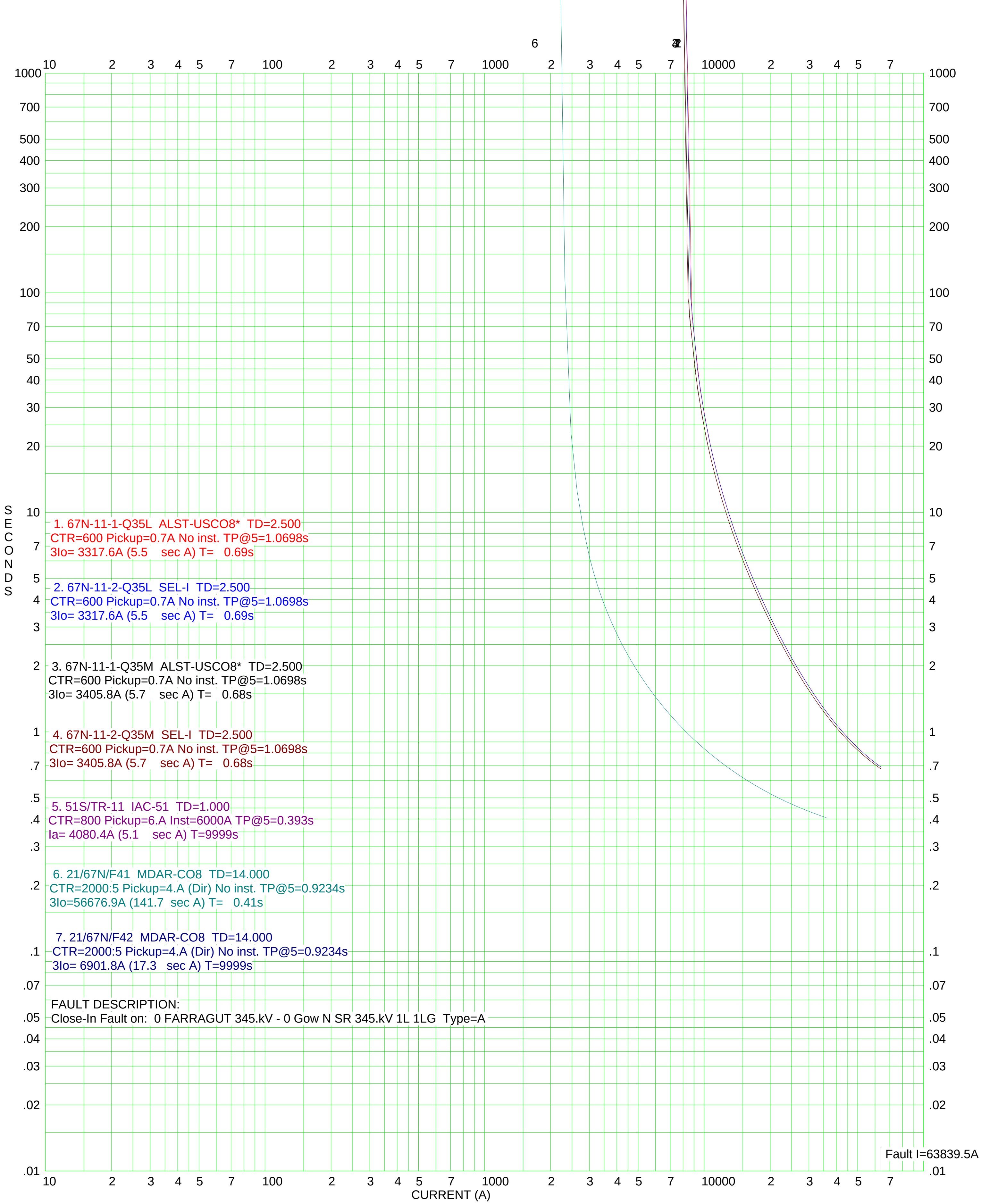
Fig. 11. Typical Time Curves of the Type CWP Relay at Maximum Torque Angle - Curves Apply if the Multiple of Tap Product in Volt-Amperes Does Not Exceed the Polarizing Voltage in Volts.



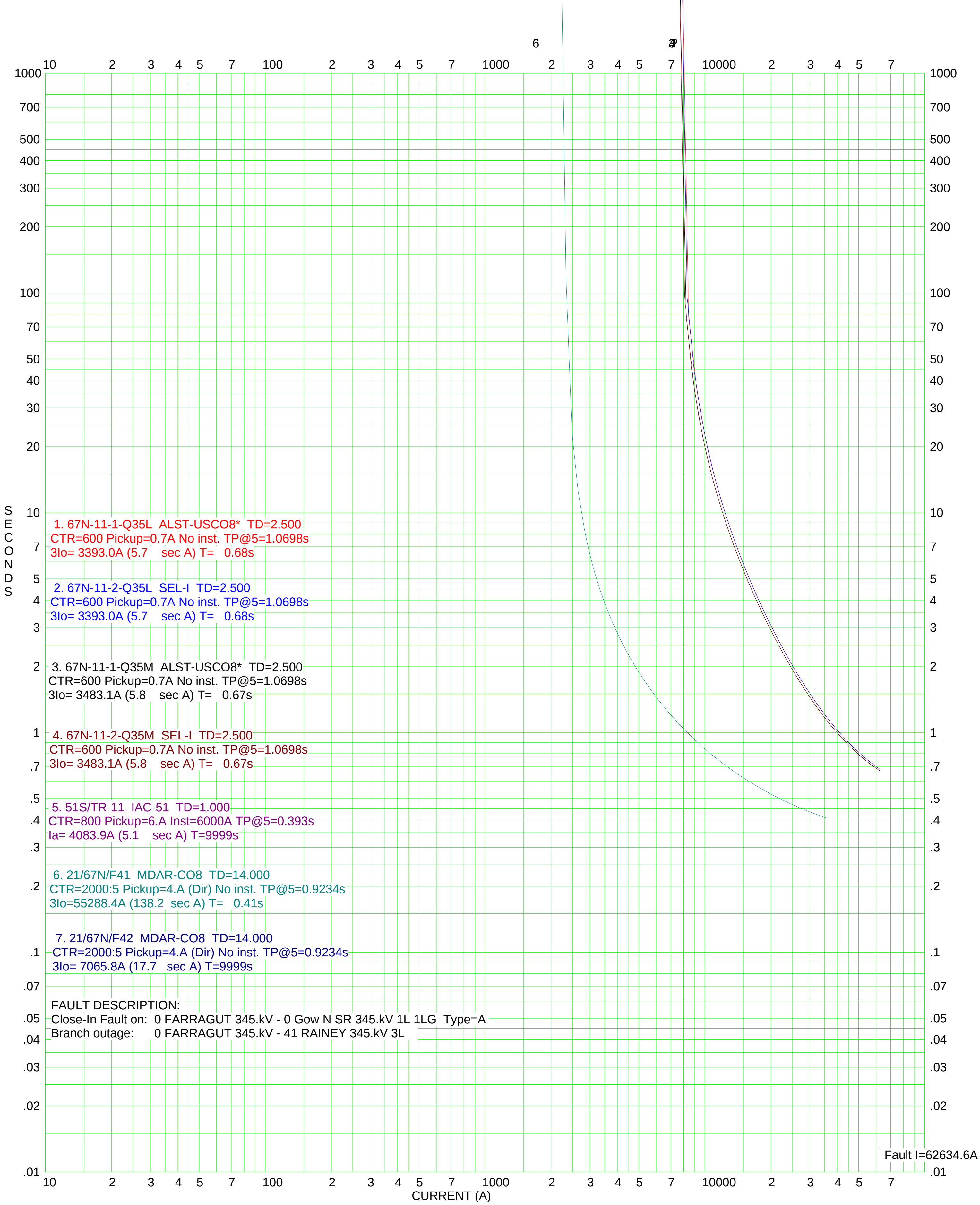
TIME-CURRENT CURVES @ Voltage	By
For	No.
Comment	Date



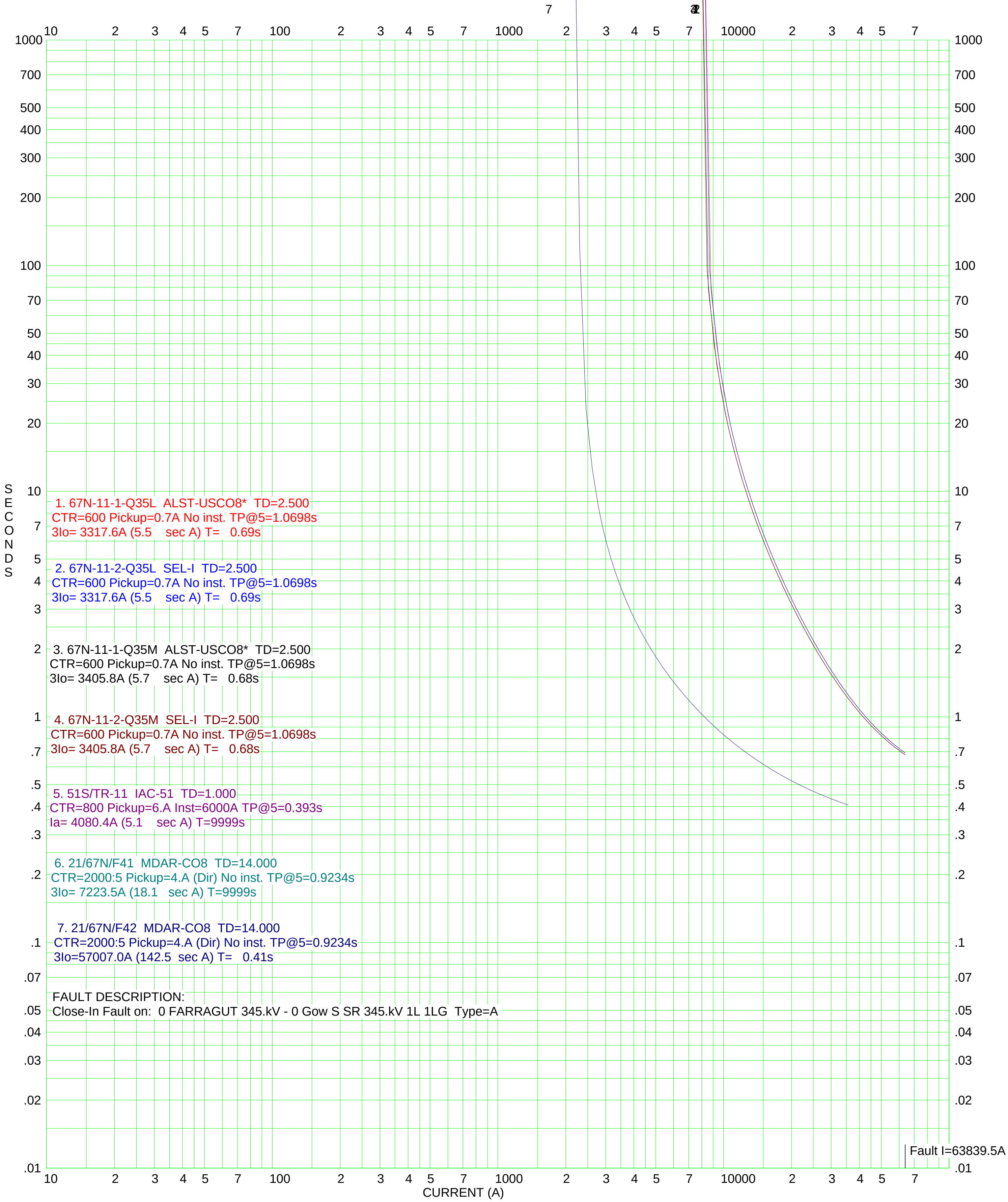
TIME-CURRENT CURVES @ Voltage	By
For	No.
Comment	Date



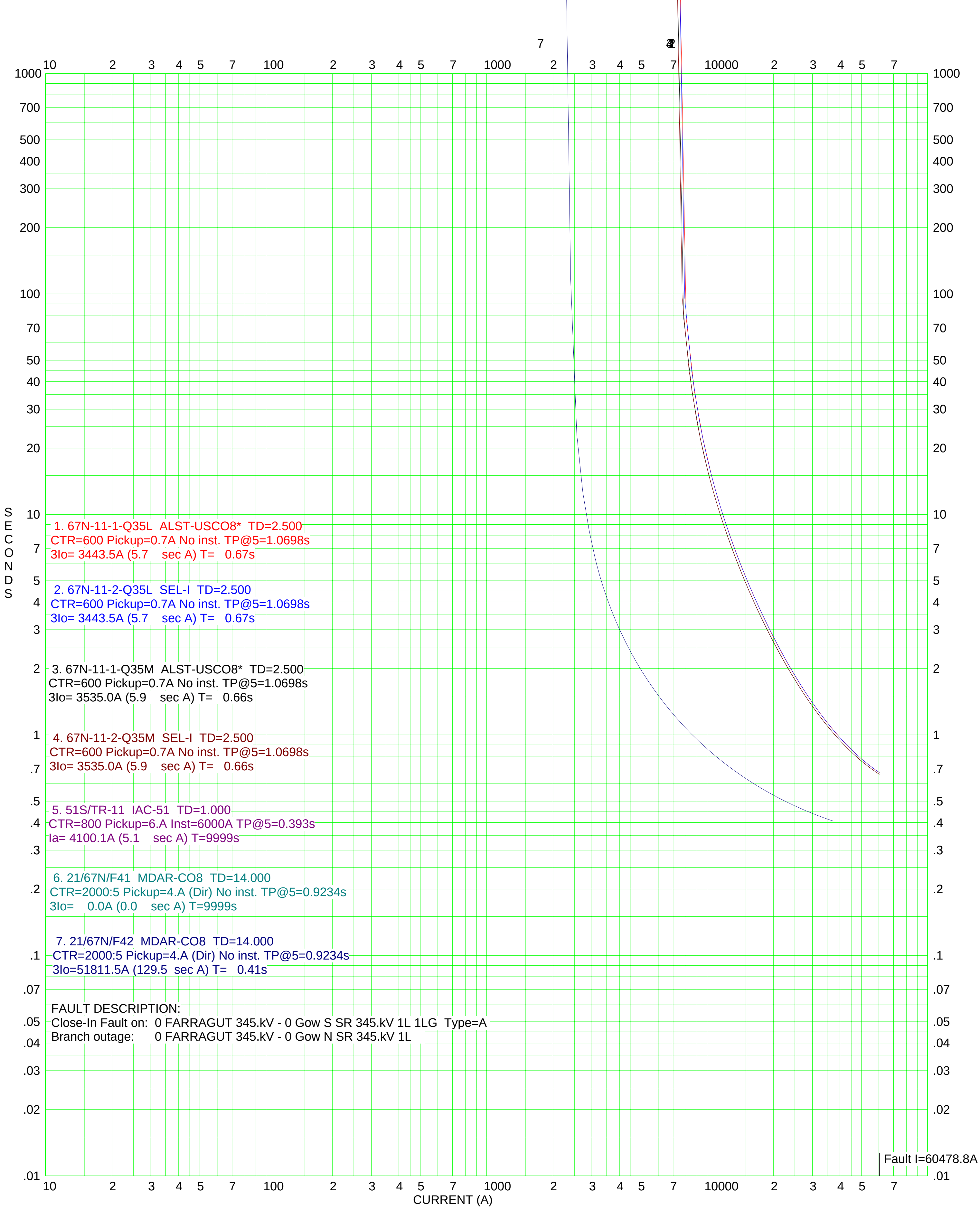
TIME-CURRENT CURVES @ Voltage	By
For	No.
Comment	Date



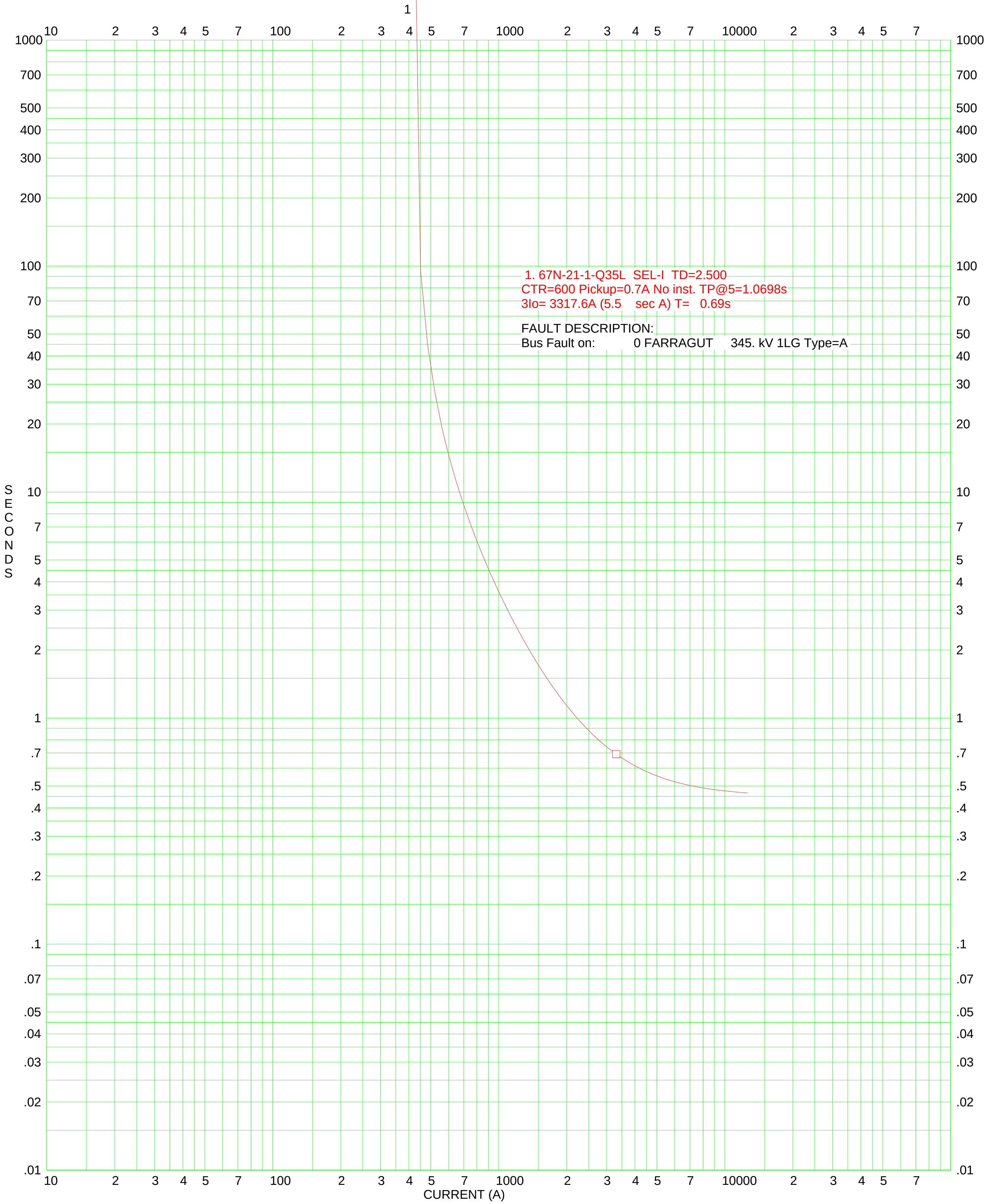
TIME-CURRENT CURVES @ Voltage	By
For	No.
Comment	Date



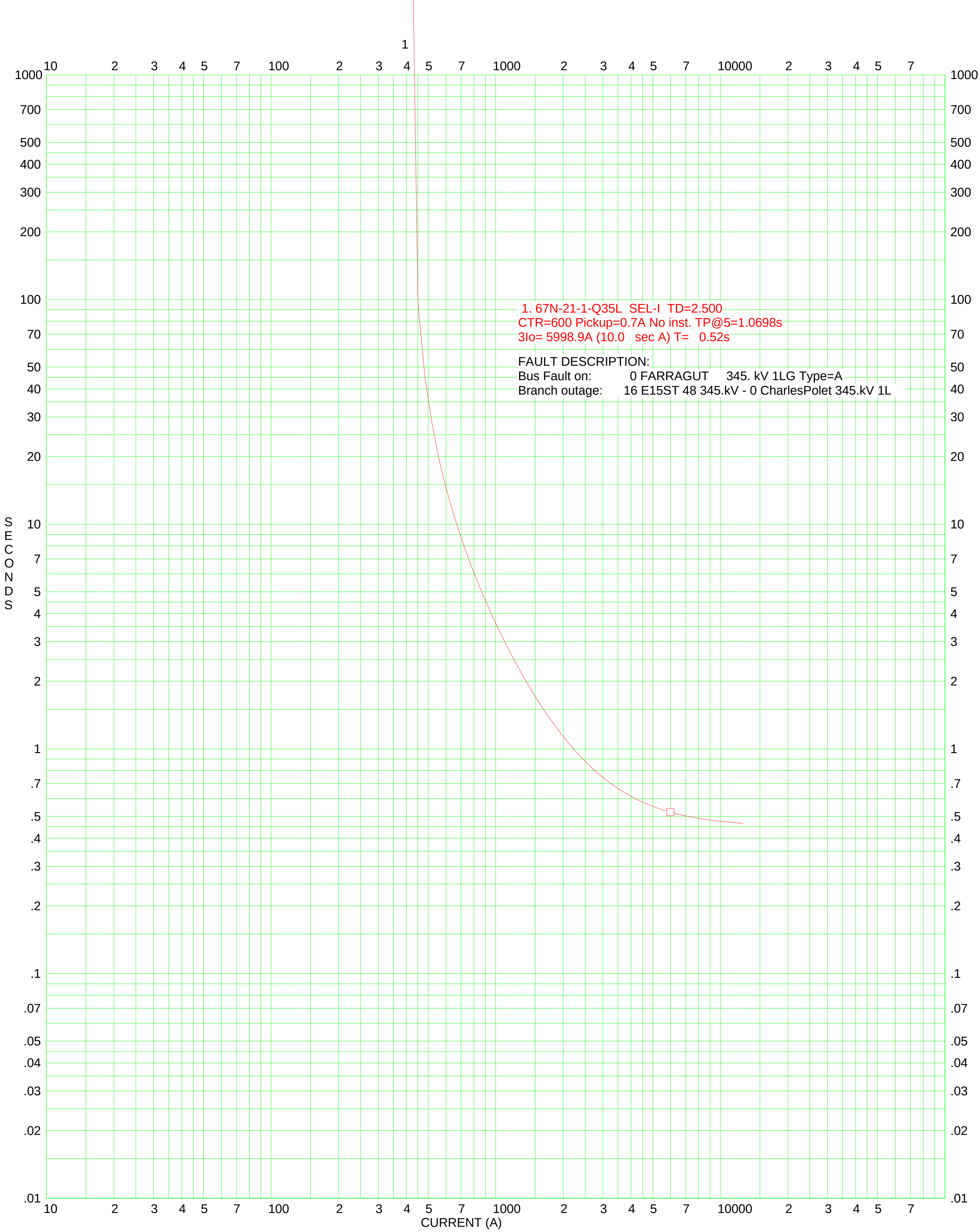
TIME-CURRENT CURVES @ Voltage	By
For	No.
Comment	Date



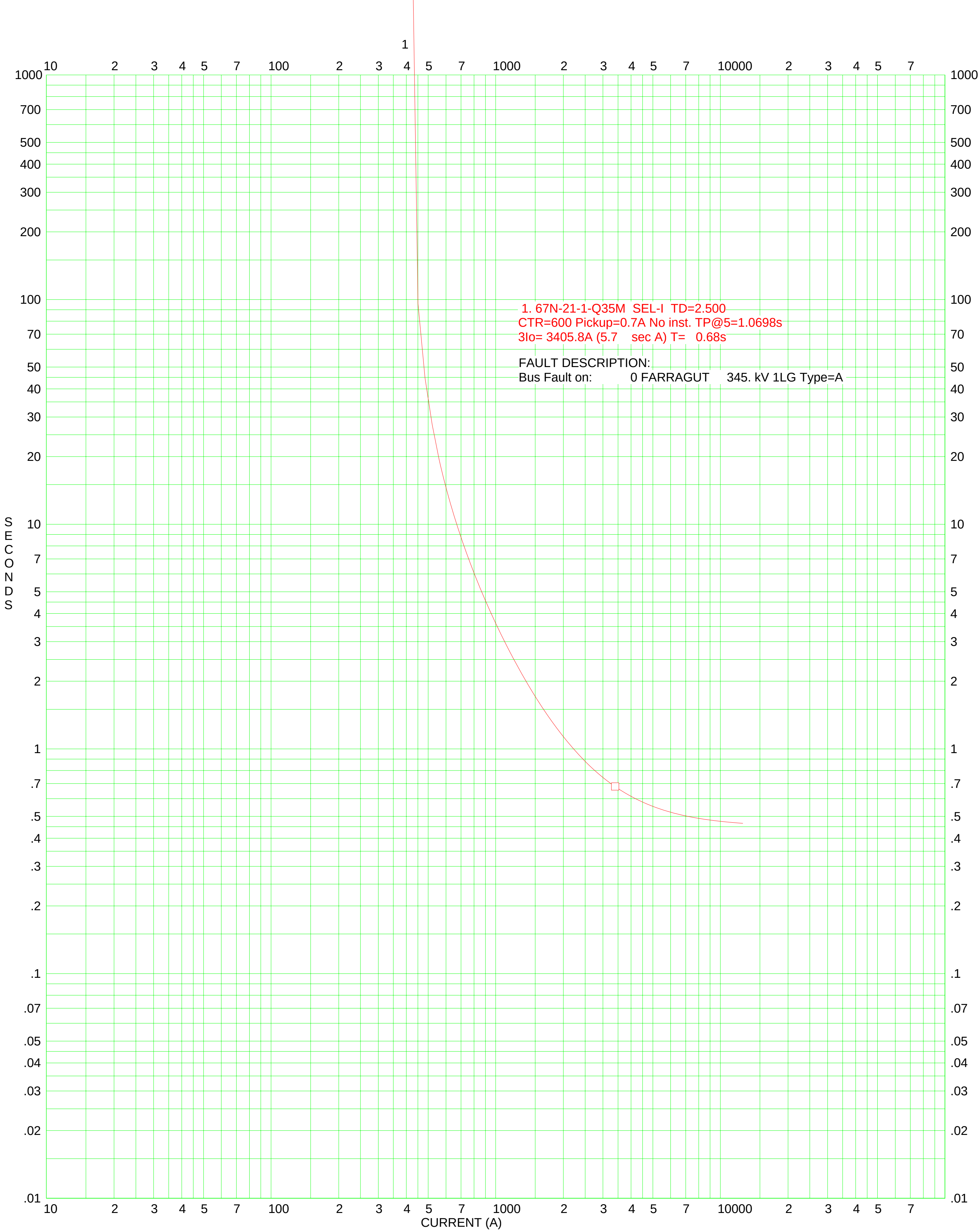
TIME-CURRENT CURVES @ Voltage	By
For	No.
Comment	Date



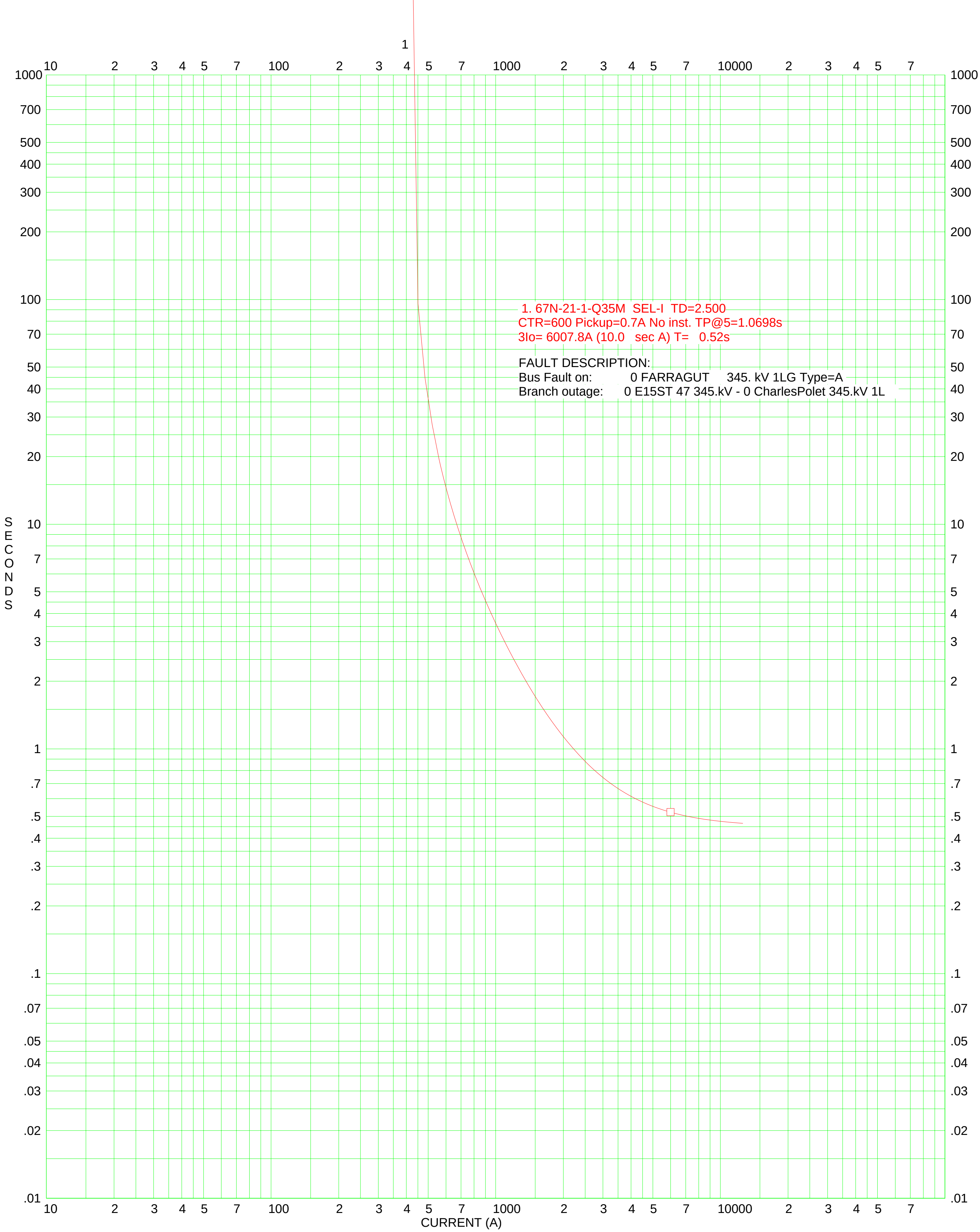
TIME-CURRENT CURVES @ Voltage	By
For 67N-21-1-Q35L	No. Appendix 28
Comment Normal Condition - 1LG Fault at Farragut 345kV bus	Date



TIME-CURRENT CURVES @ Voltage	By
For 67N-21-1-Q35L	No. Appendix 28
Comment Q35M Line Out - 1LG Fault at Farragut 345kV bus	Date



TIME-CURRENT CURVES @ Voltage	By
For 67N-21-1-Q35M	No. Appendix 28
Comment Normal Condition - 1LG Fault at Farragut 345kV bus	Date



TIME-CURRENT CURVES @ Voltage	By
For 67N-21-1-Q35M	No. Appendix 28
Comment Q35L Line Out - 1LG Fault at Farragut 345kV bus	Date

Appendix 29 Relay Coordination between Charles Poletti Station and East 13th street Station

CTR = 400 PTR = 3000

Case	3I0 Mag (Amp)	3I0 Angle	V0 Mag (kV)	V0 Angle	kVA Product	VA @ Relay	Per Unit of Pickup VA	Relay	Pickup VA	Time Dial	Time (Sec)	Q35L-67N Time (Sec)	Q35M-67N Time (Sec)	CTI (Sec)
1	16989	-72.1	43.37	-178.6	2149364.19	1791.14	5.97	67N/Q35M @E13	300	3	1.3	0.47	-	0.83
Q35M	Case 1: 1LG fault at relay (Q35L-67N @ Charlie Poletti) close-in with the AEII (G13) station in of service, which is normal.													
2	18855	-77.2	48.13	176.3	2647251.292	2206.04	7.35	67N/Q35M @E13	300	3	1	0.47	-	0.53
Q35M	Case 2: 1LG fault at relay (Q35L-67N @ Charlie Poletti) close-in with the AEII (G13) station out of service.													
Case	3I0 Mag (Amp)	3I0 Angle	V0 Mag (kV)	V0 Angle	kVA Product	VA @ Relay	Per Unit of Pickup VA	Relay	Pickup VA	Time Dial	Time (Sec)	G13-67N Time (Sec)		CTI (Sec)
3	16989	-72.1	43.37	-178.6	2149364.19	1791.14	5.97	67N/Q35M @E13	300	3	1.3	0	-	1.3
Q35M	Case 3: 1LG fault at relay (G13-67N @ Charlie Poletti) close-in.													
4	23667	-66.9	36.25	-176.9	2534684.654	2112.24	7.04	67N/Q35M @E13	300	3	1.1	0	-	1.1
Q35M	Case 4: 1LG fault at relay (G13-67N @ Charlie Poletti) close-in with Q35L line out of serice.													
Case	3I0 Mag (Amp)	3I0 Angle	V0 Mag (kV)	V0 Angle	kVA Product	VA @ Relay	Per Unit of Pickup VA	Relay	Pickup VA	Time Dial	Time (Sec)	Q35L-67N Time (Sec)	Q35M-67N Time (Sec)	CTI (Sec)
5	17297	-72.2	42.81	-178.3	2156401.729	1797.00	5.99	67N/Q35L @E13	300	3	1.3	-	0.47	0.83
Q35L	Case 5: 1LG fault at relay (Q35M-67N @ Charlie Poletti) close-in with the AEII (G13) station in of service, which is normal.													
6	19198	-77.2	47.51	176.6	2657305.932	2214.42	7.38	67N/Q35L @E13	300	3	1	-	0.47	0.53
Q35L	Case 6: 1LG fault at relay (Q35M-67N @ Charlie Poletti) close-in with the AEII (G13) station out of service.													
Case	3I0 Mag (Amp)	3I0 Angle	V0 Mag (kV)	V0 Angle	kVA Product	VA @ Relay	Per Unit of Pickup VA	Relay	Pickup VA	Time Dial	Time (Sec)	G13-67N Time (Sec)		CTI (Sec)
7	17297	-72.2	42.81	-178.3	2156401.729	1797.00	5.99	67N/Q35L @E13	300	3	1.3	0	-	1.3
Q35L	Case 7: 1LG fault at relay (G13-67N @ Charlie Poletti) close-in.													
8	23946	-67	35.66	-176.5	2518846.455	2099.04	7.00	67N/Q35L @E13	300	3	1.1	0	-	1.1
Q35L	Case 8: 1LG fault at relay (G13-67N @ Charlie Poletti) close-in with Q35L line out of serice.													

Note: It is noted that coordination between Q35L-67N or Q35M-67N at Charlie Poletti and 67N/48 or 67N/B47 at East 13th street for a relay close-in fault at East 13th line 48 or B47 is not needed, since there is no 345kV breaker at East 13th station.

Appendix 29 Relay Coordination between Charles Poletti Station and East 13th street Station

Con Ed requires to confirm if there is no need for setting changes of the ground backup relays at E13th street station because of the new GSU's.

The following short circuit calculations have been done for this purpose.
1. Applying a single phase to ground fault at E15ST-47 bus with Poletti Generation (existing) Station in and Charles Poletti (New) Station out.
2. Applying a single phase to ground fault at E15ST-47 bus with Poletti Generation (existing) Station out and Charles Poletti (New) Station in.
3. Applying a single phase to ground fault at E15ST-48 bus with Poletti Generation (existing) Station in and Charles Poletti (New) Station out.
4. Applying a single phase to ground fault at E15ST-48 bus with Poletti Generation (existing) Station out and Charles Poletti (New) Station in.

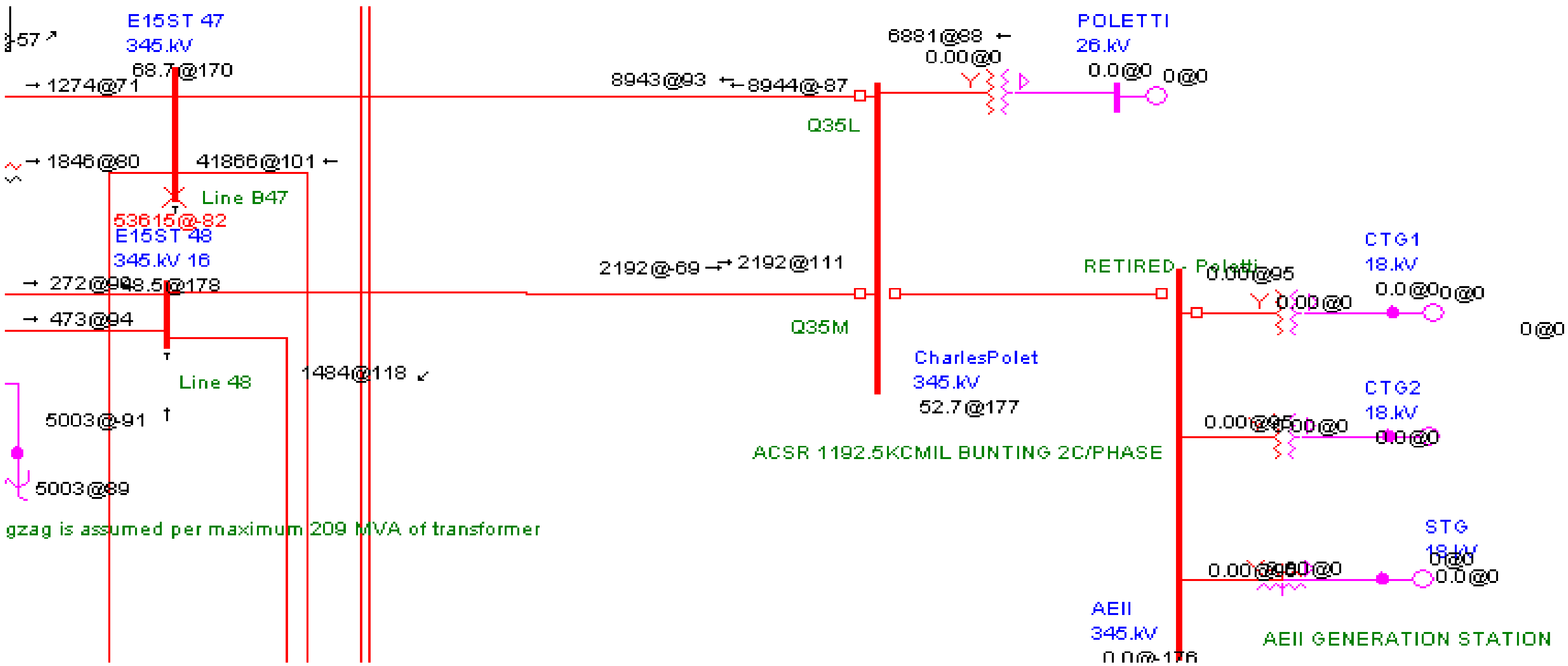
Note:
1. In NYISO Aspen model, E15ST is used for East 13th street station.
2. The impact of the adjacent BERRIANS 3 station to be built shall be evaluated during its design and engineering in the future.

Ground Fault Comparision between the Poletti Station (existing) and Charles Poletti (New) Station.

	Total 1LG fault current (A	Differen	1LG Contribution From Poletti (A)	1LG Contribution From Charles Poletti (A	Difference
Case 1	53615		6881	0	
Case 2	53747	0.25%	0	6933	0.76%
Case 3	52895		6878	0	
Case 4	53021	0.24%	0	6930	0.76%

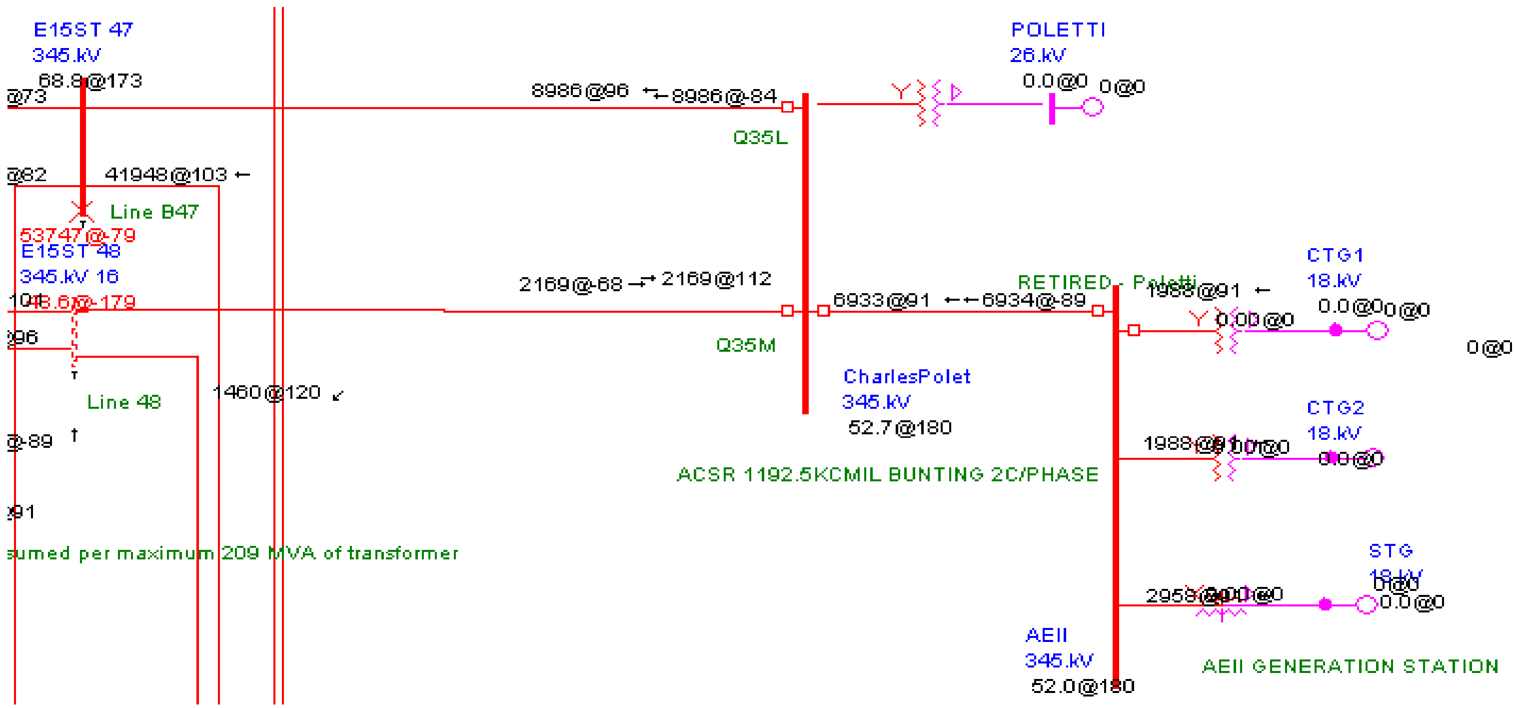
Conclusion: the ground fault differences between the existing Poletti station and the new Charles Poletti station are neglectable.

Appendix 29 Relay Coordination between Charles Poletti Station and East 13th street Station



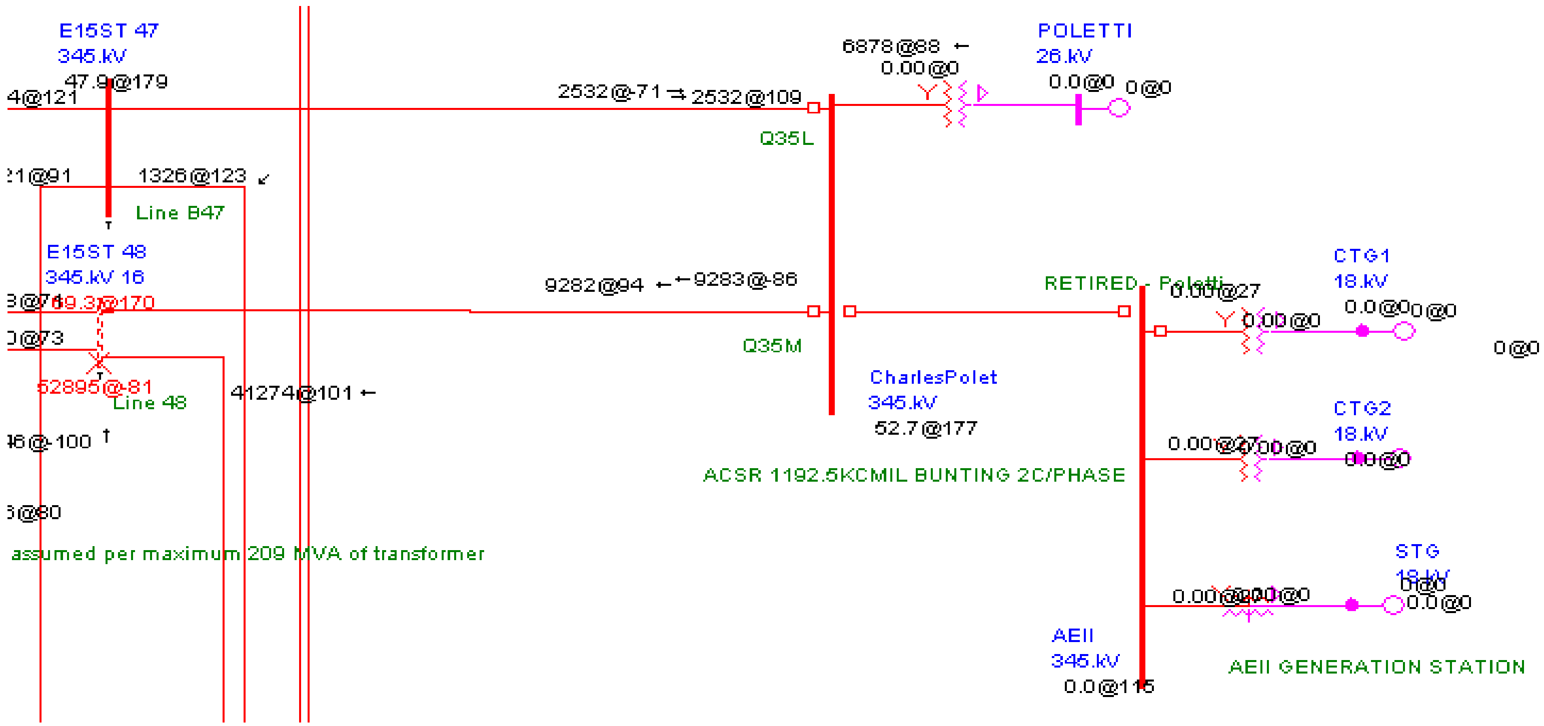
Case 1 A single phase to ground fault at E15ST-47 bus with Poletti Generation (existing) Station in and Charles Poletti (New) Station out.

Appendix 29 Relay Coordination between Charles Poletti Station and East 13th street Station



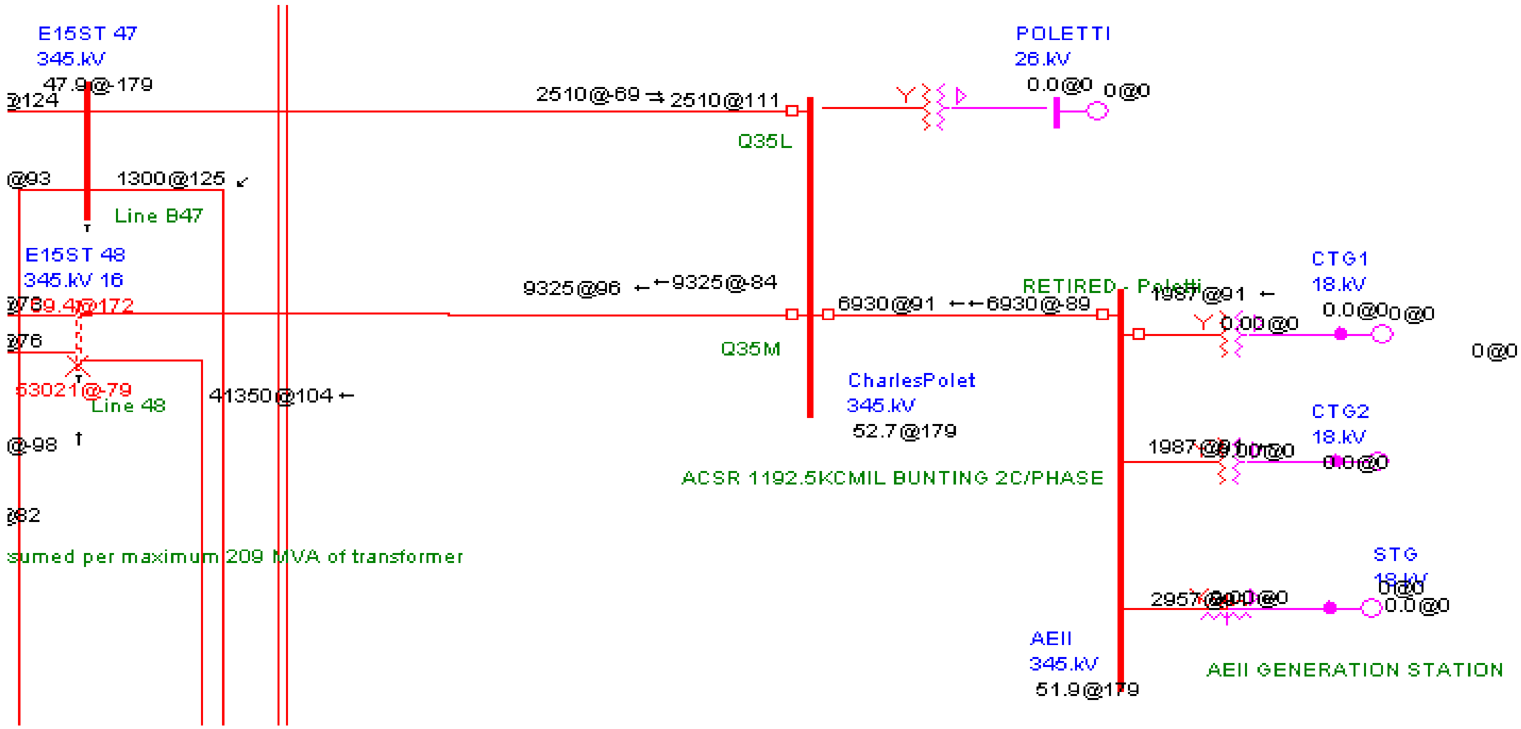
Case 2 A single phase to ground fault at E15ST-47 bus with Poletti Generation (existing) Station out and Charles Poletti (New) Station in.

Appendix 29 Relay Coordination between Charles Poletti Station and East 13th street Station

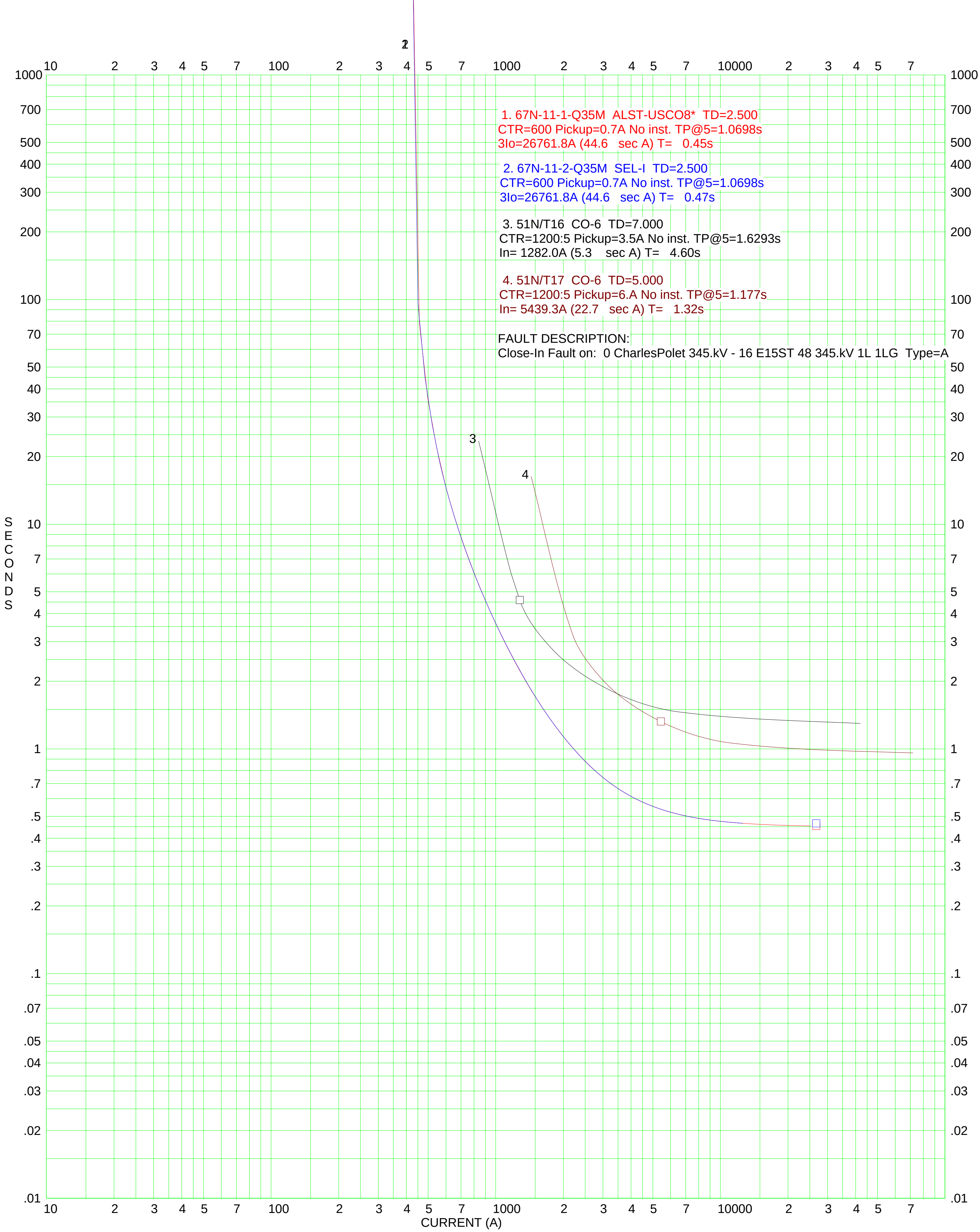


Case 3 A single phase to ground fault at E15ST-48 bus with Poletti Generation (existing) Station in and Charles Poletti (New) Station out.

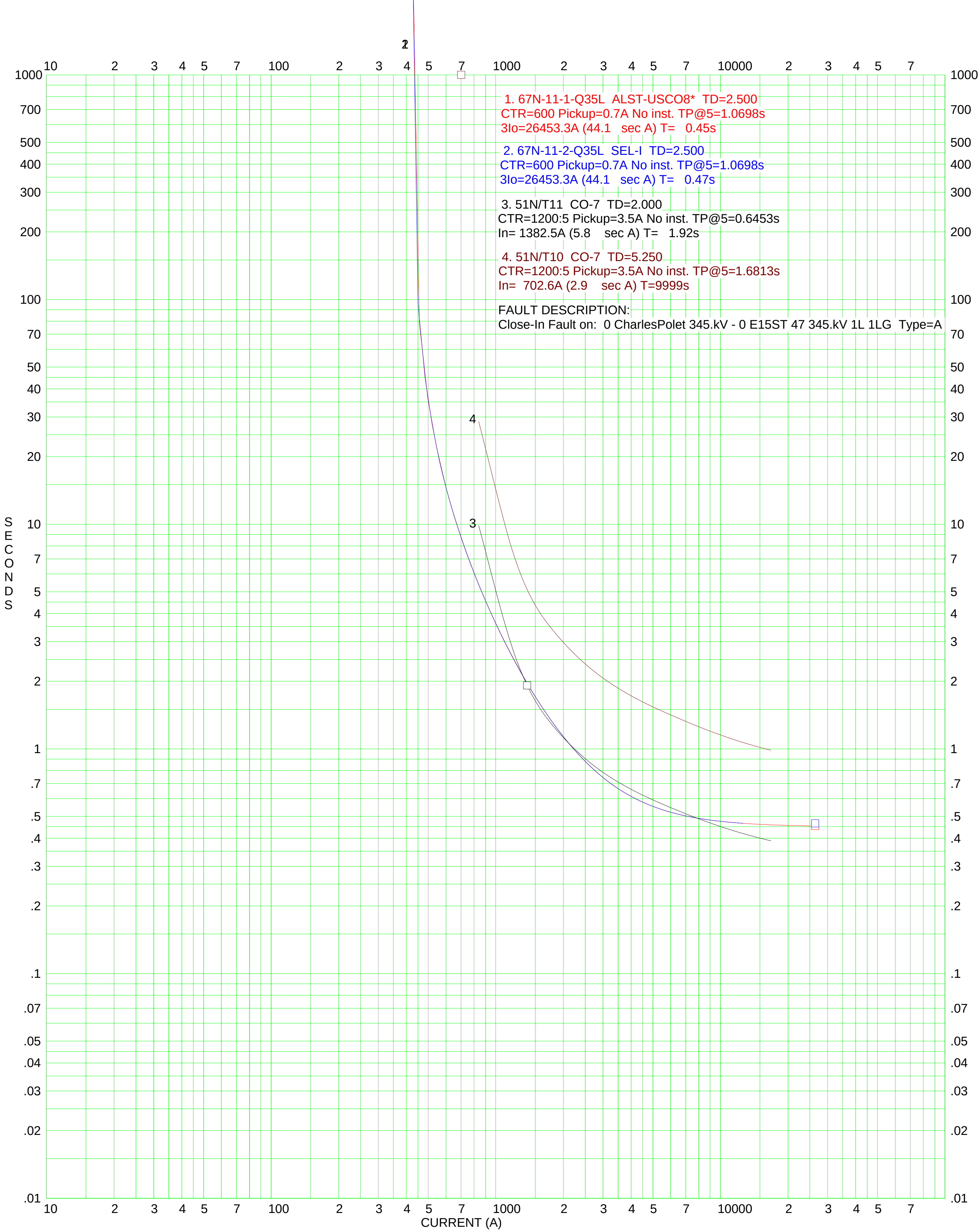
Appendix 29 Relay Coordination between Charles Poletti Station and East 13th street Station



Case 4 A single phase to ground fault at E15ST-48 bus with Poletti Generation (existing) Station out and Charles Poletti (New) Station in.



TIME-CURRENT CURVES @ Voltage	By
For	No.
Comment	Date



TIME-CURRENT CURVES @ Voltage	By
For	No.
Comment	Date

Attachment 01 Transmission Line Impedance Calculation

ACSR Table Data

Description	Resistivity	Resistance ra @ 25c	GMR	Inductive Xa	Conductor per Phase
	ohm-meters	ohm/mile	ft	ohm/mile	N/A
1192.5kcmil 45/7 ACSR Bunting	100	0.08050	0.04310	0.38200	2

Equivalent depth of return De = 2160*sqrt(p/f) in feet = 2788.55 where f = 60 Hz

Design Data

Description	Length	Ground	dab	dbc	dca
	mile	Wire Num	ft	ft	ft
1192.5kcmil 45/7 ACSR Bunting	0.35038	1	18.00	18.00	36.00

GMD in feet =	22.67858			
Zero-sequence impedance - no ground wire **Z0 (a)** in feet =	0.36670	+j	2.51192	
Zero-sequence self impedance **Z0(g)** in ohms per mile =	0.52770	+j	4.03250	

Design Data 1

Description	Length	Ground	dag1	dbg1	dcg1
	mile	Wire Num	ft	ft	ft
1192.5kcmil 45/7 ACSR Bunting	0.35038	1	15.00	33.00	51.00

Zero-sequence ground mutal impedance **Z0(ag)** ohms/mile =	0.28620	+j	1.65795	
Z0(ag)^2 =	-2.66688	+j	0.94901	
Z0(ag)^2/Z0(g) =	0.14629	+j	0.68049	
Z0 = Z0(a) - Z0(ag)^2/Z0(g) =	0.22041	+j	1.83143	

Description	kV	R1	X1	R0	X0
		ohms/mile	ohms/mile	ohms/mile	ohms/mile
1192.5kcmil 45/7 ACSR Bunting	345	0.04025	0.38038	0.11020	0.91572

Description	kV	R1	X1	R0	X0
		ohms	ohms	ohms	ohms
1192.5kcmil 45/7 ACSR Bunting	345	0.01410	0.13328	0.03861	0.32085

Zbase = 1190.25 ohms @ 100 MVA

Description	kV	R1	X1	R0	X0
		per unit	per unit	per unit	per unit
1192.5kcmil 45/7 ACSR Bunting	345	0.00001	0.00011	0.00003	0.00027

CTR = 600 PTR = 3000

CTR/PTR= 0.2

Description	kV	R1	X1	R0	X0
		2nd Ohms	2nd Ohms	2nd Ohms	2nd Ohms
1192.5kcmil 45/7 ACSR Bunting	345	0.00282	0.02666	0.00772	0.06417
			Z1		Z0
			2nd Ohms		2nd Ohms
			0.02680		0.06463

Attachment 02 Transformer Data

Data provided via an email

From: Cliff.Nebeker@slthermal.com [mailto:Cliff.Nebeker@slthermal.com]
Sent: Monday, June 08, 2009 12:39 PM
To: Scott Chiappetta; Astoria II Project; Eric.Anderson@nypa.gov; Fred.Pagano@nypa.gov; MURPHYP@coned.com; mazzattor@coned.com; Nick.Johnson@slthermal.com; Cliff.Nebeker@slthermal.com
Cc: David Klein
Subject: RE: Astoria II relay meeting notes

Zero sequence impedances and X/R ratioes are assumptions.

B.1 Combustion turbine-generator step-up transformer (typical for two units)

H Voltage	345	KV	Wye grounded		@	129	172	215	MVA	
X Voltage	18	KV	Delta		@	129	172	215	MVA	
Zps =	8.50%	@129MV'A			X/R=	45	(assumed)			
Zps =	0.0019	+j	0.0850	Zps0 =		0.0019	+j	0.0850	(assumed)	
		@ MVA=	129				@ MVA=	129		

B.2 Steam turbine-generator step-up transformer

H Voltage	345	KV	Wye grounded		@	192	256	320	MVA	
X Voltage	18	KV	Delta		@	192	256	320	MVA	
Zps =	8.50%	@192MV'A			X/R=	45	(assumed)			
Zps =	0.0019	+j	0.0850	Zps0 =		0.0019	+j	0.0850	(assumed)	
		@ MVA=	192				@ MVA=	192		

Attachment 03 Turbine Generator Data

Data provided via an attachment of "345KV InterconnectionReq.doc" from an email

From: Cliff.Nebeker@slthermal.com [mailto:Cliff.Nebeker@slthermal.com]
Sent: Monday, June 08, 2009 12:39 PM
To: Scott Chiappetta; Astoria II Project; Eric.Anderson@nypa.gov; Fred.Pagano@nypa.gov; MURPHYP@coned.com; mazzattor@coned.com; Nick.Johnson@slthermal.com; Cliff.Nebeker@slthermal.com
Cc: David Klein
Subject: RE: Astoria II relay meeting notes

C.1 Combustion turbine-generator (typical for two units)

1	Unit Rating in MVA 226.0000				
2	Connection Type: WYE				
3	Substransient impedance in R+jX" format.	0.0029	+j	0.145	'@ Unit MVA
	Transient impedance in R+jX' format.	0.0029	+j	0.255	'@ Unit MVA
	Synchronous impedance in R+jX format	0.0029	+j	2.04	'@ Unit MVA
	Negative sequence impedance in R+jX format	0.0136	+j	0.146	'@ Unit MVA
	Zero sequence impedance in R+jX format	0.0072	+j	0.12	'@ Unit MVA
	Neutral Impedance (in actual Ohms) in R+jX format	0	+j	*0.3456*	ohms

C.2 Steam turbine-generator

1	Unit Rating in MVA 325.0000				
2	Connection Type: WYE				
3	Substransient impedance in R+jX" format.	0.0028	+j	0.175	'@ Unit MVA
	Transient impedance in R+jX' format.	0.0028	+j	0.26	'@ Unit MVA
	Synchronous impedance in R+jX format	0.0028	+j	1.96	'@ Unit MVA
	Negative sequence impedance in R+jX format	0.0139	+j	0.177	'@ Unit MVA
	Zero sequence impedance in R+jX format	0.0063	+j	0.125	'@ Unit MVA
	Neutral Impedance (in actual Ohms) in R+jX format	0	+j	*0.3456*	ohms

Attachment 04 345KV CABLE DATA

Data provided per Aspen Model NYISO_2013_CY08_ATRA_rev3a.

MVA_Base =	100	kV_Base =	345	Z_Base =	1190.25	ohms
CTR =	600	PTR =	3000			

Line ID	From	To	R1(pu)	X1(pu)	R0(pu)	X0(pu)
Q35L	Charles Poletti	E13th Street.	0.00033	0.0016	0.00279	0.00408
Q35M	Charles Poletti	E13th Street.	0.00033	0.0016	0.00279	0.00408
B47	E13th Street.	FARRAGUT	0.00009	0.00041	0.00083	0.00107
48	E13th Street.	FARRAGUT	0.00009	0.00044	0.00089	0.00114
B43 [Note 1]	FARRAGUT	B43 Bus	0.00001	0.00004	0.0001	0.00016
B45	FARRAGUT	E13th Street.	0.00009	0.00043	0.0008	0.0011
46	FARRAGUT	E13th Street.	0.00009	0.00044	0.00089	0.00112
63	FARRAGUT	RAINEY	0.00031	0.00174	0.00332	0.00486
61	FARRAGUT	RAINEY	0.00031	0.00174	0.00334	0.0049
62	FARRAGUT	RAINEY	0.00034	0.00189	0.00383	0.0055
42	FARRAGUT	Gow S SR	0.00017	0.00096	0.00192	0.00279
41	FARRAGUT	Gow S SR	0.00017	0.00096	0.00177	0.00267

Note 1: B43 is the shortest 345 line out from Farrgut station.

Line ID	From	To	R1(ohms)	X1(ohms)	R0(ohms)	X0(ohms)
Q35L	Charles Poletti	E13th Street.	0.3927825	1.9044	3.3207975	4.85622
Q35M	Charles Poletti	E13th Street.	0.3927825	1.9044	3.3207975	4.85622
B47	E13th Street.	FARRAGUT	0.1071225	0.4880025	0.9879075	1.2735675
48	E13th Street.	FARRAGUT	0.1071225	0.52371	1.0593225	1.356885
B43 [Note 1]	FARRAGUT	B43 Bus	0.0119025	0.04761	0.119025	0.19044
B45	FARRAGUT	E13th Street.	0.1071225	0.5118075	0.9522	1.309275
46	FARRAGUT	E13th Street.	0.1071225	0.52371	1.0593225	1.33308
63	FARRAGUT	RAINEY	0.3689775	2.071035	3.95163	5.784615
61	FARRAGUT	RAINEY	0.3689775	2.071035	3.975435	5.832225
62	FARRAGUT	RAINEY	0.404685	2.2495725	4.5586575	6.546375
42	FARRAGUT	Gow S SR	0.2023425	1.14264	2.28528	3.3207975
41	FARRAGUT	Gow S SR	0.2023425	1.14264	2.1067425	3.1779675

Line ID	From	To	R1(ohms)	X1(ohms)	R0(ohms)	X0(ohms)
Q35L+B47	Charles Poletti	FARRAGUT	0.499905	2.3924025	4.308705	6.1297875
Q35M+48	Charles Poletti	FARRAGUT	0.499905	2.42811	4.38012	6.213105

SIZE	DWG NO	SH	REV
A	237A7271	1	-

THIRD ANGLE PROJECTION

REVISIONS

REV	DESCRIPTION	DATE	APPROVED

REV STATUS OF SHEETS

SH	REV	SH	REV
1	-		
2	-		
3	-		
4	-		
5	-		
6	-		
7	-		
8	-		
9	-		
10	-		
11	-		
12	-		
13	-		
14	-		
15	-		

SNC·LAVALIN Constructors Inc.

Vendor's drawing review for conformity with specifications and design drawing.

This review does not relieve the vendor of his responsibility for errors in design and detailing as detailed in his contract.

- ☐ 1 NO EXCEPTIONS TAKEN, RESUBMIT DOCUMENT AS CERTIFIED. PROCEED WITH FABRICATION.
- ☒ 2 NO EXCEPTIONS TAKEN, ACCEPTED AS FINAL, RESUBMITTAL NOT REQUIRED. PROCEED WITH FABRICATION.
- ☐ 3 EXCEPTIONS AS NOTED, REVISE AND RESUBMIT. PROCEED WITH FABRICATION INCLUSIVE OF MARKUPS.
- ☐ 4 EXCEPTIONS AS NOTED, REVISE AND RESUBMIT. DO NOT PROCEED WITH FABRICATION.
- ☐ 5 APPROVAL NOT REQUIRED. FOR INFORMATION / REFERENCE ONLY.
- ☐ 6 CANCELLED

Vendor: GENERAL ELECTRIC - GENE No.: C902-237a7271 Rev: - | Date Rec'd 9/19/2008
Doc. Title: ELECTRICAL DATA, GENERATOR - 15 Pages
Client Code: | Project: Astoria II Cogeneration Project
Reviewed by: VJS | Document No | Submittal
Date: 26 - Sept-08 | 0620 - T170-0003 - 001 | 01

SNC LAVALIN CONSTRUCTORS INC. CONTRACT NO. 0620
P.O. NUMBER 62000001, SPECIFICATION SP-T170
PROJECT NAME: PHASE II ASTORIA ENERGY EXPANSION PROJECT
PROJECT LOCATION: ASTORIA, NEW YORK
STEAM TURBINE GENERATOR

UNLESS OTHERWISE SPECIFIED

DIMENSIONS ARE IN INCHES
TOLERANCES ON:
2 PL DECIMALS±
3 PL DECIMALS±
ANGLES±
FRACTIONS±

SIGNATURE	DATE
DRAWN H.A. SOUTH	9/15/2008
CHECKED T. HAMMELL	9/17/2008
ENGRG H.A. SOUTH	9/17/2008
ISSUED H.A. SOUTH	9/17/2008

GENERAL ELECTRIC COMPANY
GE POWER GENERATION SCHENECTADY, NY

ELECTRICAL DATA, GENERATOR
Astoria Energy II LLC

FIRST MADE FOR 290T769 C902

SIZE	CAGE CODE	DWG NO
A		237A7271

DT-2N | SIM TO: NONE | SCALE | DFT UNIT NR5E | SHEET 1

SIZE	DWG NO	SH	REV
A	237A7271	2	-

ESTIMATED GENERATOR DATA

Customer: **Astoria Energy II LLC**

Station/Project: **Phase II Astoria Energy Expansion Project**

Generator Number: **290T769**

Generator Type: **324LD**

GENERATOR RATING

Data for Proposal No/Electrical Design: G347T19A Sep 11 2008

ATB 2 325000 kVA 3600 RPM 18000 Volts 0.85 PF 45 psig 40 °C Gas 276250 kW 10424 Amps
700 Field Volts 12 Ft Alt 0.5 SCR 60 Hz 3 Phase WYE Connection

Exciter Rating

Type Static

1235 kW 700 Volts 1764 D.C.Amps Field Amps @ Generator rated Load 1568

Total temperatures are guaranteed not to exceed:	Insulation Class		Temperature Rise
Stator coils: 104 °C by embedded detector	Armature	F	B
Field coils 120 °C by Resistance	Field class	F	B
Collector Gas Rise 20 °C by RTD			

Cooling water Requirements @ Generator Rating (C901 - Data)

Generator Output:	325000	Kva
Loss to Coolers:	2275 Kw	
Inlet Water Temperature:	30 °C	
Outlet Cold Gas Temperature	40 °C	
Coolant	40% Propylene glycol	
Maximum Fouling Factor:	0.0005	(hrs ft^2 deg F) / btu
Total Water Flow Required:	2460 GPM	(total for all coolers)
Head Loss Per Cooler:	22.5 Feet of Water	
Maximum Operating Pressure:	150 psig	(10.3 bar)

Dielectric tests (Between coils and ground, 50/60 hertz AC for 1 min)

Stator 37000V

Rotor 5400V

REACTANCES (Per Unit):	Direct Axis		Quadrature Axis	
Saturated Synchronous	X_{dv}	1.96	X_{qv}	1.87
Unsaturated Synchronous	X_{di}	1.96	X_{qi}	1.87
Saturated Transient	X'_{dv}	0.26		
Unsaturated Transient	X'_{di}	0.285	X'_{q}	0.49
Saturated Sub transient	X''_{dv}	0.175	X''_{qv}	0.175
Unsaturated Sub transient	X''_{di}	0.22	X''_{qi}	0.22
Saturated Negative Sequence	X_{2v}	0.175		
Unsaturated Negative Sequence	X_{2i}	0.22		
Saturated Zero Sequence	X_{0v}	0.125		
Unsaturated Zero Sequence	X_{0i}	0.125		
Saturated Leakage Reactance	X_{lv}	0.155		
Unsaturated Leakage Reactance	X_{li}	0.165		

FIELD TIME CONSTANTS (Seconds @ 125 °C)

Open Circuit	T'_{d0}	6.3	T'_{q0}	0.53
Three Phase Short Circuit Transient	T'_{d3}	0.75	T'_{q}	0.14
Line To Line Short Circuit Transient	T'_{d2}	1.28		
Line To Neutral Short Circuit Transient	T'_{d1}	1.56		
Short Circuit Sub transient	T''_{d}	0.026	T''_{q}	0.026
Open Circuit Sub transient	T''_{d0}	0.037	T''_{q0}	0.071

ARMATURE DC COMPONENT TIME CONSTANTS (Seconds@ 100 °C)

Three Phase Short Circuit	T_{a3}	0.47
Line To Line Short Circuit	T_{a2}	0.47
Line To Neutral Short Circuit	T_{a1}	0.36

ARMATURE WINDING SEQUENCE RESISTANCES (Per Unit)

Positive	R_1	0.0028
Negative	R_2	0.0139
Zero	R_0	0.0063

Reactance, Resistance and Time Constant data may be interpreted per IEEE 115, section VII.

The base reactance ("UNIT") is calculated by the armature kV squared / MVA.

Base reactance = 0.9969 Ohms

Rotor Short-Time Thermal Capacity, $(I_2)^2t$	10 s
Turbine-Generator Combined Inertia Constant, H	3.335 kW-s/kVA
Three Phase Armature Winding Capacitance	1.4195 µF
Armature Winding DC Resistance (Per Phase)	0.0012 Ω (100 °C)
Field Winding DC Resistance	0.3424 Ω (125 °C)
Field Current At Rated Kva, Armature Voltage, & PF	1568 A
Field Current At Rated Kva, Armature Voltage, 0 PF Lagging	1948 A

(For Systems Study Only - Not Allowable Operating Point)

MACHINE SATURATION DATA

S/1.0 = 0.0572	Machine saturation may be calculated from the data of curves A and B of
S/1.2 = 0.4604	"ESTIMATED SATURATION AND SYNCHRONOUS IMPEDANCE CURVES".
	"S/1.0" is the field amp difference from B to A divided by the field amp of A at 1.0 pu voltage.

X/R RATIO

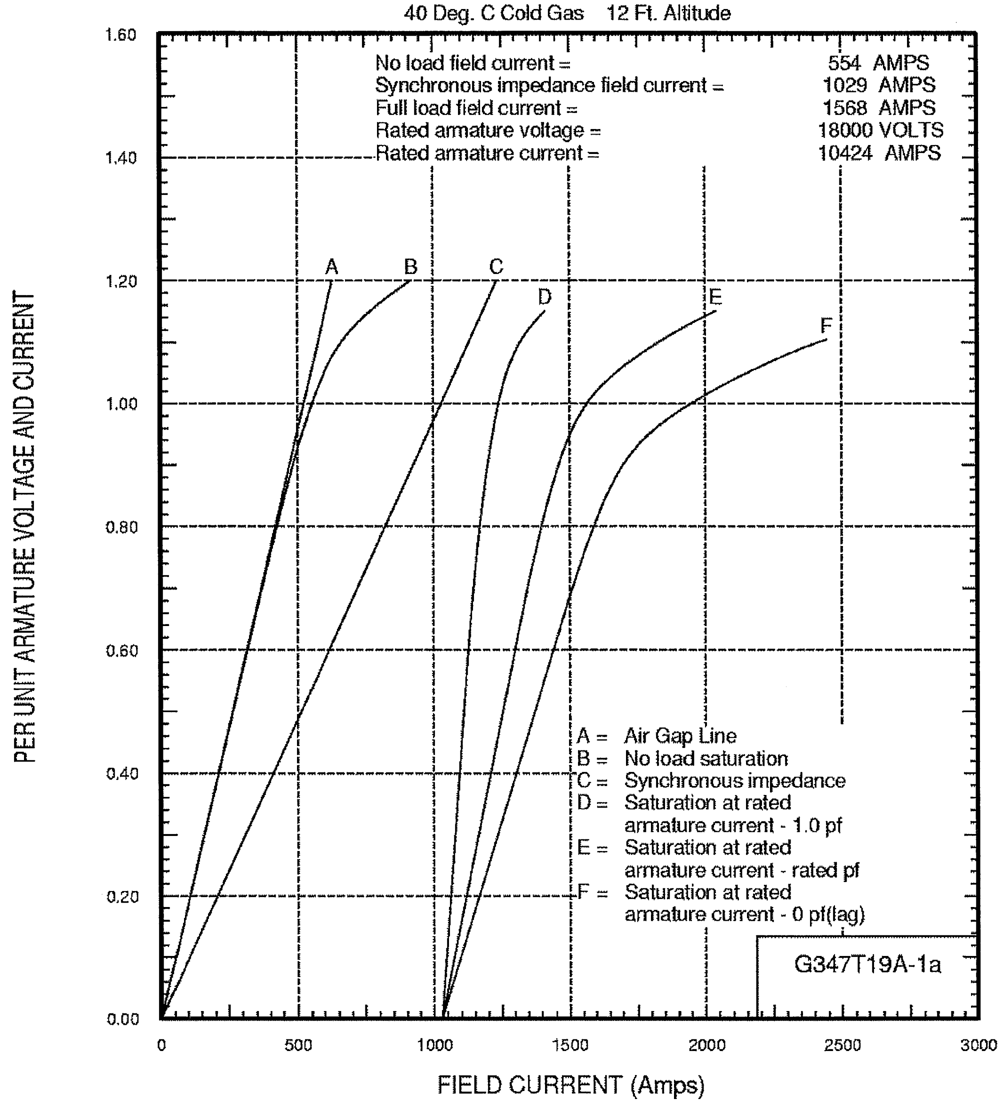
X/R = 152	X/R ratio equals "XPP/DV" * base reactance / armature DC resistance at 100 C

ESTIMATED SATURATION AND SYNCHRONOUS IMPEDANCE CURVES

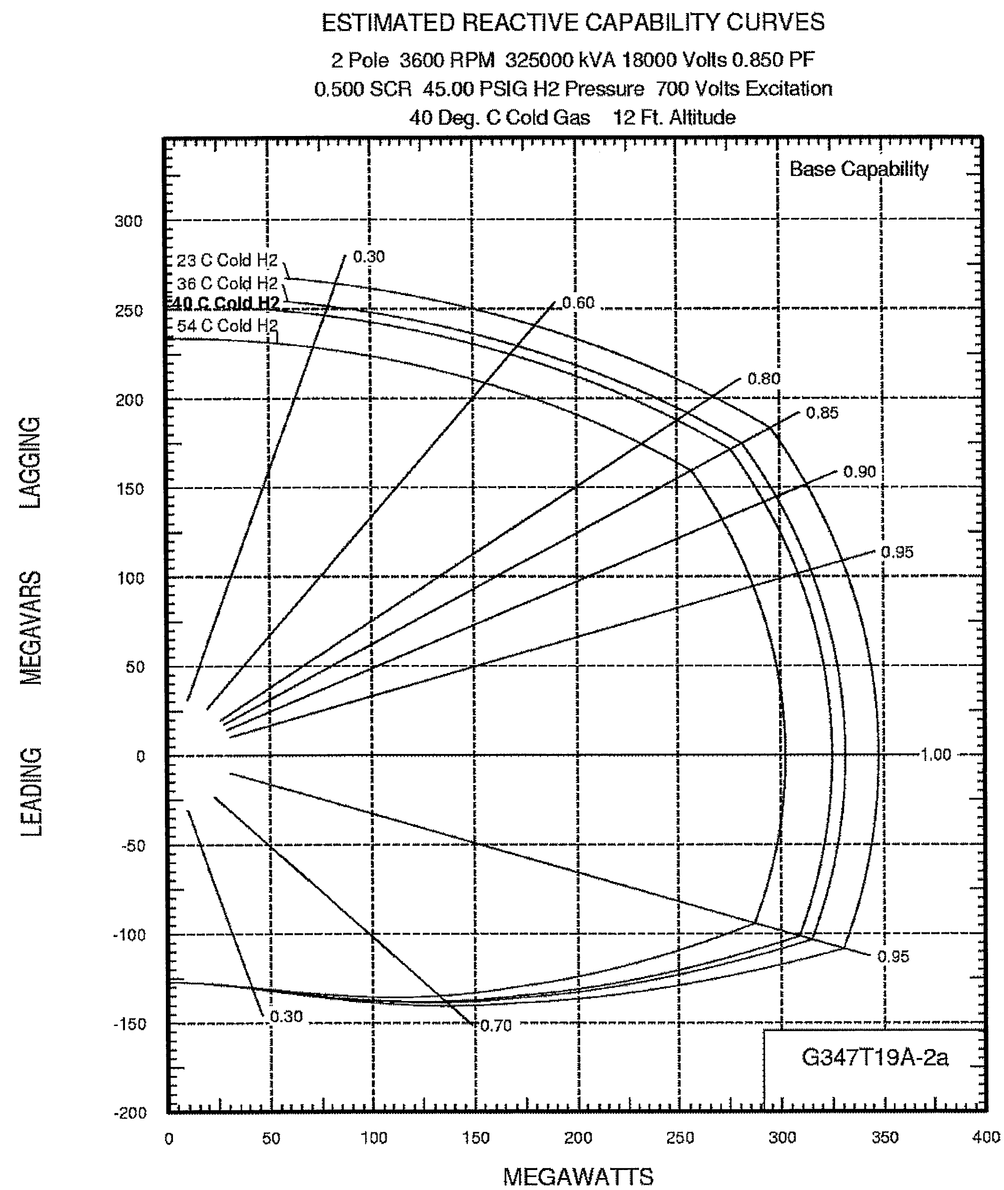
2 Pole 3600 RPM 325000 kVA 18000 Volts 0.850 PF

0.500 SCR 45.00 PSIG H2 Pressure 700 Volts Excitation

40 Deg. C Cold Gas 12 Ft. Altitude

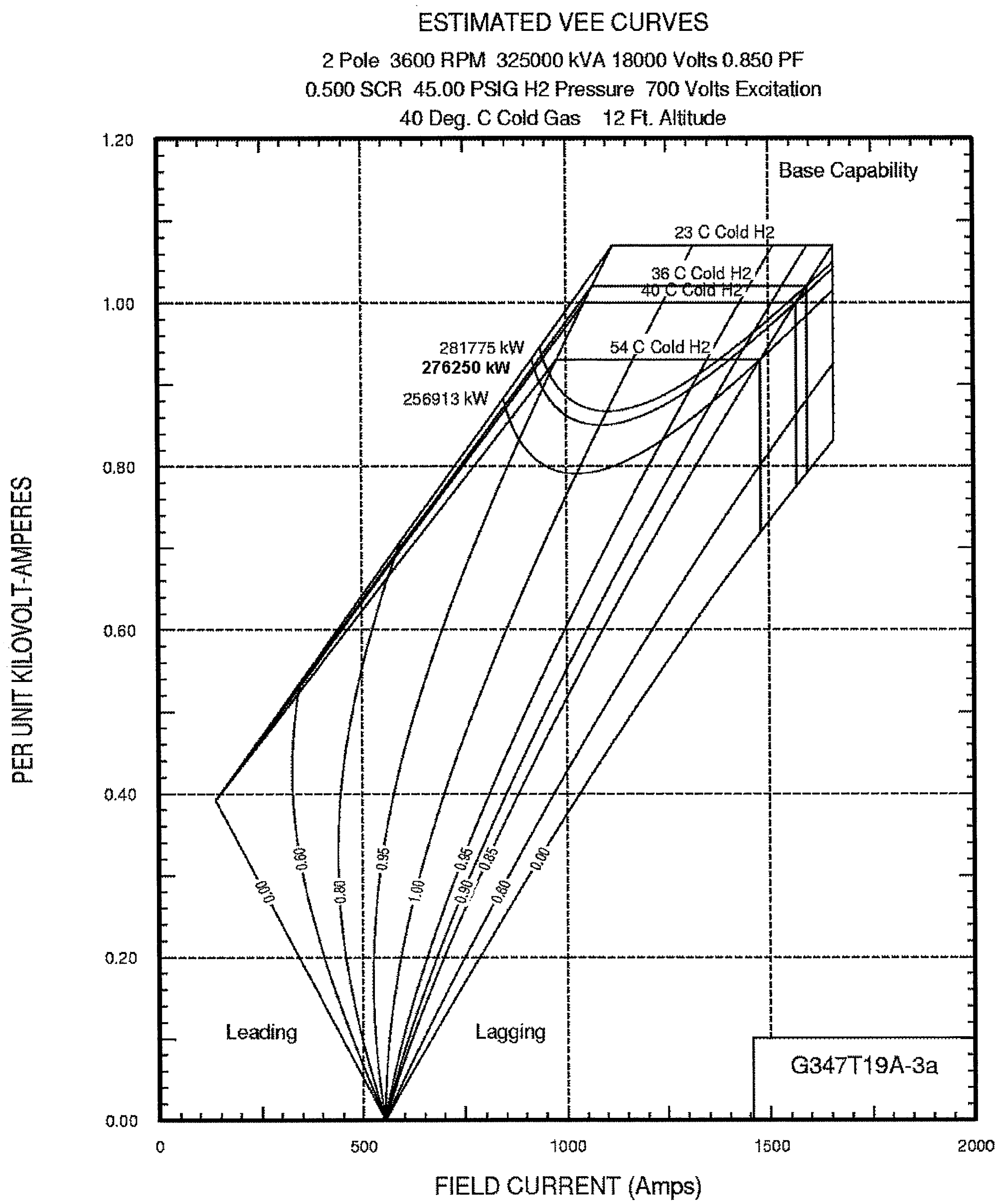


SIZE	DWG NO	SH	REV
A	237A7271	6	-



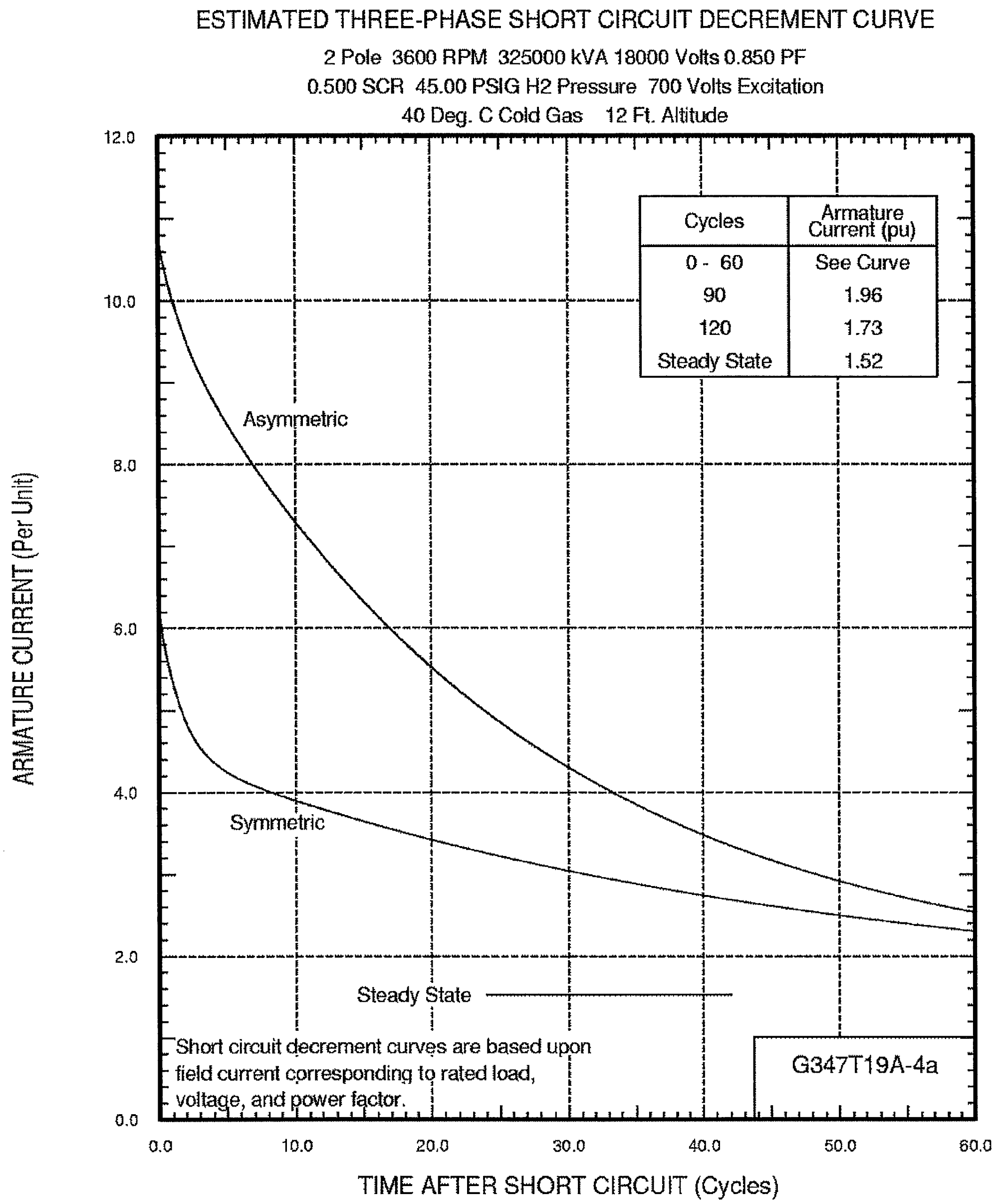
GENERAL ELECTRIC COMPANY	SIZE	CAGE CODE	DWG NO
GE POWER GENERATION SCHENECTADY, NY	A		237A7271
DRAWN H.A. SOUTH			
ISSUED H.A. SOUTH	SCALE		SHEET 6

SIZE	DWG NO	SH	REV
A	237A7271	7	-



GENERAL ELECTRIC COMPANY	SIZE	CAGE CODE	DWG NO
GE POWER GENERATION SCHENECTADY, NY	A		237A7271
DRAWN H.A. SOUTH			
ISSUED H.A. SOUTH	SCALE		SHEET 7

SIZE	DWG NO	SH	REV
A	237A7271	8	-



GENERAL ELECTRIC COMPANY	SIZE	CAGE CODE	DWG NO
GE POWER GENERATION SCHENECTADY, NY	A		237A7271
DRAWN H.A. SOUTH			
ISSUED H.A. SOUTH	SCALE		SHEET 8

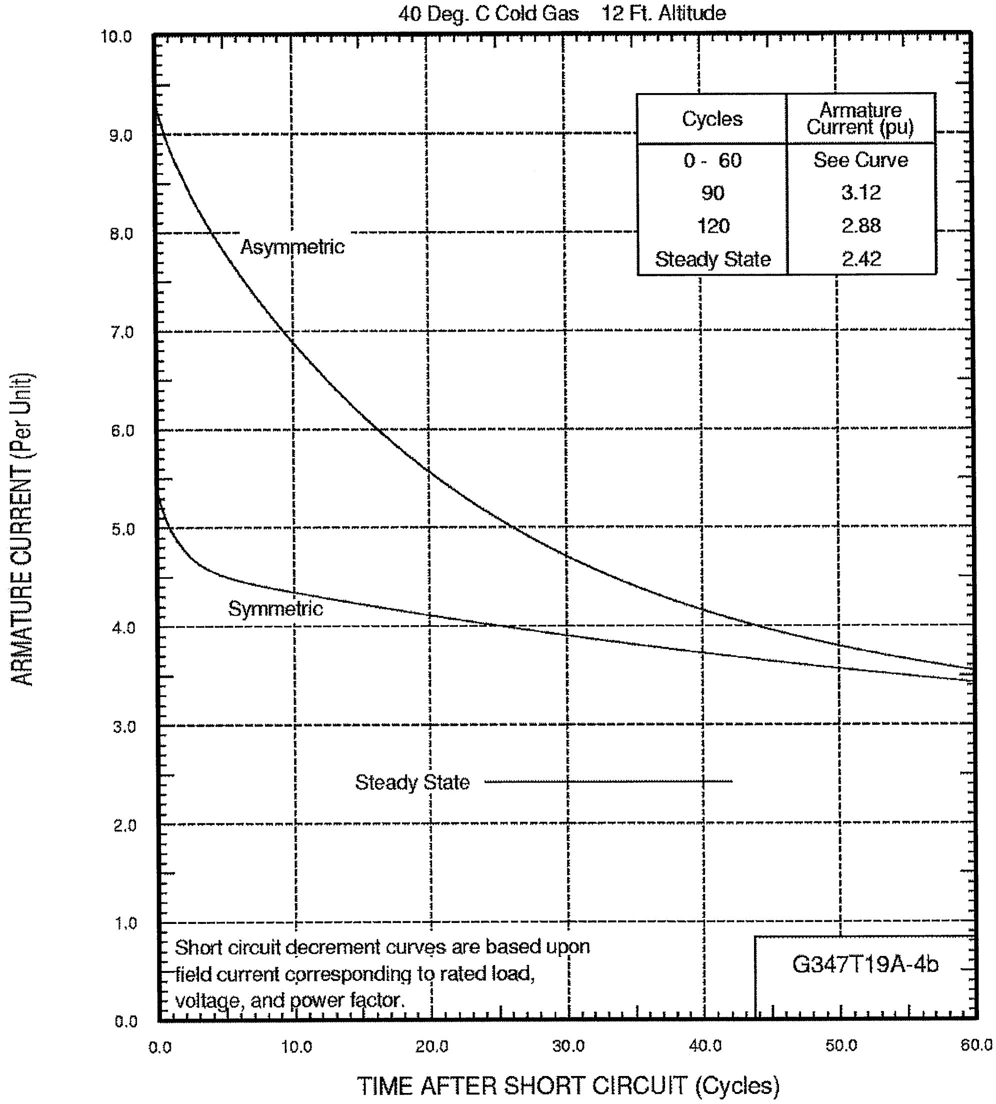
SIZE	DWG NO	SH	REV
A	237A7271	9	-

ESTIMATED LINE-LINE SHORT CIRCUIT DECREMENT CURVE

2 Pole 3600 RPM 325000 kVA 18000 Volts 0.850 PF

0.500 SCR 45.00 PSIG H2 Pressure 700 Volts Excitation

40 Deg. C Cold Gas 12 Ft. Altitude



GE POWER GENERATION	GENERAL ELECTRIC COMPANY SCHENECTADY, NY	SIZE A	CAGE CODE	DWG NO 237A7271
DRAWN H.A. SOUTH				
ISSUED H.A. SOUTH		SCALE		SHEET 9

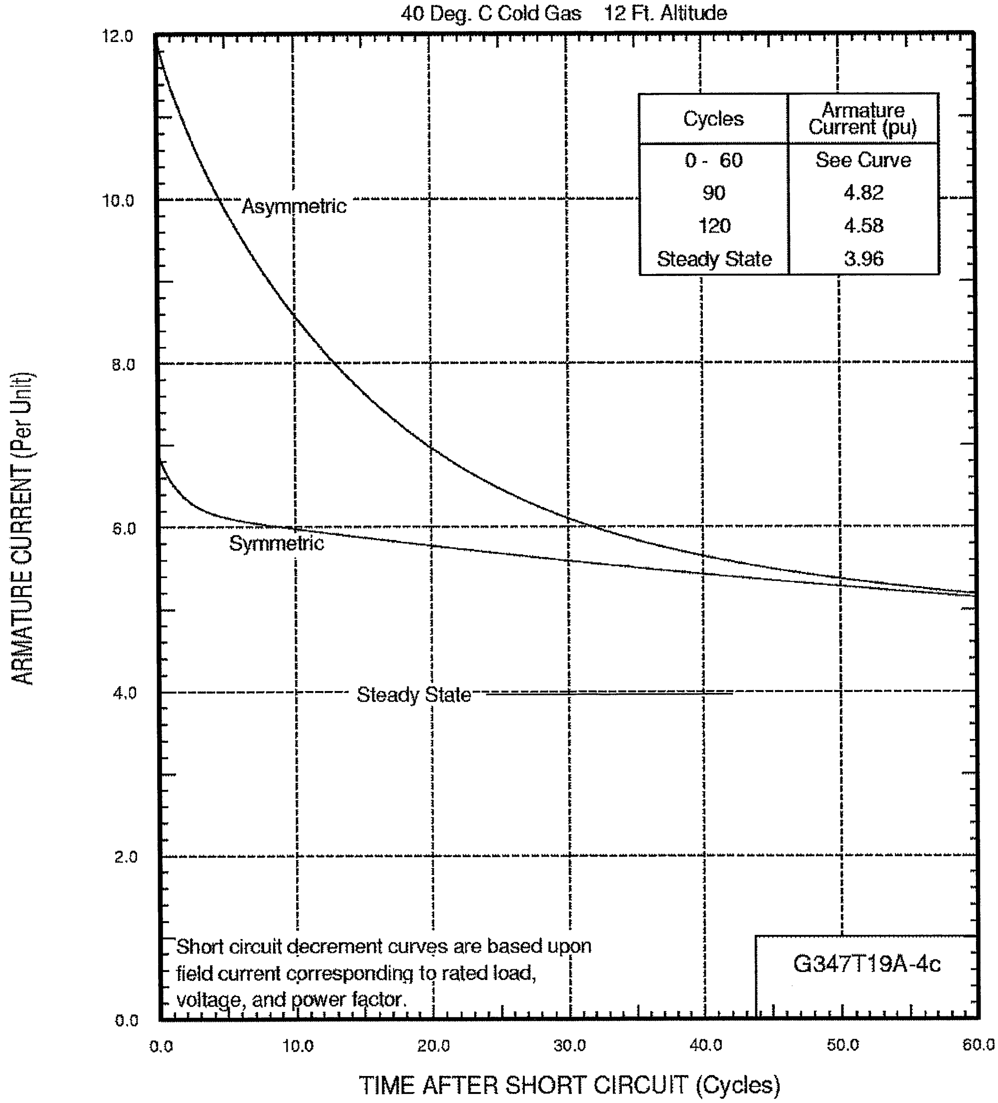
SIZE	DWG NO	SH	REV
A	237A7271	10	-

ESTIMATED LINE-NEUTRAL SHORT CIRCUIT DECREMENT CURVE

2 Pole 3600 RPM 325000 kVA 18000 Volts 0.850 PF

0.500 SCR 45.00 PSIG H2 Pressure 700 Volts Excitation

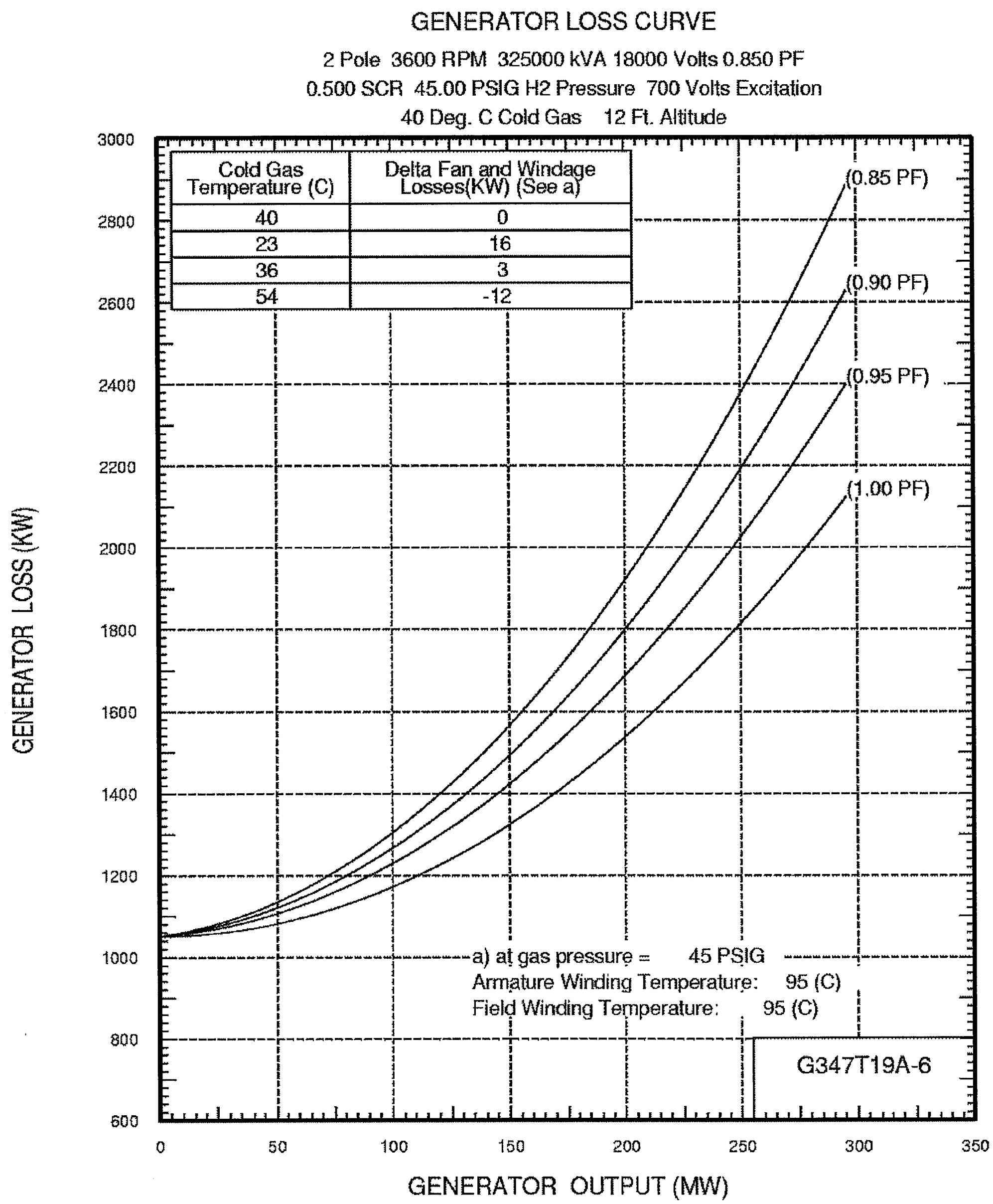
40 Deg. C Cold Gas 12 Ft. Altitude



Cycles	Armature Current (pu)
0 - 60	See Curve
90	4.82
120	4.58
Steady State	3.96

GE POWER GENERATION — GENERAL ELECTRIC COMPANY, SCHENECTADY, NY	SIZE A	CAGE CODE	DWG NO **237A7271**
DRAWN H.A. SOUTH			
ISSUED H.A. SOUTH	SCALE		SHEET 10

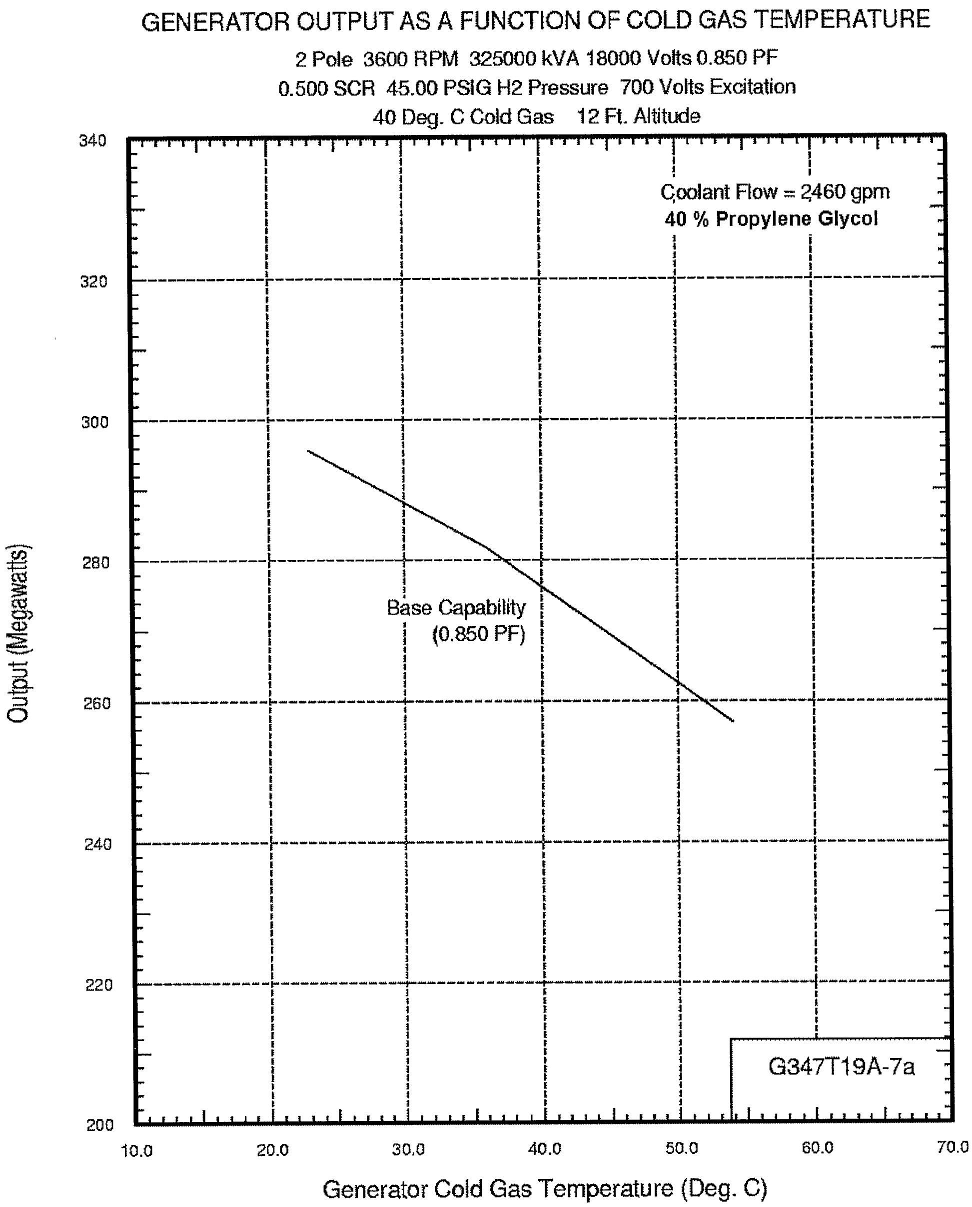
SIZE	DWG NO	SH	REV
A	237A7271	11	-



Cold Gas Temperature (C)	Delta Fan and Windage Losses(KW) (See a)
40	0
23	16
36	3
54	-12

GENERAL ELECTRIC COMPANY GE POWER GENERATION SCHENECTADY, NY	SIZE A	CAGE CODE	DWG NO **237A7271**
DRAWN H.A. SOUTH			
ISSUED H.A. SOUTH	SCALE		SHEET 11

SIZE	DWG NO	SH	REV
A	237A7271	12	-



GENERAL ELECTRIC COMPANY GE POWER GENERATION SCHENECTADY, NY	SIZE A	CAGE CODE	DWG NO **237A7271**
DRAWN H.A. SOUTH			
ISSUED H.A. SOUTH	SCALE		SHEET 12

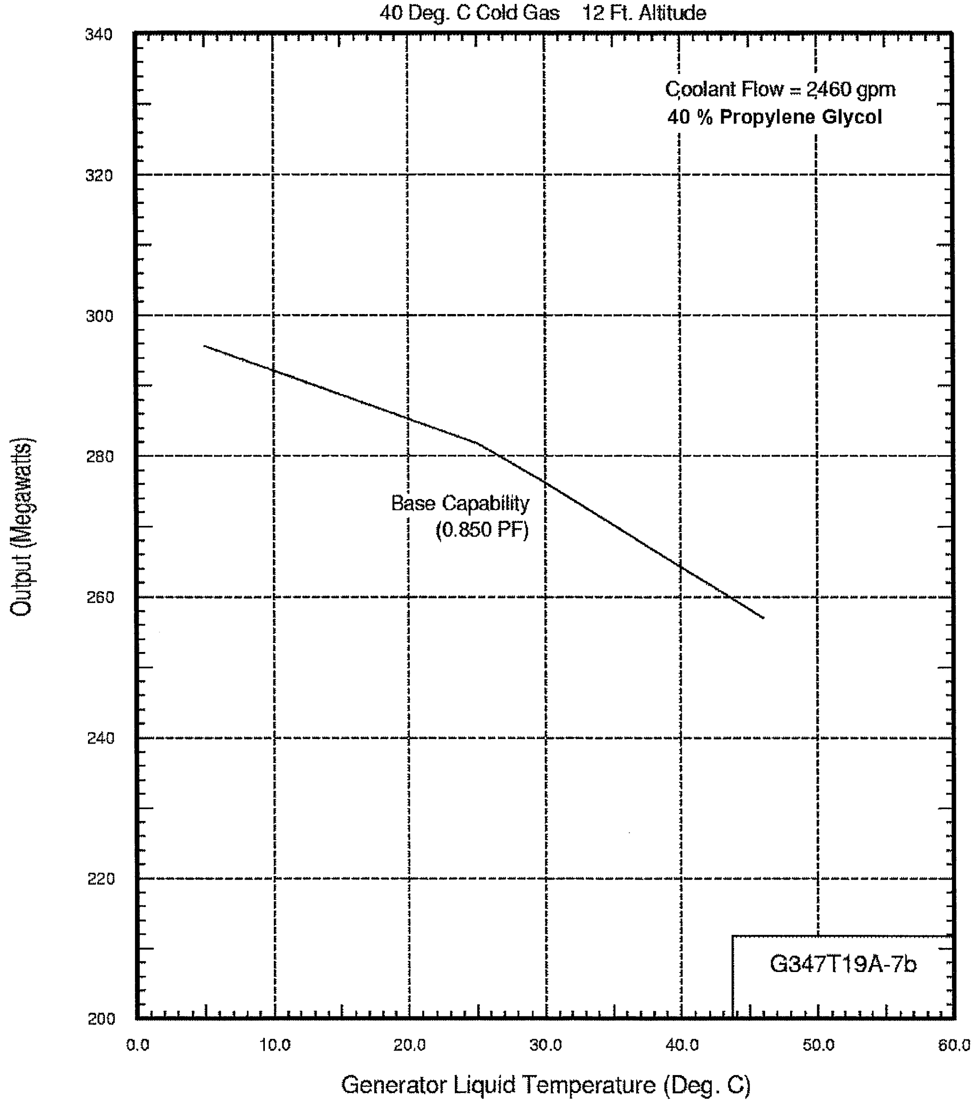
SIZE	DWG NO	SH	REV
A	237A7271	13	-

GENERATOR OUTPUT AS A FUNCTION OF LIQUID TEMPERATURE

2 Pole 3600 RPM 325000 kVA 18000 Volts 0.850 PF

0.500 SCR 45.00 PSIG H2 Pressure 700 Volts Excitation

40 Deg. C Cold Gas 12 Ft. Altitude



GE POWER GENERATION	GENERAL ELECTRIC COMPANY SCHENECTADY, NY	SIZE A	CAGE CODE	DWG NO **237A7271**
DRAWN H.A. SOUTH				
ISSUED H.A. SOUTH		SCALE		SHEET 13

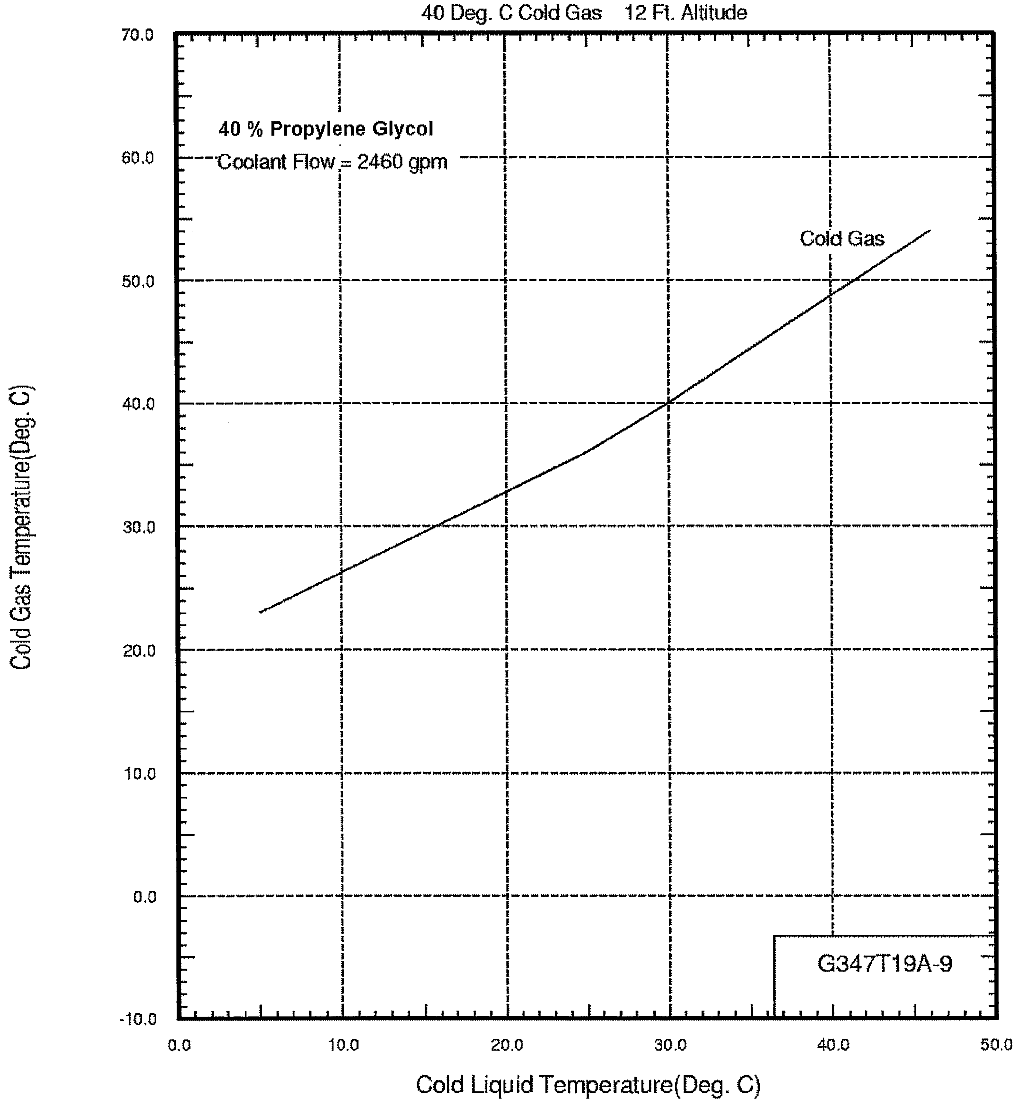
SIZE	DWG NO	SH	REV
A	237A7271	14	-

COLD LIQUID TEMPERATURE VS. COLD GAS TEMPERATURE

2 Pole 3600 RPM 325000 kVA 18000 Volts 0.850 PF

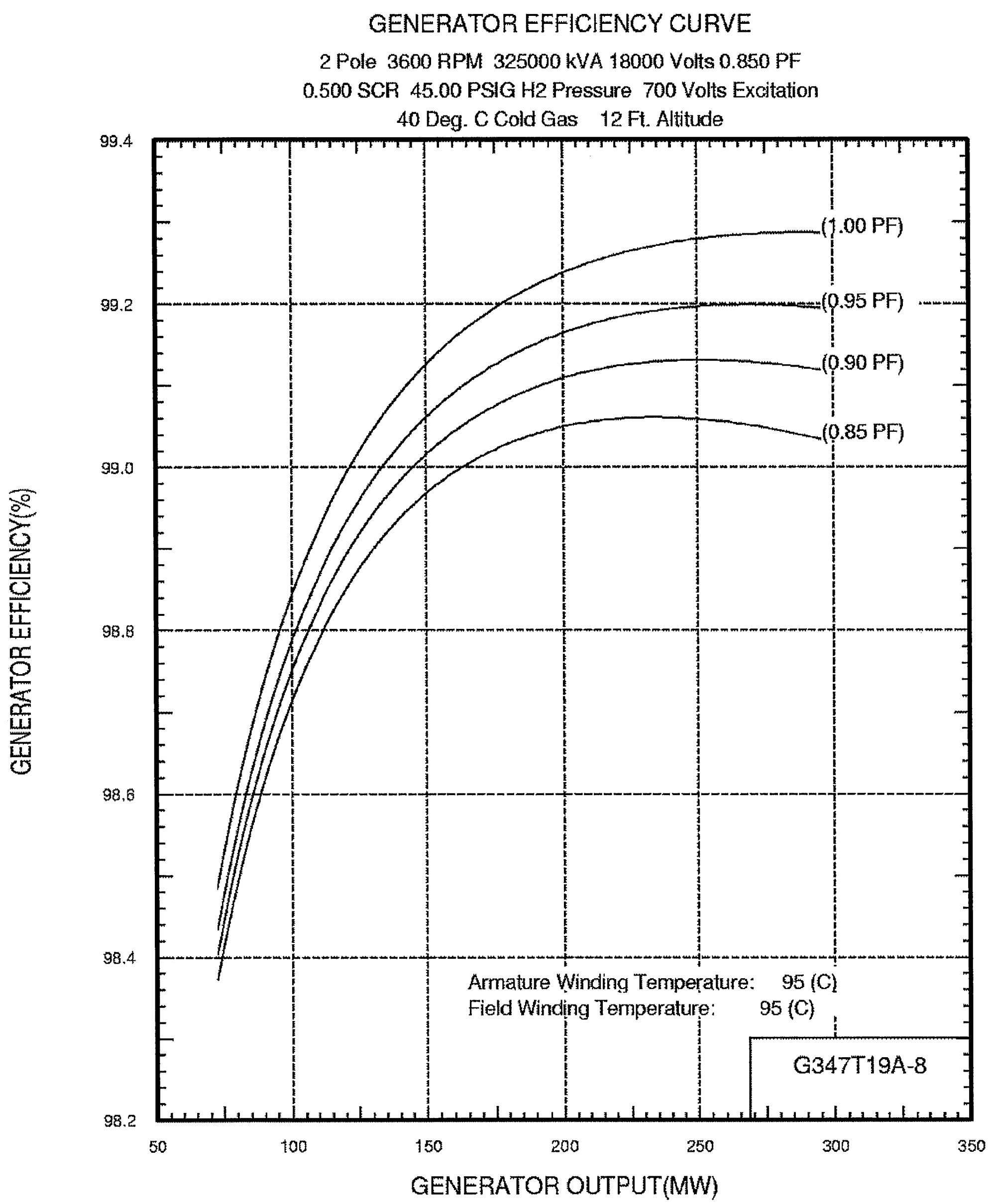
0.500 SCR 45.00 PSIG H2 Pressure 700 Volts Excitation

40 Deg. C Cold Gas 12 Ft. Altitude



GENERAL ELECTRIC COMPANY GE POWER GENERATION SCHENECTADY, NY	SIZE A	CAGE CODE	DWG NO **237A7271**
DRAWN H.A. SOUTH			
ISSUED H.A. SOUTH	SCALE		SHEET 14

SIZE	DWG NO	SH	REV
A	237A7271	15	-



GE POWER GENERATION	GENERAL ELECTRIC COMPANY SCHENECTADY, NY	SIZE A	CAGE CODE	DWG NO 237A7271
DRAWN H.A. SOUTH				
ISSUED H.A. SOUTH		SCALE		SHEET 15

SIZE	DWG NO	SH	REV
A	237A7261	1	-

THIRD ANGLE PROJECTION

REV STATUS OF SHEETS

SH	REV	SH	REV
1	-		
2	-		
3	-		
4	-		
5	-		
6	-		
7	-		
8	-		
9	-		
10	-		
11	-		
12	-		
13	-		
14	-		
15	-		

REVISIONS

REV	DESCRIPTION	DATE	APPROVED

SNC·LAVALIN Constructors Inc.

Vendor's drawing review for conformity with specifications and design drawing.

This review does not relieve the vendor of his responsibility for errors in design and detailing as detailed in his contract.

- ☐ 1 NO EXCEPTIONS TAKEN, RESUBMIT DOCUMENT AS CERTIFIED. PROCEED WITH FABRICATION.
- ☐ 2 NO EXCEPTIONS TAKEN, ACCEPTED AS FINAL, RESUBMITTAL NOT REQUIRED. PROCEED WITH FABRICATION.
- ☒ 3 EXCEPTIONS AS NOTED, REVISE AND RESUBMIT. PROCEED WITH FABRICATION INCLUSIVE OF MARKUPS.
- ☐ 4 EXCEPTIONS AS NOTED, REVISE AND RESUBMIT. DO NOT PROCEED WITH FABRICATION.
- ☐ 5 APPROVAL NOT REQUIRED. FOR INFORMATION / REFERENCE ONLY.
- ☐ 6 CANCELLED

Vendor: GENERAL ELECTRIC - GENE No.: C902-237A7261 Rev: -

Doc. Title: ELECTRICAL DATA, GENERATOR - 15 PAGES

Date Rec'd 9/17/2008

Client Code:

Project: Astoria II Cogeneration Project

Reviewed by: VJS

Date: 26-Sept-08

Document No 0620 - T160-0121 - 001

Submittal 01

SNC LAVALIN CONSTRUCTORS INC. CONTRACT NO. 0620
P.O. NUMBER 62000001, SPECIFICATION SP-T160
PROJECT NAME: PHASE II ASTORIA ENERGY EXPANSION PROJECT
PROJECT LOCATION: ASTORIA, NY

UNLESS OTHERWISE SPECIFIED

DIMENSIONS ARE IN INCHES
TOLERANCES ON:
2 PL DECIMALS±
3 PL DECIMALS±
ANGLES±
FRACTIONS±

SIGNATURE	DATE
DRAWN T.Hammell	9/11/2008
CHECKED H. South	9/16/2008
ENGRG T.Hammell	9/16/2008
ISSUED C.J.Peck	08/09/16

GENERAL ELECTRIC COMPANY
GE POWER GENERATION SCHENECTADY, NY

ELECTRICAL DATA, GENERATOR
Astoria Energy II

FIRST MADE FOR 338X389, 338X390 C902

SIZE	CAGE CODE	DWG NO
A		**237A7261**

DT-2N

SIM TO: NONE

SCALE | DFT UNIT NR5E | SHEET 1

SIZE	DWG NO	SH	REV
A	237A7261	2	-

ESTIMATED GENERATOR DATA

Customer: **Astoria Energy II, LLC**

Station/Project: **Phase II Astoria Energy Expansion Project**

Generator Number: **338X389, 338X390**

Generator Type: **7FH2 LU**

GENERATOR RATING

Data for Proposal No/Electrical Design: F317T160D Jul 22 2008

ATB 2 226000 kVA 3600 RPM 18000 Volts 0.85 PF 30 psig 40 °C Gas 192100 kW 7249 Amps
375 Field Volts 12 Ft Alt 0.5 SCR 60 Hz 3 Phase WYE Connection

Exciter Rating

Type Static

705 kW 375 Volts 1880 D.C.Amps Field Amps @ Generator rated Load 1622

Total temperatures are guaranteed not to exceed:	**Insulation Class**		**Temperature Rise**
Stator coils: 107 °C by embedded detector	Armature	F	B
Field coils 120 °C by Resistance	Field class	F	B
Collector Gas Rise 20 °C by RTD			

Cooling water Requirements @ Generator Rating (C901 - Data)

Generator Output:	226000 Kva
Loss to Coolers:	1618 Kw
Inlet Water Temperature:	31.5°C
Outlet Cold Gas Temperature	40°C
Coolant	40% Proplyene Glycol
Maximum Fouling Factor:	0.0005 (hrs*ft^2*deg F)/btu
Total Water Flow Required:	1860 GPM (total for all coolers)
Coolant temperature Max	46 °C
Head Loss Per Cooler:	20.8 Feet of Water
Maximum Operating Pressure:	150 psig [10.3 bar]

Dielectric tests (Between coils and ground, 50/60 hertz AC for 1 min)

Stator 37000V

Rotor 3128V

GENERAL ELECTRIC COMPANY GE POWER GENERATION SCHENECTADY, NY	SIZE A	CAGE CODE	DWG NO 237A7261
DRAWN: T.Hammell			
ISSUED:	SCALE		SHEET 2

REACTANCES (Per Unit):	**Direct Axis**		**Quadrature Axis**	
Saturated Synchronous	X_{dv}	2.04	X_{qv}	1.92
Unsaturated Synchronous	X_{di}	2.04	X_{qi}	1.92
Saturated Transient	X'_{dv}	0.225		
Unsaturated Transient	X'_{di}	0.255	X'_{q}	0.45
Saturated Sub transient	X''_{dv}	0.145	X''_{qv}	0.145
Unsaturated Sub transient	X''_{di}	0.19	X''_{qi}	0.19
Saturated Negative Sequence	X_{2v}	0.145		
Unsaturated Negative Sequence	X_{2I}	0.19		
Saturated Zero Sequence	X_{0v}	0.12		
Unsaturated Zero Sequence	X_{0I}	0.12		
Saturated Leakage Reactance	X_{lv}	0.13		
Unsaturated Leakage Reactance	X_{li}	0.145		

FIELD TIME CONSTANTS (Seconds @ 125 °C)

Open Circuit	T'_{d0}	7.1	T'_{q0}	0.57
Three Phase Short Circuit Transient	T'_{d3}	0.71	T'_{q}	0.13
Line To Line Short Circuit Transient	T'_{d2}	1.2		
Line To Neutral Short Circuit Transient	T'_{d1}	1.51		
Short Circuit Sub transient	T''_{d}	0.026	T''_{q}	0.026
Open Circuit Sub transient	T''_{d0}	0.04	T''_{q0}	0.079

ARMATURE DC COMPONENT TIME CONSTANTS (Seconds@ 100 °C)

Three Phase Short Circuit	T_{a3}	0.39
Line To Line Short Circuit	T_{a2}	0.39
Line To Neutral Short Circuit	T_{a1}	0.31

ARMATURE WINDING SEQUENCE RESISTANCES (Per Unit)

Positive	R_1	0.0029
Negative	R_2	0.0136
Zero	R_0	0.0072

Reactance, Resistance and Time Constant data may be interpreted per IEEE 115, section VII.

The base reactance ("UNIT") is calculated by the armature kV squared / MVA.

Base reactance = 1.4336 Ohms

Rotor Short-Time Thermal Capacity, $(I_2)^2t$	10 s
Turbine-Generator Combined Inertia Constant, H	5.037 kW-s/kVA
Three Phase Armature Winding Capacitance	0.8171 μF
Armature Winding DC Resistance (Per Phase)	0.0017 Ω (100 °C)
Field Winding DC Resistance	0.1929 Ω (125 °C)
Field Current At Rated Kva, Armature Voltage, & PF	1622 A
Field Current At Rated Kva, Armature Voltage, 0 PF Lagging	1977 A

(For Systems Study Only - Not Allowable Operating Point)

MACHINE SATURATION DATA

S/1.0 = 0.068 Machine saturation may be calculated from the data of curves A and B of

S/1.2 = 0.5806 "ESTIMATED SATURATION AND SYNCHRONOUS IMPEDANCE CURVES".

"S/1.0" is the field amp difference from B to A divided by the field amp of A at 1.0 pu voltage.

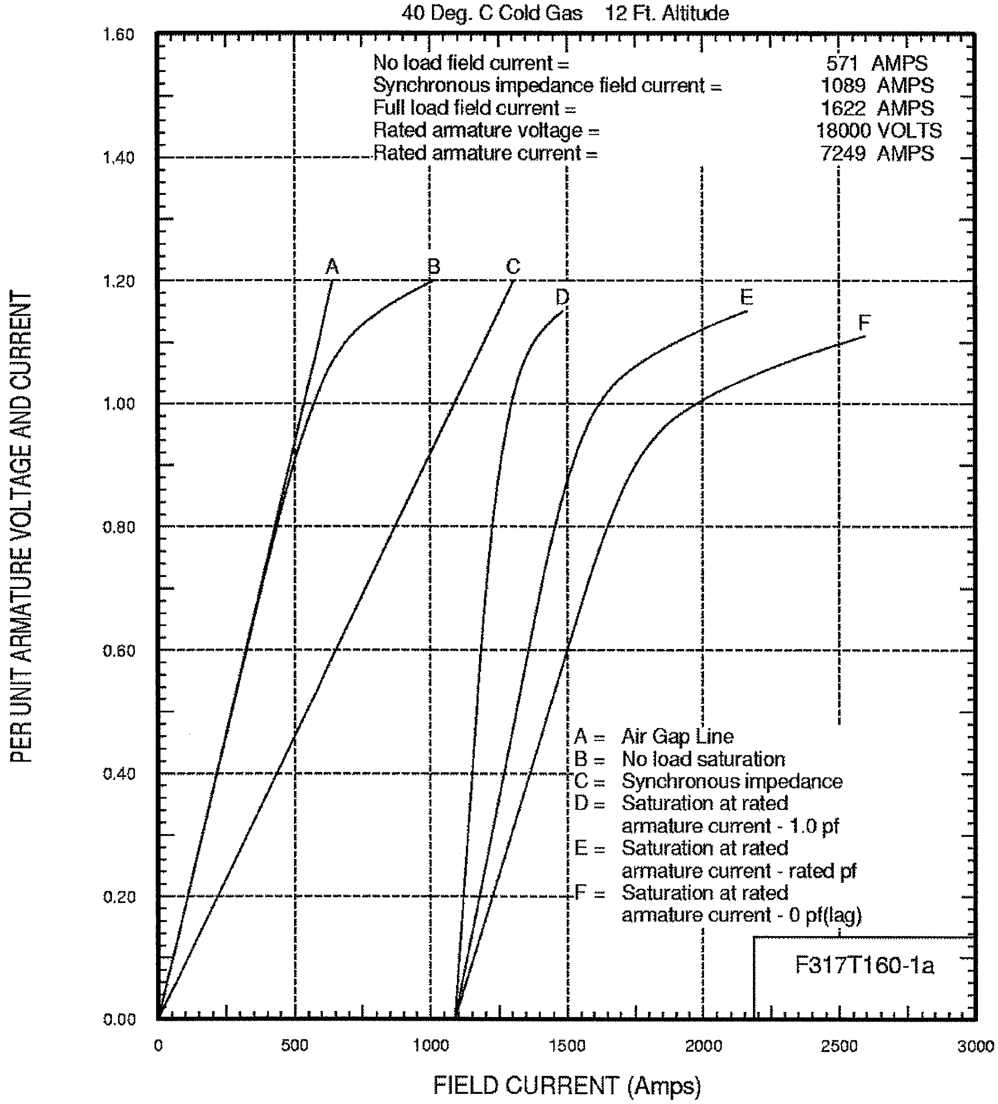
X/R RATIO

X/R = 125 X/R ratio equals "XPP/DV" * base reactance / armature DC resistance at 100 C

SIZE	DWG NO	SH	REV
A	237A7261	5	-

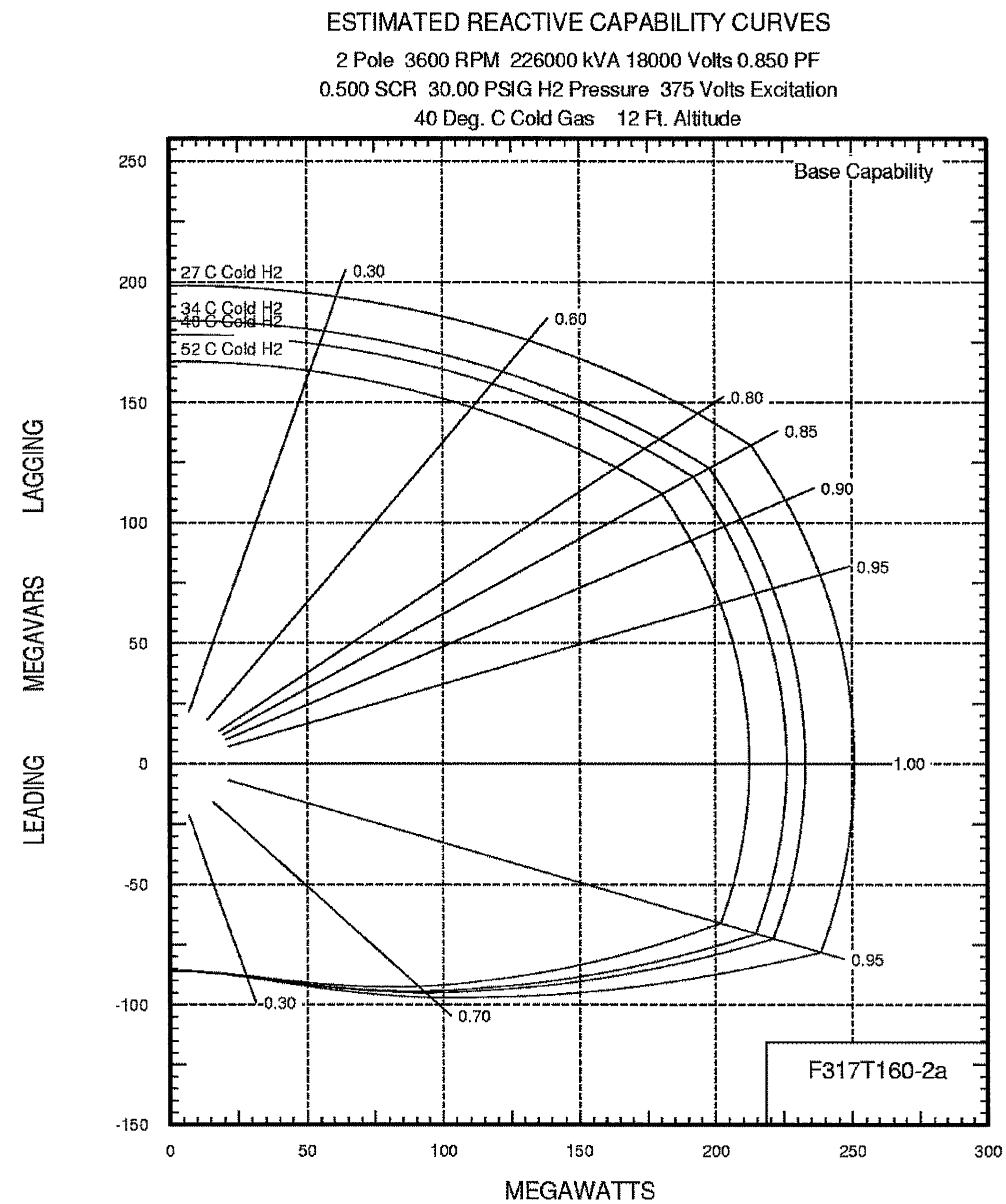
ESTIMATED SATURATION AND SYNCHRONOUS IMPEDANCE CURVES

2 Pole 3600 RPM 226000 kVA 18000 Volts 0.850 PF
0.500 SCR 30.00 PSIG H2 Pressure 375 Volts Excitation
40 Deg. C Cold Gas 12 Ft. Altitude



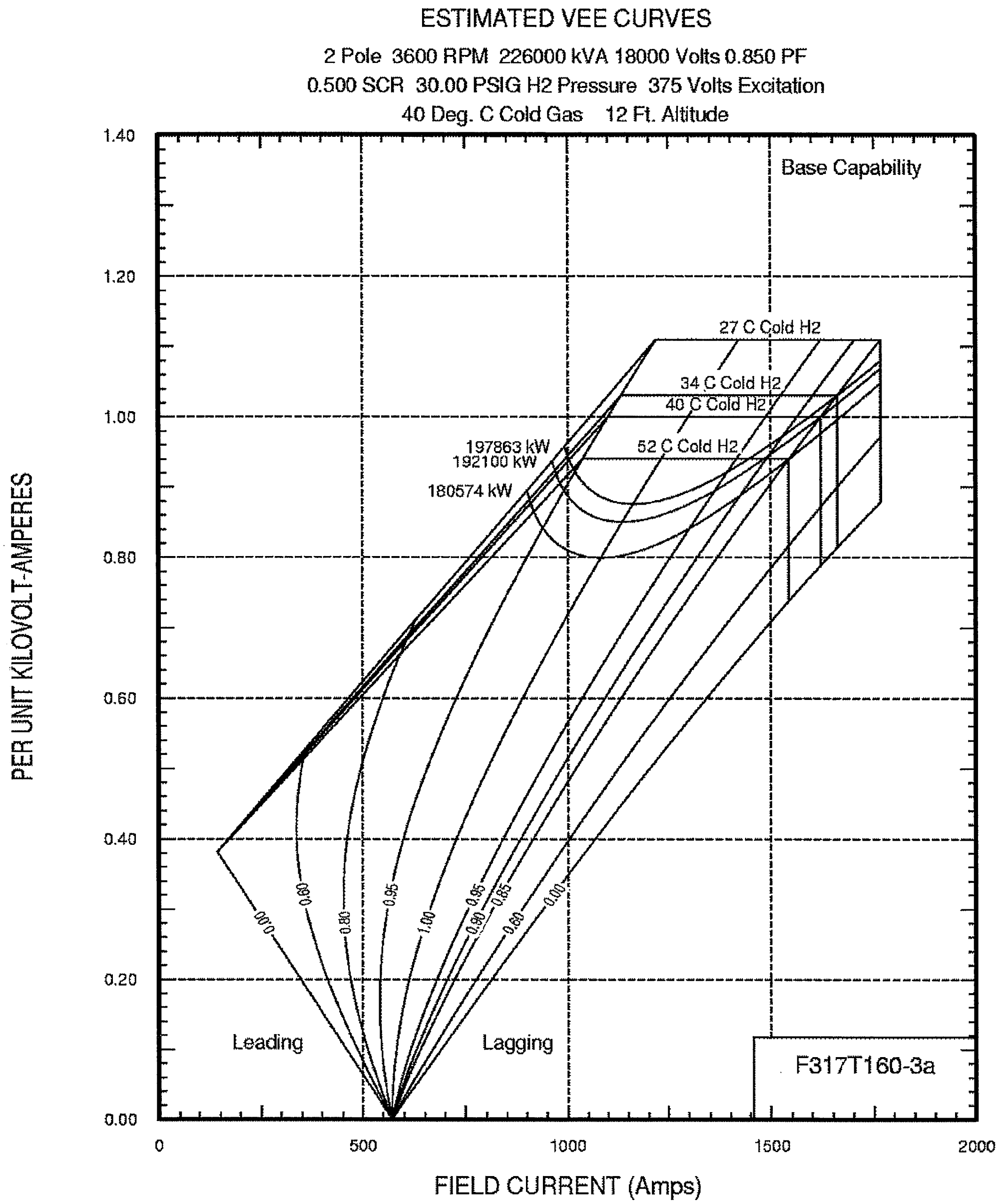
GENERAL ELECTRIC COMPANY GE POWER GENERATION SCHENECTADY, NY	SIZE A	CAGE CODE	DWG NO 237A7261
DRAWN: T.Hammell			
ISSUED:	SCALE		SHEET 5

SIZE	DWG NO	SH	REV
A	237A7261	6	-



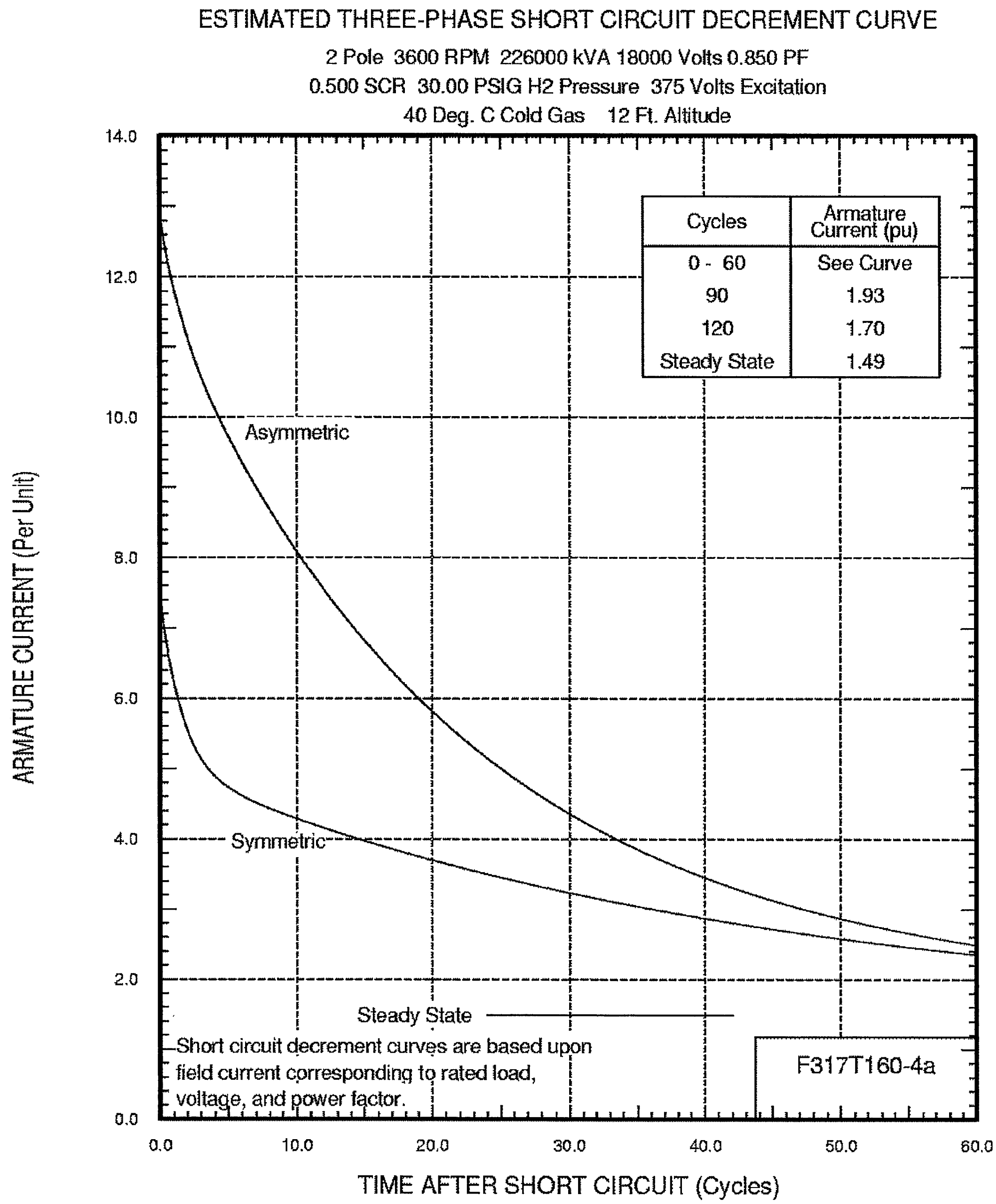
GENERAL ELECTRIC COMPANY	SIZE	CAGE CODE	DWG NO
GE POWER GENERATION SCHENECTADY, NY	A		237A7261
DRAWN: T.Hammell			
ISSUED:	SCALE		SHEET 6

SIZE	DWG NO	SH	REV
A	237A7261	7	-



GE POWER GENERATION	GENERAL ELECTRIC COMPANY SCHENECTADY, NY	SIZE A	CAGE CODE	DWG NO 237A7261
DRAWN: T.Hammell				
ISSUED:		SCALE		SHEET 7

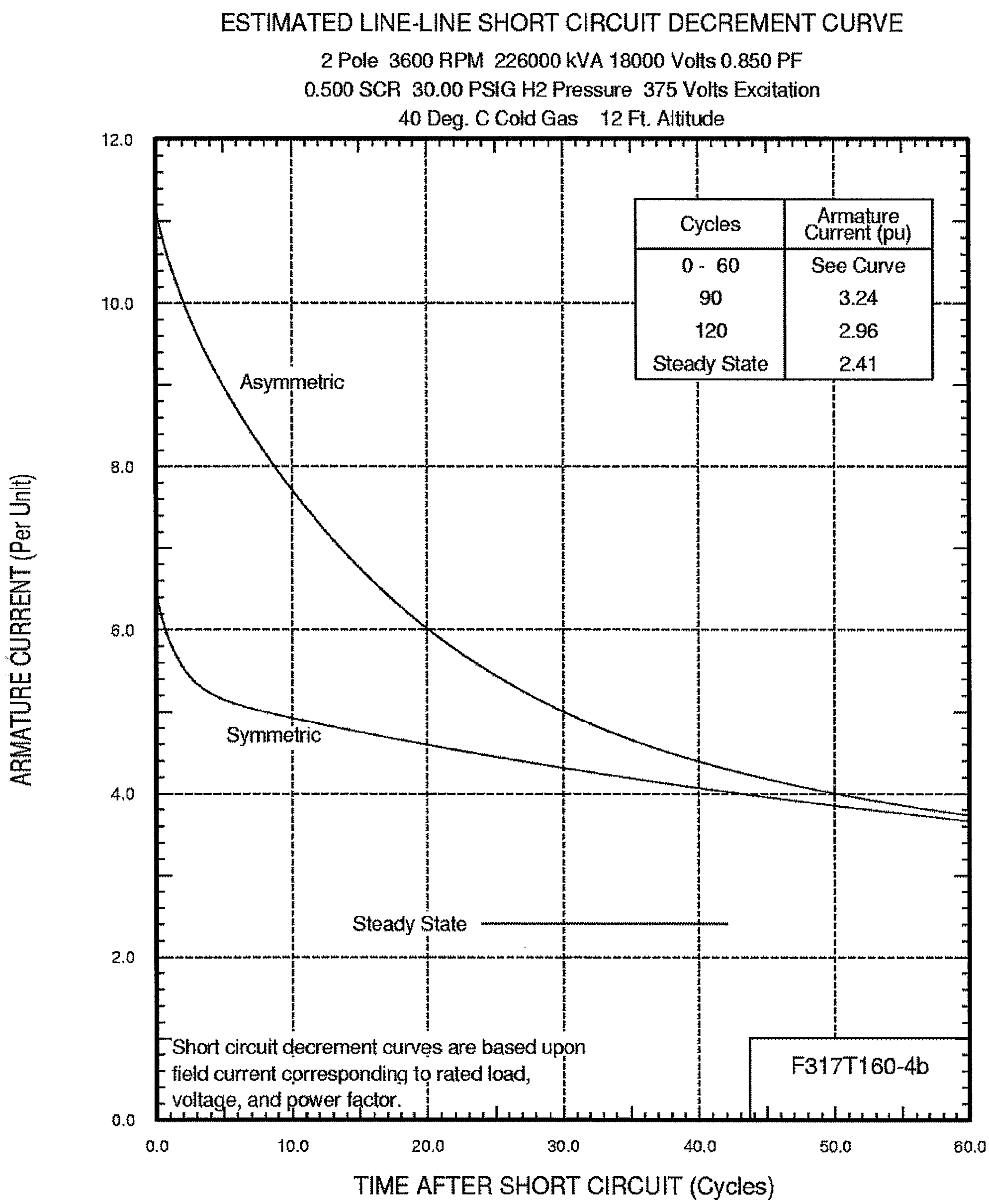
SIZE	DWG NO	SH	REV
A	237A7261	8	-



Cycles	Armature Current (pu)
0 - 60	See Curve
90	1.93
120	1.70
Steady State	1.49

GENERAL ELECTRIC COMPANY GE POWER GENERATION SCHENECTADY, NY	SIZE A	CAGE CODE	DWG NO **237A7261**
DRAWN: T.Hammell			
ISSUED:	SCALE		SHEET 8

SIZE	DWG NO	SH	REV
A	237A7261	9	-



Cycles	Armature Current (pu)
0 - 60	See Curve
90	3.24
120	2.96
Steady State	2.41

GENERAL ELECTRIC COMPANY GE POWER GENERATION SCHENECTADY, NY	SIZE A	CAGE CODE	DWG NO **237A7261**
DRAWN: T.Hammell			
ISSUED:	SCALE		SHEET 9

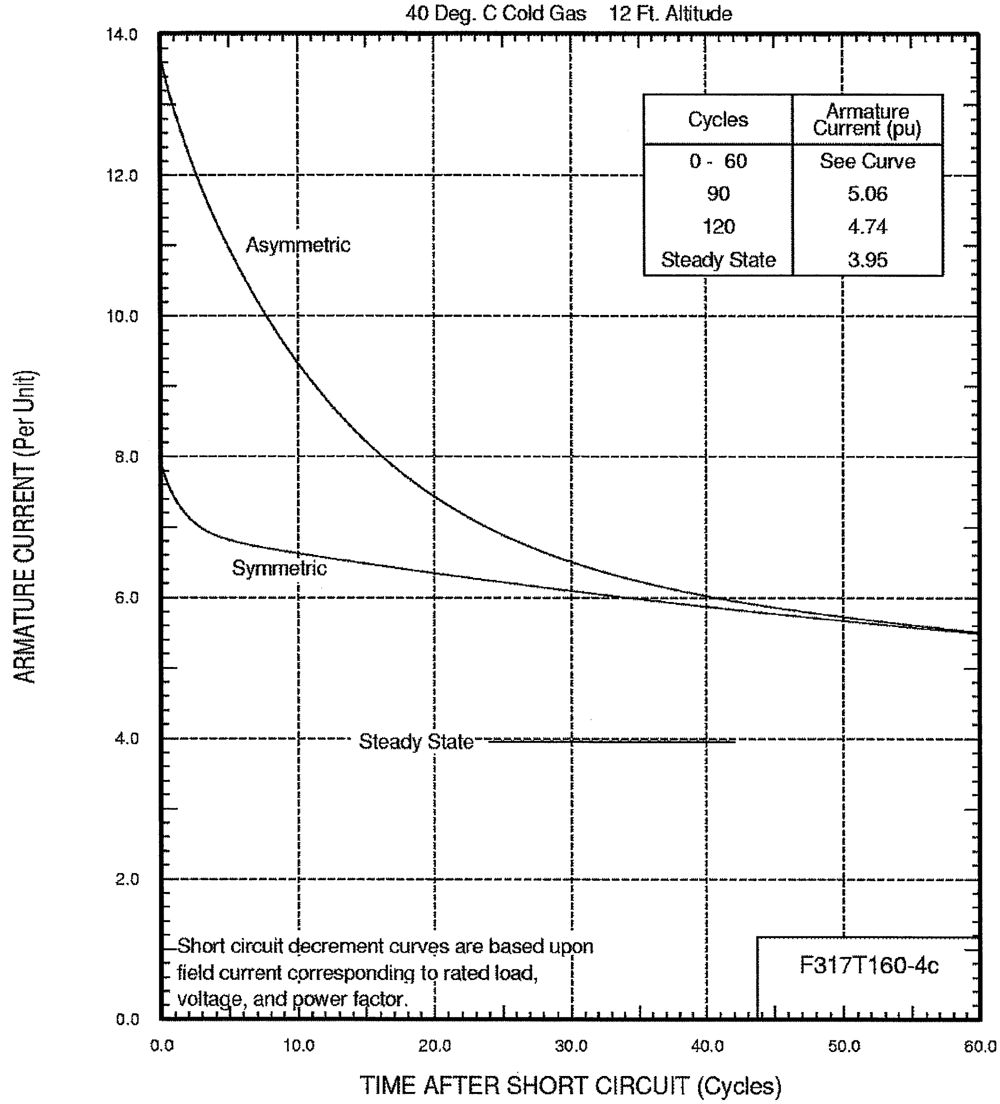
SIZE	DWG NO	SH	REV
A	237A7261	10	-

ESTIMATED LINE-NEUTRAL SHORT CIRCUIT DECREMENT CURVE

2 Pole 3600 RPM 226000 kVA 18000 Volts 0.850 PF

0.500 SCR 30.00 PSIG H2 Pressure 375 Volts Excitation

40 Deg. C Cold Gas 12 Ft. Altitude

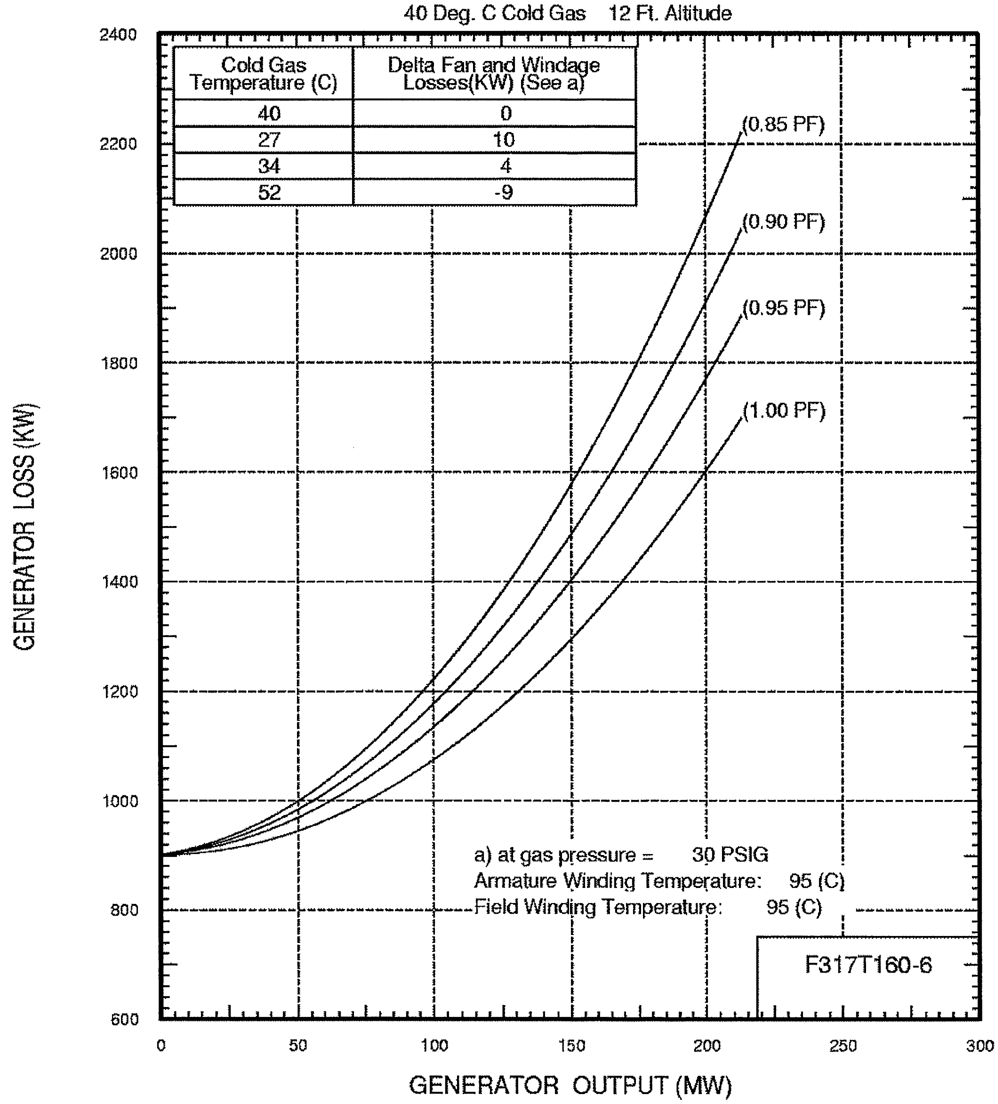


GENERAL ELECTRIC COMPANY	SIZE	CAGE CODE	DWG NO
GE POWER GENERATION SCHENECTADY, NY	A		237A7261
DRAWN: T.Hammell			
ISSUED:	SCALE		SHEET 10

SIZE	DWG NO	SH	REV
A	237A7261	11	-

GENERATOR LOSS CURVE

2 Pole 3600 RPM 226000 kVA 18000 Volts 0.850 PF
0.500 SCR 30.00 PSIG H2 Pressure 375 Volts Excitation
40 Deg. C Cold Gas 12 Ft. Altitude



GENERAL ELECTRIC COMPANY GE POWER GENERATION SCHENECTADY, NY	SIZE A	CAGE CODE	DWG NO **237A7261**
DRAWN: T.Hammell			
ISSUED:	SCALE		SHEET 11

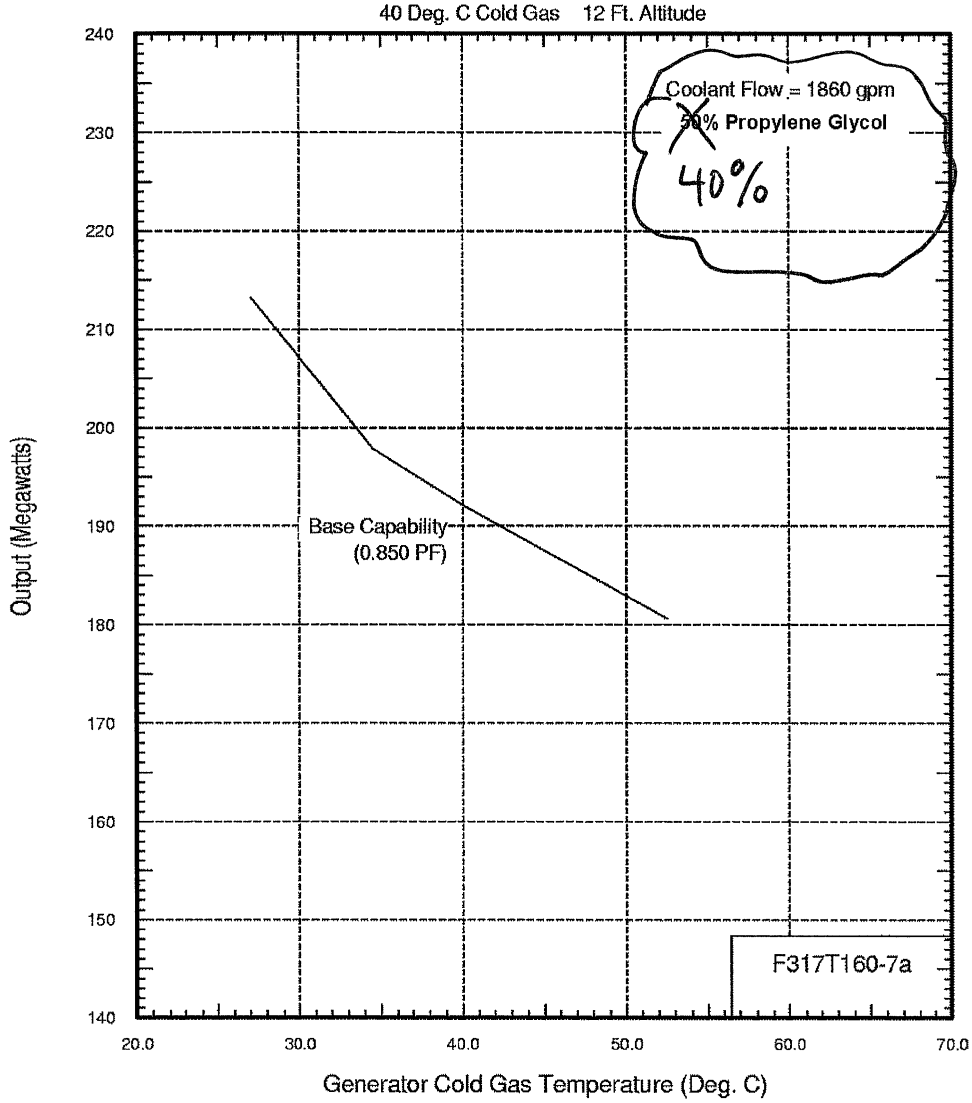
SIZE	DWG NO	SH	REV
A	237A7261	12	-

GENERATOR OUTPUT AS A FUNCTION OF COLD GAS TEMPERATURE

2 Pole 3600 RPM 226000 kVA 18000 Volts 0.850 PF

0.500 SCR 30.00 PSIG H2 Pressure 375 Volts Excitation

40 Deg. C Cold Gas 12 Ft. Altitude



VJS 9/19/08

GENERAL ELECTRIC COMPANY GE POWER GENERATION SCHENECTADY, NY	SIZE A	CAGE CODE	DWG NO **237A7261**
DRAWN: T.Hammell			
ISSUED:	SCALE		SHEET 12

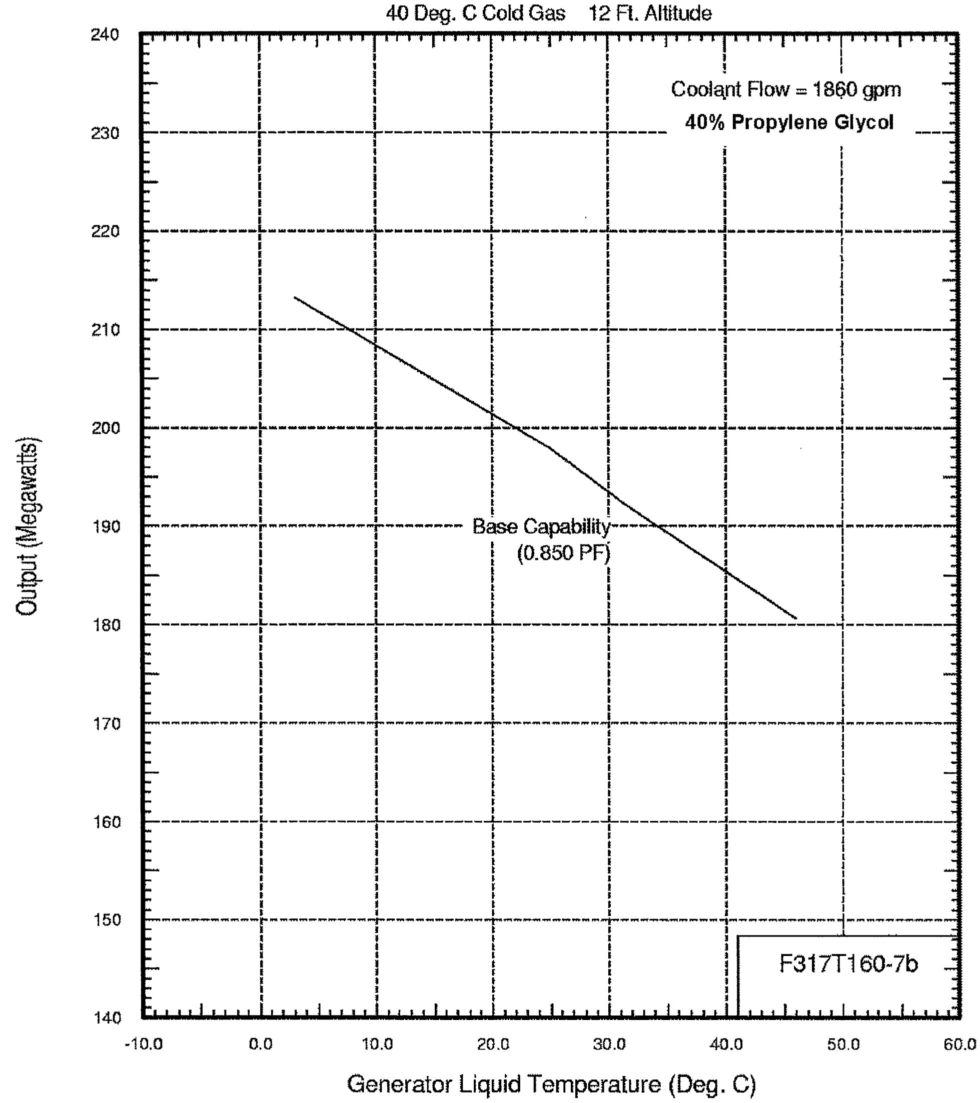
SIZE	DWG NO	SH	REV
A	237A7261	13	-

GENERATOR OUTPUT AS A FUNCTION OF LIQUID TEMPERATURE

2 Pole 3600 RPM 226000 kVA 18000 Volts 0.850 PF

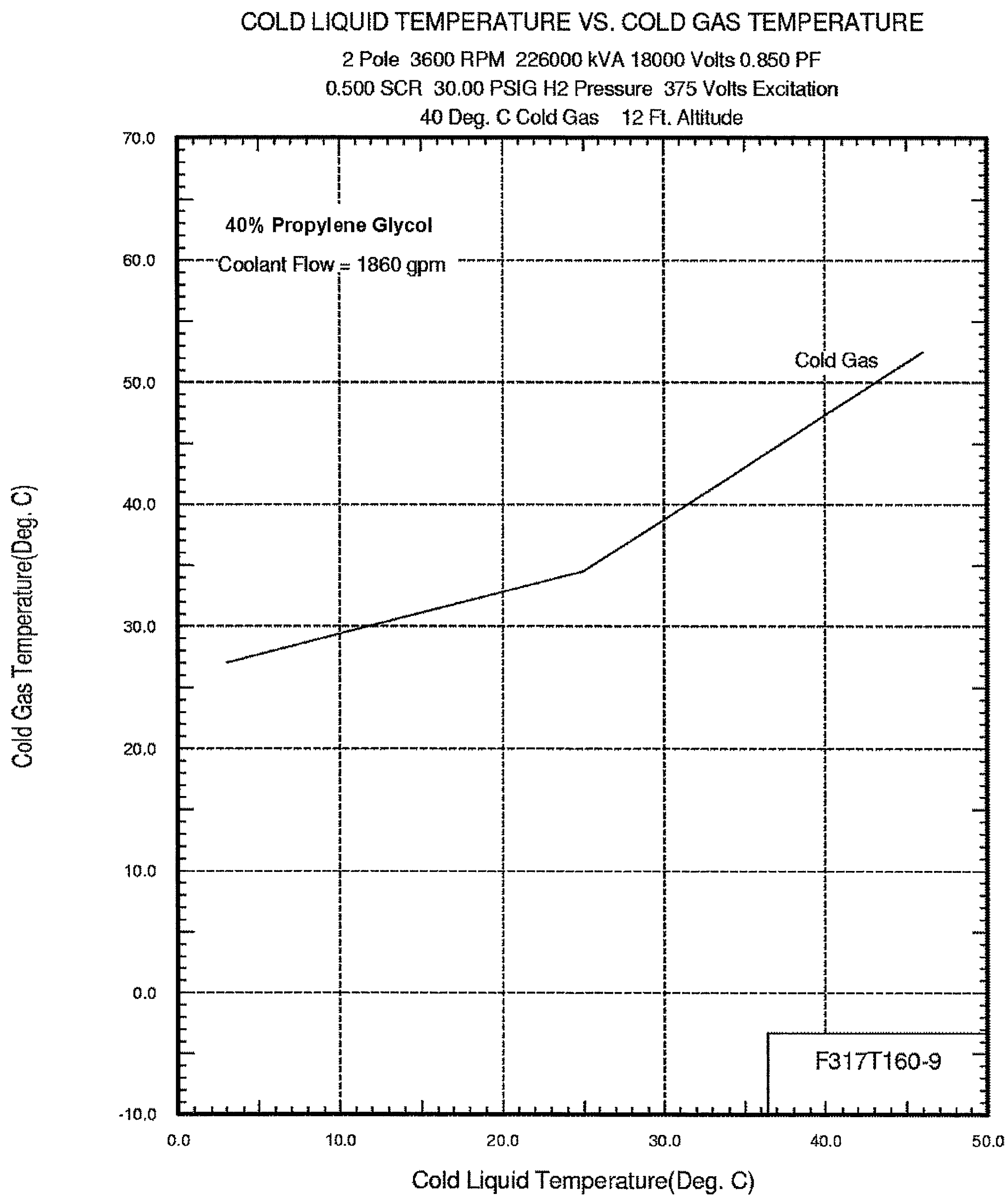
0.500 SCR 30.00 PSIG H2 Pressure 375 Volts Excitation

40 Deg. C Cold Gas 12 Ft. Altitude



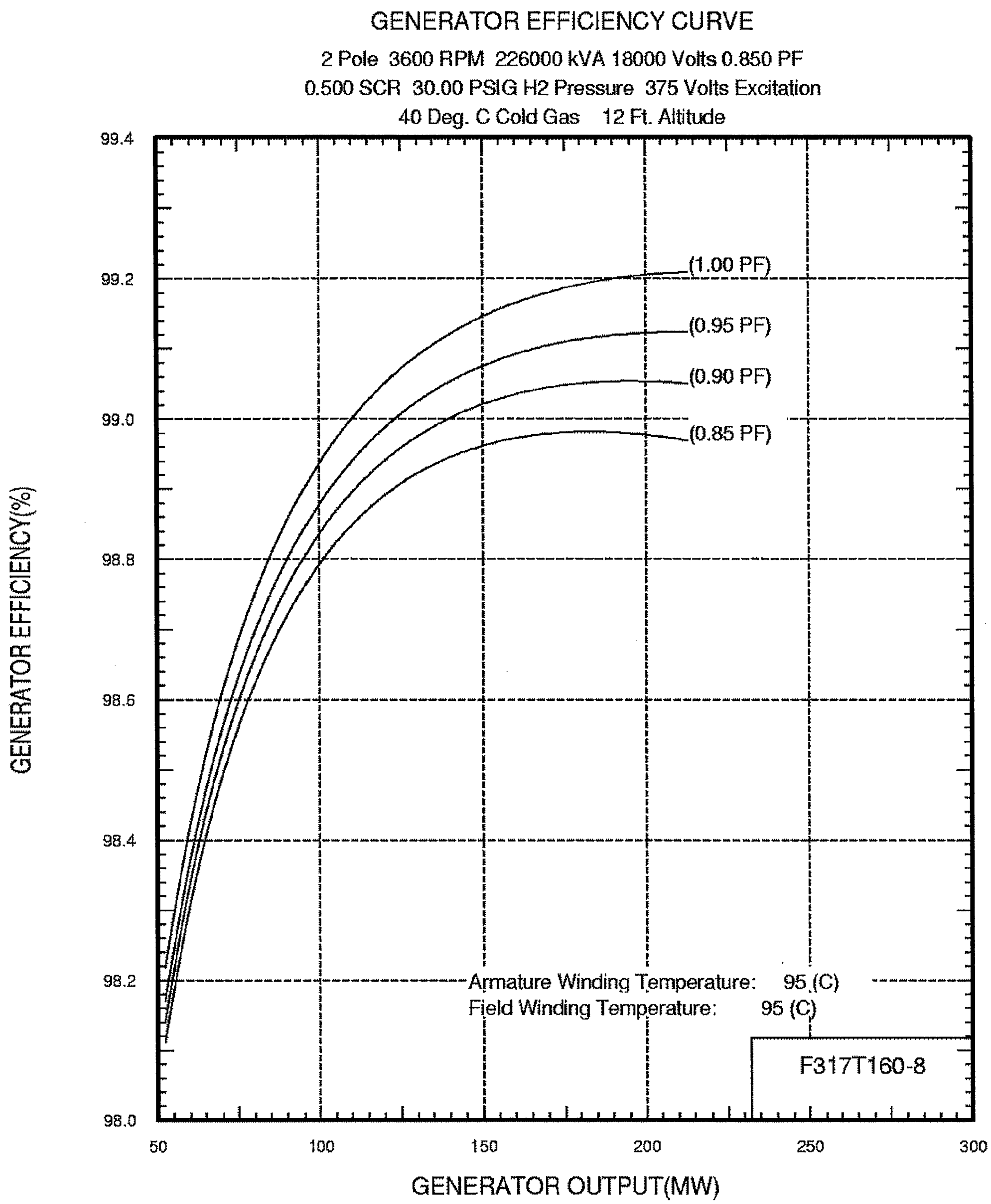
GENERAL ELECTRIC COMPANY GE POWER GENERATION SCHENECTADY, NY	SIZE A	CAGE CODE	DWG NO **237A7261**
DRAWN: T.Hammell			
ISSUED:	SCALE		SHEET 13

SIZE	DWG NO	SH	REV
A	237A7261	14	-



GENERAL ELECTRIC COMPANY GE POWER GENERATION SCHENECTADY, NY	SIZE A	CAGE CODE	DWG NO 237A7261	
DRAWN: T.Hammell				
ISSUED:	SCALE			SHEET 14

SIZE	DWG NO	SH	REV
A	237A7261	15	-



GENERAL ELECTRIC COMPANY GE POWER GENERATION SCHENECTADY, NY	SIZE A	CAGE CODE	DWG NO **237A7261**
DRAWN: T.Hammell			
ISSUED:	SCALE		SHEET 15

GE Power Systems

Product Quality Report

Customer: ASTORIA ENERGY II #2 LLC

Generator: 338X390

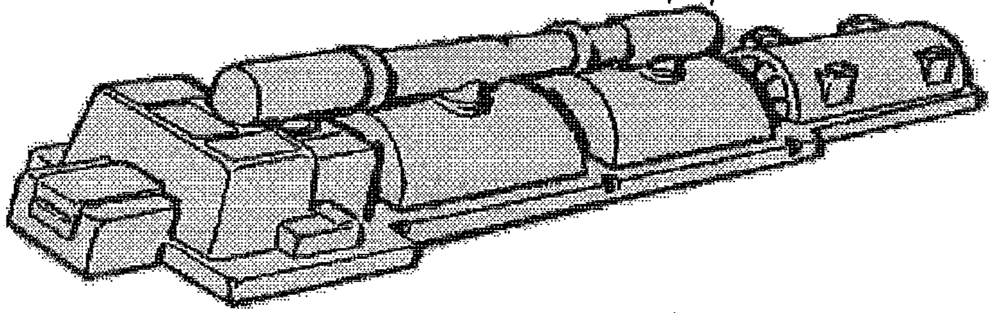
SNC·LAVALIN Constructors Inc.

Vendor's drawing review for conformity with specifications and design drawing.

This review does not relieve the vendor of his responsibility for errors in design and detailing as detailed in his contract.

- ☐ 1 NO EXCEPTIONS TAKEN, RESUBMIT DOCUMENT AS CERTIFIED. PROCEED WITH FABRICATION.
- ☐ 2 NO EXCEPTIONS TAKEN, ACCEPTED AS FINAL, RESUBMITTAL NOT REQUIRED. PROCEED WITH FABRICATION.
- ☐ 3 EXCEPTIONS AS NOTED, REVISE AND RESUBMIT. PROCEED WITH FABRICATION INCLUSIVE OF MARKUPS.
- ☐ 4 EXCEPTIONS AS NOTED, REVISE AND RESUBMIT. DO NOT PROCEED WITH FABRICATION.
- ☒ 5 APPROVAL NOT REQUIRED. FOR INFORMATION / REFERENCE ONLY.
- ☐ 6 CANCELLED

Vendor: GENERAL ELECTRIC - GENE	No.: C903-338x390-C903	Rev: –	Date Rec'd 4/1/2009
Doc. Title: GEN FACTORY TEST REPORT			
Client Code.	Project: Astoria II Cogeneration Project		
Reviewed by: Date. 5/5/09	Document No 0620 - T160-0190 - 001		Submittal 01



SNC LAVALIN CONSTRUCTORS INC. CONTRACT NO. 0620
P.O. NUMBER 62000001, SPECIFICATION SP-T160
PROJECT NAME: PHASE II ASTORIA ENERGY EXPANSION PROJECT
PROJECT LOCATION: ASTORIA, NY

This report contains Quality and Test information created during the manufacture of the generator noted above. The data and certifications included are intended to provide information on the final electrical and mechanical testing performed on the generator and its major components

Gas Turbine Generator

Manufacturing Department

Schenectady, New York

C903

Doosan Heavy Industries & Construction

HEAD OFFICE & CHANGWON PLANT
555 GUYGOK-DONG CHANGWON
KYONGSANGNAM-DO 641-792,KOREA
(P.O BOX 77, CHANGWON,KOREA)
TEL(055)278-6114 FAX(055)264-5551~2

INSPECTION REPORT

Frame Model : 7FH2 COMPLETE GEN.

Supplier Name and Code : DOOSAN / 48163

GE PO NO : 181094165

Supplier Frame Serial NO : 7C068

2009-03-03 11:00/발전)터빈/발전기품질관리부 발전기검사과 발전기검사반/H507542/성기수

Sungkisu	유 우종	김 종훈
Prepared by	Reviewed by	Approved by
TBN/GEN QUALITY CONTROL DEPARTMENT		

Doosan Heavy Industries & Construction

QUALITY VERIFICATION DOCUMENT LIST

PROJECT : 7C068 COMPLETE GENARATOR
P/O No : 181094165
CUSTOMER SHOP ORDER : 338X390

STATOR (VOL.I)	page no
GQC (GEN. QUALITY CERT).tif	A~C
FHPT (STATOR FINAL HIPOT).tif	20
HPT (STATOR HIPOT TEST DATA).tif	18~20
PI (STATOR POLARIZATION INDEX).tif	20
RTD (RTD DATA).tif	24
QCS-G-12 (FRAME AIR TEST).tif	3~6
QCS-G-08 (STATOR FRAME DATA).tif	1~101
QCS-G-09 (STATOR CORE DATA).tif	1~34
QCS-G-10 (STATOR BAR DATA).tif	1~27
QCS-G-13 (STATOR ASSEMBLY).tif	1~24
QCS-G-14 (GEN ASSEMBLY).tif	1~28
(COOLER).tif	1~27
(AUX PIPING)).tif	A1~E1
QCS-G-11 (BEARING & OUTER END SHIELDS)	1~62

2009-03-03 18:35/발전)터빈/발전기품질관리부 발전기검사과 발전기검사반/H507542/성기수

ROTOR (VOL.II)	page no
MAC (ROTOR MATL CERT)	5~7
QCS-G-01 (FIELD FORGING MAT'L PROPERTIES)	1~23
QCS-G-01-1 (FIELD MACHINING & ASSM DATA)	1~29
QCS-G-02 (FIELD MP INSPECTION DATA)	28~29
QCS-G-03 (FIELD RETAINING RING DATA)	1~21
QCS-G-04 (FIELD COIL DATA)	1~21
QCS-G-05 (FIELD WEDGE DATA)	1~2
QCS-G-06 (COLLECTOR RING DATA)	1~3
QCS-G-07 (FIELD FAN RING DATA)	1
RT-1 (FIELD WINDING RESISTANCE)	3
RT-2 (FIELD HIPOT TEST)	1~3
RT-3 (FIELD FLUX PROBE DATA)	1~3
RT-4 (FIELD BALANCE AND OVERSPEED)	1~28
RT-5 (FIELD FINAL HIPOT)	3
RUNOUT (3RD LATHE DIM RUNOUTS)	22~25
SDR (SDR LOG)	1~8

Doosan Heavy Industries & Construction

DOOSAN HEAVY INDUSTRIES & CONSTRUCTION CO., LTD.

HEAD OFFICE & CHANGWON PLANT
555 GUYGOK-DONG CHANGWON
KYONGSANGNAM-DO 641-792,KOREA
(P.O BOX 77, CHANGWON,KOREA)
TEL(055)278-6114 FAX(055)264-5551~2

CERTIFICATE OF CONFORMANCE

NO : COCDCASSPR0038

1. PROJECT NAME :7FH2 GENERATOR
2. PURCHASE ORDER NO :181094165
3. CUSTOMER :GENERAL ELECTRIC INTERNATIONAL,INC
4. M/O NO :T07113
5. ITEM NAME :7C068 COMPLETE GENERATOR
6. MPP NO :MPPDDEBAAA0001
7. DWG NO :338X390
8. QUANTITY :1 set

2009-03-03 18:33/발전)터빈/발전기품질관리부 발전기검사과 발전기검사반/H507542/성기수

WE HEREBY CERTIFY THAT THE ITEMS LISTED ABOVE HAVE BEEN MANUFACTURED, TESTED AND INSPECTED IN COMPLIANCE WITH THE REQUIREMENTS SPECIFIED IN THIS CONTRACT, APPLICABLE SPECIFICATION, DRAWING AND OWNER REQUIREMENTS.

CERTIFIED BY : T.M. Kwon
KWON, TAE MYUNG
GENERAL MANAGER
TG QC. DEPT.

2009.3.9
DATE

Page No. A

PK2009-02-0037

PACKING LIST(A)

PJT NO. : T07113

EXPORTER / SHIPPER	NO.& DATE OF INVOICE
DOOSAN HEAVY INDUSTRIES AND CONSTRUCTION CO.,LTD. CHANGWON, KOREA	DOOSAN09-003 2009-02-26
	NO. & DATE OF L/C 2009-02-27
FOR ACCOUNT & RISK OF MESSRS ~~General Electric International, Inc.~~ Building 59E Rom 240, 1 River Road Schenectady, NY 12345 USA	REMARK Contract No. Contract No. : 181094165 Shop Order No. : 338X390 GE P/O Line No.: 2
CONSIGNEE Same as above	
NOTIFY PARTY Att.: Joanne Langley (Tel : 518-385-3294)	

PORT OF LOADING	FINAL DESTINATION
	USA
CARRIER	**SAILING DATE**
Multi-loader	2009-02-27

MARKS NO. OF PKGS	DESCRIPTION / GOODS	QUANTITY	NET_W'T	GROSS_W'T	MEASURE'T
General Electric PJT : Astoria Electric CONT. NO.: 181094165	7FH2 Complete Generator (7C068)				
	TOTAL =	3 EA 1 SE 0 SH 0 ETC 2 PKG	231,507.000 (KG)	234,054.011 (KG)	170.3 (CBM)

MAIL ADD : GUYGOK-DONG 555 CHANG WON KYUNG NAM, KOREA

P.O.BOX : C.P.O BOX 77 CHANG WON

TELEPHONE : 055-278-6186

FAX : 055-278-8439

SIGNED BY Seungsu, Kim

S.S.KIM / General Manager

Logistics and Service Dept

DOOSAN HEAVY INDUSTRIES & CONSTRUCTION.,LTD

PACKING LIST(B)

MARKS OF PKGS	PACKING TYPE			MEASUREMENT			
OWNER TAG	DESCRIPTION OF GOODS			Quantity	UOM	Net_Wgt(Kg)	(CBM)
SPECIFICATION	Level	Parent Item No.	Position	Child Item No.		Gross_WgtKg)	
Packing List No. : PK2009-02-0037							
PKG # 001		SKID		9420 X		4300 X	4200
7C068-181094165-10	STATOR FINAL ASSY			1	set	231,500.000	
		T071131-117E1628		T071131-117E1628		231,500.000	
		SUB_TOTAL =		1		231,500.000	170.125
						234,046.500	
PKG # 002		BOX		980 X		880 X	210
7C068-181094165-20	FILLER PLATE			1	EA	3.000	
9.5T x 114.3W x 579.6L	2	798L241G0005		124E2393P0004		3.000	
7C068-181094165-30	FILLER PLATE			1	EA	1.000	
9.5T x 67.1W x 74.2L	2	798L241G0005		124E2393P0005		1.000	
7C068-181094165-40	FILLER PLATE			1	EA	3.000	
9.5T X 114.3W X 579.6L	2	798L241G0005		124E2393P0009		3.000	
		SUB_TOTAL =		3		7.000	0.181
						7.511	
		GRAND TOTAL =		4		231,507.000	170.306
						234,054.011	

Page No. c

Doosan Heavy Industries & Construction	ELECTRICAL TEST FOR STATOR (FINAL HI-POT)		PCG NO : PC-SW-015 PAGE : 1 of 1
ITEM	STATOR WINDING	PJT. NAME	7FH2 7C068 GEN. STATOR .
P/O NO.	181094165 (338X390)	M/O NO.	T07113
APPLIED DOOSAN DWG NO / Rev No		135E3454 Rev.J (June.30.2008)	
APPLIED GE SPEC No / Rev No		P12A-AL-7486 Rev.L (AUG.15.2005.)	
STATOR FRAME ID	7S110	TEST DATE	2009.02.20

※ INSTRUCTION

1) Winding resistance : Within ± 6 % of drawing requirement
2) Pre-hipot test
   - Insulation resistance to be above 1000 megaohms and the polarization index to be greater than 2.0 (DC 500V)
3) Hi-pot test : Test voltage AC 37000 V, Duration 1 Minute
4) Post hi-pot test (30 minutes after hi-pot test)
   - Insulation resistance is not less than 85% of pre-hipot test reading and not less than 1000 megahoms (DC 500V)

INSTRUMENTS ID No

EQUIPMENT NAME	I.D NO
Low resistance ohm meter	08E2J2022-0001
Insulation tester	08E1F0112-0004
Hi-pot equipment	08E1F1068-0001

Ambient Condition	
Amb' Temp'	10 ℃
Amb' humi'	31 %
Core temp'	10.5 ℃

B. Winding resistance check

Drawing requirement : 0.00129 Ω at 25 ℃

Phase	Act'l Resistance (at 10.5 ℃)	Cal' Resistance (25 ℃)	Act'l / Drawing (%)
T1 - T4	0.001171 Ω	0.0012403 Ω	-3.85%
T2 - T5	0.001181 Ω	0.0012509 Ω	-3.03%
T3 - T6	0.001173 Ω	0.0012424 Ω	-3.69%

C. Polarization index check

Phase \ Time	1 min (MΩ)	5 min (MΩ)	10 min (MΩ)	P.I Value
Ground, T1 - T4	4780	20800	30100	6.30
Ground, T2 - T5	5010	29600	48900	9.76
Ground, T3 - T6	5390	28800	52300	9.70

(TEST VOLTAGE : 500VOLT D.C)

D. Hi-pot test

Phase	Test voltage	Holding time	Insulation resistance			Result
			Pre-hipot	Post-hipot	%	
T1, T4 - E	AC 37 KV	1 min	4780 MΩ	4670 MΩ	98%	Pass
T2, T5 - E	AC 37 KV	1 min	5010 MΩ	4780 MΩ	95%	Pass
T3, T6 - E	AC 37 KV	1 min	5390 MΩ	5500 MΩ	102%	Pass

E. After Hi-pot test

Visual Inspection : No indication

Reviewed / Witnessed By: Andy Ang
SLCI Rep. 20 Feb 2009

정성덕 2/20/09	정종훈 2/20/09	심종현 2/20/09	
TESTED BY	REVIEWED BY	APPROVED BY	WITNESSED BY

Doosan Heavy Industries & Construction

QUALITY VERIFICATION DOCUMENT LIST

PROJECT : 7C068 COMPLETE GENARATOR
P/O No : 181094165
CUSTOMER SHOP ORDER : 338X390

STATOR (VOL.I)	page no
GQC (GEN. QUALITY CERT).tif	A~C
FHPT (STATOR FINAL HIPOT).tif	20
HPT (STATOR HIPOT TEST DATA).tif	18~20
PI (STATOR POLARIZATION INDEX).tif	20
RTD (RTD DATA).tif	24
QCS-G-12 (FRAME AIR TEST).tif	3~6
QCS-G-08 (STATOR FRAME DATA).tif	1~101
QCS-G-09 (STATOR CORE DATA).tif	1~34
QCS-G-10 (STATOR BAR DATA).tif	1~27
QCS-G-13 (STATOR ASSEMBLY).tif	1~24
QCS-G-14 (GEN ASSEMBLY).tif	1~28
(COOLER).tif	1~27
(AUX PIPING)).tif	A1~E1
QCS-G-11 (BEARING & OUTER END SHIELDS)	1~62

2009-03-03 18:35/발전)터빈/발전기품질관리부 발전기검사과 발전기검사반/H507542/성기수

ROTOR (VOL.II)	page no
MAC (ROTOR MATL CERT)	5~7
QCS-G-01 (FIELD FORGING MAT'L PROPERTIES)	1~23
QCS-G-01-1 (FIELD MACHINING & ASSM DATA)	1~29
QCS-G-02 (FIELD MP INSPECTION DATA)	28~29
QCS-G-03 (FIELD RETAINING RING DATA)	1~21
QCS-G-04 (FIELD COIL DATA)	1~21
QCS-G-05 (FIELD WEDGE DATA)	1~2
QCS-G-06 (COLLECTOR RING DATA)	1~3
QCS-G-07 (FIELD FAN RING DATA)	1
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RT-2 (FIELD HIPOT TEST)	1~3
RT-3 (FIELD FLUX PROBE DATA)	1~3
RT-4 (FIELD BALANCE AND OVERSPEED)	1~28
RT-5 (FIELD FINAL HIPOT)	3
RUNOUT (3RD LATHE DIM RUNOUTS)	22~25
SDR (SDR LOG)	1~8

DOOSAN Doosan Heavy Industries & Construction

CERTIFIED MATERIAL TEST REPORT

CUSTOMER : GENERIAL ELECTRIC Co.

CMTR No. : I2008080018

CUSTOMER'S PURCHASE ORDER No. : ~~181094083~~ changed P/o: 181094165

MATERIAL : B50A375A85

CUSTOMER'S SPECIFICATION No. : P14A-AL-0200 Rev.L B50A375-D

HEAT No. : 2B82821

G.E SERIAL No. : 48163

PRODUCT NAME : 7FH2 GEN ROTOR #70C~~070~~ 68

IDENTIFICATION OF MATERIAL : F07479 140

DOOSAN M/O No. : F07479

DOOSAN PURCHASE SPEC No. : N/A

The attachments described hereunder are part of this Certified Material Test Report :

1. Material Acceptance Certification (MAC) : MAC808-0018 (2 Sheet)
2. Forging Work Report : FWR808-0018
3. Report of Heat Treatment : RHT808-0018
4. Sampling Drawing : RM-TN-7FH2-001
5. Test Results of FATT : IP-08-07-079S1
6. Micro Structure Test Report : IM-08-07-063-01
7. Report of Ultrasonic Examination : U080526-056-001
8. Bore Eccentricity Test Report : EA07479140
9. Report of Magnetic Particle Examination : M080825-003-001
10. Report of Magnetic Permeability Test : 07-5011-07479-140
11. Dimensional Check Report : PP08-08-18-001, KSM-08026-193

- Blank -

We hereby certify that the contents of this report are correct and accurate and that all test and examination results and operations performed by Doosan Heavy Industries & Construction co.,Ltd. are in compliance with the requirements of the material specification and the applicable material requirements as designeted by the Customer's Order

Certified by D. R. Soe 9/02/'08

CFQC Dept Gen Manager Date

DOOSAN HEAVY INDUSTRIES & CONSTRUCTION CO.,LTD.

(760 - 전생 - 008) 두산중공업(주) A4(210×297mm)

MATERIAL ACCEPTANCE CERTIFICATE(MAC)

Report No. : MAC808-0018
Sheet No. : 1 of 2

GE SPEC. B50A375 ISSUE D CLASS A85

FORGING
Supplier DOOSAN
Drawing 120E9018P01 Rev.B — Thru Bore
Serial No. F07479 140 — Not Thru Bore *
Heat No.(s) 2BB2821
MPP No. MIP-CF-B50A375 Rev. No. 06 Rev Date Oct. 25. '04
Melting Practice VSD ____ VCD * VAD ____ ESR ____ VAR ____ LR ____ Other ____

GE, PGO
Purchase Order ~~181094063~~ changed P/O : 181094165
Special Requirements N/A

MECHANICAL PROPERTIES :

Tensile Tests
(Radial Body)

	Drawing Location	T.S (KSI)	0.02% (0.2%) Y.S (KSI)	El (%)	RA (%)
Mid Body					
Body "A"	0°	114.0	96.0 (97.0)	22.0	69.0
	120°	113.0	95.0 (97.0)	23.0	68.0
	240°	114.0	95.0 (97.0)	24.0	69.0
Turbine End Prolong		115.0	97.0 (99.0)	23.0	68.0

Charpy V-Notch Test
(Radial Body)

Location	RT (Ft-lbs)	Hot/Cold Temp (F)	(Ft-lbs)	FATT (°F)
Mid Body				
Body "A" 0° "I"	130	+75		-5.0
10° "I"		-40	74	
120° "I"		-70	59	
130° "I"		-10	68	
240° "I"		+20	95	
250° "I"		+50	119	

2008-08-28 10:35/주단)주단품질관리부 단조검사과 주단검사직 단조검사반/H506311/이기봉

Bore Properties

Location	T.S (KSI)	0.02% (0.2%) Y.S (KSI)	El (%)	RA (%)	Charpy (Ft-lbs)	FATT (°F)
Collector End						
Thru Bore						

APPROVED SDR(s)

Report No. : MAC808-0018

Sheet No. : 2 of 2

CHEMICAL COMPOSITION

1. Weight percent(%) Heat Analysis

	C	Mn	P	S	Si	Ni	Cr	Mo	V	Sb	As	Sn	Al	O (PPM)	H (PPM)
2B82821	0.25	0.29	0.006	0.001	0.07	3.13	1.43	0.31	0.10	0.0007	0.0027	0.0021	0.003	31	1.02
							-------	Blank	-------						

2. Product Analysis (%)

	C	Mn	P	S	Si	Ni	Cr	Mo	V	Sb	As	Sn	Al	O (PPM)	H (PPM)
TOP	0.24	0.29	0.005	0.001	0.08	3.05	1.41	0.31	0.11	0.0008	0.0025	0.0024	0.003	29	0.72
BOTTOM	0.24	0.29	0.006	0.001	0.08	3.02	1.40	0.30	0.10	0.0008	0.0023	0.0023	0.003	27	0.69
							-------	Blank	-------						

AUTHORIZED SIGNATURE : 기봉 8/28/08

Page No. 7

DOOSAN Heavy Industries & Construction	ELECTRICAL TEST FOR STATOR (FINAL HI-POT)		PCG NO : PC-SW-015 PAGE : 1 of 1
ITEM	STATOR WINDING	PJT. NAME	7FH2 7C068 GEN. STATOR
P/O NO.	181094165 (338X390)	M/O NO.	T07113
APPLIED DOOSAN DWG NO / Rev No		135E3454 Rev.J (June.30.2008)	
APPLIED GE SPEC No / Rev No		P12A-AL-7486 Rev.L (AUG.15.2005.)	
STATOR FRAME ID	7S110	TEST DATE	2009.02.20

※ INSTRUCTION

1) Winding resistance : Within ± 6 % of drawing requirement
2) Pre-hipot test
   - Insulation resistance to be above 1000 megaohms and the polarization index to be greater than 2.0 (DC 500V)
3) Hi-pot test : Test voltage AC 37000 V, Duration 1 Minute
4) Post hi-pot test (30 minutes after hi-pot test)
   - Insulation resistance is not less than 85% of pre-hipot test reading and not less than 1000 megahoms (DC 500V)

INSTRUMENTS ID No

EQUIPMENT NAME	I.D NO
Low resistance ohm meter	08E2J2022-0001
Insulation tester	08E1F0112-0004
Hi-pot equipment	08E1F1068-0001

Ambient Condition	
Amb' Temp'	10 ℃
Amb' humi'	31 %
Core temp'	10.5 ℃

B. Winding resistance check

Drawing requirement : 0.00129 Ω at 25 ℃

Phase	Act'l Resistance (at 10.5 ℃)	Cal' Resistance (25 ℃)	Act'l / Drawing (%)
T1 - T4	0.001171 Ω	0.0012403 Ω	-3.85%
T2 - T5	0.001181 Ω	0.0012509 Ω	-3.03%
T3 - T6	0.001173 Ω	0.0012424 Ω	-3.69%

C. Polarization index check

Phase \ Time	1 min (MΩ)	5 min (MΩ)	10 min (MΩ)	P.I Value
Ground, T1 - T4	4780	20800	30100	6.30
Ground, T2 - T5	5010	29600	48900	9.76
Ground, T3 - T6	5390	28800	52300	9.70

(TEST VOLTAGE : 500VOLT D.C)

D. Hi-pot test

Phase	Test voltage	Holding time	Insulation resistance			Result
			Pre-hipot	Post-hipot	%	
T1, T4 - E	AC 37 KV	1 min	4780 MΩ	4670 MΩ	98%	Pass
T2, T5 - E	AC 37 KV	1 min	5010 MΩ	4780 MΩ	95%	Pass
T3, T6 - E	AC 37 KV	1 min	5390 MΩ	5500 MΩ	102%	Pass

E. After Hi-pot test

Visual Inspection : No indication

Reviewed / Witnessed By:
Andy Ang
SLCI Rep. 20 Feb 2009

정성덕 2/20/09	정종동 2/20/09	심종호 2/20/09	
TESTED BY	REVIEWED BY	APPROVED BY	WITNESSED BY

Page No. 20

Doosan Heavy Industries & Construction

REPORT OF MAGNETIC PARTICLE EXAMINATION
자 기 탐 상 시 험 보 고 서

Report No.	M081110-018-001
Page	1 OF 1

Customer	GE		
Project	T07113 / 7FH2 Complete (14 Unit)_T07113	Unit	1 / 7FH2 GEN. CPL-'09년 납품
WBS	1020201 / ROTOR FORGING & MACH	Activity	1020201M020 / ROTOR MACH
Item	T071131-134E3617P0001 / FIELD MACHINING		

TRV No.	Rev.	Oper. Seq.	Procedure No. & Rev No. (적용규격 & 개정번호)
100477258	0	110	P3C-AL-2153 Rev.E

Material Type B50A375A85 | Thickness N/A mm

Examination Phase (검사시기) : After Final Machined

Surface Condition (표면상태) : As Machined Condition

Magnetization 자 화 법		Method 검사방법
Head Shot-DC-Circular	Coil-DC-Longitudinal	Wet-Non Fluorescent-Continuous

Testing Equipment (시험장비)

ID No. (번호)	Type (형식)	Model (모델)	Maker (제작처)	Due Date (유효일)
43-01-28	PROD	PICOMAG S-2000(20000AMP)	NAWOO	2009-03-04

Magnetic Particle (자분)			Field Indicator (자장지시계)
Maker (제조처)	Color/Type (색상/형태)	Density (농도)	GE Taper Block
MAGNAFLUX(U.S.A)	MAGNAFLUX 7C BLACK	1.5 ml/100ml	Test Temp (시험온도)
Current Power (전류)	Lighting Equip. (조명장치)	B/L Intensity (흑광광도)	Ambient 상온
100~125 Amp/in	Glow Lamp Min. 1000 Lux	N/A μW/cm²	Demagnetization (탈자) Yes

*Exam Areas: All External, Visibly Accessible, Finished Surfaces, Which are Outborad of the Rotor Body on the Turbine end & Collector end.

Joint(Part) No. 이음(부품)번호	Decision (판정)	Interpretation (평가)	Remarks (비고)
F07479 140	Accept	No Recordable Indication	N/A
--BLANK--			

Examined By 시 험 자 최진오 JIN OH, CHOI 2008-11-11	Level II	Witnessed By 입 회 자	N/A	N/A
Reviewed & Approved By 검토/승인자 정해광 HAE KWANG, JEONG 2008-11-11	Level II	Reviewed By 검 토 자	N/A	N/A

(품질-NDE-003) 두산중공업 (A4백상지)

Doosan Heavy Industries & Construction

REPORT OF MAGNETIC PARTICLE EXAMINATION
자 기 탐 상 시 험 보 고 서

Report No.	M081224-033-001
Page	1 OF 1

Customer	GE		
Project	T07113 / 7FH2 Complete (14 Unit)_T07113	Unit	1 / 7FH2 GEN. CPL-'09년 납품
WBS	1020203 / FIELD WINDING	Activity	1020203M030 / THIRD LATHE
Item	T071131-135E6004G0002 / GEN ROTOR THIRD LATHE		

TRV No.	Rev.	Oper. Seq.	Procedure No. & Rev No. (적용규격 & 개정번호)
100477272	0	70	P3C-AL-0003 Rev. B

Material Type B50A375A85	Thickness N/A mm
Examination Phase (검사시기) : After Final Machined	
Surface Condition (표면상태) : As Machined Condition	
Magnetization 자 화 법 Yoke-AC-Longitudinal	Method 검사방법 Wet-Non Fluorescent-Continuous

Testing Equipment (시험장비)

ID No. (번호)	Type (형식)	Model (모델)	Maker (제작처)	Due Date (유효일)
43-02-11	AC YOKE	MP-A3	KYUNG-DO	2009-05-16

Magnetic Particle (자분)			Field Indicator (자장지시계)
Maker (제조처)	Color/Type (색상/형태)	Density (농도)	GE Taper Block
NAWOO(KOREA)	BLACK(NMP-B) CAN	2.0 ml/100ml	Test Temp (시험온도)
Lifting (자력)	Lighting Equip. (조명장치)	B/L Intensity (흑광광도)	Ambient 상온
Min 10 Pound (4.5 kg)	Glow Lamp Min. 1000 Lux	N/A μW/cm²	Demagnetization (탈자) Yes

** Examination Areas : Third Lathe Machined areas. (Coupling & oil deflector areas)

Joint(Part) No. 이음(부품)번호	Decision (판정)	Interpretation (평가)	Remarks (비고)
F07479 140	Accept	No Recordable Indication	N/A
-BLANK-			

Examined By 시 험 자 박진석 JIN SEOK, PARK	2008-12-30	Level II	Witnessed By 입 회 자	N/A
Reviewed & Approved By 검토/승인자 임영태 YOUNG TAE, LIM	2008-12-30	Level II	Reviewed By 검 토 자	N/A

(품질-NDE-003) 두산중공업 (A4백상지)

Doosan Heavy Industries & Construction

ELECTRICAL TEST (Final hi-pot Test)

PCG No : **PCG-RW-005**

ITEM	FIELD WINDING	PJT. NAME	7FH2 7C68 GENERATOR ROTOR
P/O NO.	181094165(338X390)	M/O NO.	T07113
APPLIED DOOSAN DWG NO / Rev No		138E7050 Rev.A (MAR.27.2008)	
APPLIED GE SPEC No / Rev No		P12A-AL-6129.Rev.K (AUG.2006)	
VF. NO.	F07479-140	TEST DATE	2009.01.19

*. INSTRUCTION

~~1) Winding Resistance : Design Value ± 2 %~~

2) Impedance : Design Value ± 25 %

3) Pre-hipot

- Insulation Resistance : Min 25 Mohm (DC 500V MEGGER)
- Polarization index

Insulation Resistance	Polarization Index
25 - 199 Mohm	Min 1.10
≥ 200 Mohm	Min 1.00

TEST CONDITION	
ambient temp:	17 ℃
humidity :	30 %

4) Hi-pot Test : Test Voltage : AC 3500 V, Holding Time : 1 Min

5) Post-hipot

Insulation resistance at 1 minute after hipot should be 25MΩ or greater and at least 60 percent of the one-minute pre-high potential measurement, or 200MΩ or greater.

1. WINDING RESISTANCE CHECK

RESISTANCE (Ω) at 12.5 ℃	RESISTANCE (Ω) at 25 ℃	REMARKS
0.1315	0.13815	-1.53%
※. Design value = 0.1403 (Ω) at 25 ℃		

Winding temperature measurement

Section	1	2	3	4	5	Average	REMARKS
Temp(℃)	12.3	12.5	12.7	12.4	12.5	12.5	

2. IMPEDANCE CHECK

VOLTAGE	CURRENT	ACT'L DATA	DESIGN VALUE	DIFFERENCE(%)
100 Vac	12.2 A	8.20 Ω	8.49 Ω	-3.45%

3. INSULATION RESISTANCE CHECK

	INSULATION RESISTANCE	Ration of Insulation resistance between pre and post Hi-pot Test (%)
PRE HI - POT TEST	6430 MΩ	
POST HI - POT TEST	4520 MΩ	70.3

4. POLARIZATION INDEX TEST (BEFORE HI POT)

TIME	1 MIN	5 MIN	10 MIN	P.I
MΩ	6430	24200	41100	6.39

5. HI - POT TEST

TEST VOLTAGE	HOLDING TIME	RESULT	REMARKS
3500V. AC	60 SEC	Pass	

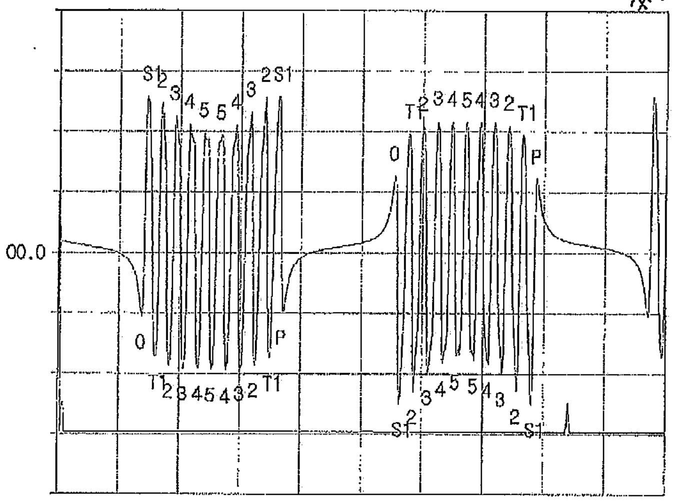
Page No. 3

Reviewed / Witnessed By: Andy Ang

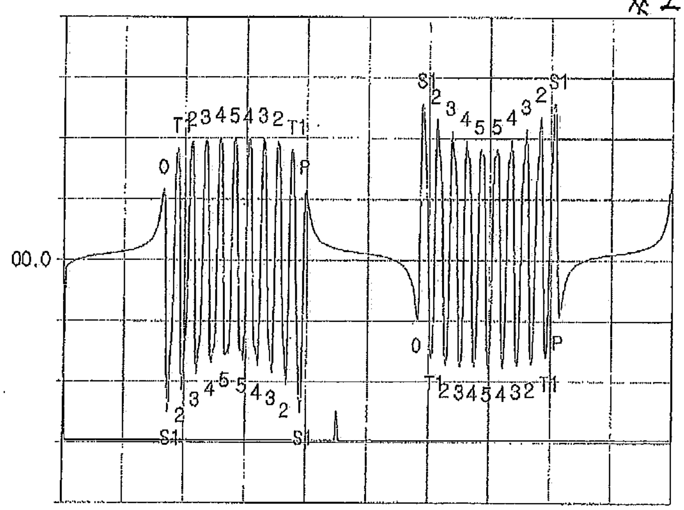
장성원 1/19/09	유우종 1/19/09	최종철 1/19/09	G.E. Energy 1/19/09	SICL Rep 19 Jan 2009
TESTED BY	REVIEWED BY	APPROVED BY	WITNESSED BY	WITNESSED BY

DOOSAN DooSan Heavy Industries & Construction Co.,Ltd	Generator Rotor Flux Probe Data	From No.	HPCT-401
		Rev. No	1
		Rev. Date	2001-04-11

※1



※2



M/O NO : T071 13
Project Name : 7FH2 #7C068
Customer : GE
Date/Time : 2009-01-13(09:38:31)

Submit results to manager of test operation if a short indication exists.

Before Thermal (◆)
After Thermal ( )

Field S/N # : 338X390
RPM : 3600
Field Amps : 200
Of Poles : 2
Coils/Pole : 5
Physical Count

'FP' Mark = 350 Deg.

Angles increase with rot.(◆)
Angles decrease with rot.( )

TESTER : 홍현택

Directions :
Locate'FP'Mark on drive shaft and record angle on field at same location.
Determine if the angles are increasing or decreasing as field turns on TG

Location of Short(s)	
Coil#	Pole
Coil#	Pole
Coil#	Pole
Coil#	Pole
Coil#	Pole

Comments : Good

Page No. 1

Short is speed sensitive (No)
Attempt was made to burn short out procedure (No)

Signature : 유 순 철

Reviewed / Witnessed By:
Andy Ang
SLCI Rep 14 Jan 2009

GENERATOR SHORTED TURN TEST

DOOSAN BALANCING SHOP
PJT : 7FH2 #7C068

LEGEND : T-TOOTH, S-SLOT, P-POLE

COILS/POLE : 5   # TURNS/#1 COIL : 16   # TURNS/#2~5 COIL : 16   TOTAL : 80

COIL	POLE X					POLE Y					POLE X/POLE Y		
	LEFT		RIGHT			LEFT		RIGHT					
NO.	Location	Amplitude	Location	Amplitude	Average	Location	Amplitude	Location	Amplitude	Average	Result	T.D.R(%)	Remarks
#1	T1-S1	21.50	S1-P	18.19	19.85	T1-S1	21.62	S1-P	17.81	19.72	1.0066	0.7	Before Thermal picture ※1
#2	T2-S2	21.67	S2-T1	20.91	21.29	T2-S2	22.12	S2-T1	21.55	21.84	0.9750	2.5	
#3	T3-S3	20.85	S3-T2	20.65	20.75	T3-S3	21.16	S3-T2	20.88	21.02	0.9872	1.3	
#4	T4-S4	20.17	S4-T3	20.18	20.18	T4-S4	20.32	S4-T3	20.15	20.24	0.9970	0.3	
#5	T5-S5	19.55	S5-T4	19.46	19.51	T5-S5	19.35	S5-T4	19.45	19.40	1.0054	0.5	
	POLE X'					POLE Y'					Result	T.D.R(%)	Remarks
#1	T1-S1	21.70	S1-P	18.27	19.99	T1-S1	21.56	S1-P	18.26	19.91	1.0038	0.4	Before Thermal picture ※2
#2	T2-S2	20.36	S2-T1	19.85	20.11	T2-S2	19.99	S2-T1	19.31	19.65	1.0232	2.3	
#3	T3-S3	19.21	S3-T2	19.04	19.13	T3-S3	19.23	S3-T2	18.99	19.11	1.0008	0.1	
#4	T4-S4	18.55	S4-T3	18.34	18.45	T4-S4	18.66	S4-T3	18.70	18.68	0.9874	1.3	
#5	T5-S5	17.78	S5-T4	17.85	17.82	T5-S5	18.24	S5-T4	18.16	18.20	0.9788	2.1	

NOTE

* Criteria Formula : ± 0.25 (1/Turns per slot by design)
* Shortage Tolerance of each Coil Number

Coil No	±Tolerance	±%	SHORT RANGE OF COIL(%)			
Coil #1	0.016	1.56	6.3±1.56	4.74 %	~	7.86 %
Coil #2~5	0.016	1.56	6.3±1.56	4.74 %	~	7.86 %

* ACCEPTANCE CRITERIA (NO SHORT) : SHORT RANGE(%) > TOTAL DIFFERENTIAL RATIO (%)

Reviewed / ~~Witnessed~~ By:
Andy Ang
SLCI Rep 14 Jan 2009

DOOSAN DooSan Heavy Industries & Construction Co.,Ltd	T.D.R DIAGRAM	From No.	HPCT-401
		Rev. No.	1
		Rev. Date	2001-04-11

M/O NO : T071 13

CUSTOMER : GE

PJT NAME : 7FH2 #7C068

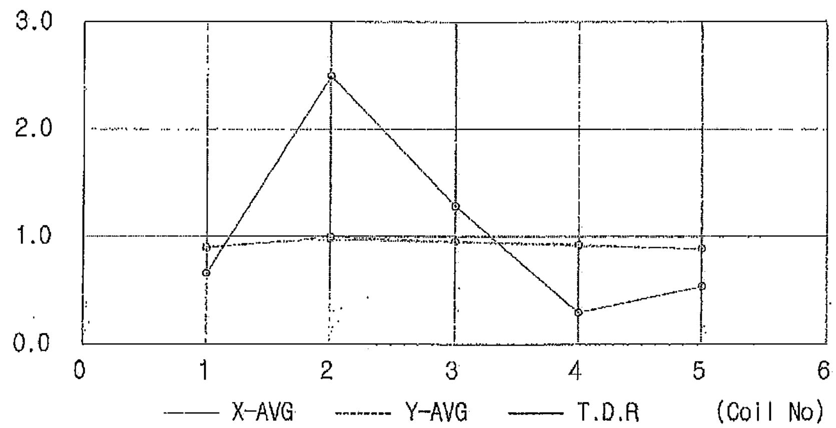
CAPACITY(MW) : 180

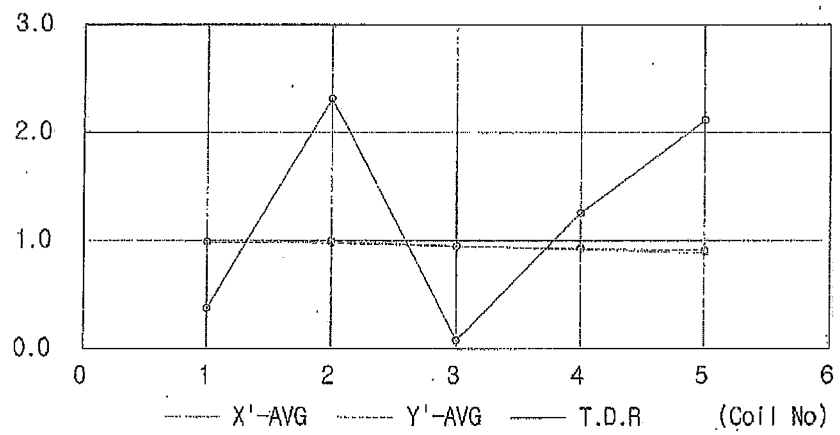
RATED SPEED : 3600RPM

TEST SPEED : 3600 RPM

TEST TIMING : Before Thermal

CURRENT : 200 AMPS



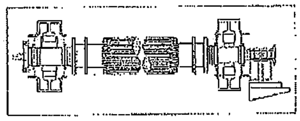


Page No. 3

Reviewed / ~~Witnessed~~ By:
Andy Ang
SLCI Rep 14-Jan-2019

DOOSAN Heavy Industries & Construction

BALANCING TEST REPORT
(Generator Field)



Balancing Shop

Field Information

Project	7FH2 #7C068	**M/O No.**	T07113
Material No.	F07479-140	**Rotor Type**	Gen Field(230Mw)
Serial No.	338X390	**Customer**	General Electric
~~**P/O No.**~~	~~181094165~~		
Rated Speed	3600rpm	**Overspeed**	120% of Rated Speed(4320rpm)

Test Name	Applied GE Spec No./Rev. No.	Test Speed & Condition				Results	Remarks
		Test Speed	Test Condition(Specification Criterion)				
Overspeed Test	P24C-AL-6502/E (APR.2006)	Rpm	4320Rpm Holding Time	Max.Limits (㎛) of Balancing M/C during Balancing		Actual(Max ㎛)	Results
		100~ 4320	3Min.	Coupling	508	145	GOOD
				Journal	254	62.6	
				Collector	508	293	
Flux Probe Test	P24C-AL-6502/E (APR.2006) E50A42/A (MAY.2000)	Rpm	Applied Current	Test Group		-	Results
		3600	200A	(Before Thermal Test)			GOOD

Test Name	Applied GE Spec No./Rev. No.	Test Group	Speed Range	Spec.(Ω)	Actual(Ω)	Results
Impedance Check	P24A-AL-5080/- (OCT.2000)	Before Final Balancing	5rpm	6.3675 ~ 10.6125	8.7111	GOOD
			3600rpm		8.4911	
		After Final Balancing	5rpm		8.9135	

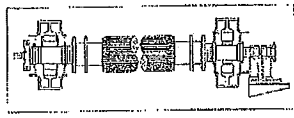
Test Name	Applied GE Spec No./Rev. No.	Position	Speed Range	Spec.(㎛)	Actual(Max ㎛)	Results
Final Balancing	P24C-AL-6502/E (APR.2006)	Coupling & Collector	125 ~ 3780rpm	76.2	24.6	GOOD
		Journal	125 ~ 2880rpm	76.2	18.2	
			2880 ~ 3240rpm	50.8	19.1	
			3240 ~ 3600rpm	50.8	13.9	
			3600 ~ 3780rpm	76.2	7.91	

Andy Ang
SLCI Rep. 14 Jan 2009

01. 14. 2009	홍 현 택	류 순 철	장 성 원 1/14/2009	GE Energy Y.R. 1/14/2009
Date	Prepared by Balancing Engineer	Reviewed by Balancing Manager	Approved by QA	Witnessed by Customer

Heavy Industries & Construction

BALANCING TEST REPORT
(Generator Field)



Balancing Shop

Field Information

Project	7FH2 #7C068	**M/O No.**	T07113
Material No.	F07479-140	**Rotor Type**	Gen Field(230Mw)
Serial No.	338X390	**Customer**	General Electric
P/O No.	181094165		
Rated Speed	3600rpm	**Overspeed**	120% of Rated Speed(4320rpm)

Test Name	Applied GE Spec No./Rev. No.	Test Speed & Condition: Test Speed	Test Condition(Specification Criterion)		Results	Approved by QA
		Rpm	Specification	Probe	Actual(㎛)	Results
Response Spectra Test	P24C-AL-6502/E (APR.2006)	3600	Not exceed 7.62㎛ peak-to-peak, at frequencies higher than 40% of rated frequency, other than 1/rev or 2/rev at any probe in the frequency range between 9 and 200Hz. 40% of rated frequency=24Hz	CH1	3.108	GOOD
				CH2	0.4439	
				CH3	0.3233	
				CH4	0.6657	
				CH5	1.212	
				CH6	3.215	
				CH7	1.356	
				CH8	1.966	

2009.01.14 14:04/발전)발전품질관리부/H502302/

Test Name	Applied GE Spec No./Rev. No.	Position	Speed Range	Spec.(㎛)	Actual(Max ㎛)	Results
2/rev	P24C-AL-6502/E (APR.2006)	Coupling / Collector	125～500rpm	25.4	5.09	GOOD
			500～3600rpm	101.6	84.6	
			3600～3780rpm	50.8	12.8	
		Journal	125～500rpm	12.7	4.28	
			500～3600rpm	25.4	19.2	
			3600～3780rpm	12.7	3.03	

Measuring Values

Rotor: 7FH2_7C068

Run: OVERSPEED TEST from 2009-01-12 17:13

Comment:

1 per rev

Measuring Values

		TE CPLG WEST CH 1		TE CPLG EAST CH 2		TE JNL WEST CH 3		TE JNL EAST CH 4	
Speed [rpm]	Time [s]	Amount [µm pp]	Angle [°]	Amount [µm pp]	Angle [°]	Amount [µm pp]	Angle [°]	Amount [µm pp]	Angle [°]
100.000	33.6	7.87	146	15.9	196	0.691	270	2.76	180
200.000	57.6	7.87	146	11.1	191	0.691	270	0.977	225
300.000	76.2	9.26	135	11.8	202	0.691	270	0.977	225
400.000	95.3	9.26	135	11.1	191	0.977	225	1.54	243
500.000	116.2	9.26	135	11.1	191	0.691	270	2.49	236
600.000	138.2	9.26	135	11.1	191	0.691	270	4.03	239
700.000	157.0	10.9	127	11.1	191	0.691	0	5.26	247
800.000	176.7	12.7	121	11.8	202	0.691	0	8.54	256
900.000	199.3	17.0	130	13.8	198	3.45	53.1	14.5	273
1000.00	223.1	21.8	143	12.7	211	4.83	90.0	22.4	304
1100.00	250.4	19.8	174	12.7	211	4.88	135	24.0	348
1200.00	271.5	15.3	180	10.9	217	2.49	146	18.0	4.40
1300.00	295.3	6.55	180	11.1	259	3.91	45.0	16.8	9.46
1400.00	319.3	16.6	113	8.73	90.0	14.6	109	15.8	28.8
1500.00	343.6	18.8	144	11.8	158	9.96	146	12.4	26.6
1600.00	369.7	17.6	150	13.3	171	7.72	153	10.5	23.2
1700.00	398.4	17.6	150	15.3	180	7.11	151	11.4	14.0
1800.00	421.5	17.6	150	15.3	180	7.11	151	11.4	14.0
1900.00	446.0	19.5	153	15.3	180	7.11	151	12.7	12.5
2000.00	466.0	19.5	153	15.3	180	6.51	148	12.7	12.5
2100.00	492.3	22.5	151	17.6	187	6.37	139	12.5	6.34
2200.00	512.4	22.5	151	19.8	186	7.34	131	13.8	2.86
2300.00	537.2	22.5	151	19.8	186	7.87	128	15.9	0
2400.00	586.2	26.4	156	19.8	186	9.29	132	18.1	6.58
2500.00	613.1	25.5	160	19.8	186	10.3	138	19.7	18.4
2600.00	634.9	22.8	163	19.8	186	9.39	144	17.9	27.6
2700.00	650.9	20.7	162	19.8	186	8.32	138	15.5	32.3
2800.00	678.8	21.5	156	19.8	186	8.32	138	14.4	35.2
2900.00	707.9	20.7	162	21.9	186	8.32	138	13.8	36.9
3000.00	725.9	20.7	162	22.8	197	8.79	135	12.7	40.6
3100.00	744.8	17.6	150	20.7	198	9.81	141	11.7	45.0
3200.00	772.3	17.0	140	20.7	198	9.59	150	9.39	54.0
3300.00	801.7	21.8	143	20.1	193	8.08	160	8.43	55.0
3400.00	826.0	23.6	146	22.8	197	7.44	158	7.47	56.3
3500.00	856.5	25.4	149	22.8	197	6.55	162	6.51	58.0
3600.00	880.4	31.2	155	26.4	204	9.39	163	5.57	82.9
3700.00	916.5	32.2	152	25.4	211	6.51	148	3.45	180
3800.00	943.5	38.1	156	26.3	222	5.86	135	7.47	304

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Reviewed / Witnessed By:
Andy Ang

SLCI Rep 14 Jan 2009

		CH 1		CH 2		CH 3		CH 4	
3900.00	974.9	47.1	167	26.6	235	6.51	122	8.08	340
4000.00	1004.7	76.5	177	21.9	264	8.43	125	12.1	347
4100.00	1025.9	91.0	226	23.6	146	8.84	141	8.84	38.7
4200.00	1049.9	107	239	86.5	227	9.29	132	6.25	276
4300.00	1077.6	131	306	105	313	9.39	144	19.6	321
4322.00	1098.0	105	313	82.9	325	7.87	142	19.0	327
4322.00	1163.6	130	316	111	328	8.79	135	22.0	328
4320.00	1223.9	145	317	129	330	9.81	129	23.9	327
4323.00	1286.2	136	316	118	330	9.81	129	23.6	328

3 MIN HOLDING

Reviewed / ~~Witnessed~~ By:
Andy Ang
SLC2 Rep 14 Jan 2009

Page No. 4

Measuring Values

Rotor: 7FH2_7C068

Run: OVERSPEED TEST from 2009-01-12 17:13

Comment:

1 per rev

Measuring Values

		CE JNL WEST CH 5		CE JNL EAST CH 6		COLLECTOR WEST CH 7		COLLECTOR EAST CH 8	
Speed [rpm]	Time [s]	Amount [µm pp]	Angle [°]	Amount [µm pp]	Angle [°]	Amount [µm pp]	Angle [°]	Amount [µm pp]	Angle [°]
100.000	33.6	0	0	2.18	198	7.87	146	2.18	90.0
200.000	57.6	0.977	135	0.691	270	6.17	135	2.18	90.0
300.000	76.2	0.691	270	1.54	207	4.88	153	2.18	90.0
400.000	95.3	0.691	270	1.54	207	4.88	153	3.09	45.0
500.000	116.2	0.691	270	1.54	207	4.88	153	2.18	0
600.000	138.2	0.691	270	2.49	236	4.88	153	2.18	0
700.000	157.0	0.977	315	4.37	252	7.87	124	4.88	333
800.000	176.7	0.691	0	6.25	264	7.87	146	4.36	0
900.000	199.3	1.95	45.0	11.9	280	6.90	162	8.73	0
1000.00	223.1	4.20	80.5	19.6	312	7.87	146	13.3	9.46
1100.00	250.4	4.20	99.5	20.9	352	7.87	146	12.3	45.0
1200.00	271.5	4.42	129	18.1	17.7	9.76	153	9.00	76.0
1300.00	295.3	3.52	101	17.3	28.6	20.7	162	9.00	104
1400.00	319.3	9.81	129	14.2	67.2	23.6	236	9.26	225
1500.00	343.6	6.55	162	8.34	65.6	6.90	288	7.87	304
1600.00	369.7	5.57	173	7.47	56.3	6.90	288	6.90	342
1700.00	398.4	4.83	180	6.80	66.0	7.87	304	4.88	333
1800.00	421.5	4.83	180	6.80	66.0	4.88	333	4.88	333
1900.00	446.0	4.14	180	5.69	76.0	4.88	333	4.88	333
2000.00	466.0	3.52	191	5.57	82.9	4.88	333	4.88	297
2100.00	492.3	3.52	191	6.21	90.0	2.18	0	4.88	297
2200.00	512.4	3.52	191	5.90	111	4.36	0	6.90	288
2300.00	537.2	3.45	217	7.34	131	9.00	346	8.73	270
2400.00	586.2	2.18	252	7.60	180	11.1	11.3	9.00	284
2500.00	613.1	0.977	315	7.87	218	21.5	24.0	13.1	270
2600.00	634.9	0.691	90.0	6.25	264	19.5	63.4	17.6	300
2700.00	650.9	1.54	117	5.03	286	13.3	80.5	20.1	311
2800.00	678.8	1.54	117	5.39	310	11.1	78.7	21.8	323
2900.00	707.9	1.95	135	5.39	320	11.1	78.7	20.6	328
3000.00	725.9	0.977	135	6.37	319	9.00	76.0	23.6	326
3100.00	744.8	2.07	90.0	7.87	322	14.0	51.3	28.5	328
3200.00	772.3	3.52	78.7	8.98	337	15.7	56.3	30.4	339
3300.00	801.7	5.57	97.1	9.00	356	19.5	63.4	29.7	343
3400.00	826.0	5.90	111	9.69	356	20.7	71.6	33.9	345
3500.00	856.5	7.11	119	9.77	8.13	24.4	79.7	36.0	346
3600.00	880.4	8.32	138	6.18	26.6	28.5	85.6	40.8	344
3700.00	916.5	9.69	176	5.94	35.5	35.0	93.6	47.7	344
3800.00	943.5	8.79	225	3.45	90.0	42.0	99.0	62.1	342

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Reviewed / Witnessed By:
Andy Ang

SLCL Rep 14 Jan 2009

		CH 5		CH 6		CH 7		CH 8	
3900.00	974.9	9.08	261	3.52	191	51.9	112	84.3	350
4000.00	1004.7	18.2	307	10.9	235	80.5	147	164	0.764
4100.00	1025.9	27.1	19.4	33.9	356	85.8	263	210	59.4
4200.00	1049.9	36.8	55.7	30.3	153	114	48.1	218	76.1
4300.00	1077.6	42.4	127	51.5	302	168	159	278	144
4322.00	1098.0	37.2	138	46.3	327	133	179	232	156
4322.00	1163.6	42.6	140	57.6	326	167	174	268	157
4320.00	1223.9	45.2	141	62.6	326	191	174	293	159
4323.00	1286.2	42.2	140	61.0	329	184	175	286	160

3 MIN HOLDING

Technician	홍현택 2009 1/12
QC	장성인 1/12/2009
Customer	

Reviewed / Witnessed By:
Andy Ang
SLCL Rep 14 Jan 2009

Page No. 6

Measuring Values

Rotor: 7FH2_7C068

Run: **OVERSPEED TEST** from 2009-01-12 17:13

Comment:

Unfiltered

Measuring Values

		TE CPLG WEST VC4000 CH 1	TE CPLG EAST VC4000 CH 2	TE JNL WEST VC4000 CH 3	TE JNL EAST VC4000 CH 4
Speed [rpm]	Time [s]	Amount [µm]	Amount [µm]	Amount [µm]	Amount [µm]
100.000	33.6	15.0	19.1	5.30	5.90
200.000	57.6	14.4	17.0	5.90	6.40
300.000	76.2	14.5	14.9	5.40	5.80
400.000	95.3	14.5	14.8	5.20	6.80
500.000	116.2	13.9	14.9	5.20	8.90
600.000	138.2	15.6	15.6	3.60	9.80
700.000	157.0	15.6	19.5	5.20	9.60
800.000	176.7	15.7	14.6	4.20	9.70
900.000	199.3	20.4	14.9	5.60	14.9
1000.00	223.1	24.9	15.8	7.50	22.7
1100.00	250.4	24.0	14.8	7.30	26.0
1200.00	271.5	17.8	13.7	4.60	22.1
1300.00	295.3	13.5	12.3	5.90	21.6
1400.00	319.3	23.9	13.8	17.1	24.2
1500.00	343.6	25.7	17.1	11.6	20.6
1600.00	369.7	28.4	21.6	10.1	18.7
1700.00	398.4	28.4	23.5	9.00	16.8
1800.00	421.5	27.9	23.1	8.70	15.7
1900.00	446.0	29.4	22.5	8.60	16.8
2000.00	466.0	30.2	22.5	8.00	15.3
2100.00	492.3	30.9	28.2	8.30	15.9
2200.00	512.4	29.7	23.5	8.70	16.1
2300.00	537.2	37.6	28.8	9.30	19.4
2400.00	586.2	49.8	37.8	11.6	26.5
2500.00	613.1	58.7	67.6	17.2	32.1
2600.00	634.9	34.4	41.5	15.1	29.9
2700.00	650.9	29.9	34.5	14.2	27.9
2800.00	678.8	24.7	28.7	13.0	23.0
2900.00	707.9	25.3	25.9	12.8	21.9
3000.00	725.9	25.3	25.4	12.7	20.6
3100.00	744.8	22.0	26.4	12.9	19.9
3200.00	772.3	24.1	26.5	13.0	17.2
3300.00	801.7	25.2	23.6	11.7	17.1
3400.00	826.0	26.0	25.6	11.0	15.9
3500.00	856.5	29.4	24.9	10.4	14.8
3600.00	880.4	33.0	24.9	9.60	14.0
3700.00	916.5	35.0	27.8	9.30	12.0

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Andy Ang
SLCI Rep 14 Jan 2009

		CH 1	CH 2	CH 3	CH 4
3800.00	943.5	41.5	27.1	8.70	14.8
3900.00	974.9	52.1	27.1	8.70	16.4
4000.00	1004.7	78.1	25.8	11.3	19.8
4100.00	1025.9	93.4	28.3	11.5	15.6
4200.00	1049.9	104	78.5	11.1	10.8
4300.00	1077.6	133	109	11.6	23.3
4322.00	1098.0	129	102	11.9	24.7
4322.00	1163.6	142	125	11.5	26.7
4320.00	1223.9	149	132	12.0	28.2
4323.00	1286.2	157	139	12.4	29.1

Reviewed / Witnessed By:
Andy Ang
SLCL Rep 14 Jan 2009

Page No. 8

Measuring Values

Rotor: 7FH2_7C068

Run: **OVERSPEED TEST** from 2009-01-12 17:13

Comment:

Unfiltered

Measuring Values

		CE JNL WEST VC4000 CH 5	CE JNL EAST VC4000 CH 6	COLLECTOR WEST VC4000 CH 7	COLLECTOR EAST VC4000 CH 8
Speed [rpm]	Time [s]	Amount [µm]	Amount [µm]	Amount [µm]	Amount [µm]
100.000	33.6	3.90	4.90	10.5	5.20
200.000	57.6	4.70	5.80	8.90	3.40
300.000	76.2	4.60	5.10	5.60	5.70
400.000	95.3	4.60	6.50	5.50	5.60
500.000	116.2	5.00	9.20	6.30	6.40
600.000	138.2	4.10	8.70	6.90	8.90
700.000	157.0	4.30	8.30	13.8	13.5
800.000	176.7	3.70	7.70	8.60	8.90
900.000	199.3	4.40	12.7	8.10	12.1
1000.00	223.1	6.10	22.8	9.70	18.3
1100.00	250.4	6.40	27.4	10.3	18.0
1200.00	271.5	6.20	24.9	11.4	14.4
1300.00	295.3	5.80	25.9	20.1	14.1
1400.00	319.3	11.6	23.3	24.3	18.1
1500.00	343.6	8.30	15.4	10.5	19.1
1600.00	369.7	7.00	15.5	16.5	17.6
1700.00	398.4	6.90	14.9	16.8	13.8
1800.00	421.5	6.50	13.4	13.7	13.5
1900.00	446.0	6.30	12.5	13.7	11.9
2000.00	466.0	5.60	13.7	18.2	14.8
2100.00	492.3	6.00	10.8	10.6	37.5
2200.00	512.4	5.50	13.5	26.3	32.4
2300.00	537.2	6.00	15.8	26.7	37.5
2400.00	586.2	7.00	18.9	44.3	54.2
2500.00	613.1	8.50	23.8	103	79.4
2600.00	634.9	8.60	18.2	74.1	52.0
2700.00	650.9	7.70	13.6	53.5	46.2
2800.00	678.8	6.40	11.0	38.7	37.6
2900.00	707.9	5.20	10.5	31.6	35.2
3000.00	725.9	4.40	10.5	28.8	35.4
3100.00	744.8	4.40	11.5	26.6	37.9
3200.00	772.3	5.90	22.1	28.4	39.9
3300.00	801.7	6.90	26.7	30.9	40.7
3400.00	826.0	7.20	33.1	33.0	41.3
3500.00	856.5	7.90	30.5	37.5	45.4
3600.00	880.4	9.40	33.7	36.5	49.6
3700.00	916.5	10.9	35.7	43.0	58.5

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Andy Ang
SCI Rep 12 January 09 1/12/09

		CH 5	CH 6	CH 7	CH 8
3800.00	943.5	10.2	27.7	45.3	71.8
3900.00	974.9	11.8	19.4	58.6	94.5
4000.00	1004.7	20.0	32.1	81.4	164
4100.00	1025.9	31.3	54.1	100	231
4200.00	1049.9	34.6	44.7	118	212
4300.00	1077.6	45.8	64.4	181	297
4322.00	1098.0	45.7	64.8	166	272
4322.00	1163.6	47.8	71.7	197	290
4320.00	1223.9	48.6	74.5	204	295
4323.00	1286.2	49.4	76.6	207	303

Reviewed / Witnessed By:
Andy Ang
8LCI Rep 14.Jan09

Page No. 10

Measuring Values

Rotor: 7FH2_7C068

Run: **OVERSPEED TEST** from 2009-01-12 17:13

Comment:

2 per rev

Measuring Values

		TE CPLG WEST 2X CH 1		TE CPLG EAST 2X CH 2		TE JNL WEST 2X CH 3		TE JNL EAST 2X CH 4	
Speed [rpm]	Time [s]	Amount [µm pp]	Angle [°]	Amount [µm pp]	Angle [°]	Amount [µm pp]	Angle [°]	Amount [µm pp]	Angle [°]
100.000	33.6	5.03	344	4.20	9.46	0	0	2.76	270
200.000	57.6	3.52	349	4.42	38.7	2.07	180	1.54	26.6
300.000	76.2	3.52	11.3	3.45	53.1	1.38	180	0.977	315
400.000	95.3	1.54	333	3.45	36.9	2.07	180	2.85	14.0
500.000	116.2	4.42	309	3.91	45.0	2.49	214	5.26	66.8
600.000	138.2	6.25	354	4.42	51.3	1.38	270	5.86	135
700.000	157.0	2.85	76.0	9.62	111	2.85	194	5.52	180
800.000	176.7	3.09	333	0.691	180	1.54	297	3.52	191
900.000	199.3	3.52	349	0.691	0	0.691	270	2.18	198
1000.00	223.1	3.09	333	0.691	0	0.691	270	1.95	225
1100.00	250.4	3.91	315	1.38	0	0.691	270	2.49	236
1200.00	271.5	4.98	304	2.07	0	0.977	225	3.72	248
1300.00	295.3	7.34	319	2.85	14.0	0.691	270	4.88	225
1400.00	319.3	8.79	315	2.76	0	0.977	225	5.39	220
1500.00	343.6	10.9	325	4.20	351	0.977	225	7.11	209
1600.00	369.7	14.6	341	9.69	4.09	2.93	225	8.34	204
1700.00	398.4	12.4	0	9.81	39.3	2.07	270	7.72	190
1800.00	421.5	14.2	14.0	9.39	54.0	3.72	21.8	6.80	204
1900.00	446.0	12.4	3.18	9.59	59.7	0.977	315	3.52	259
2000.00	466.0	15.6	12.8	8.08	70.0	0.691	270	3.45	217
2100.00	492.3	10.8	39.8	14.4	73.3	0	0	1.38	270
2200.00	512.4	13.3	351	9.39	54.0	0.691	180	6.25	264
2300.00	537.2	19.3	2.05	13.6	59.5	2.07	180	8.98	270
2400.00	586.2	30.0	23.0	23.5	61.9	3.72	202	10.7	255
2500.00	613.1	39.6	73.8	52.6	107	9.81	219	13.9	207
2600.00	634.9	17.4	96.8	29.3	165	10.4	278	15.2	177
2700.00	650.9	11.9	100	19.3	178	7.72	297	12.1	193
2800.00	678.8	9.21	103	15.9	185	6.84	315	11.2	202
2900.00	707.9	8.29	90.0	10.4	188	5.94	324	9.59	210
3000.00	725.9	8.32	85.2	6.94	186	4.63	333	7.87	218
3100.00	744.8	5.94	126	10.7	195	3.72	338	7.47	214
3200.00	772.3	6.91	127	12.6	189	3.72	338	5.94	216
3300.00	801.7	4.20	99.5	8.54	194	3.52	349	6.37	221
3400.00	826.0	2.49	33.7	7.11	241	3.52	349	6.84	225
3500.00	856.5	6.25	83.7	4.63	207	2.85	14.0	5.94	234
3600.00	880.4	7.72	79.7	2.07	180	2.18	18.4	5.94	234
3700.00	916.5	6.55	108	6.25	186	2.49	33.7	5.94	234
3800.00	943.5	5.57	82.9	2.49	214	1.54	63.4	5.26	247

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Reviewed / Witnessed By:
Andy Ang

SCCI Rep 14 Jan 2009

		CH 1		CH 2		CH 3		CH 4	
3900.00	974.9	9.39	107	5.86	135	0.691	90.0	5.26	247
4000.00	1004.7	3.45	127	6.37	167	1.54	63.4	5.03	254
4100.00	1025.9	2.18	342	5.26	157	0.691	180	2.18	288
4200.00	1049.9	6.21	0	7.81	135	1.54	243	2.49	236
4300.00	1077.6	12.4	19.4	13.3	152	2.93	315	4.83	180
4322.00	1098.0	13.8	17.5	13.8	162	2.93	315	4.88	188
4322.00	1163.6	13.6	24.0	12.9	164	2.49	326	4.88	188
4320.00	1223.9	13.6	30.5	12.9	164	2.18	342	4.37	198
4323.00	1286.2	13.3	27.9	13.8	162	1.54	333	4.37	198

Reviewed / ~~Witnessed~~ By:
Andy Ang
SLCI Rep 14 Jan 2009

Page No. 12

Measuring Values

Rotor: 7FH2_7C068

Run: OVERSPEED TEST from 2009-01-12 17:13

Comment:

2 per rev

Measuring Values

		CE JNL WEST 2X CH 5		CE JNL EAST 2X CH 6		COLLECTOR WEST 2X CH 7		COLLECTOR EAST 2X CH 8	
Speed [rpm]	Time [s]	Amount [µm pp]	Angle [°]	Amount [µm pp]	Angle [°]	Amount [µm pp]	Angle [°]	Amount [µm pp]	Angle [°]
100.000	33.6	2.07	180	2.85	284	4.03	239	1.54	243
200.000	57.6	3.52	191	3.52	11.3	3.52	259	0.691	180
300.000	76.2	2.85	194	2.07	0	2.76	270	1.54	243
400.000	95.3	3.52	191	3.09	26.6	2.85	256	0.977	225
500.000	116.2	4.03	211	5.90	69.4	3.52	259	2.18	198
600.000	138.2	2.93	225	5.57	120	3.45	270	3.45	233
700.000	157.0	3.45	233	4.88	188	8.79	315	7.72	297
800.000	176.7	2.18	252	2.18	198	1.38	90.0	0.977	225
900.000	199.3	1.54	243	2.18	198	0.977	135	2.18	252
1000.00	223.1	0.977	225	2.93	225	0.977	135	2.07	270
1100.00	250.4	0.977	225	3.45	233	0.977	135	2.85	284
1200.00	271.5	0.691	180	4.20	261	1.38	180	0.977	315
1300.00	295.3	0.691	180	4.88	278	4.88	172	4.63	243
1400.00	319.3	2.18	198	4.37	288	3.45	270	7.72	280
1500.00	343.6	0.977	225	5.57	300	3.09	297	8.32	312
1600.00	369.7	0.691	90.0	6.91	323	9.67	0	8.98	337
1700.00	398.4	2.49	146	5.57	353	9.26	63.4	5.57	353
1800.00	421.5	2.85	166	5.26	337	6.94	84.3	5.69	346
1900.00	446.0	3.52	191	4.03	329	6.21	90.0	4.03	329
2000.00	466.0	3.52	191	2.85	194	12.9	74.5	9.69	274
2100.00	492.3	3.72	248	2.49	214	3.45	90.0	30.5	322
2200.00	512.4	0.977	315	7.11	241	18.3	101	24.9	1.59
2300.00	537.2	1.95	45.0	9.67	270	20.1	106	31.6	10.1
2400.00	586.2	4.14	90.0	12.4	304	33.7	101	48.3	31.0
2500.00	613.1	7.11	119	17.7	339	87.5	129	66.2	82.2
2600.00	634.9	7.72	170	10.4	7.59	58.5	197	31.9	120
2700.00	650.9	6.25	186	4.63	333	38.1	215	23.5	133
2800.00	678.8	5.03	196	3.72	292	28.3	227	19.1	139
2900.00	707.9	4.03	211	4.20	279	22.8	235	16.5	147
3000.00	725.9	4.03	211	3.45	270	19.3	255	15.8	157
3100.00	744.8	2.49	214	3.45	270	19.8	241	13.8	162
3200.00	772.3	2.49	214	2.76	270	16.6	253	12.1	167
3300.00	801.7	2.18	198	3.52	281	15.3	252	9.00	176
3400.00	826.0	1.54	207	3.52	281	14.5	267	13.1	177
3500.00	856.5	1.54	207	4.20	279	17.3	272	12.9	196
3600.00	880.4	1.54	153	4.03	301	10.4	266	12.2	196
3700.00	916.5	0.977	135	4.98	304	15.2	273	12.3	218

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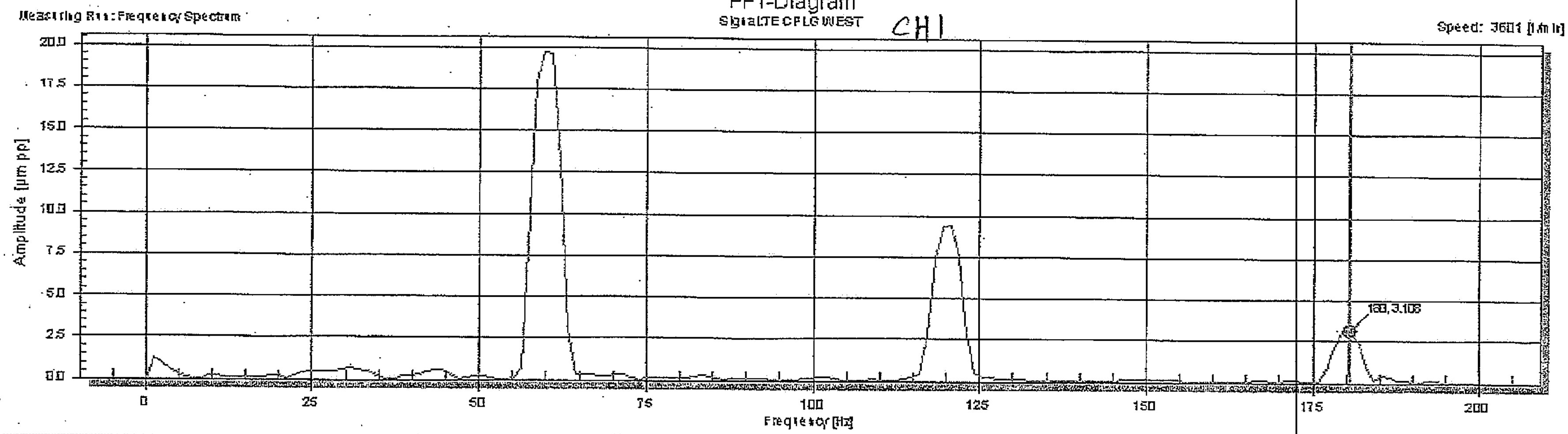
Reviewed / Witnessed By:
Andy Ang
SLCZ Rep 14 Jan 2009 1/12/09

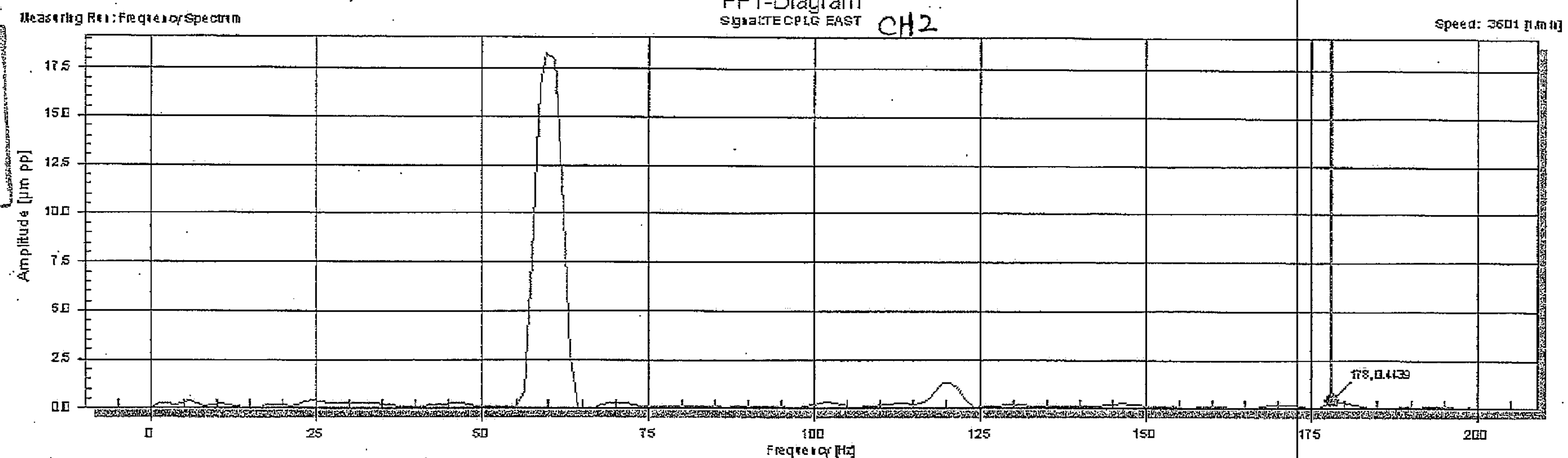
		CH 5		CH 6		CH 7		CH 8	
3800.00	943.5	1.54	117	4.88	315	10.4	262	11.8	267
3900.00	974.9	3.52	101	5.86	315	13.0	295	9.21	283
4000.00	1004.7	6.18	117	7.34	319	20.5	303	3.45	233
4100.00	1025.9	6.37	139	7.87	345	13.6	345	13.6	210
4200.00	1049.9	7.87	142	9.39	343	16.6	315	14.9	236
4300.00	1077.6	9.39	144	11.7	0	18.3	10.9	29.8	275
4322.00	1098.0	10.2	152	11.7	0	14.9	21.8	29.1	284
4322.00	1163.6	10.2	152	11.1	356	14.9	21.8	29.5	286
4320.00	1223.9	10.2	152	11.8	357	15.5	20.9	30.2	286
4323.00	1286.2	10.2	152	11.8	357	15.3	18.4	29.3	285

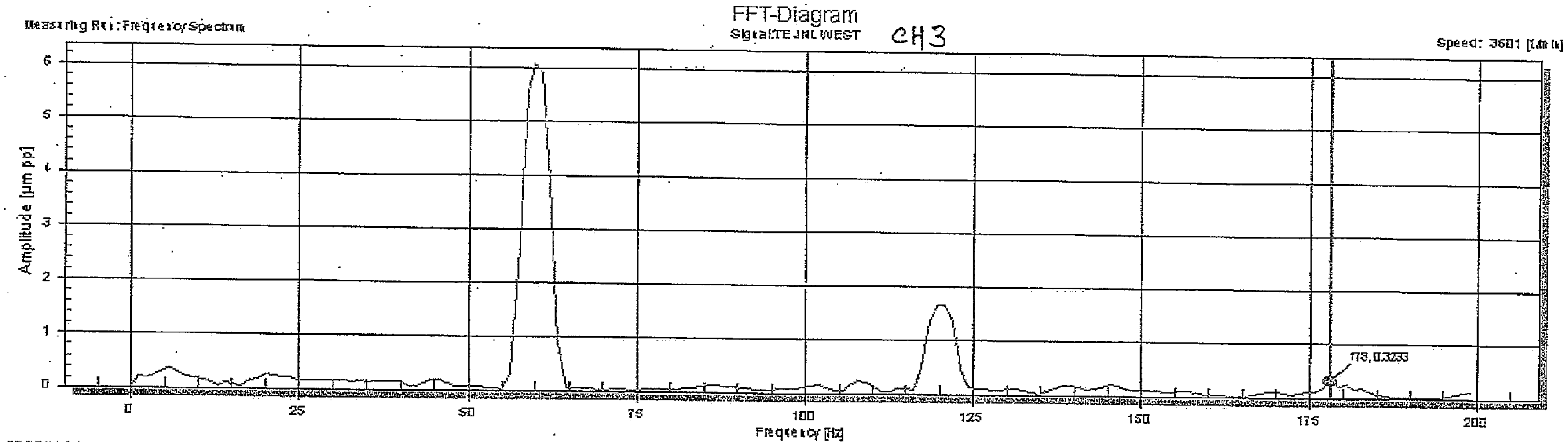
Reviewed / ~~Witnessed~~ By:
Andy Ang
SLCI Rep 14 Jan 2009

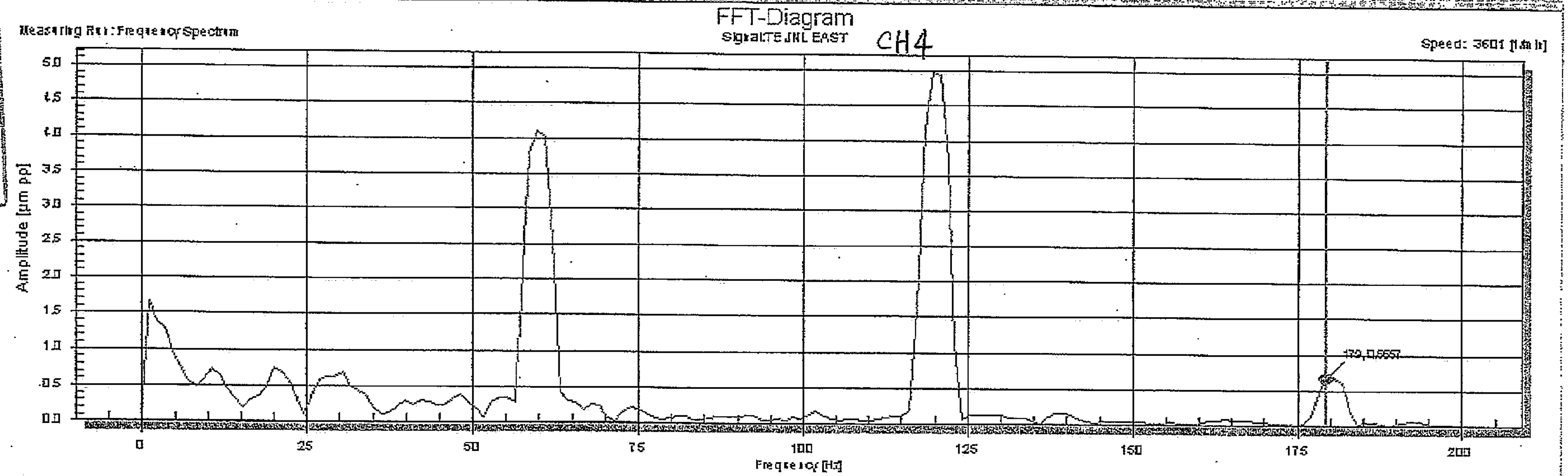
FFT-Diagram
Signal:TE CPLG WEST CH1

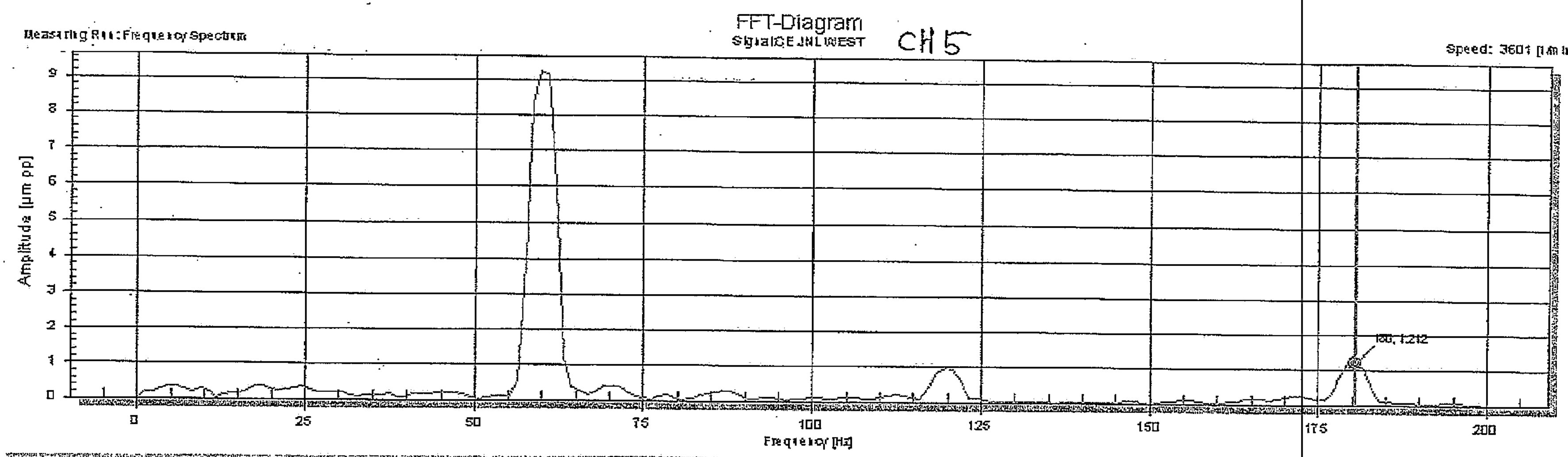


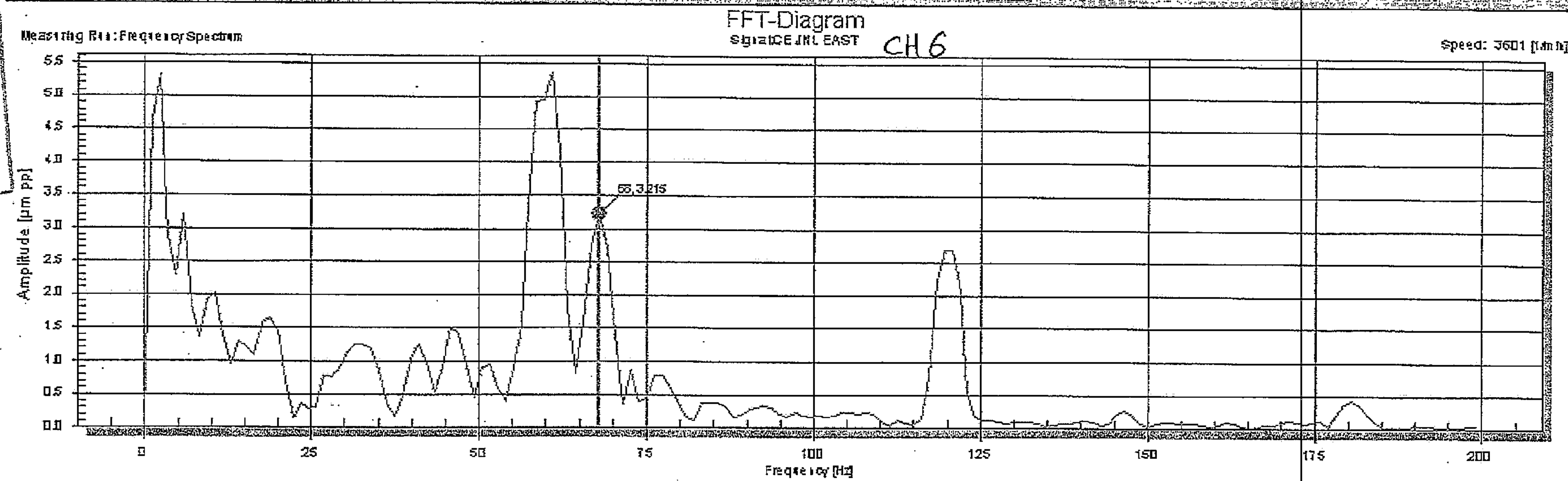
FFT-Diagram
Signal:TE CPLG EAST CH2




FFT-Diagram
Signal:TE JNL WEST
CH3
Measuring Run: Frequency Spectrum
Speed: 3601 [1/min]
Amplitude [µm pp]
Frequency [Hz]
178, 0.3233


FFT-Diagram
Signal:TE JNL EAST
CH4
Measuring Run: Frequency Spectrum
Speed: 3601 [1/min]
Amplitude [µm pp]
Frequency [Hz]


FFT-Diagram
Signal:CE JNL WEST
CH 5
Measuring Run: Frequency Spectrum
Speed: 3601 [1/min]
Amplitude [µm pp]
Frequency [Hz]
180, 1.212


FFT-Diagram
Signal:CE JNL EAST
CH 6
Measuring Run: Frequency Spectrum
Speed: 3601 [1/min]
Amplitude [µm pp]
Frequency [Hz]
68, 3.215

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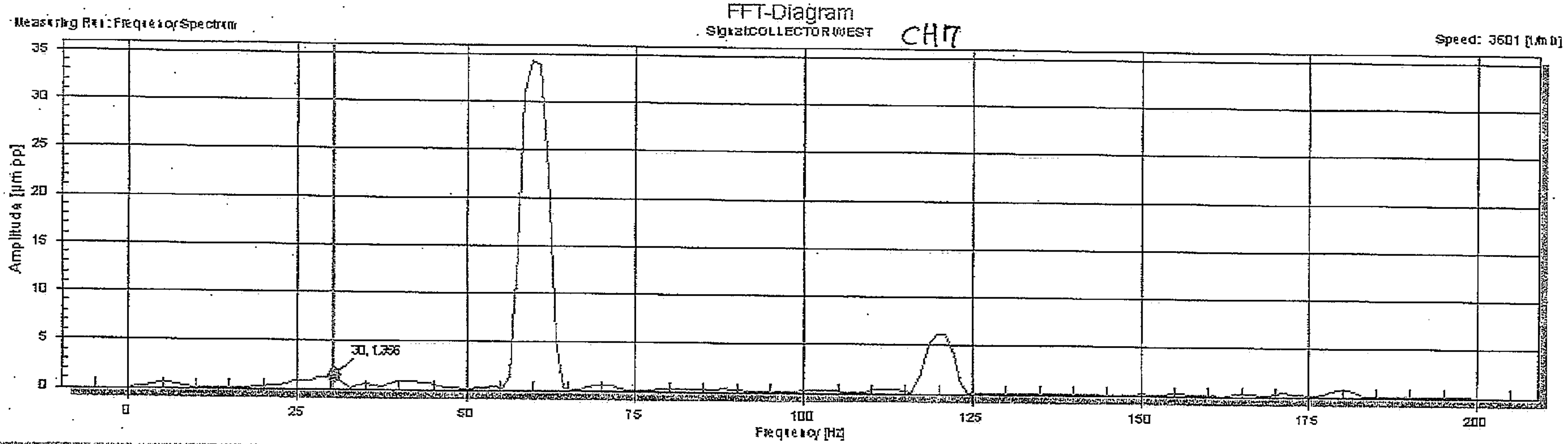
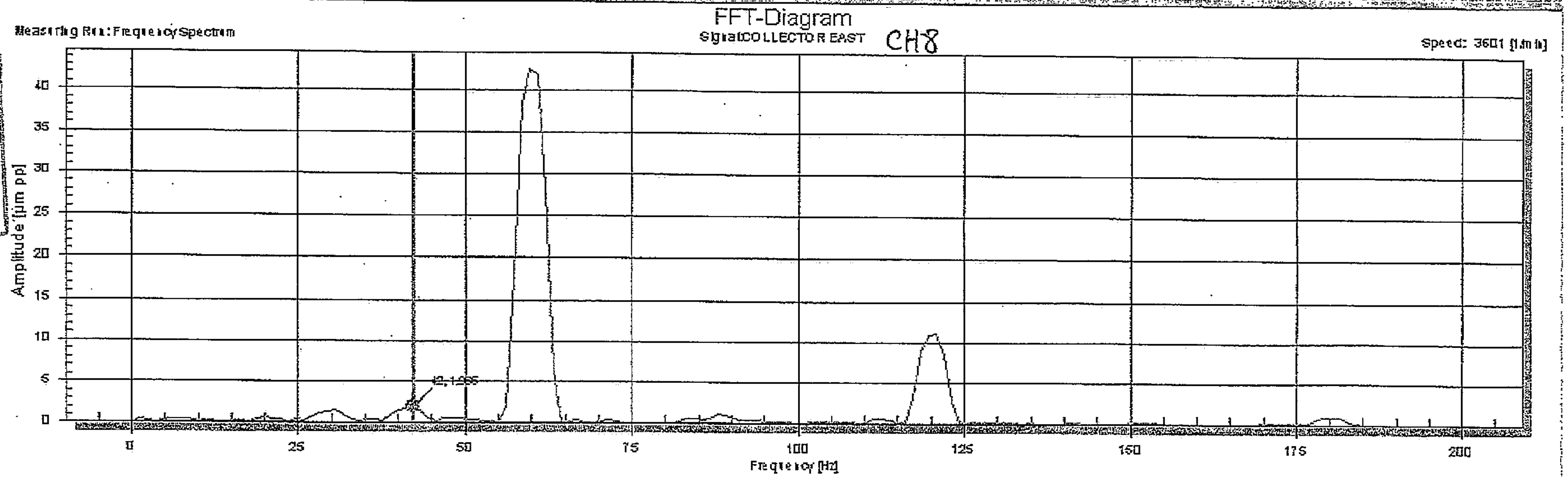

Measuring Run: Frequency Spectrum
FFT-Diagram
Signal:COLLECTOR WEST
CH7
Speed: 3601 [1/min]
Amplitude [µm pp]
Frequency [Hz]
30, 1.356


Measuring Run: Frequency Spectrum
FFT-Diagram
Signal:COLLECTOR EAST
CH8
Speed: 3601 [1/min]
Amplitude [µm pp]
Frequency [Hz]

Page No. 18

Measuring Values

Rotor: 7FH2_7C068

Run: 1 per rev , Speed UP from 2009-01-13 17:12

Measuring Values

Runout corrected

		TE CPLG WEST CH 1		TE CPLG EAST CH 2		TE JNL WEST CH 3		TE JNL EAST CH 4	
Speed [rpm]	Time [s]	Amount [µm pp]	Angle [°]	Amount [µm pp]	Angle [°]	Amount [µm pp]	Angle [°]	Amount [µm pp]	Angle [°]
500.000	67.4	2.79	51.3	0.436	90.0	0.437	162	0.276	270
600.000	92.3	2.23	101	0.436	90.0	0.437	162	0.967	270
700.000	108.3	2.23	101	0.436	90.0	0.437	162	1.80	293
800.000	126.9	2.23	101	0.436	90.0	0.437	162	2.16	310
901.000	145.4	3.41	140	0.436	90.0	0.926	117	3.63	320
1000.00	167.6	2.62	180	0.436	90.0	1.38	143	5.53	357
1100.00	189.4	2.23	259	0.436	90.0	1.80	176	5.67	43.0
1200.00	206.8	0.436	180	0.436	90.0	0.437	162	3.24	50.2
1301.00	231.4	2.79	51.3	2.23	11.3	0.926	117	2.84	60.9
1400.00	251.7	5.09	121	3.41	130	3.28	165	1.80	90.0
1500.00	267.7	3.41	140	2.23	169	1.88	197	0.414	90.0
1600.00	286.4	3.41	140	2.23	169	1.88	197	0.744	338
1700.00	317.6	3.41	140	2.23	169	1.11	173	2.09	352
1800.00	335.4	5.27	156	2.23	169	1.11	173	2.93	341
1900.00	353.6	7.32	163	2.79	219	1.11	173	3.59	344
2000.00	370.1	5.27	156	2.23	169	0.437	162	3.46	355
2100.00	385.0	5.27	156	4.39	174	0.926	117	3.59	344
2200.00	400.1	7.32	163	6.77	195	1.57	105	5.11	341
2300.00	417.7	11.6	169	6.77	195	2.47	117	7.77	348
2400.00	431.1	13.7	171	7.63	211	4.37	125	11.7	2.02
2500.00	453.8	15.9	188	7.63	211	5.28	137	14.2	13.0
2600.00	473.2	14.2	198	7.63	211	5.80	142	14.1	28.1
2700.00	488.8	13.1	210	4.49	241	5.06	154	12.6	39.6
2800.00	506.6	8.23	212	4.70	202	4.15	159	10.5	43.9
2900.00	522.6	7.32	197	6.77	195	3.87	145	10.6	49.2
3000.00	539.0	10.2	205	9.57	204	4.30	138	11.3	56.5
3100.00	555.9	8.23	212	8.95	223	6.25	137	11.2	64.4
3201.00	571.6	7.05	248	10.6	232	8.15	154	10.3	78.4
3300.00	590.6	5.09	239	4.49	241	8.83	170	9.42	85.8
3400.00	607.5	3.41	220	4.49	241	8.01	179	8.73	94.5
3500.00	626.2	4.80	180	2.79	219	8.03	184	7.45	101
3600.00	643.4	9.16	180	2.79	219	10.1	179	6.55	115
3700.00	660.9	8.23	212	2.79	219	7.42	190	3.46	113
3780.00	679.1	9.57	223	2.23	169	6.91	196	4.39	61.8

Reviewed / Witnessed By:
Andy Ang
SLCL Rep 14 Jan 2009

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Measuring Values

Rotor: 7FH2_7C068

Run: 1 per rev , Speed UP from 2009-01-13 17:12

Measuring Values

Runout corrected

		CE JNL WEST CH 5		CE JNL EAST CH 6		COLLECTOR WEST CH 7		COLLECTOR EAST CH 8	
Speed [rpm]	Time [s]	Amount [µm pp]	Angle [°]	Amount [µm pp]	Angle [°]	Amount [µm pp]	Angle [°]	Amount [µm pp]	Angle [°]
500.000	67.4	0.437	288	0	0	0	0	2.18	0
600.000	92.3	0.437	288	0	0	0	0	2.18	0
700.000	108.3	0.437	288	0.691	0	0	0	3.09	315
800.000	126.9	0.691	217	1.38	0	0	0	2.18	0
901.000	145.4	0.618	153	3.52	349	0	0	2.18	0
1000.00	167.6	1.27	167	5.57	7.13	0	0	2.18	0
1100.00	189.4	1.95	172	7.47	56.3	2.18	180	3.09	45.0
1200.00	206.8	2.23	210	6.37	77.5	3.09	225	0	0
1301.00	231.4	1.98	192	6.25	83.7	3.09	225	2.18	270
1400.00	251.7	3.49	198	5.69	104	4.88	297	4.88	297
1500.00	267.7	3.18	214	5.03	106	2.18	0	3.09	315
1600.00	286.4	2.64	223	5.03	106	4.36	0	3.09	315
1700.00	317.6	3.15	232	6.55	108	6.55	0	2.18	270
1800.00	335.4	3.72	239	7.11	119	4.36	0	2.18	270
1900.00	353.6	3.72	239	7.87	128	6.55	0	3.09	225
2000.00	370.1	4.32	243	8.84	129	7.87	33.7	2.18	270
2100.00	385.0	5.26	240	10.9	125	6.17	45.0	0	0
2200.00	400.1	6.49	246	12.7	135	6.17	45.0	3.09	225
2300.00	417.7	6.91	254	15.2	150	7.87	56.3	4.88	243
2400.00	431.1	8.03	266	17.1	166	4.36	90.0	6.90	342
2500.00	453.8	7.37	276	18.0	180	11.1	349	14.6	117
2600.00	473.2	7.48	282	16.8	189	10.9	53.1	15.4	188
2700.00	488.8	6.80	283	15.7	195	7.87	56.3	16.6	203
2800.00	506.6	6.80	283	16.2	200	9.26	45.0	17.0	220
2900.00	522.6	6.68	277	15.5	201	9.26	45.0	17.0	230
3000.00	539.0	7.37	276	14.2	209	6.90	71.6	16.6	247
3100.00	555.9	8.31	285	12.3	218	4.88	63.4	19.6	270
3201.00	571.6	8.15	296	8.84	231	6.55	0	19.5	297
3300.00	590.6	6.36	304	4.98	236	9.76	26.6	17.0	320
3400.00	607.5	4.83	307	3.45	233	10.9	36.9	14.6	333
3500.00	626.2	3.87	305	1.95	225	9.76	26.6	13.3	351
3600.00	643.4	3.52	296	0.691	270	9.76	26.6	10.9	0
3700.00	660.9	3.33	312	1.38	270	8.73	0	9.76	26.6
3780.00	679.1	2.25	349	3.52	349	11.8	338	12.7	59.0

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Andy Ang
SLCI Rep 14 Jan 2009

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Measuring Values

Rotor: 7FH2_7C068

Run: **Final Balancing (1 per rev) Speed Down** from 2009-01-14 13:29

Measuring Values

Runout corrected

		TE CPLG WEST CH 1		TE CPLG EAST CH 2		TE JNL WEST CH 3		TE JNL EAST CH 4	
Speed [rpm]	Time [s]	Amount [µm pp]	Angle [°]	Amount [µm pp]	Angle [°]	Amount [µm pp]	Angle [°]	Amount [µm pp]	Angle [°]
3780.00	299.0	14.4	245	9.57	294	6.12	186	2.10	23.2
3700.00	320.5	12.0	226	8.74	267	6.77	180	3.27	152
3600.00	336.8	8.95	227	10.9	268	4.24	161	7.91	117
3500.00	385.1	10.6	218	11.2	257	8.18	185	10.7	102
3400.00	405.7	13.6	220	13.4	259	9.55	184	12.7	96.9
3300.00	420.8	13.6	220	17.7	261	10.9	176	13.9	90.6
3200.00	436.0	18.2	226	20.2	256	11.4	162	16.8	83.4
3100.00	452.0	21.5	218	24.6	243	10.7	140	19.1	71.4
3000.00	467.0	23.1	202	23.5	220	6.28	130	18.3	61.1
2900.00	514.0	19.7	193	18.0	209	4.31	140	16.9	55.7
2800.00	570.5	17.2	187	16.3	196	4.87	145	16.1	47.4
2700.00	604.0	19.3	186	13.7	189	5.77	159	17.6	45.6
2600.00	628.0	19.2	180	13.7	189	6.05	153	18.2	37.9
2500.00	656.5	19.3	174	13.5	180	6.05	153	16.7	30.4
2400.00	678.5	18.2	159	11.3	180	4.87	145	15.4	21.5
2300.00	710.5	17.2	150	11.3	180	4.31	140	12.6	13.3
2200.00	731.6	16.7	139	11.6	169	3.34	142	9.65	9.06
2100.00	748.4	12.0	134	9.42	167	2.97	152	7.61	11.5
2000.00	772.7	10.7	125	10.2	155	2.71	165	6.26	14.0
1900.00	789.5	7.63	121	8.23	148	2.62	180	4.28	20.8
1800.00	811.5	7.63	121	8.23	148	2.62	180	4.40	41.2
1700.00	838.8	5.87	132	8.23	148	3.39	192	4.89	47.3
1600.00	859.2	5.87	132	8.23	148	4.06	190	5.33	68.7
1500.00	879.4	5.87	132	9.57	137	6.08	180	7.17	62.4
1400.00	899.0	13.7	107	13.4	101	10.2	137	10.3	48.8
1300.00	919.6	5.09	59.0	2.79	51.3	2.08	86.2	8.82	39.9
1200.00	938.0	2.79	129	3.41	140	2.05	160	11.1	30.7
1100.00	955.2	7.51	144	3.41	140	3.81	134	15.1	358
1000.00	969.4	11.6	110	3.41	140	3.46	87.7	11.1	307
900.000	984.0	8.74	87.1	3.41	140	1.61	59.0	6.20	282
800.000	1002.8	6.56	86.2	3.41	140	1.08	39.8	4.01	268
700.000	1023.9	5.09	59.0	3.41	140	0.138	0	2.63	267
600.000	1039.2	4.39	84.3	3.41	140	0.138	0	1.25	264
500.000	1054.6	4.39	84.3	2.62	180	0.138	0	0.569	256
400.000	1069.8	4.39	84.3	3.41	140	0.138	0	0.569	256
300.000	1086.5	4.39	84.3	3.41	140	0.138	0	0.569	256
200.000	1100.8	2.23	78.7	2.62	180	0.704	78.7	0.195	135
125.000	1123.8	4.49	151	2.23	259	0.138	0	0.195	135

Reviewed / Witnessed By:
Andy Ang
SICI Rep. 14 Jan 2009

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Measuring Values

Rotor: 7FH2_7C068

Run: Final Balancing (∠ per rev) Speed Down from 2009-01-14 13:29

Measuring Values

Runout corrected

		CE JNL WEST CH 5		CE JNL EAST CH 6		COLLECTOR WEST CH 7		COLLECTOR EAST CH 8	
Speed [rpm]	Time [s]	Amount [µm pp]	Angle [°]	Amount [µm pp]	Angle [°]	Amount [µm pp]	Angle [°]	Amount [µm pp]	Angle [°]
3780.00	299.0	3.32	343	2.18	342	12.0	316	9.81	111
3700.00	320.5	3.42	317	0.977	315	9.57	336	1.95	297
3600.00	336.8	3.93	309	1.54	297	11.0	351	8.05	311
3500.00	385.1	4.40	316	3.45	270	11.0	351	8.05	311
3400.00	405.7	5.37	316	4.14	270	13.2	352	11.1	312
3300.00	420.8	6.44	325	6.37	283	14.4	335	14.7	300
3200.00	436.0	8.80	312	11.1	266	15.4	305	15.7	289
3100.00	452.0	9.78	289	12.4	243	15.5	254	14.9	265
3000.00	467.0	8.57	273	12.3	218	14.4	205	11.0	252
2900.00	514.0	6.50	268	11.1	210	11.9	156	7.04	240
2800.00	570.5	5.82	274	12.4	207	9.57	133	8.34	227
2700.00	604.0	5.13	275	12.4	207	13.1	120	9.95	218
2600.00	628.0	5.82	274	13.8	198	17.9	90.0	9.21	149
2500.00	656.5	6.50	268	13.8	183	5.27	65.6	15.4	61.3
2400.00	678.5	5.81	267	13.3	171	9.42	103	11.8	2.12
2300.00	710.5	5.20	259	12.7	158	11.3	90.0	7.62	347
2200.00	731.6	4.72	249	10.9	145	11.3	90.0	7.43	3.37
2100.00	748.4	4.08	246	9.77	135	9.42	103	9.76	350
2000.00	772.7	4.41	238	8.84	129	10.2	64.5	5.52	342
1900.00	789.5	3.84	232	7.72	117	10.2	64.5	7.62	347
1800.00	811.5	2.87	235	6.80	114	9.57	46.8	7.62	347
1700.00	838.8	2.87	235	5.69	104	9.96	28.8	8.39	332
1600.00	859.2	3.84	218	5.57	97.1	9.96	28.8	10.4	338
1500.00	879.4	3.84	218	5.03	106	9.11	16.7	11.4	328
1400.00	899.0	3.85	195	11.2	112	11.3	293	12.7	264
1300.00	919.6	1.92	210	11.2	68.2	2.23	169	2.18	233
1200.00	938.0	3.19	198	10.8	50.2	3.41	130	3.09	8.13
1100.00	955.2	2.44	133	11.9	10.0	3.41	130	5.52	342
1000.00	969.4	0.586	45.0	7.11	331	2.62	90.0	8.39	332
900.000	984.0	0.498	326	3.45	307	2.62	90.0	6.55	323
800.000	1002.8	1.05	293	1.54	297	2.62	90.0	4.98	308
700.000	1023.9	1.05	293	0.691	270	3.41	50.2	6.83	297
600.000	1039.2	1.05	293	0	0	2.62	90.0	4.98	308
500.000	1054.6	1.71	284	0.691	180	2.62	90.0	4.98	308
400.000	1069.8	1.71	284	0	0	2.62	90.0	4.98	308
300.000	1086.5	1.71	284	0.691	180	2.23	11.3	4.02	283
200.000	1100.8	0.391	225	0.977	45.0	2.62	90.0	3.52	330
125.000	1123.8	0.391	225	0	0	2.62	90.0	0.976	26.6

Technician	홍현택 2009 1/14
QC	장성천 1/14/2009
Customer	GE Energy Y.B.park 1/14/2009

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Reviewed / Witnessed By:
Andy Ang
SLCI Rep. 14 Jan 2009

1/14/09

Measuring Values

Rotor: 7FH2_7C068

Run: Final Balancing (2 per rev) Speed Down from 2009-01-14 13:29

Measuring Values

Runout corrected

		TE CPLG WEST 2X CH 1		TE CPLG EAST 2X CH 2		TE JNL WEST 2X CH 3		TE JNL EAST 2X CH 4	
Speed [rpm]	Time [s]	Amount [µm pp]	Angle [°]	Amount [µm pp]	Angle [°]	Amount [µm pp]	Angle [°]	Amount [µm pp]	Angle [°]
3780.00	299.0	4.84	182	6.76	229	2.07	323	3.03	210
3700.00	320.5	6.24	175	7.29	217	1.75	342	3.03	210
3600.00	336.8	5.21	158	5.00	242	1.75	342	3.03	210
3500.00	385.1	7.39	159	8.26	232	2.35	3.37	3.16	247
3400.00	405.7	7.64	186	12.8	250	3.04	2.60	4.70	246
3300.00	420.8	11.5	163	12.7	218	3.04	2.60	4.70	246
3200.00	436.0	17.9	158	17.4	202	3.73	2.12	5.62	242
3100.00	452.0	15.7	152	15.9	213	4.42	1.79	6.87	248
3000.00	467.0	16.1	130	13.2	217	5.14	354	9.33	245
2900.00	514.0	18.5	122	17.4	207	6.61	349	11.4	233
2800.00	570.5	16.9	117	19.8	197	7.63	328	12.4	215
2700.00	604.0	20.0	95.9	23.1	182	9.38	314	16.1	201
2600.00	628.0	20.2	72.1	28.0	166	10.9	290	19.2	180
2500.00	656.5	28.3	67.1	47.8	115	9.12	235	17.6	201
2400.00	678.5	23.8	16.5	21.2	63.8	3.18	236	9.77	226
2300.00	710.5	14.6	354	10.9	52.7	1.66	228	6.38	265
2200.00	731.6	9.03	337	5.98	49.7	0.691	233	3.59	272
2100.00	748.4	6.82	35.9	8.28	62.2	1.11	330	1.53	275
2000.00	772.7	9.68	3.27	3.65	60.5	1.57	308	3.03	210
1900.00	789.5	8.42	350	5.00	50.6	2.07	323	2.54	241
1800.00	811.5	4.23	349	5.00	39.4	2.18	215	7.36	203
1700.00	838.8	9.43	342	7.08	20.6	2.80	290	8.15	181
1600.00	859.2	11.8	315	10.1	330	2.23	240	8.00	201
1500.00	879.4	8.87	288	6.31	293	0.618	297	6.12	208
1400.00	899.0	7.76	275	4.44	275	1.57	308	4.94	216
1300.00	919.6	7.18	259	3.89	287	1.27	283	3.49	236
1200.00	938.0	6.30	244	4.56	284	1.27	283	1.96	231
1100.00	955.2	4.53	232	4.43	266	0.618	297	1.25	186
1000.00	969.4	3.54	219	4.43	266	1.11	330	1.25	186
900.000	984.0	3.03	227	4.52	258	1.11	330	2.63	183
800.000	1002.8	3.56	234	5.00	242	2.07	323	4.01	182
700.000	1023.9	3.96	151	5.13	117	1.24	207	4.19	163
600.000	1039.2	3.21	295	1.47	319	2.16	297	6.17	130
500.000	1054.6	5.09	237	1.99	304	1.31	252	4.28	69.2
400.000	1069.8	3.54	219	2.59	295	0.437	162	0.996	33.7
300.000	1086.5	2.57	216	2.38	280	0.309	26.6	0.195	315
200.000	1100.8	2.61	238	2.04	332	1.24	207	0.996	33.7
125.000	1123.8	2.97	118	2.59	155	0.691	233	0.781	135

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Measuring Values

Rotor: 7FH2_7C068

Run: **Final Balancing (2 per rev) Speed Down** from 2009-01-14 13:29

Measuring Values

Runout corrected

		CE JNL WEST 2X CH 5		CE JNL EAST 2X CH 6		COLLECTOR WEST 2X CH 7		COLLECTOR EAST 2X CH 8	
Speed [rpm]	Time [s]	Amount [µm pp]	Angle [°]	Amount [µm pp]	Angle [°]	Amount [µm pp]	Angle [°]	Amount [µm pp]	Angle [°]
3780.00	299.0	2.23	82.9	1.62	290	2.59	25.2	12.8	270
3700.00	320.5	1.80	57.5	1.62	290	10.6	291	8.30	183
3600.00	336.8	0.873	71.6	0.840	261	7.25	278	9.68	182
3500.00	385.1	0.977	8.13	3.02	254	15.5	274	11.8	185
3400.00	405.7	0.873	71.6	3.02	254	12.8	262	13.0	163
3300.00	420.8	0.309	26.6	3.90	247	14.2	251	9.95	166
3200.00	436.0	0.691	233	4.82	243	17.1	245	13.7	155
3100.00	452.0	1.24	207	6.08	249	18.7	232	16.2	148
3000.00	467.0	1.88	197	7.38	253	21.7	244	22.7	139
2900.00	514.0	2.55	193	8.56	260	24.5	228	24.9	126
2800.00	570.5	3.18	178	6.35	269	29.5	218	26.2	115
2700.00	604.0	4.63	170	6.56	300	39.1	207	30.2	96.6
2600.00	628.0	5.28	137	8.86	3.58	54.5	191	29.7	80.6
2500.00	656.5	6.43	81.3	11.8	324	84.6	135	50.5	71.7
2400.00	678.5	3.34	60.3	8.52	278	34.7	105	44.6	26.1
2300.00	710.5	2.49	19.4	7.62	248	25.6	107	33.9	2.80
2200.00	731.6	1.75	342	7.10	217	24.3	101	27.9	352
2100.00	748.4	1.95	278	5.17	214	13.2	104	27.7	318
2000.00	772.7	1.11	173	5.72	188	19.3	72.5	10.1	274
1900.00	789.5	2.49	177	2.46	322	13.0	82.6	6.74	325
1800.00	811.5	2.35	140	2.46	322	13.7	80.2	7.60	335
1700.00	838.8	2.25	101	4.01	358	15.4	56.3	8.23	337
1600.00	859.2	1.27	40.6	5.38	318	12.0	1.97	11.6	321
1500.00	879.4	0.309	26.6	4.32	277	1.68	351	10.5	285
1400.00	899.0	0.309	26.6	3.69	257	0.498	56.3	7.82	249
1300.00	919.6	0.309	26.6	4.62	231	2.54	135	4.25	167
1200.00	938.0	0.309	26.6	4.22	212	2.54	135	2.45	73.6
1100.00	955.2	0.618	297	3.69	193	3.07	126	2.29	25.0
1000.00	969.4	0.618	297	3.59	182	3.07	126	2.29	25.0
900.000	984.0	0.309	26.6	2.90	183	4.26	115	1.41	11.3
800.000	1002.8	0.618	297	2.90	183	5.95	94.0	1.80	67.4
700.000	1023.9	1.95	278	6.38	175	7.23	315	7.45	281
600.000	1039.2	1.66	228	5.91	127	0.498	214	2.27	232
500.000	1054.6	1.88	197	4.04	82.1	1.84	167	1.19	126
400.000	1069.8	1.80	176	1.36	66.0	2.11	148	0.967	90.0
300.000	1086.5	1.80	176	0.195	225	2.11	148	0.967	90.0
200.000	1100.8	1.11	173	0.781	45.0	1.18	159	1.19	54.5
125.000	1123.8	0.977	8.13	1.49	124	1.05	23.2	1.41	11.3

Page No. 24

DATE : 2009-01-13 TESTER : 홍현택

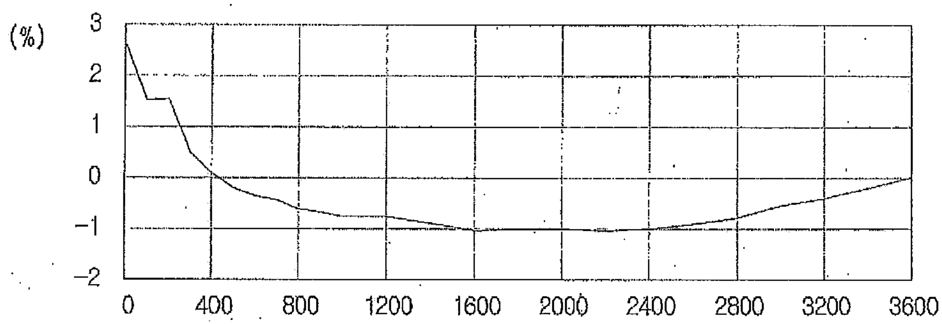
DOOSAN DooSan Heavy Industries & Construction Co.,Ltd	IMPEDANCE TEST (Before Final Balancing)	HPCT NO.	HPCT-907
		Page No.	1
		Rev. Date	2001-04-11

PROJECT NAME : 7FH2 #7C068 Design Value : 8.49

* Tolerance : Design Value ±25% [6.3675 ~ 10.6125]

SPEED	VOLTAGE(V)		AMP.	IMPEDANCE	DEVIATION	REMARK
(RPM)	INPUT	OUTPUT	(A)	(Ω)	(%)	
5	103.76	101.92	11.70	8.7111	2.60	
100	103.46	101.61	11.79	8.6183	1.51	
201	103.49	101.64	11.79	8.6209	1.54	
300	103.74	101.88	11.94	8.5327	0.50	
400	104.00	102.13	12.02	8.4967	0.08	
500	104.22	102.35	12.08	8.4727	-0.20	
600	104.06	102.19	12.08	8.4594	-0.36	
701	103.90	102.03	12.07	8.4532	-0.43	
800	103.47	101.60	12.04	8.4385	-0.61	
900	102.63	100.78	11.95	8.4335	-0.67	
1000	102.97	101.11	12.00	8.4258	-0.76	
1200	102.96	101.11	12.00	8.4258	-0.76	
1400	103.17	101.31	12.04	8.4145	-0.89	
1600	102.85	101.00	12.02	8.4027	-1.03	
1800	102.63	100.78	11.99	8.4053	-1.00	
2000	102.46	100.61	11.97	8.4052	-1.00	
2200	102.43	100.58	11.97	8.4027	-1.03	
2400	102.36	100.52	11.96	8.4047	-1.00	
2600	102.04	100.21	11.91	8.4139	-0.90	
2800	102.42	100.58	11.94	8.4238	-0.78	
3000	102.24	100.40	11.89	8.4441	-0.54	
3200	102.20	100.37	11.87	8.4558	-0.40	
3400	102.23	100.41	11.85	8.4734	-0.20	
3600	102.10	100.28	11.81	8.4911	0.01	

IMPEDANCE GRAPH



Page No. 25

Reviewed / Witnessed By:
Andy Ahn
SLCL Rep 14 Jan 2009

DATE : 2009-01-14 TESTER : 홍현택

DOOSAN DooSan Heavy Industries & Construction Co.,Ltd	IMPEDANCE TEST (After Final Balancing)	HPCT NO.	HPCT-907
		Page No.	1
		Rev. Date	2001-04-11

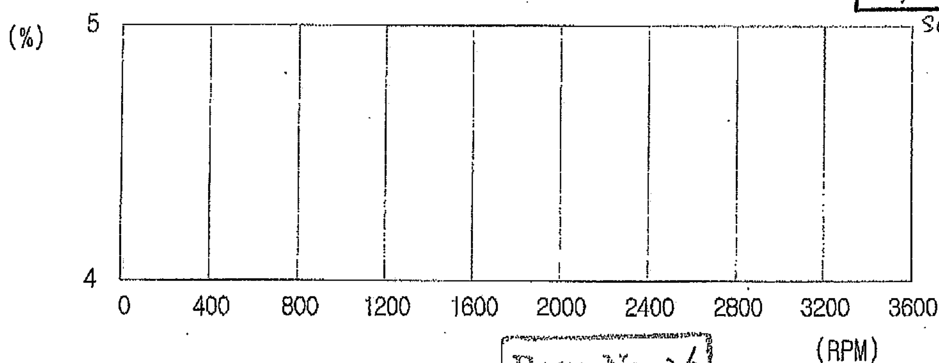
* Tolerance : Design Value ±25%
[6.3675 ~ 10.6125]

PROJECT NAME : 7FH2 #7C068 Design Value : 8.49

SPEED (RPM)	VOLTAGE(V) INPUT	OUTPUT	AMP. (A)	IMPEDANCE (Ω)	DEVIATION (%)	REMARK
5	102.81	100.99	11.33	8.9135	4.99	

Reviewed / Witnessed By:
Andy Ang
SCCL Rep 14 Jan 2009

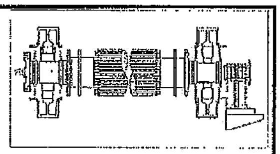
IMPEDANCE GRAPH



Heavy Industries & Construction

LOCATION OF VIB. SENSOR

(GEN ROTOR)



BALANCING SHOP

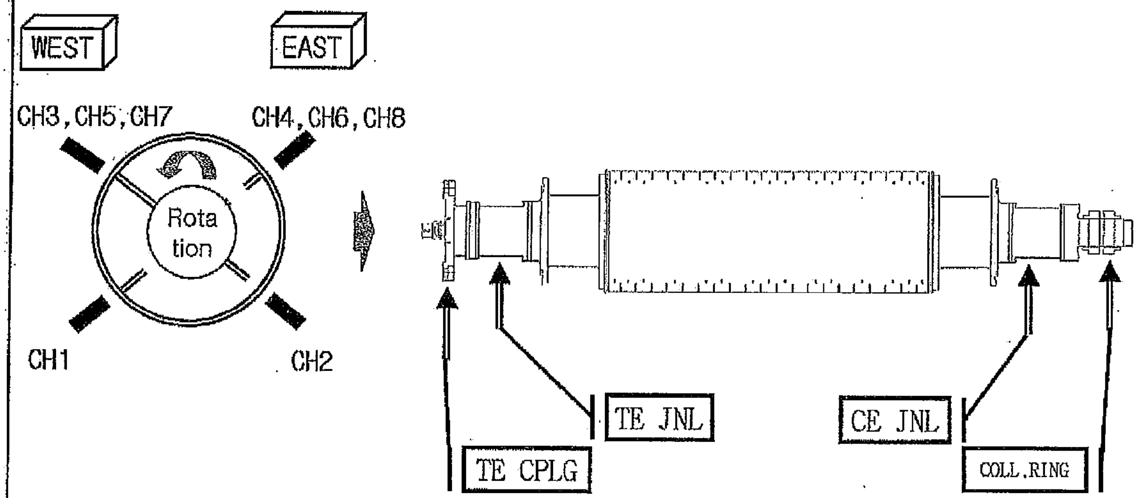
HPCT-904

Field Information

PROJECT	:	7FH2#7C068	M/O NO.	:	T07113
MATERIAL NO.	:	F07479-140	RTR TYPE	:	GEN FIELD
SERIAL NO.	:	338X390	CUSTOMER	:	GE
P/O NO.	:	181094165			

SENSOR POSITION

GENERATOR ROTOR DSCRIPTION



LEGEND

ME : MOTOR END JNL : JOURNAL W : WEST E : EAST
DE : DOOR END

Rotor Type \ Channel		CH1	CH2	CH3	CH4	CH5	CH6	CH7	CH8
GEN	DOOSAN Facilities	TE CPLG W	TE CPLG E	TE JNL W	TE JNL E	CE JNL W	CE JNL E	COLL-RING W	COLL-RING E
	TBN/CEN SIDE	TBN END	TBN END	TBN END	TBN END	COLL END	COLL END	COLL END	COLL END

Reviewed / Witnessed By:
Andy Ang
SLCT Rep 14 Jan 2009

2009.01.14 10:28 / 발전)발전품질관리부 / H502302 /

DOOSAN Heavy Industries & Construction

GENERATOR FIELD
PLUGS & WEIGHTS RESOLUTION DATA

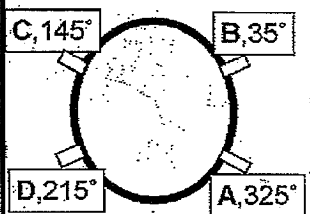
Form No.	HPCT-367
Rev. No.	3
Rev. No.	2000-09-20

PJT : 7FH2#7C068   P/O NO. : 181094165(338X390)   MATERIAL NO. : F07479-140   CUSTOMER : GE

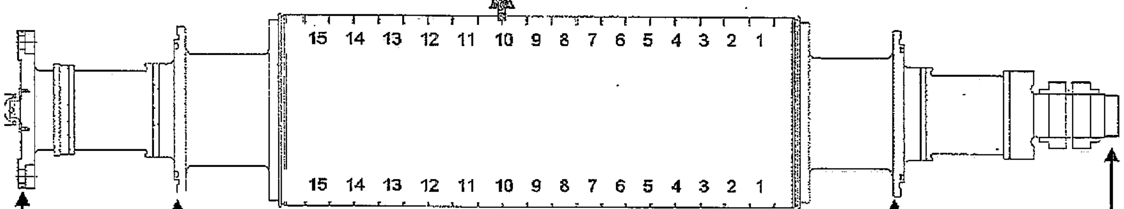
* BODY PLUGS

LOCATION	TE END	ROTOR PLUG NO.													CE END	REMARKS
ROW	DEG.	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
A	325°	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	101.0 g
B	35°	1	1	1	1	1	4	1	1	1	4	1	1	1	1	1	518.0 g
C	145°	2	1	1	1	1	2	3	2	1	2	1	1	1	1	1	586.0 g
D	215°	1	1	1	1	1	1	1	2	3	1	1	1	1	1	1	283.0 g
TOTAL WEIGHT																	1,488.0 g

2009.01.14 10:28/발전)발전품질관리부/H50230



ROTOR PLUG Angle



TE FAN RING		
W'T	133g < 17°	
	133g < 335°	
Dwg.	719A817	

TE COUPLING	
W'T	N/A
Dwg.	-

CE FAN RING	
W'T	133g < 17°
	133g < 335°
Dwg.	719A817

BALANCE RING	
W'T	N/A
Dwg	-

ROTOR WEIGHT

PLUG NO.	WEIGHT(g) Each Weight	Effect Weight
1	282	
2	383	101
3	464	182
4	541	259
5	620	338
6	699	417
7	783	501

Plug/Punching Reviewed	Plug/Punching Reviewed
홍 현익	이

Page No. 28

Doosan Heavy Industries & Construction

ELECTRICAL TEST (Final hi-pot Test)

PCG No : **PCG-RW-005**

ITEM	FIELD WINDING	PJT. NAME	7FH2 7C68 GENERATOR ROTOR
P/O NO.	181094165(338X390)	M/O NO.	T07113
APPLIED DOOSAN DWG NO / Rev No		138E7050 Rev.A (MAR.27.2008)	
APPLIED GE SPEC No / Rev No		P12A-AL-6129.Rev.K (AUG.2006)	
VF. NO.	F07479-140	TEST DATE	2009.01.19

*. INSTRUCTION

1) Winding Resistance : Design Value ± 2 %
2) Impedance : Design Value ± 25 %
3) Pre-hipot
   - Insulation Resistance : Min 25 Mohm (DC 500V MEGGER)
   - Polarization index

Insulation Resistance	Polarization Index
25 - 199 Mohm	Min 1.10
≥ 200 Mohm	Min 1.00

TEST CONDITION	
ambient temp:	17 ℃
humidity :	30 %

4) Hi-pot Test : Test Voltage : AC 3500 V, Holding Time : 1 Min
5) Post-hipot
   Insulation resistance at 1 minute after hipot should be 25MΩ or greater and at least 60 percent of the one-minute pre-high potential measurement, or 200MΩ or greater.

1. WINDING RESISTANCE CHECK

RESISTANCE (Ω) at 12.5 ℃	RESISTANCE (Ω) at 25 ℃	REMARKS
0.1315	0.13815	-1.53%
※. Design value = 0.1403 (Ω) at 25 ℃		

Winding temperature measurement

Section	1	2	3	4	5	Average	REMARKS
Temp(℃)	12.3	12.5	12.7	12.4	12.5	12.5	

2. IMPEDANCE CHECK

VOLTAGE	CURRENT	ACT'L DATA	DESIGN VALUE	DIFFERENCE(%)
100 Vac	12.2 A	8.20 Ω	8.49 Ω	-3.45%

3. INSULATION RESISTANCE CHECK

	INSULATION RESISTANCE	Ration of Insulation resistance between pre and post Hi-pot Test (%)
PRE HI - POT TEST	6430 MΩ	
POST HI - POT TEST	4520 MΩ	70.3

4. POLARIZATION INDEX TEST (BEFORE HI POT)

TIME	1 MIN	5 MIN	10 MIN	P.I
MΩ	6430	24200	41100	6.39

5. HI - POT TEST

TEST VOLTAGE	HOLDING TIME	RESULT	REMARKS
3500V. AC	60 SEC	Pass	

Page No. 3

~~Reviewed~~ / Witnessed By: Andy Ang

장성원 1/19/09	유우종 1/19/09	1/19/09	1/19/09	SLCI Rep 19 Jan 2009
TESTED BY	REVIEWED BY	APPROVED BY	WITNESSED BY	WITNESSED BY

DOOSAN Heavy Industries & Construction	RTD TEST REPORT (AFTER FINAL HI-POT TEST)	PCG NO : PC -SW- 016 PAGE : 1 OF 1

※ INSTRUCTION

1) DIFF : [(A-B + A-C) ÷ 2] - B-C
2)TEMP : (DIFF-100)*2.544
3) All the temperature should be within ±2℃ of ambient temperature.
- Ambient temperature is the average of the all measured temperature.

PROJECT NAME	7FH2 7C068.GEN
M / O NO	T07113
DWG NO	135E3545 Rev.J
SPEC' NO	P24A -AL -5068Q
P/O	181094165 (338X390)
CHECK DATE	2009.02.21

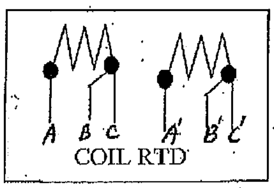
RTD NO	A~B / A'~B'	A~C / A'~C'	B~C / B'~C'	DIFF Ω	TEMP ℃	SLOT NO	REMARKS
1	105.38	105.38	0.85	104.53	11.5	1 TE SIDE	DWG NO : U7189D1096P04045
	105.29	105.29	0.85	104.44	11.3		
2	105.75	105.75	1.05	104.70	12.0	21 TE SIDE	↓
	105.72	105.72	1.04	104.68	11.9		
3	105.45	105.45	1.05	104.40	11.2	41 TE SIDE	
	105.41	105.41	1.04	104.37	11.1		
4	105.19	105.19	0.45	104.74	12.1	3 CE SIDE	
	105.13	105.13	0.45	104.68	11.9		
5	105.75	105.75	0.65	105.10	13.0	23 CE SIDE	
	105.74	105.74	0.65	105.09	12.9		
6	105.21	105.21	0.61	104.60	11.7	43 CE SIDE	
	105.22	105.22	0.61	104.61	11.7		
7	105.16	105.16	0.57	104.59	11.7	2 CE CENTER	DWG NO : U7189D1096P09945
	105.08	105.08	0.58	104.50	11.4		
8	105.64	105.64	0.78	104.86	12.4	22 CE CENTER	↓
	105.66	105.66	0.78	104.88	12.4		
9	105.09	105.09	0.74	104.35	11.1	42 CE CENTER	
	105.22	105.22	0.74	104.48	11.4		
10	104.65	104.65	0.81	103.84	9.8	TE FRAME COLD GAS	DWG NO : U7193DIXXXPXXX55
	104.65	104.65	0.82	103.84	9.8		
11	103.89	103.89	0.26	103.63	9.2	CE FRAME COLD GAS	↓
	103.96	103.96	0.27	103.70	9.4		
12	104.05	104.05	0.27	103.78	9.6	CE FRAME COLD GAS	
	103.95	103.95	0.26	103.68	9.4		
13	104.49	104.49	0.82	103.67	9.3	TE FRAME COLD GAS	
	104.51	104.51	0.82	103.69	9.4		
20	105.43	105.43	0.69	104.74	12.1	11 CE CENTER	DWG NO : U7189D1096P09945
	105.47	105.47	0.70	104.77	12.1		
21	105.61	105.61	0.86	104.75	12.1	31 CE CENTER	↓
	105.60	105.60	0.85	104.75	12.1		
22	105.12	105.12	0.66	104.46	11.3	51 CE CENTER	
	105.07	105.07	0.66	104.41	11.2		
28	104.52	104.52	0.48	104.04	10.3	CENTER FRAME HOT GAS	DWG NO : U7193DIXXXPXXX55
	104.47	104.47	0.48	103.99	10.2		
29	104.38	104.38	0.48	103.90	9.9	CENTER FRAME HOT GAS	↓
	104.35	104.35	0.48	103.87	9.8		

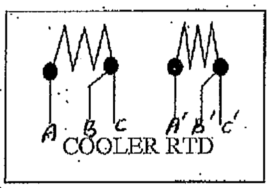
0.48

COMMENTS :

	SLOT TEMP (℃)	COOLER TEMP (℃)
Min. Temperature	11.1	9.2
Max. Temperature	13.0	10.3
Average Temperature	11.8	9.5

※ FLUX PROBE CHECK : 6.14 Ω





정성덕 2/21/09
TESTED BY

2/21/09
APPROVED BY

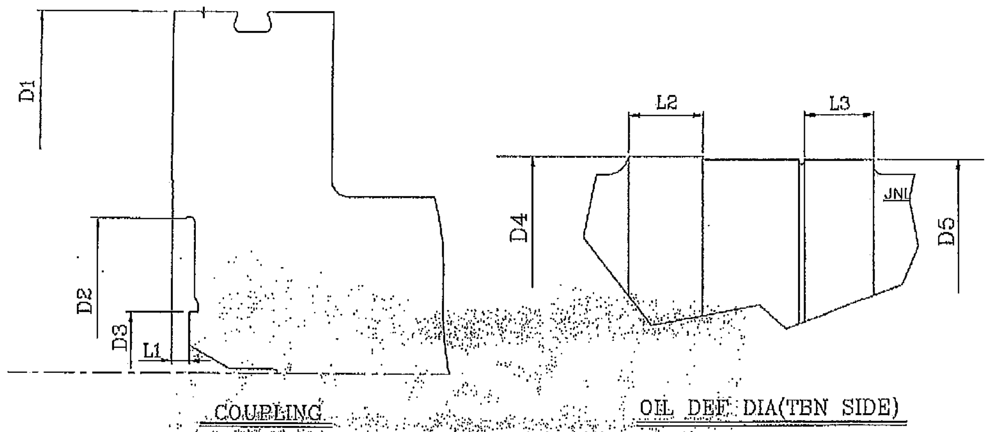
DOOSAN 두산중공업 DIMENSIONAL INSPECTION RECORD 치 수 검 사 기 록 서

Record No. : PCDCAGRMM0016

Sheet 1 of 4

Project Name 사 업 명: 7FH2 GEN	M/O No. : 공사번호 T07113	Mfg Serial No. : 제조일련번호 F07479-140
Item/Part Name 제품/부품명 #7C068 : GEN.ROTOR	Item/Part No. : 제품/부품번호 N/A	Dwg. No. 도면번호 : 134E3617 138E7050 Rev. 개정 C A
Spec. No. : 사양서 번호 N / A	Traveler No. : 트레블라 번호 100477272 Rev. 개정 0	Step No. : 공정번호 30
Instruments ID No. : 측정장비 식별번호 유니마스터 : 08A2E1018-0008		
Result 결 과 ☒ Satisfactory (합격) ☐ Unsatisfactory (불합격)	Prepared by 작 성 자 김남건 Inspector 08.12.19 Date	Reviewed by 검 토 자 유우종 Q.C Eng'r 12/19/08 Date

Sketch



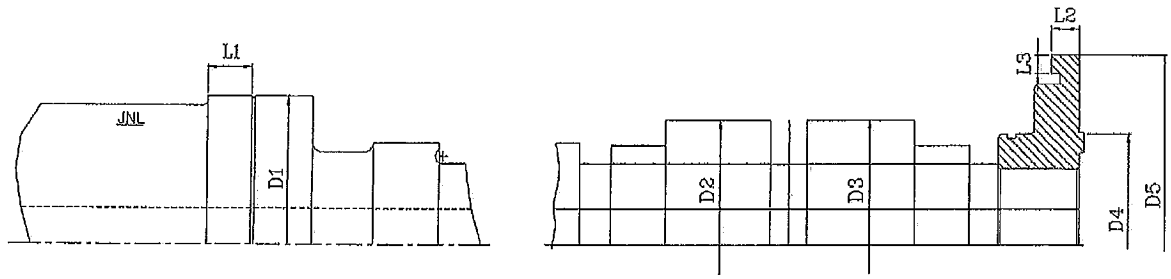
1. TBN SIDE DIM CHECK Unit: mm

GR	CP	DWG	ACT'L	비고
S	D1	Φ812.8±0.5	Φ812.78	COUPLING 외경
C	D2	Φ507.61±0.01	Φ507.60	RABBIT FIT
C	D3	Φ140.024±0.006	Φ140.03	BALANCE FIT
C	D4	Φ469.9±0.5	Φ469.92	
C	D5	Φ457.20±0.05	Φ457.22	OUT OIL DEF.
S	L1	20.8±0.5	20.8	
S	L2	48.8±0.5	48.80	
S	L3	41.4±0.5	41.4	

치 수 검 사 기 록 서 (B)
DIMENSIONAL INSPECTION RECORD

Record No. : PCDCAGRMM0016

Sheet 2 of 4



OIL DEF DIA(COLL SIDE)

COLL END RING

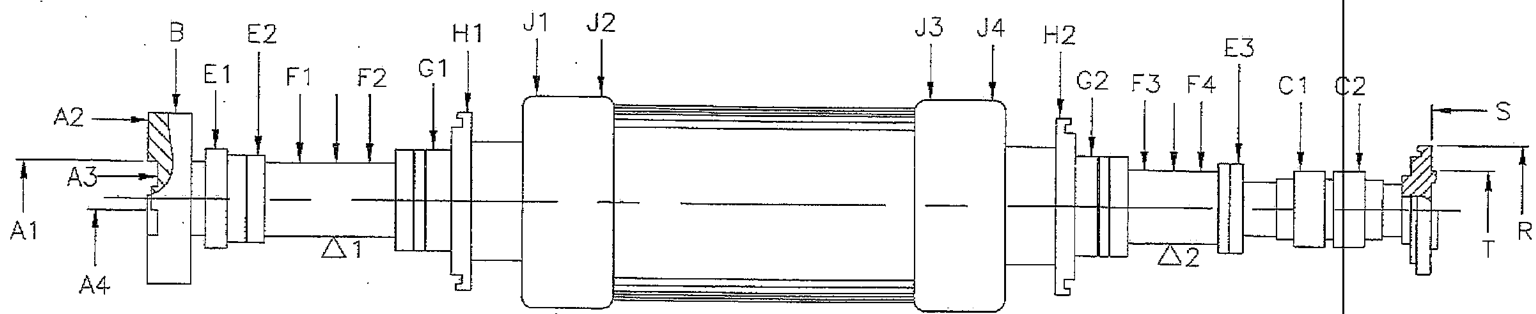
2. COLL SIDE DIM CHECK

GR	CP	DWG	ACT'L	비고
C	D1	Φ457.20±0.05	Φ457.20	
C	D2	Min Φ342.9	Φ344.26	
C	D3	Min Φ342.9	Φ344.18	
C	D4	Φ309.61±0.01	Φ309.60	
C	D5	Φ522.92±0.06	Φ522.96	
S	L1	46.5±0.5	46.51	
S	L2	38.1±0.5	38.49	
S	L3	25.39±0.01	25.395	

치 수 검 사 기 록 서 (B)
DIMENSIONAL INSPECTION RECORD (B)

Record No. : **PCDCAGRMM0016**

Sheet 3 of 4



6. RUNOUT CHECK

Unit: μm

GR	CP	DWG μm	INDICATOR READING 0°	30°	60°	90°	120°	150°	180°	210°	240°	270°	300°	330°	TIR	Diagonal Max Run-out
C	A1	12.7	18	10	6	0	6	6	6	2	2	10	18	18	**18**	**12**
C	A2	12.7	1	1	1	1	0	1	1	1	1	1	1	1	**1**	**1**
C	A3	12.7	1	1	0	0	1	1	1	1	1	1	1	1	**1**	**1**
C	A4	12.7	0	6	14	16	12	12	12	18	20	16	2	0	**20**	**12**
C	B	25.4	5	14	19	21	17	16	17	19	17	12	3	0	**21**	**16**
C	E1	25.4	3	5	8	6	3	0	1	3	3	3	1	0	**8**	**5**
C	E2	25.4	2	5	6	3	0	0	2	5	6	5	2	1	**6**	**2**
C	F1	7.6	0	1	2	2	3	2	2	2	4	1	0	0	**4**	**N/A**
C	△1	7.6	1	1	1	1	1	1	1	0	1	1	1	1	**1**	**N/A**

Page No. 24

치 수 검 사 기 록 서 (B)
DIMENSIONAL INSPECTION RECORD (B)

Record No. : PCDCAGRMM0016

Sheet 4 of 4

GR	CP	DWG	INDICATOR READING												TIR	Diagonal Max Run-out
			0°	30°	60°	90°	120°	150°	180°	210°	240°	270°	300°	330°		
C	F2	7.6	3	0	1	2	4	5	6	5	5	5	6	6	**6**	**N/A**
C	G1	25.4	9	3	0	2	5	8	9	9	10	12	14	13	**14**	**10**
C	H1	50.8	9	2	0	0	5	9	10	7	7	11	17	15	**17**	**12**
C	J1	635	23	22	14	4	0	4	10	9	4	1	5	14	**23**	**13**
C	J2	254	20	18	1	0	1	11	20	19	3	2	1	10	**20**	**2**
C	J3	254	21	17	2	1	0	15	20	19	3	3	3	19	**21**	**4**
C	J4	635	24	18	7	0	0	5	9	6	0	1	10	20	**24**	**15**
C	H2	50.8	5	5	7	2	0	0	6	12	14	12	9	8	**14**	**10**
C	G2	25.4	3	4	4	0	1	1	1	3	4	4	3	1	**4**	**4**
C	F3	7.6	1	1	1	1	0	1	2	3	4	5	2	1	**5**	**N/A**
C	△2	7.6	2	1	1	0	0	0	1	1	1	1	1	1	**2**	**N/A**
C	F4	7.6	1	0	2	3	3	3	2	1	3	2	4	1	**4**	**N/A**
C	E3	25.4	2	4	6	7	6	5	2	0	2	3	2	3	**7**	**4**
C	C1	50.8	0	2	4	8	9	9	3	0	2	6	5	4	**9**	**N/A**
C	C2	50.8	0	0	3	10	12	15	9	2	2	6	6	5	**15**	**N/A**
C	R	25.4	5	2	3	11	15	14	8	0	1	6	7	8	**15**	**8**
C	S	25.4	1	1	1	1	0	0	1	1	1	1	1	1	**1**	**1**
C	T	25.4	0	0	4	14	18	18	12	2	2	8	10	6	**18**	**12**

※**SDR 48163-07-6085** 에 따라 **JOURNAL(F1 ~F4, △1, △2)** 및 **COLL RING (C1, C2)**를 제외한 전 부위는 대각 **RUNOUT** 값을 적용할 것

Page No. 25

(품질보증-15100-054) 두산중공업㈜ (A4/복사용지)

SNC·LAVALIN Constructors Inc.	☐1	No exceptions taken, resubmit document as certified, proceed with fabrication.
	☐2	No exceptions taken, accepted as final, resubmittal not required, proceed with fabrication.
Vendor's drawing review for conformity with specifications and design drawing.	☐3	Exceptions as noted, revise and resubmit, proceed with fabrication inclusive of markups.
	☐4	Exceptions as noted, revise and resubmit, do not proceed with fabrication.
This review does not relieve the vendor of his responsibility for errors in design and detailing as detailed in his contract.	☒5	Approval not required, for information / reference only.
	☐6	Cancelled

Vendor: GENERAL ELECTRIC - GENE No.: C903-290T769	Rev:	Date Rec'd
Doc. Title: PRODUCT QUALITY REPORT - GENERATOR 290T769		2010-03-08
Client Code:	Project: Astoria II Cogeneration Project	
Reviewed by: VSS	Document No	Submittal
Date: 15-march-10	0620 - T170-0245 - 001	01

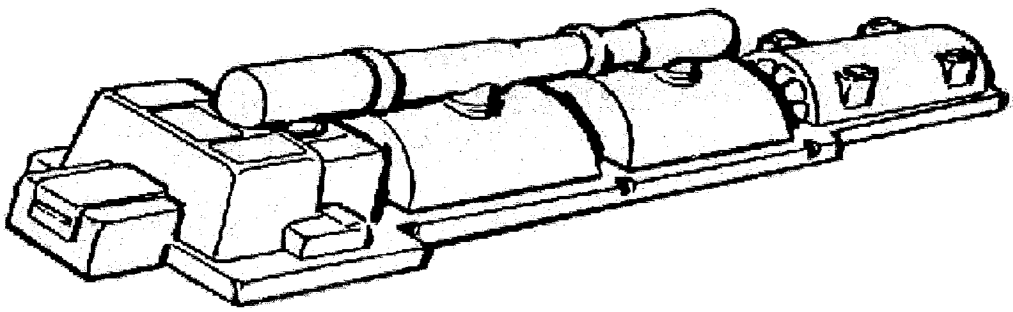
GE Power Systems

Product Quality Report

Customer: **ASTORIA ENERGY II, LLC**

PHASE II ASTORIA ENERGY EXPANSION PROJECT

Generator: **290T769**



This report contains Quality and Test information created during the manufacture of the generator noted above. The data and certifications included are intended to provide information on the final electrical and mechanical testing performed on the generator and its major components

Steam Turbine Generator

Manufacturing Department

Schenectady, New York

C903

Generator Quality Certification

GENERATOR SERIAL NO.: 290T769

Equipment Description: 324 LD 60HZ

CERTIFICATION TO SHIP THE GENERATOR IDENTIFIED ABOVE HAS BEEN GIVEN BY THE FOLLOWING:

APPROVED FOR SHIPMENT: PASS FOR LOAD

Signature	Function	Title	Date
[illegible]	CENTER OF EXCELLENCE	[illegible] GFA/Test	12/29/09
P.R. [illegible]	CENTER OF EXCELLENCE	GFA METHODS ENGINEER	29 DEC 2009
[illegible]	QUALITY ASSURANCE	Quality Process Engineer	30 Dec 09.
Michael [illegible]	ENGINEERING	Engineer	12-29-09
[illegible]	PROJECTS	GPO [illegible]	Dec 30, 2009
Michael [illegible]	MRP - GENERATOR PARTS	MRP	Dec 29, 2009

Stator Serial # 181167351

Generator Manufacturing Dept.
General Electric Co.
Schenectady, N.Y.

Any Problems?......Please Call 1-800-4GE-FAST

12/29/2009

GE POWER SYSTEMS
Test Operations
PCG-5811A PJR 02/23/06

Armature Hipot Test Data

For Medium (Conventionally Cooled) Armatures - Split Phase

Wind Stand Hipot: X Shipping Hipot

SER # 181167351 Customer ASTORIA ENERGY Date 9/28/09

Stator Phase Resistance Test (Per P24A-AL-5069Q)

Therm. S/Ns 78560064 | 78490014 Cal Due 2/9/10 | 2/9/10

Bridge Serial# 1390 Cal Due 6/9/10

Measured Winding Temps TE 23.6°C Design Resistance/Phase 0.0009 Ω

CE 23.5°C **Circuit Resistance/Circuit** Ω

	Phase 1-4	Phase 2-5	Phase 3-6
Measured:	2.568	2.598	2.605
Measured:	2.607	2.651	2.564
Measured:	2.645	2.585	2.652

METER SCALE: X m Ohm u Ohm

Note: Write Down Exact Meter Reading, Do Not Covert. Attach Program Analysis Sheet (PCT-409)

Testers GA/MM/TS/BM/JF Date 9/28/09

Insulation Resistance Test (500 volt Megger) Before & After Hipot (Per P12A-AL-7486)

Ambient Temp 23.4°C °C

Rel. Humidity 51.8% % RH S/N 100-04-02352 Cal Due 10/10/10

Megger S/N 2233 Cal Due 4/8/10

Before Hipot					**After Hipot**	**Min Req.**
Phase MΩ	1 Min	3 Min	10 Min	PI	1 Min	1 Min
1-4	3300	9700	24400	7.4	2960	2805
2-5	3460	10500	26600	7.65	3200	2941
3-6	3080	9750	24000	7.55	2780	2703

Notes: Proceed with hipot if resistance > 1000 MΩ AND PI > 2.0 After hipot megger to be done at least 30 minutes after hipot. After hipot resistance should be ≥ 85% of initial, before-hipot, one minute value and also ≥ 1000MΩ. Issue a QCR for any out of tolerance readings.

Testers GA/MM/TS/BM/JF Date 9/28/09

Hipot (Ground Insulation Test)- Complete Winding (Per P12A-AL-7486)

Hipot Set Serial# 53436 Cal Due Date: 2/14/10

Hipot Safety Checklist, Form PCT-004 had been completed and is attached ( )

For Wind Stand & Shipping Hipot: Hipotted @ 37 kVac for 1 Minute

	Phase 1-4	Phase 2-5	Phase 3-6
Enter Pass/Fail:	PASS	PASS	PASS

Testers GA/MM/TS/BM/JF Date 9/28/09

Head of Test [signature] Date 9-29-09

PCG-5811A

STATOR PHASE RESISTANCE MEASUREMENT PC - T00604353□

290T769 324 Generator Serial Number - 18116735 I

PCT 409

ASTORIA

Software Rev 1.01

PHASE 1

Engineering Design Resistance @ 25 DegC is: 0.0009 Ohms

At Measured Temperature of 23.6 DegC .0008688 Ohms was measured

This Corrects to a Resistance of: .0008735 Ohms @ 25 DegC

Compared to the Design Resistance, This is 2.95% LOWER Than the Design Resistance

*** WITHIN TOLERANCE ***

PHASE 2

Engineering Design Resistance @ 25 DegC is: 0.0009 Ohms

At Measured Temperature of 23.6 DegC .0008703 Ohms was measured

This Corrects to a Resistance of: .0008751 Ohms @ 25 DegC

Compared to the Design Resistance, This is 2.77% LOWER Than the Design Resistance

*** WITHIN TOLERANCE ***

PHASE 3

Engineering Design Resistance @ 25 DegC is: 0.0009 Ohms

At Measured Temperature of 23.6 DegC .0008688 Ohms was measured

This Corrects to a Resistance of: .0008735 Ohms @ 25 DegC

Compared to the Design Resistance, This is 2.94% LOWER Than the Design Resistance

*** WITHIN TOLERANCE ***

METER CALIBRATION

Fluke Thermometer S/N 78560064 Used Calibration Due: 2/9/10

BIDDLE DLRO S/N 13910 USED CAL DUE: 6/9/10

Fluke Thermometer S/N 78490014 Used Calibration Due: 2/9/10

TEST MEN WORKING UNIT: GA MMTS BM DATE: 9/28/09

TEST DATA REVIEWED BY: [signature] DATE: 9/29/11

DATA RECORDED ON 9/28/2009

Test Data Stored to: X:\Test-Data\StatorRes\181167_1Res.dat

RTD WIRE CHECK RECORD SHEET (PER P24A-AL-5068Q)

PCG-5810 Rev DPI 10/06 PC - GFBADRE

290T769 Gen S/N - 181167351 ASTORIA

Res. Meter: Valhalla 4020 S/N 28-876 Cal Due: 8/11/2010 TC Meter: Fluke 51 S/N 78850473 Cal Due: 8/11/2010

Date: 10/22/2009

Operator: BL/BH RESULTS: (A-B) & (A-C) All RTD's within Limits
High to Low Comparison .Diff = .550 ALL RTD's WITHIN TOLERANCE
Comparison with Ambient ALL RTD's WITHIN LIMITS Ambient Temp = 26.2

Flux Probe Reading was 6.28 Ohms

RTD #	LOCN	A-B	A-C	B-C	DIFF	Temp DEG C	(A-B)&(A-C) Comparison	Comparison w/ Ambient	Comparison Hi to Lo
1A	SLOT	111.580	111.580	1.410	110.170	26.2	OK	OK	OK
1B	SLOT	111.530	111.530	1.350	110.180	26.2	OK	OK	OK
2A	SLOT	111.750	111.780	1.620	110.145	26.1	OK	OK	OK
2B	SLOT	111.690	111.690	1.620	110.070	25.9	OK	OK	OK
3A	SLOT	111.530	111.530	1.630	109.900	25.5	OK	OK	OK
3B	SLOT	111.600	111.600	1.620	109.980	25.7	OK	OK	OK
4A	SLOT	110.900	110.870	.920	109.965	25.6	OK	OK	OK
4B	SLOT	110.790	110.810	.880	109.920	25.5	OK	OK	OK
5A	SLOT	110.580	110.580	.650	109.930	25.5	OK	OK	OK
5B	SLOT	110.540	110.520	.620	109.910	25.5	OK	OK	OK
6A	SLOT	110.380	110.380	.640	109.740	25.0	OK	OK	OK
6B	SLOT	110.350	110.350	.630	109.720	25.0	OK	OK	OK
20A	SLOT	111.970	111.960	1.890	110.075	25.9	OK	OK	OK
20B	SLOT	112.010	112.010	1.880	110.130	26.1	OK	OK	OK
21A	SLOT	112.310	112.310	2.120	110.190	26.2	OK	OK	OK
21B	SLOT	112.280	112.270	2.120	110.155	26.1	OK	OK	OK
22A	SLOT	111.740	111.760	1.890	109.860	25.4	OK	OK	OK
22B	SLOT	111.760	111.770	1.880	109.885	25.4	OK	OK	OK
31A	SLOT	111.800	111.760	1.750	110.030	25.8	OK	OK	OK
31B	SLOT	111.850	111.850	1.730	110.120	26.0	OK	OK	OK
32A	SLOT	112.140	112.140	1.980	110.160	26.1	OK	OK	OK
32B	SLOT	112.230	112.250	1.970	110.270	26.4	OK	OK	OK
33A	SLOT	111.990	111.990	1.950	110.040	25.8	OK	OK	OK
33B	SLOT	112.020	112.030	1.940	110.085	25.9	OK	OK	OK
34A	SLOT	111.150	111.150	1.100	110.050	25.8	OK	OK	OK
34B	SLOT	111.110	111.110	1.100	110.010	25.7	OK	OK	OK
35A	SLOT	111.340	111.350	1.120	110.225	26.3	OK	OK	OK
35B	SLOT	111.180	111.190	1.140	110.045	25.8	OK	OK	OK
36A	SLOT	110.890	110.890	.890	110.000	25.7	OK	OK	OK
36B	SLOT	110.930	110.940	.880	110.055	25.9	OK	OK	OK

Approved: Kz Date: 10-22-09 X:\Test-Data\RTD\181167351_WIRE _2Rtd.dat

RTD WIRE CHECK RECORD SHEET (PER P24A-AL-5068Q)

PCG-5810 Rev DPI 10/06 PC - GFBADRE

290T769 Gen S/N - 181167351 ASTORIA

Res. Meter: Valhalla 4020 S/N 28-876 Cal Due: 8/11/2010 TC Meter: Fluke 51 S/N 78850473 Cal Due: 8/11/2010

Date: 10/22/2009

Operator: BL/BH RESULTS: (A-B) & (A-C) All RTD's within Limits
High to Low Comparison Diff = .000 ALL RTD's WITHIN TOLERANCE
Comparison with Ambient ALL RTD's WITHIN LIMITS Ambient Temp = 26.2

Flux Probe Reading was 6.30 Ohms

RTD #	LOCN	A-B	A-C	B-C	DIFF	Temp DEG C	(A-B)&(A-C) Comparison	Comparison w/ Ambient	Comparison Hi to Lo
10A	GAS	111.050	111.030	1.260	109.780	25.2	OK	OK	OK
10B	GAS	111.190	111.200	1.270	109.925	25.5	OK	OK	OK
11A	GAS	110.360	110.360	.540	109.820	25.3	OK	OK	OK
11B	GAS	110.320	110.310	.540	109.775	25.1	OK	OK	OK
12A	GAS	110.000	109.990	.270	109.725	25.0	OK	OK	OK
12B	GAS	110.020	110.010	.260	109.755	25.1	OK	OK	OK
13A	GAS	111.350	111.360	1.570	109.785	25.2	OK	OK	OK
13B	GAS	111.450	111.430	1.570	109.870	25.4	OK	OK	OK
15A	GAS	110.410	110.410	.660	109.750	25.1	OK	OK	OK
15B	GAS	110.380	110.380	.660	109.720	25.0	OK	OK	OK
16A	GAS	110.960	110.960	1.180	109.780	25.2	OK	OK	OK
16B	GAS	110.990	110.990	1.160	109.830	25.3	OK	OK	OK
18A	GAS	111.510	111.510	1.690	109.820	25.3	OK	OK	OK
18B	GAS	111.480	111.470	1.690	109.785	25.2	OK	OK	OK
19A	GAS	110.160	110.120	.370	109.770	25.1	OK	OK	OK
19B	GAS	110.160	110.160	.370	109.790	25.2	OK	OK	OK

Approved: *[signature]* Date: *10-22-09* X:\Test-Data\RTD\181167351_WIRE _3Rtd.dat

GE Generator Field Balance Facility

290T769	Generator Field	Astoria	181073326	Page 1
Shot 22P5	RUN 38	OPERATOR - BS/AA	10/5/2009	

SPEED RPM			VIBRATION - Mils Peak-Peak TE Coup	TEJ	CEJ	Coll	STATIC	COUPLE	Time
301	F	S	0.5	0.5	0.0	2.0	0.3	0.2	7:34:36 AM
			155	352	0	111	353	351	
		N	0.6	0.4	0.0	2.0	0.2	0.2	
			251	228	0	203	232	224	
300	F	S	0.2	0.0	0.0	2.1	0.0	0.0	7:35:09 AM
			0	0	0	111	0	0	
		N	0.1	0.0	0.0	2.0	0.0	0.0	
			0	0	0	201	0	0	
860	F	S	0.3	0.2	0.2	2.1	0.2	0.0	7:36:56 AM
			188	43	53	109	47	10	
		N	0.2	0.4	0.6	2.0	0.5	0.2	
			0	286	253	202	267	22	
950	F	S	0.4	0.1	0.3	1.9	0.2	0.1	7:37:10 AM
			216	105	123	113	118	314	
		N	0.3	0.5	0.7	1.8	0.6	0.1	
			358	349	338	202	343	127	
1100	F	S	0.4	0.5	0.7	2.9	0.6	0.1	7:37:31 AM
			274	354	351	76	352	159	
		N	1.0	0.9	0.7	0.8	0.8	0.1	
			1	9	11	223	10	3	
2155	F	S	0.6	0.2	0.1	2.5	0.1	0.1	7:40:05 AM
			214	102	0	78	83	119	
		N	0.1	0.9	1.0	2.3	0.1	0.9	
			0	26	199	189	167	22	

RAW DATA - ENGINEERING INTERPRETATION MAY BE REQUIRED

F/B

GE Generator Field Balance Facility

290T769	Generator Field	Astoria	181073326	Page 2
Shot 22P5	RUN 38	OPERATOR - BS/AA	10/5/2009	

SPEED RPM			VIBRATION - Mils Peak-Peak TE Coup	TEJ	CEJ	Coll	STATIC	COUPLE	Time
2766	F	S	0.1	0.9	1.1	2.1	0.1	1.0	7:41:35 AM
			0	114	306	95	352	120	
		N	0.3	0.4	0.8	1.9	0.2	0.6	
			267	119	279	193	259	106	
3405	F	S	1.1	0.2	0.3	2.2	0.2	0.1	7:43:30 AM
			119	65	29	96	45	157	
		N	0.7	0.6	0.7	1.6	0.6	0.1	
			229	299	290	181	294	78	
3511	F	S	1.3	0.3	0.3	2.7	0.3	0.1	7:43:52 AM
			124	65	35	106	51	129	
		N	0.8	0.7	0.7	1.4	0.7	0.1	
			236	315	299	178	307	48	
3600	F	S	1.5	0.2	0.2	2.2	0.2	0.0	7:44:11 AM
			140	64	44	114	54	137	
		N	0.7	0.8	0.8	1.5	0.8	0.1	
			239	335	322	166	329	52	
3780	F	S	1.6	0.7	0.4	1.1	0.6	0.2	7:45:11 AM
			157	50	32	125	43	74	
		N	1.3	0.8	0.6	1.9	0.7	0.1	
			232	2	5	176	3	353	
3781	F	S	1.6	0.7	0.5	1.1	0.6	0.1	7:45:22 AM
			156	52	42	126	48	75	
		N	1.3	0.8	0.6	1.9	0.7	0.1	
			232	3	9	177	6	348	

RAW DATA - ENGINEERING INTERPRETATION MAY BE REQUIRED

GE Generator Field Balance Facility

290T769	Generator Field	Astoria	181073326	Page 3
Shot 22P5	RUN 38	OPERATOR - BS/AA	10/5/2009	

SPEED RPM			VIBRATION - Mils Peak-Peak TE Coup	TEJ	CEJ	Coll	STATIC	COUPLE	Time
Starting Reverse SV Run									
3781	F	S	1.5 158	0.7 55	0.4 41	0.9 123	0.6 50	0.1 77	7:45:52 AM
		N	1.3 232	0.7 5	0.5 14	1.9 178	0.6 9	0.1 346	
3698	F	S	1.3 160	0.5 57	0.3 25	0.9 119	0.4 44	0.1 103	7:46:56 AM
		N	1.0 230	0.6 12	0.5 15	1.9 168	0.5 13	0.1 1	
3597	F	S	1.4 172	0.3 91	0.2 121	1.3 142	0.2 102	0.1 59	7:47:43 AM
		N	0.6 246	0.8 20	0.7 14	1.4 160	0.7 17	0.1 60	
3495	F	S	1.4 161	0.4 99	0.3 74	2.2 136	0.3 87	0.1 158	7:48:30 AM
		N	0.6 261	0.8 357	0.8 352	1.1 177	0.8 355	0.0 84	
3396	F	S	1.3 155	0.4 98	0.3 69	2.2 111	0.3 84	0.1 161	7:49:16 AM
		N	0.6 255	0.7 349	0.8 338	1.6 188	0.7 343	0.1 102	
3295	F	S	1.1 149	0.3 102	0.4 68	2.2 116	0.3 82	0.1 204	7:50:02 AM
		N	0.5 252	0.6 341	0.8 332	1.6 182	0.7 336	0.1 132	

RAW DATA - ENGINEERING INTERPRETATION MAY BE REQUIRED

GE Generator Field Balance Facility

290T769	Generator Field	Astoria	181073326	Page 4
Shot 22P5	RUN 38	OPERATOR - BS/AA	10/5/2009	

SPEED RPM			VIBRATION - Mils Peak-Peak TE Coup	TEJ	CEJ	Coll	STATIC	COUPLE	Time
3197	F	S	0.8	0.2	0.5	2.4	0.3	0.2	7:50:49 AM
			147	127	51	114	74	202	
		N	0.4	0.4	0.8	1.6	0.6	0.2	
			246	342	328	181	333	130	
3100	F	S	0.7	0.2	0.6	2.4	0.3	0.3	7:51:32 AM
			150	152	59	111	82	217	
		N	0.3	0.3	0.7	1.6	0.5	0.3	
			248	353	334	184	339	145	
3000	F	S	0.6	0.4	0.7	2.5	0.3	0.5	7:52:19 AM
			150	169	43	110	76	205	
		N	0.2	0.1	0.8	1.6	0.4	0.3	
			0	1	334	185	337	150	
2900	F	S	0.4	0.6	0.9	2.8	0.3	0.7	7:53:06 AM
			155	173	32	98	75	196	
		N	0.2	0.1	0.9	1.4	0.5	0.4	
			0	0	335	177	336	154	
2792	F	S	0.2	1.3	1.3	2.1	0.2	1.3	7:53:55 AM
			0	157	354	92	70	166	
		N	0.4	0.4	1.2	1.4	0.4	0.8	
			314	119	324	183	336	138	
2699	F	S	0.3	1.4	1.2	2.0	0.1	1.3	7:54:38 AM
			195	109	295	101	80	112	
		N	0.6	0.7	1.4	1.4	0.4	1.0	
			283	91	300	194	321	111	

RAW DATA - ENGINEERING INTERPRETATION MAY BE REQUIRED

GE Generator Field Balance Facility

290T769	Generator Field	Astoria	181073326	Page 5
Shot 22P5	RUN 38	OPERATOR - BS/AA	10/5/2009	

SPEED RPM			VIBRATION - Mils Peak-Peak TE Coup	TEJ	CEJ	Coll	STATIC	COUPLE	Time
2600	F	S	0.3	0.8	0.5	2.2	0.2	0.7	7:55:25 AM
			193	76	249	106	87	73	
		N	0.5	0.6	1.0	1.4	0.3	0.7	
			237	62	284	195	321	88	
2499	F	S	0.3	0.6	0.3	2.5	0.2	0.4	7:56:11 AM
			222	68	222	106	85	60	
		N	0.3	0.6	1.1	1.5	0.3	0.8	
			201	65	280	203	312	87	
2399	F	S	0.3	0.4	0.2	2.6	0.2	0.2	7:56:58 AM
			223	63	175	103	87	45	
		N	0.3	0.6	1.0	1.7	0.3	0.8	
			180	61	277	202	312	84	
2298	F	S	0.4	0.3	0.1	2.7	0.2	0.1	7:57:44 AM
			235	66	0	100	52	84	
		N	0.2	0.7	1.0	1.8	0.3	0.8	
			0	57	268	199	307	76	
2197	F	S	0.5	0.2	0.2	2.8	0.2	0.0	7:58:31 AM
			231	77	78	95	77	67	
		N	0.2	0.8	1.0	1.8	0.2	0.9	
			135	53	257	196	304	67	
2097	F	S	0.5	0.2	0.2	2.7	0.2	0.0	7:59:17 AM
			215	92	67	90	80	163	
		N	0.2	0.7	0.9	2.0	0.2	0.8	
			0	35	243	197	301	50	

RAW DATA - ENGINEERING INTERPRETATION MAY BE REQUIRED

GE Generator Field Balance Facility

290T769	Generator Field	Astoria	181073326	Page 6
Shot 22P5	RUN 38	OPERATOR - BS/AA	10/5/2009	

SPEED VIBRATION - Mils Peak-Peak

RPM			TE Coup	TEJ	CEJ	Coll	STATIC	COUPLE	Time
1998	F	S	0.5	0.2	0.2	2.4	0.1	0.1	8:00:04 AM
			197	116	49	86	86	165	
		N	0.1	0.7	0.6	2.1	0.1	0.6	
			0	17	223	192	318	29	
1896	F	S	0.5	0.2	0.1	1.9	0.1	0.1	8:00:51 AM
			186	109	28	92	85	136	
		N	0.1	0.6	0.4	1.7	0.1	0.5	
			0	11	206	185	338	17	
1797	F	S	0.5	0.3	0.1	2.0	0.1	0.1	8:01:37 AM
			171	105	0	94	91	117	
		N	0.1	0.5	0.3	1.9	0.1	0.4	
			0	3	191	194	352	6	
1697	F	S	0.4	0.2	0.0	2.0	0.1	0.1	8:02:24 AM
			159	99	0	99	97	101	
		N	0.1	0.3	0.2	1.9	0.1	0.2	
			0	353	166	194	358	351	
1594	F	S	0.3	0.2	0.0	2.0	0.1	0.1	8:03:10 AM
			157	95	0	101	85	105	
		N	0.1	0.3	0.1	2.0	0.1	0.2	
			0	347	145	193	359	341	
1500	F	S	0.3	0.2	0.1	2.0	0.1	0.1	8:03:54 AM
			159	94	0	103	77	111	
		N	0.1	0.3	0.1	2.0	0.2	0.1	
			0	347	0	193	350	343	

RAW DATA - ENGINEERING INTERPRETATION MAY BE REQUIRED

GE Generator Field Balance Facility

290T769	Generator Field	Astoria	181073326	Page 7
Shot 22P5	RUN 38	OPERATOR - BS/AA	10/5/2009	

SPEED RPM			VIBRATION - Mils Peak-Peak TE Coup	TEJ	CEJ	Coll	STATIC	COUPLE	Time
1400	F	S	0.3	0.3	0.2	2.0	0.2	0.1	8:04:40 AM
			160	94	160	104	118	58	
		N	0.1	0.3	0.1	2.0	0.1	0.2	
			0	348	99	192	5	334	
1295	F	S	0.2	0.2	0.2	2.1	0.2	0.1	8:05:30 AM
			168	93	143	105	117	34	
		N	0.1	0.2	0.1	2.1	0.1	0.1	
			0	354	0	192	356	350	
1198	F	S	0.2	0.3	0.3	2.2	0.3	0.1	8:06:13 AM
			0	94	121	106	109	0	
		N	0.3	0.2	0.1	2.0	0.1	0.1	
			113	15	82	188	42	332	
1099	F	S	0.4	0.9	0.8	3.0	0.9	0.1	8:07:00 AM
			71	64	52	96	58	139	
		N	0.8	0.7	0.5	1.6	0.6	0.1	
			71	34	42	148	37	16	
999	F	S	0.3	0.0	0.2	1.8	0.1	0.1	8:07:46 AM
			226	0	194	108	196	12	
		N	0.2	0.4	0.3	1.9	0.3	0.1	
			0	326	323	212	325	333	
898	F	S	0.3	0.2	0.3	2.2	0.2	0.0	8:08:33 AM
			188	79	86	109	83	293	
		N	0.1	0.5	0.6	2.0	0.5	0.1	
			0	298	276	205	286	40	

RAW DATA - ENGINEERING INTERPRETATION MAY BE REQUIRED

GE Generator Field Balance Facility

290T769	Generator Field	Astoria	181073326	Page 8
Shot 22P5	RUN 38	OPERATOR - BS/AA	10/5/2009	

SPEED RPM			VIBRATION - Mils Peak-Peak TE Coup	TEJ	CEJ	Coil	STATIC	COUPLE	Time
798	F	S	0.1	0.1	0.1	2.1	0.1	0.0	8:09:19 AM
			0	21	2	106	12	77	
		N	0.0	0.1	0.3	2.1	0.2	0.1	
			0	239	206	201	217	359	
699	F	S	0.1	0.1	0.1	2.1	0.1	0.0	8:10:06 AM
			0	25	0	107	16	50	
		N	0.0	0.1	0.1	2.0	0.0	0.1	
			0	0	175	201	172	356	
598	F	S	0.1	0.1	0.0	2.1	0.0	0.0	8:10:52 AM
			0	0	0	108	0	0	
		N	0.1	0.1	0.1	2.1	0.1	0.0	
			0	0	0	200	0	270	
496	F	S	0.2	0.1	0.0	2.1	0.0	0.0	8:11:39 AM
			0	0	0	108	0	0	
		N	0.0	0.1	0.1	2.1	0.1	0.0	
			0	0	0	199	0	270	
397	F	S	0.1	0.1	0.0	2.1	0.0	0.0	8:12:25 AM
			0	0	0	109	0	0	
		N	0.1	0.0	0.0	2.1	0.0	0.0	
			0	0	0	199	0	0	
300	F	S	0.1	0.1	0.0	2.1	0.0	0.0	8:13:12 AM
			0	0	0	109	0	0	
		N	0.1	0.0	0.0	2.1	0.0	0.0	
			0	0	0	199	0	180	

RAW DATA - ENGINEERING INTERPRETATION MAY BE REQUIRED

GE Generator Field Balance Facility

290T769	Generator Field	Astoria	181073326	Page 9
Shot 22P5	RUN 38	OPERATOR - BS/AA	10/5/2009	

SPEED VIBRATION - Mils Peak-Peak

RPM			TE Coup	TEJ	CEJ	Coll	STATIC	COUPLE	Time
298	F	S	0.1	0.1	0.0	2.1	0.0	0.0	8:13:15 AM
			0	0	0	109	0	0	
		N	0.1	0.0	0.0	2.1	0.0	0.0	
			0	0	0	199	0	270	

Final Balance complete

Byron J. Seufried 10/5/09

GE Generator Field Balance Facility

290T769	Generator Field	Astoria	181073326	Page 1
Shot 13-14	RUN 20	OPERATOR - BS / JE	10/2/2009	

SPEED RPM			VIBRATION - Mils Peak-Peak TE Coup	TEJ	CEJ	Coll	STATIC	COUPLE	Time
303	F	S	0.4	0.0	0.0	2.1	0.0	0.0	11:20:12 AM
			201	0	0	117	0	0	
		N	0.2	0.1	0.1	2.0	0.1	0.0	
			0	0	0	207	0	270	
854	F	S	0.3	0.1	0.3	2.0	0.1	0.1	11:21:51 AM
			210	0	320	110	327	129	
		N	0.1	0.2	0.6	2.3	0.4	0.2	
			0	185	169	204	173	342	
967	F	S	0.5	0.1	0.2	2.1	0.1	0.0	11:22:07 AM
			197	91	60	113	74	179	
		N	0.3	0.2	0.7	2.2	0.4	0.3	
			317	294	227	207	240	31	
1101	F	S	0.6	0.3	0.5	1.6	0.4	0.2	11:22:29 AM
			230	290	323	91	312	171	
		N	0.7	0.5	0.5	2.3	0.4	0.2	
			314	327	268	210	297	29	
2152	F	S	1.6	0.3	0.2	3.4	0.1	0.2	11:25:13 AM
			328	273	155	128	216	303	
		N	0.8	1.9	1.9	1.4	0.1	1.9	
			144	137	312	228	205	135	
2751	F	S	1.8	3.5	3.3	0.8	0.2	3.4	11:26:56 AM
			19	237	54	140	268	236	
		N	1.5	3.3	2.8	0.5	0.5	3.0	
			99	208	44	168	156	215	

RAW DATA - ENGINEERING INTERPRETATION MAY BE REQUIRED

o/s

GE Generator Field Balance Facility

290T769 Shot 13-14 | Generator Field RUN 20 | Astoria OPERATOR - BS / JE | 181073326 10/2/2009 | Page 2

SPEED RPM			VIBRATION - Mils Peak-Peak TE Coup	TEJ	CEJ	Coll	STATIC	COUPLE	Time
3500	F	S	5.1 20	2.2 301	1.3 209	5.1 353	1.3 271	1.3 330	11:29:38 AM
		N	3.2 161	3.9 189	2.9 159	0.5 172	3.3 176	1.0 236	
3600	F	S	6.6 39	2.1 307	1.1 209	6.6 23	1.1 279	1.3 332	11:30:13 AM
		N	3.4 180	4.8 208	3.1 192	0.8 44	3.9 202	1.0 233	
3780	F	S	8.1 64	3.7 295	2.7 245	7.6 60	2.9 274	1.4 340	11:31:19 AM
		N	3.3 159	6.0 237	3.5 239	4.8 73	4.7 238	1.2 234	
4322	F	S	13.8 123	6.0 19	1.1 152	14.8 320	2.6 28	3.4 12	11:34:46 AM
		N	7.0 209	7.5 311	3.3 139	4.1 359	2.1 305	5.4 313	
4322	D	S	1.1 138	0.1 319	0.9 265	0.5 351	2.7 33	3.3 15	11:34:49 AM
		N	0.1 0	0.7 282	0.3 175	0.9 243	2.1 307	5.5 313	
4322	U	S	14.0	6.3	2.6	14.9	2.7 33	3.3 13	11:34:50 AM
		N	7.4	8.2	3.8	4.5	2.1 307	5.4 313	

RAW DATA - ENGINEERING INTERPRETATION MAY BE REQUIRED

GE Generator Field Balance Facility

290T769	Generator Field	Astoria	181073326	Page 3
Shot 13-14	RUN 20	OPERATOR - BS / JE	10/2/2009	

SPEED RPM			VIBRATION - Mils Peak-Peak TE Coup	TEJ	CEJ	Coll	STATIC	COUPLE	Time
4322	F	S	13.7	5.8	1.2	14.7	2.6	3.3	11:34:55 AM
			123	24	152	320	34	16	
		N	7.1	7.6	3.4	4.2	2.1	5.5	
			210	311	137	1	306	313	
4321	F	S	13.4	5.7	0.9	13.8	2.5	3.2	11:37:50 AM
			125	20	164	325	26	15	
		N	6.6	7.3	3.1	3.2	2.2	5.2	
			211	312	142	3	305	315	

Overspeed completed
4320 rpm for 3 minutes
Bryan J. Seyfarin 10/2/09
J. S. Eldridge Jr. 10/2/2009

GE POWER SYSTEMS
Test Operations
PCT-401 PJR 12/03/02

GENERATOR FIELD FLUX PROBE DATA

FLUX PROBE DATA

BEFORE THERMAL —
AFTER THERMAL # Yes
FLUX PROBE RUN # 29
SHOP ORDER 2907769
FIELD SN# 180173326
CUSTOMER Astoria
OF POLES 2
OF COILS/POLE 6
TURNS COIL #1 17
TURNS COIL #2 17
"FP" MARK 180° Yes
ANGLES INCREASE Yes
ANGLES DECREASE —
RPM 3600
FIELD AMPS 400
DATE/TIME 10/2/09 21:1?

SHORTS FOUND

IF SHORT SUSPECTED SEE IF SHORT IS SPEED SENSITIVE. LEAVE EXCITATION ON DURING RUN DOWN TO SEE IF SHORT IS SPEED SENSITIVE.

WAS SHORT SPEED SENSITIVE?(Y/N) N/A
IF YES, SHORT DROPS OUT AT RPM:
WAS BURNOUT ATTMPT MADE: (Y/N)
BURNOUT CURRENT APPLIED:

IF SHORT(S) ARE STILL PRESENT AFTER COMPLETION OF ALL THERMAL TESTING, DIAGNOSTICS, AND BURNOUT ATTEMPT(S) A QCR MUST BE ISSUED AND THE LOCATION OF THE SHORT(S) NOTED. A COPY OF PCT-401 SHOULD ACCOMPANY THE QCR. THE QCR SHOULD BE LOGGED ON PCT-362 JOB CLOSEOUT SHEET, ON PCG-268 COMPLETED TEST SHEET, AND HERE ON PCT-401.

QCR # ______

LOCATION OF SHORT(S) IF PRESENT

COIL#: ______ DEGREE POLE: ______
COIL#: ______ DEGREE POLE: ______
COIL#: ______ DEGREE POLE:

Additional Notes: [X] NO SHORTS ARE PRESENT

FLUX PROBE DATA TAKEN BY:
TECHS: DH/BL DATE: 10-2-09

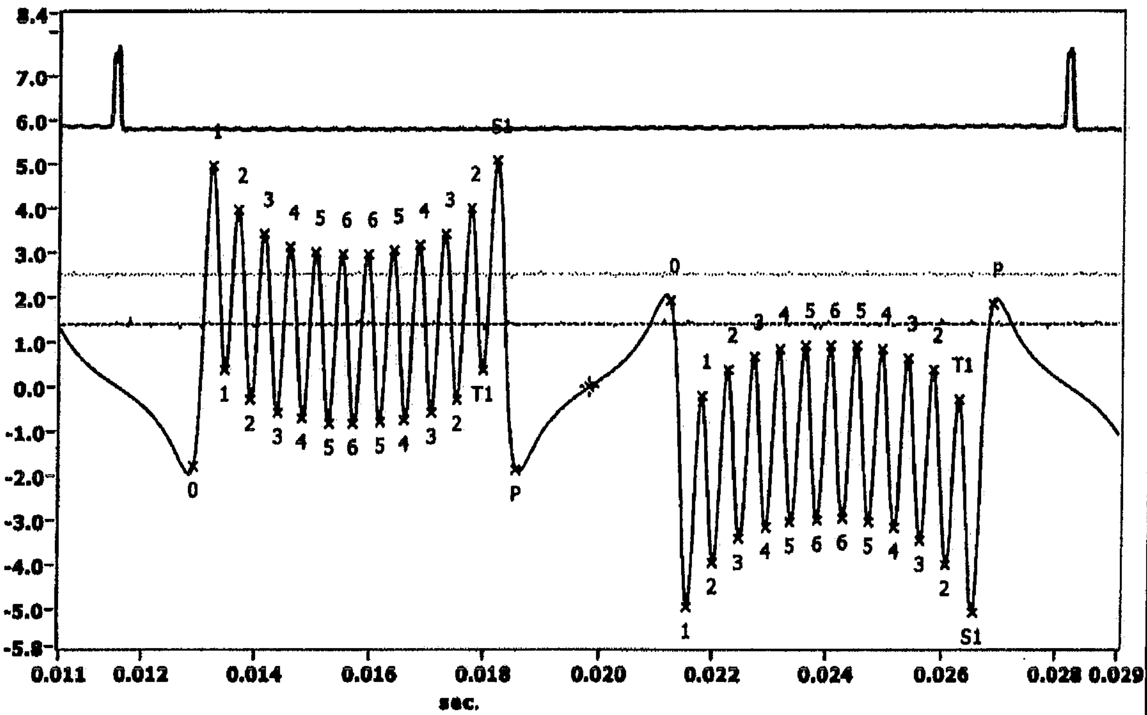
AUTHORIZED SIGNATURE BELOW
[signature] DATE: 10-5-09

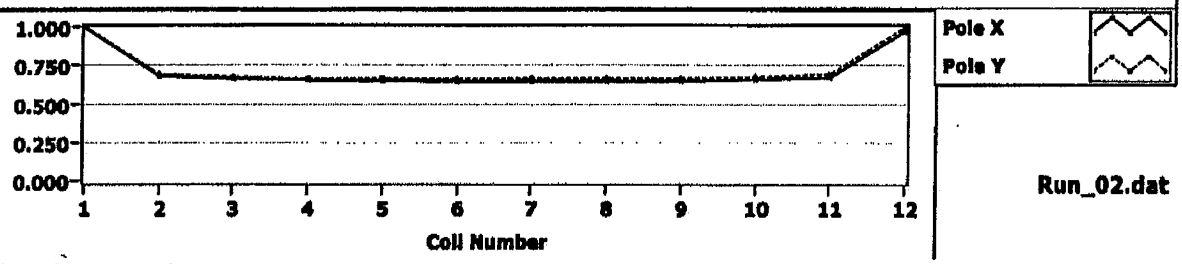
PCT-401

GE POWER SYSTEMS
GE FLUX PROBE TEST DATA - 2 POLE REPORT

Normalized Slot Amplitude Measurement

	Pole X		Pole Y							
	LE	TE	LE	TE	Pole X	Pole Y	% Diff	Short?		Single Turn Short
	LE	TE	LE	TE	Pole X Avg	Pole Y Avg	% Diff X-Y	Short?		5.88 %
T1-S1	0.969	0.996	0.996	1.000	0.984	0.996	-1.168%			
2-2	0.669	0.681	0.692	0.694	0.681	0.686	-0.734%			
3-3	0.657	0.663	0.675	0.677	0.667	0.669	-0.300%			
4-4	0.646	0.654	0.667	0.665	0.655	0.661	-0.763%			
5-5	0.644	0.649	0.666	0.667	0.655	0.657	-0.305%			
6-6	0.646	0.643	0.666	0.661	0.653	0.655	-0.153%			





Run_02.dat

Field Serial #: 181073326; Customer: Astoria; Test Facility: Bld 281 GFB
Test Timing: After Thermal; Field Current: 418; Field Voltage: 114; Time & Date: 21:13:25 2009/10/02; File Path: Run_02.dat
Licensed to: GE Test Facility
SN:0x00

GE POWER SYSTEMS
Test Operations
PCT-367 PJR 06/29/04

Customer: N/A Shop Order: 290T769 Serial Number: 181073326
Balancer / Technician: TC / WK Date: 10/5/2009

Generator Field Balance Bunker Weight Resolution

Location of Balance Plane	No. of Weights	Ounces	Angle
TE Coupling			
TE Body Fan Ring	1	1.937	83°
TE Spindle			
CE Spindle			
CE Body Fan Ring	1	1.937	83°
Collector Fan Rim			
Coll. Fan Hub Groove	2	1.0	240°
Coll. End Bal. Ring or Coupling			
Brushless Exciter			
All weights are installed at least 1/2" away from weight openings to allow for proper weight staking procedures.	Balancer / Technician: TC / WK		Date: 10/05/2009

PCT-367

Field Shipping Hipot

PCG-5625

Per P12A-AL-6129

Shop Order/DL: 290T769 **Customer:** ASTORIA ENERGY
S/N: 181073326 **Prototype:** 324
Rated Field Voltage: 675

Field Resistance Data

Bridge S/N: 1485 **Cal Due:** 6/12/2010

Engineering calc. resistance at 25 deg C = 0.24600 Ω
Measured resistance at 25.86 deg C = 0.24590 Ω
Corrected resistance at 25 deg C = 0.24509 Ω
Percent Difference resistance at 25 deg C = 0.37%

Thermometer S/Ns:	Cal Due:
78560062	5/28/2010
78590014	2/9/2010
78560064	2/9/2010

The maximum allowable difference is 2%. The measured field resistance is WITHIN THE LIMITS

Field Megger Data

Time (min)	Megohms
1	2320
2	3000
3	3340
4	3520
5	3560
6	3640
7	3740
8	3820
9	3880
10	3900

Megger S/N: 2233 **Cal Due:** 8/4/2010
RH S/N: 100-04-02352 **Cal Due:** 10/10/2010
Megger Voltage: 500 VDC **Rel Humidity:** 38 %

P.I. (Polarization Index) = 10 Min Reading/1 Min Reading

PI = 1.68

NOTE: PI must be greater than 1.00 for hipot test

The PI (Polarization Index) is IN TOLERANCE

The post-hipot megger must be >= 25Mohm and >=60% of the 1 minute pre-hipot reading or >= 200Mohm

Before HIPOT (1 min) megger x 0.6 = 1392 After HIPOT (1 min) megger = 1160

The Pre- to Post-Hipot Megger Comparison is WITHIN TOLERANCE

Hipot Data

Hipot S/N: 053142 **Hipot Cal Due:** 2/14/2010

☑ Completed Safety Check Sheet PCT-004:

Passed Hipot at 5.350 KV AC for 1 min. and @ 1.5 amps

Tester: MB/BP **Test Review:** [signature]
Date: 10/7/2009 **Date:** 10/7/09

GE POWER SYSTEMS
Test Operations
PCG-268 PJR 10/29/02

COMPLETED TEST SHEET FOR GENERATOR FIELDS

Customer: Astoria Serial: 181073326 Shop Order: 290T769
Field Rotor Description: 324 - 60HZ Date: 10/5/09

1 **FIELD ROTOR BALANCE AND OVERSPEED COMPLETE.**
ISSUE QCR IF FAILED & RECORD AT ITEM 2.
OVERSPEED ACHIEVED 4320 RPM @ 120 PERCENT RATED SPEED

Test Signature [signature] Date: 10/05/2009

EXCEPTIONS:

2 **QCR'S GENERATED IN BLDG. 281**
S0911043
S0911073
ATTENTION: ROTOR INSPECTION TO RECORD THESE QCR'S IN THE ROTOR FOLDER.

3 **ENGINEERING MI's COMPLETED:**
MI # 387A2501 Test Signature [signature] Date: 10/5/09
MI # ______ Test Signature ______ Date: ______
MI # ______ Test Signature ______ Date: ______
MI # ______ Test Signature ______ Date: ______

4 **FLUX PROBE CHECK FOR SHORTED TURNS APPROVED FOR SHIP**
Test Signature [signature] Date: 10/5/09

5 **THERMAL APPROVED FOR SHIP:**
Test Signature [signature] Date: 10/5/09

6 **COMMENTS:**

gnatures, initials, or typed names are permissible.
PCG-268

Energietechnik Essen GmbH · seit 1811	**MATERIAL ACCEPTANCE CERTIFICATE (MAC)** Inspection - Certificate No.: 090301	Page -1- of 6

Purchaser : GE Power Systems, 1 River Road, Schenectady, NY12345

GE SPEC: B50A743 ISSUE E

FORGING: Supplier Name Energietechnik Essen GmbH CLASS T 165

DATE: 03-11-2009

Drawing No. 203 D 4736 -01 Rev. A

Supplier Serial Number 5002180 5100 9571

GE Manufacturing Process Plan:

No. SQ-019530-MPP-1 Rev. No. ____ Rev. Date 30 MAY 2007

MELTING: Heat Number E28232

Electrode Melting Practice: LR X AOD ___ VCD ___ VSD ___ VOD ___

SERIAL NUMBER: 600 009 386/2

MECHANICAL PROPERTIES: (at inner diameter)

Location	Tensile Strength (ksi)	0.2% Y.S. (ksi)	El. (%)	R.A. (%)	Charpy R.T. Energy (ft-lbs.)
(Spec. min.)	174	164	19	48	60
A-1 (1)	182,5	179,5	27	66	145
A-2 (2)	187,5	186,0	27	62	133
B-1 (3)	NA				
B-2 (4)	NA				

PERMEABILITY 1,0013

METALLURGICAL PROPERTIES:

GRAIN SIZE 3 (2) ASTM CLEANLINESS B1th, D2th

SONIC: Ultrasonic Indications: NO X YES ____

Reportable Indications: NO X YES ____

Energietechnik Essen GmbH · seit 1811	MATERIAL ACCEPTANCE CERTIFICATE (MAC) Inspection - Certificate No.: 090301	Page -2- of 6

Purchaser : GE Power Systems, 1 River Road, Schenectady, NY12345

Supplier Serial Number: 5002180 5100 9571

RE-MELT CHEMICAL COMPOSITION:

Method Used: Ingot X Billet ______ Forging ______

TESTING LOCATION ELEMENT	TOP	BOTTOM
	Weight Percentage	
C	0,076	0,061
Mn	19,46	18,63
P	0,019	0,015
S	<0,001	0,001
Si	0,31	0,35
Cr	17,83	17,76
N	0,59	0,54
V	0,069	0,070
Sb	0,0005	0,0004
As	0,003	0,003
Sn	0,002	0,002
Al	0,004	0,011

AUTHORIZED SIGNATURE ETE 3

- Bonsen -

Energietechnik Essen
GmbH - seit 1911

Abnahmeprüfzeugnis EN 10204/3.1
Inspection-Certificate / Certificat de réception
Nr./No. 090301 Seite/Page 3 von/of/de 5

Auftrags- Nr.: / Order No.: / Notre commande No.: 5002180

Besteller/Purchaser/Commettant: GE Power Systems, 1 River Road, Schenectady NY 12345
Bestellung-Nr./Order No./Commande No.: see Page -1-
Liefervorschrift/Purch. Spec./Conditions de livraison: P14A-AL-0201 Rev. E, B50A743-E

Location of Specimen No.	Lateral Expansion of Impact Specimen (mm)
A-1 (1)	1,86
A-2 (2)	1,81

HARDNESS Equotip G

Location of Specimen No.		1				2			
1 - 8 TOP	=	640	642	644	642	644	642	645	642
1 - 8 BOTTOM	=	644	644	646	645	646	646	644	645

Location of Specimen No.

All tensile and impact specimens taken from inside diameter, as per GE's drawing.
Location of test specimen as per GE's Specification P14A-AL-0201 Rev. E Paragraph 6.4.

INGOT SIZE: mm dia. 1030 INGOT WEIGHT: 13420 kg's

INGOT DISCARDS: Top end 400 kg's
Bottom end 270 kg's

ORIENTATION OF FORGING WITHIN INGOT: Middle

HEAT TREATMENT: Quenching: 1080°C / water

Stress relieving: 10h - 400°C/ furnace cooling down, heating and cooling rate 25°C per hour.

ULTRASONIC TEST: see attached ULTRASONIC TEST REPORT (page -4-)

Es wird bestätigt, daß die Lieferung den Vereinbarungen bei der Bestellannahme entspricht. Besichtigung und Abmessung ohne Beanstandung.
We hereby certify that the material described above has been tested and complies with the terms of the order confirmation. Inspection and dimensional control without complaints.

Nous certifions que la livraison est conforme aux stipulations de l'acception de la commande. Inspection et contrôle des dimensions sans objection.

Datum/Date Essen, 03-112009

ETE 3

- Bonsen -
(ABNAHMEBEAUFTRAGTER WERK)
(Work's inspection)
(L'expert de l'usine)

Energietechnik Essen GmbH · seit 1811

ULTRASCHALL - PRÜFPROTOKOLL

Ultrasonic Test Report

Enclosure to Certificare - No.	PK0301	Page 4 of 6

Purchase Order No. : 600 009 386
Serial No. : 600 009 386/2
Purchase Specification : P 14A-AL-0201 Rev. "E"
Examination Specification : P 3C-AL-0653 Rev. "B" / P 3C-AL-6501 Rev. "C"
Manufacturing Stage : final machined
Drawing Number : 203D4736-01 Rev. A

Ultrasonic Examination

Examination No. : 5002180 / 51009571
Examination Instruction : PV - KR 1/72 Rev. 7
Equipment and No. : Symphonic 310 / 2002 - 117
Couplant : Water
Surface Condition : turned

Search Unit Design	Freq. (MHz)	Calibration	Gates - Lengths and Thresholds	Noise Level
No.1 Long. Wave rad.	2,25	DAC 1,6mm + 6 dB *1.BE 80%* 29,0 + 30,0 = 59,0 dB	46,1 mm 20%	2-7/10 %
No.2 Long. Wave rad.	2,25	DAC 1,6mm + 6 dB *1.BE 80%* 30,5 + 30,0 = 60,5 dB	45,1 mm 20%	2-8/10 %
No.3 Long. Wave rad	2,25	*1.BE 80%* 33,9 dB	——	——
No.4 Shear Wave tang	2,25	*Notch Echo 80%* (0,75mm dep) 39 + 6 = 45 dB	100 mm 20%	1-6/9 %
No.5 Shear Wave tang.	2,25	*Notch Echo 80%* (0,75mm dep) 44 + 6 = 50 dB	100 mm 20%	2-7/10 %
No.6 Shear Wave ax.	2,25	*Edge Echo 80%* 33 + 10 = 43 dB	30 mm 20%	1-5/7 %
No.7 Shear Wave ax.	2,25	*Edge Echo 80%* 42 + 8 = 50 dB	30 mm 20%	3-10/13 %
No.8 Long. Wave rad.	2,25	*1.BE 40%* 28,0 dB	——	——

Remark: ⌀ A= 1046 mm
⌀ I= 915 mm
L= 646 mm
W= 65,1 mm

Recordable Indications: ⊗ no O yes, page:	Date / Operator 03.03.2009 Carl...
⊗ Released O Released, acceptable indications O Hold, unaccepted indications	Date / Exam. Supervisor 03.03.2009

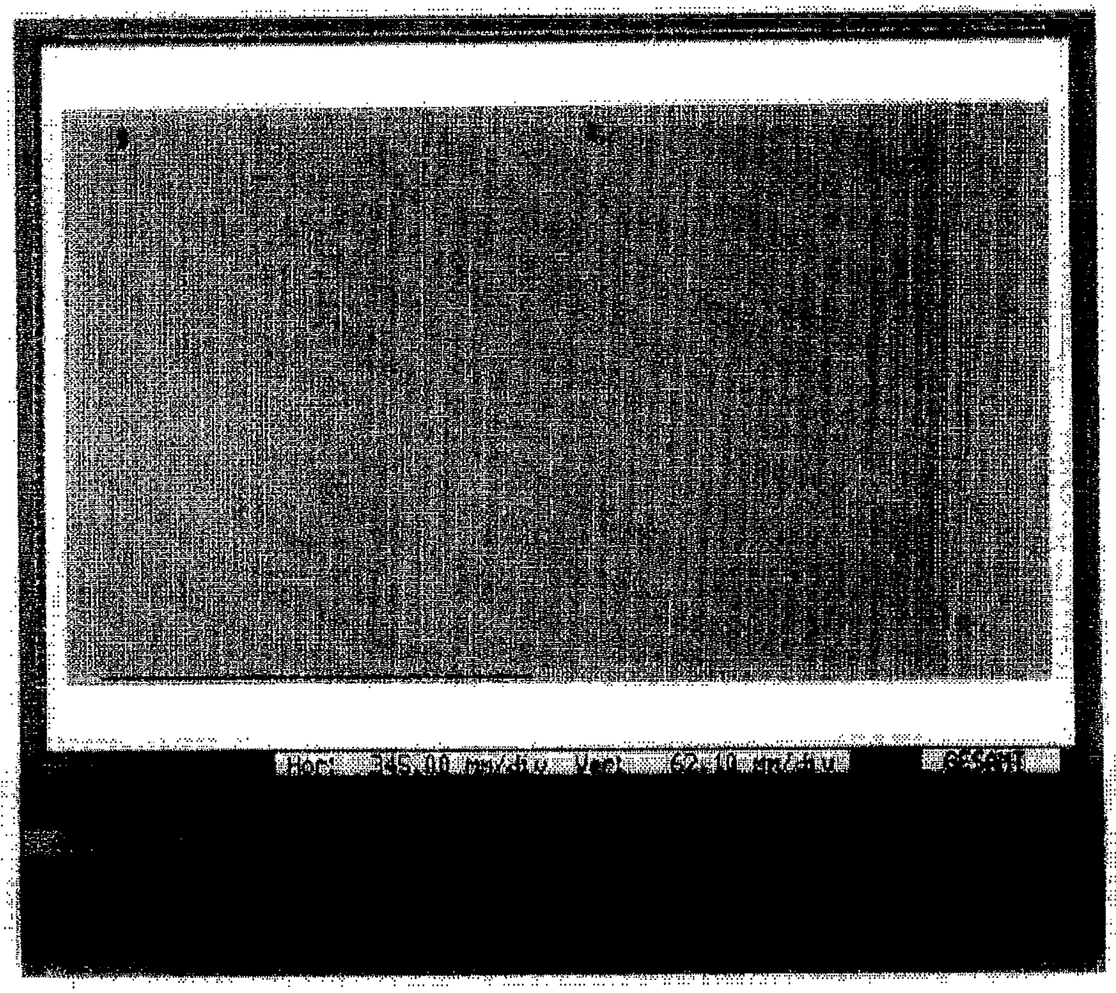
Annex: C- plot "print of all probes"
3-8 plot

Energietechnik Essen
GmbH · seit 1811

Abnahmeprüfzeugnis EN 10204/3.1
Inspection-Certificate / Certificat de réception

Nr./No. 090301 Seite/Page 5 von/of/de 6

Auftrags-Nr.:
Order No.:
Notre commande No.: 5002180

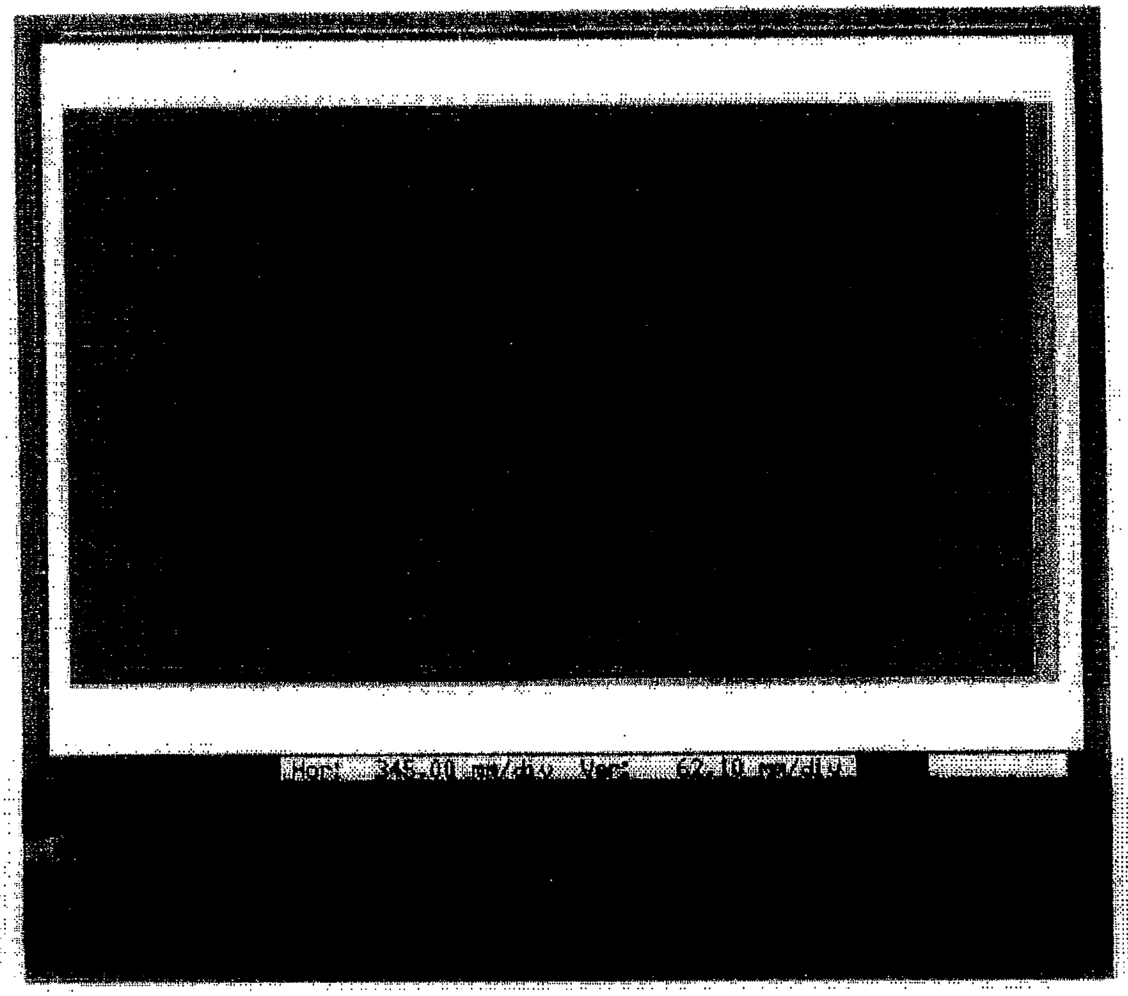


51009571 03.03.09 PRINT OF ALL PROBES
CH.1 59dB CH.2 60.5dB DAC 1.6mm + 6dB GATES 20%
CH.4 45dB CH.5 50dB NOTCH ECHOS 80% + 6dB GATES 20%
CH.6 33+10dB CH.7 42+8dB EDGE ECHOS 80% GATES 20%

Energietechnik Essen
GmbH · seit 1811

Abnahmeprüfzeugnis EN 10204/3.1
Inspection-Certificate / Certificat de réception

Auftrags-Nr.:
Order No.:
Notre commande No.: 5002180



51009571 03.03.09
BE ATTENUATION CH.3 - CH.8
CH.3 1.BE 80% 33.9dB
CH.8 1.BE 40% 28.0dB

Energietechnik Essen GmbH . seit 1811	MATERIAL ACCEPTANCE CERTIFICATE (MAC) Inspection - Certificate No.: 090300	Page -1- of 6

Purchaser : GE Power Systems, 1 River Road, Schenectady, NY12345

GE SPEC: B50A743 ISSUE E

FORGING: Supplier Name Energietechnik Essen GmbH CLASS T 165

DATE: 03-11-2009

Drawing No. 203 D 4736 -01 Rev. A

Supplier Serial Number 5002180 5100 9560

GE Manufacturing Process Plan:

No. SQ-019530-MPP-1 Rev. No. ____ Rev. Date 30 MAY 2007

MELTING: Heat Number E28221

Electrode Melting Practice: LR X AOD ___ VCD ___ VSD ___ VOD ___

SERIAL NUMBER: 600 009 386/1

MECHANICAL PROPERTIES: (at inner diameter)

Location	Tensile Strength (ksi)	0.2% Y.S. (ksi)	El. (%)	R.A. (%)	Charpy R.T. Energy (ft-lbs.)
(Spec. min.)	174	164	19	48	60
A-1 (1)	184,5	179,5	25	61	106
A-2 (2)	187,0	186,0	19	60	81
B-1 (3)	NA				
B-2 (4)	NA				

PERMEABILITY 1,0013

METALLURGICAL PROPERTIES:

GRAIN SIZE 3 (2) ASTM CLEANLINESS B1th, D2th

SONIC: Ultrasonic Indications: NO X YES ____

Reportable Indications: NO X YES ____

Energietechnik Essen GmbH · seit 1811	**MATERIAL ACCEPTANCE CERTIFICATE (MAC)** Inspection - Certificate No.: 090300	

Purchaser : GE Power Systems, 1 River Road, Schenectady, NY12345

Supplier Serial Number: 5002180 5100 9560

RE-MELT CHEMICAL COMPOSITION:

Method Used: Ingot X Billet _______ Forging _______

TESTING LOCATION ELEMENT	TOP	BOTTOM
	Weight Percentage	
C	0,069	0,061
Mn	19,14	18,36
P	0,019	0,017
S	0,001	0,001
Si	0,26	0,30
Cr	17,89	17,62
N	0,63	0,56
V	0,071	0,069
Sb	0,0004	0,0004
As	0,003	0,003
Sn	0,002	0,002
Al	0,004	0,012

AUTHORIZED SIGNATURE ETE 8

- Bonsen -

Energietechnik Essen
GmbH - seit 1811

Abnahmeprüfzeugnis EN 10204/3.1
Inspection-Certificate / Certificat de réception

Auftrags-Nr.: / Order No.: / Notre commande No.: 5002180

Besteller/Purchaser/Commettant: GE Power Systems, 1 River Road, Schenectady NY 12345
Bestellung-Nr./Order No./Commande No.: see Page -1-
Liefervorschrift/Purch. Spec./Conditions de livraison: P14A-AL-0201 Rev. E, B50A743-E

Location of Specimen No.	Lateral Expansion of Impact Specimen (mm)
A-1 (1)	1,42
A-2 (2)	1,17

HARDNESS Equotip G

Location of Specimen No.		1				2			
1 - 8 TOP	=	642	644	645	643	644	644	646	644
1 - 8 BOTTOM	=	643	645	646	645	646	646	645	645

Location of Specimen No.

All tensile and impact specimens taken from inside diameter, as per GE's drawing.
Location of test specimen as per GE's Specification P14A-AL-0201 Rev. E Paragraph 6.4.

INGOT SIZE: mm dia. 1030 INGOT WEIGHT: 26230 kg's

INGOT DISCARDS: Top end 790 kg's
Bottom end 520 kg's

ORIENTATION OF FORGING WITHIN INGOT: Middle

HEAT TREATMENT: Quenching: 1080°C / water

Stress relieving: 10h - 400°C/ furnace cooling down, heating and cooling rate 25°C per hour.

ULTRASONIC TEST: see attached ULTRASONIC TEST REPORT (page -4-)

Es wird bestätigt, daß die Lieferung den Vereinbarungen bei der Bestellannahme entspricht. Besichtigung und Abmessung ohne Beanstandung.
We hereby certify that the material described above has been tested and complies with the terms of the order confirmation. Inspection and dimensional control without complaints.

Nous certifions que la livraison est conforme aux stipulations de l'acception de la commande. Inspection et contrôle des dimensions sans objection.

Datum/Date Essen, 03-11-2009

ETE 8

Bossau
(Abnahmebeauftragter)
(Works Inspector)
(L'expert de l'usine)

Energietechnik Essen
GmbH · seit 1811

ULTRASCHALL - PRÜFPROTOKOLL

Ultrasonic Test Report

Enclosure to Certificare - No.	090300	Page 4 of 6

Purchase Order No. : 600 009 386
Serial No. : 600 009 38611
Purchase Specification : P 14A-AL-0201 Rev. "E"
Examination Specification : P 3C-AL-0653 Rev. "B" / P 3C-AL-6501 Rev. "C"
Manufacturing Stage : final machined
Drawing Number : 203D4736-01 Rev. A

Ultrasonic Examination

Examination No. : 5002180 / 51009560
Examination Instruction : PV - KR 1/72 Rev. 7
Equipment and No. : Symphonic 310 / 2002 - 117
Couplant : Water
Surface Condition : turned

Search Unit Design	Freq. (MHz)	Calibration	Gates - Lengths and Thresholds	Noise Level
No.1 Long. Wave rad.	2,25	DAC 1,6mm + 6 dB 1.BE 80% 28,3 + 30,0 = 58,3 dB	46,0 mm 20%	1-6/8 %
No.2 Long. Wave rad.	2,25	DAC 1,6mm + 6 dB 1.BE 80% 30,5 + 30,0 = 60,5 dB	45,0 mm 20%	2-8/10 %
No.3 Long. Wave rad.	2,25	1.BE 80% 33,7 dB	------	------
No.4 Shear Wave tang.	2,25	Notch Echo 80% (0,75mm dep) 39 + 6 = 45 dB	100 mm 20%	1-5/8 %
No.5 Shear Wave tang.	2,25	Notch Echo 80% (0,75mm dep) 43 + 6 = 49 dB	100 mm 20%	1-7/10 %
No.6 Shear Wave ax.	2,25	Edge Echo 80% 33 + 10 = 43 dB	30 mm 20%	1-5/7 %
No.7 Shear Wave ax.	2,25	Edge Echo 80% 40 + 10 = 50 dB	30 mm 20%	2-7/12 %
No.8 Long. Wave rad.	2,25	1.BE 40% 27,9 dB	------	------

Remark: ∅ A= 1046 mm
∅ I = 915 mm
L= 646 mm
W= 65,0 mm

Recordable Indications:	Date / Operator
⊗ no ○ yes, page:	03.03.2009 Ceglarek

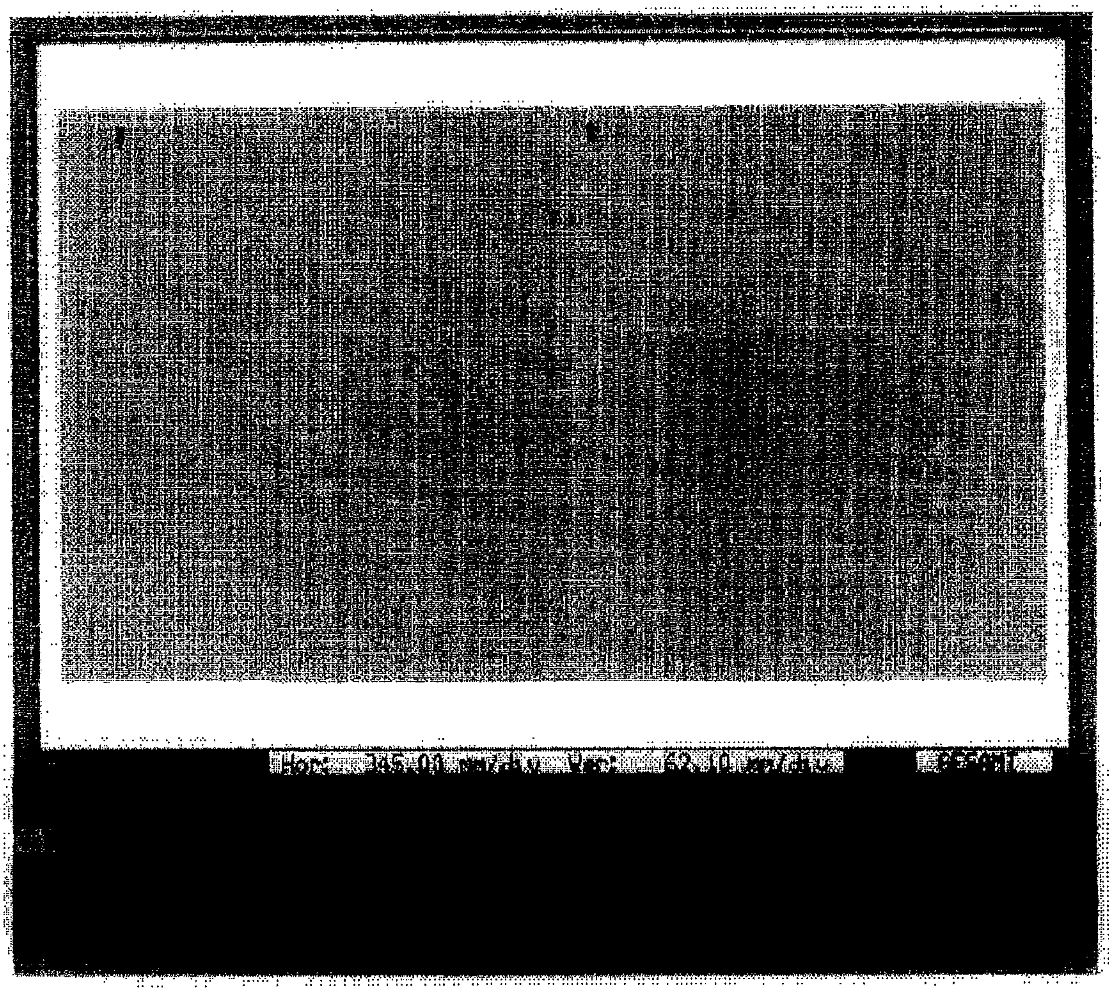
	Date / Exam. Supervisor
☑ Released ○ Released, acceptable indications ○ Hold, unaccepted indications	03.03.2009

Annex: C- plot "print of all probes"
3-8 plot

Energietechnik Essen
GmbH - seit 1811

Abnahmeprüfzeugnis EN 10204/3.1
Inspection-Certificate / Certificat de réception
Nr./No. 090300 Seite/Page 5 von/of/de 6

Auftrags-Nr.:
Order No.:
Notre commande No.: 5002180

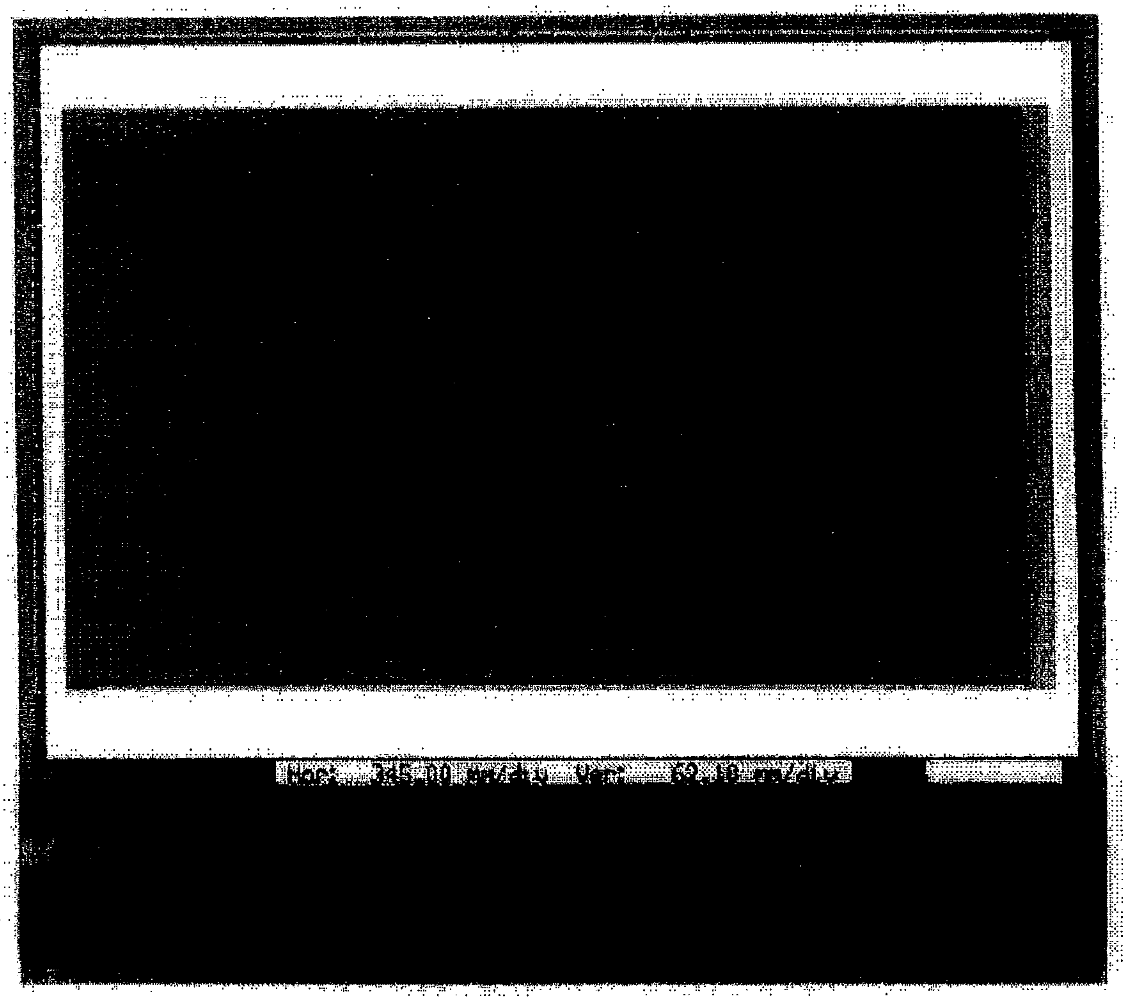


51009560 03.03.09 PRINT OF ALL PROBES
CH.1 58.3dB CH.2 60.5dB DAC 1.6mm + 6dB GATES 20%
CH.4 45dB CH.5 49dB NOTCH ECHOS 80% + 6dB GATES 20%
CH.6 43dB CH.7 50dB EDGE ECHOS 80% + 10dB GATES 20%

Energietechnik Essen
GmbH · seit 1811

Abnahmeprüfzeugnis EN 10204/3.1
Inspection-Certificate / Certificat de réception

Auftrags-Nr.: / Order No.: / Notre commande No.: 5002180



51009560 03.03.09
BE ATTENUATION CH.3 - CH.8
CH.3 1.BE 80% 33.7dB
CH.8 1.BE 40% 27.9dB

TURBINE GENERATOR MANUFACTURING PCT-316

PJR REV. 03/13/02

CUSTOMER'S REPRESENTATIVE WITNESS/REVIEW OF TEST / INSPECTION

CUSTOMER ASTORIA ENERGY

PART DESCRIPTION Field

DWG # OF PART 134E5709

SERIAL # 181073326

DATE 10/7/09

THE SIGNING OF THIS FORM BY THE CUSTOMER(S) REPRESENTATIVE / WITNESS DOES NOT IMPLY ACCEPTANCE OR REJECTION OF THE TEST OR OF THE DATA BEING DEMONSTRATED. THIS FORM REPRESENTS THE PRESENCE AND/OR REVIEW OF THE DATA OF SAID CUSTOMER(S).

NAME OF TEST /DATA BEING DEMONSTRATED :

1. SHIPPING DEPOT

CUSTOMER(S) REPRESENTATIVE SIGNATURE [signature]

DATE Oct 7, 2009.

GE COMPANY REPRESENTATIVE SIGNATURE [signature]

DATE 10/7/09

Date Accessed: 1/14/2009

TURBINE GENERATOR MANUFACTURING PCT-316

PJR REV. 03/13/02

CUSTOMER'S REPRESENTATIVE WITNESS/REVIEW OF TEST / INSPECTION

CUSTOMER	Astoria Energy 290T769
PART DESCRIPTION	STATOR 324 (LD)
DWG # OF PART	138E8462
SERIAL #	181167351
DATE	9-28-09

THE SIGNING OF THIS FORM BY THE CUSTOMER(S) REPRESENTATIVE / WITNESS DOES NOT IMPLY ACCEPTANCE OR REJECTION OF THE TEST OR OF THE DATA BEING DEMONSTRATED. THIS FORM REPRESENTS THE PRESENCE AND/OR REVIEW OF THE DATA OF SAID CUSTOMER(S).

NAME OF TEST /DATA BEING DEMONSTRATED :

Wind Stand Final at 37.0KV for 1 minute.

CUSTOMER(S) REPRESENTATIVE SIGNATURE [signature] M. Angelico

DATE 9-28-09

GE COMPANY REPRESENTATIVE SIGNATURE Glenn Adams

DATE 9-28-09.

TURBINE GENERATOR MANUFACTURING

PCT-316
PJR REV. 03/13/02

CUSTOMER'S REPRESENTATIVE WITNESS/REVIEW OF TEST / INSPECTION

CUSTOMER Astoria

PART DESCRIPTION 324-60Hz

DWG # OF PART 134E5700

SERIAL # 181073326

DATE 10/5/09

THE SIGNING OF THIS FORM BY THE CUSTOMER(S) REPRESENTATIVE / WITNESS DOES NOT IMPLY ACCEPTANCE OR REJECTION OF THE TEST OR OF THE DATA BEING DEMONSTRATED. THIS FORM REPRESENTS THE PRESENCE AND/OR REVIEW OF THE DATA OF SAID CUSTOMER(S).

NAME OF TEST /DATA BEING DEMONSTRATED :

Final Balance

CUSTOMER(S) REPRESENTATIVE SIGNATURE [signature]

DATE Oct 5, 2009

GE COMPANY REPRESENTATIVE SIGNATURE [signature]

DATE 10/5/09

Date Accessed: 4/25/2008

Magnetic Particle Test
Turbine Rotors, Generator Rotors, & Shafts

QCR's #1 ______ #2 ______ #3 ______

Turbine Rotor Mag Test Before Bucket Assembly

		Sign Offs	Amperes	Indications Yes	Indications No	Operator	Date
Bore Visual (Including the Radius in a blind bore).		PCR-336					

		Sign Offs	Amperes	Yes	No	Operator	Date
Bore (Including radius in end of a blind bore)	"1st Mag" Headshot	PCR-336					
	2nd Mag Headshot						
"Plug Bore" Mag							
Demagnetization after completion of bore mag.							
Periphery Test (No heat test)	"1st Mag" Headshot	FQP or PC- 382					
	"2nd Mag" Wrap						
Coupling / Coupling Holes (Integral Coupling)							
Demagnetization after periphery mag.							

Generator Rotor Mag Test

		Sign Offs	Amperes	Yes	No	Operator	Date
Mag Bore	"1st Mag" Headshot	G7600A,B,N					
	"2nd Mag" Headshot	G7629 A,					
	Demag.	PCR-336					
Mag Ends	"1st Mag" Headshot	G7600A,B,N	3600		X	[signature]	1-24-09
	"2nd Mag" Wrap	G7629 A,	3600		X	[signature]	1-24-09
	Demag.	PCR-336				[signature]	1-24-09

*Note: When **all mag tests** before assembly have been **signed off** on this form, place **original** in master folder at inspection.*

Shop Order: ______ **Serial #:** 181073326 **Drawing #:** 134E5700
Prototype: 324 **Workstation:** ______ **Inspector Audit:** [signature] **Date:** 7-29-09

GE Steam Turbine Manufacturing

Generator Field - 3rd Lathe Machining

Do all machining to the drawing. - This PC Form is for record only!

	Designate Area		Diameters	Pay #	Date
	TE CPLG O.D.	D	32.750	59304	9/25
		A	32.745		
▶	TE RABBET FIT	D	~~17.995~~ 17.9995	INSP M. Facci 07741	9. 28 09
		A	17.9990		
▶	TE SPIN FIT	D	5.5130	INSP 41137	
		A	5.5125	PSO	9-26
	TE CPLG (flatness)	D	.001"	13194	
		A	OK		
	TE OB DEFL	D	17.000	39182	9/29
		A	17.000		
	TE IB DEFL	D	19.000	62874	9/21
		A	19.001		
	CE FAN ASSY (fan face recessed per drawing)	D	Verify Y/N	67889	9-16
		A	OK		
	CE FAN OD	D	20.5875	62874	9/22
		A	20.590		
▶	CE FAN FIT	D	0.9995	INSP 67889	
		A	1.000	PSO	9-22
▶	CE RABBET FIT (if ~~static start unit~~)	D		INSP	
		A			
	CE IB DEFL	D	19.000	13194	9/22
		A	19.000		
	CE OB DEFL	D	17.000	07741	9/23
		A	16.9995		
	COLL RINGS	D	13.50 MIN	13194	9/22
		A	OK		

FAN RING R/O'S NOT VERIFIED BY INSPECTOR

Fan Ring Runout Check

Required after setup on oil deflectors, PRIOR to Machining

Location	TIR	Pay No.	Date
CE	.0019	07322	9/16
TE	.0018	07322	9/16

Inspector: ______ Date: ______

If fan ring total Runout is > 0.002", review setup and 12 point plot. **Contact ops leader to review**

If fan ring total Runout and electronic 1/rev plot data remain out of tolerance, **Stop - contact Methods/QPE.**

T.E. Journal			
	Inboard	Center	Outboard
Diameter	16.000	16.000	16.000
Runout *		*.0007	
Lobe		.0001	
Oper. Pay No.: 13194		Date: 9/19/09	

Insp Dia. Check: TL Date: 9/19/09

C.E. Journal			
	Inboard	Center	Outboard
Diameter	16.000	15.9998	16.000
Runout *		*.0006	
Lobe		.0002	
Oper. Pay No.: 13194		Date: 9/17/09	

Insp Dia. Check: TL Date: 9/17/09

	Inspector Sign	Date
H Stamp Verification	TL	9/29
M Stamp Verification	TL	9/29

Instructions:

1. Runout opposite tool post to be less than .001"
2. Record all dimensions required. **Call for inspector verification.** All others are operator verification.
3. When a QCR is written, list the QCR # next to the error.
4. Operator is responsible to report all out of tolerance conditions.
5. Inspector visual signoff required for final Journal acceptance after Profilometer check.
6. The H-Stamp (high spot of the coupling face Runout) is to be stamped in the coupling face relief.
7. The M-Stamp is to be stamped on the coupling outer diameter and to be located 180° away from the H-Stamp.
8. All dimensions to be machined in lathe

▶ ***Notify inspector and operations leader for any discrepancies between measurements and drawing dimensions***

Shop Order: 290T769 **Serial #:** 181073326 **Drawing #:** 134E5700

Prototype: 324 **Workstation:** 76-3 **Inspector Audit:** TLoscavo **Date:** 9/29/09

8

GE Steam Turbine Manufacturing

Generator Field Journal Surface Finish Inspection And Final Visual Inspection

Finish Journal Machining					
Inch	**CE**	**TE**	**Inch**	**CE**	**TE**
1	6	10	13	5	9
2	6	13	14	5	11
3	5	11	15	5	11
4	5	11	16	5	10
5	5	9	17	6	12
6	5	9	18	6	12
7	6	10	19	5	14
8	6	9	20	5	12
9	6	11	21	5	9
10	5	12	22	6	10
11	5	12	23		
12	6	12	24		

	TE	CE
Date:	9-30-09	9·30·09
Inspector:	P. DeFatigo	M. Facci
Degree Loc:	0°	0°
Comments:	OK	ok
Final Visual Inspection:	P.D. 9-30-09	M. Facci 9·30·09

1. Wipe Journal prior to taking measurements.
2. Position Profilometer directly on top of the journal (working form outboard to inboard).
3. Record surface finish every 1" along both Collector and Turbine End Journals.
4. If the data appears to vary significantly - recheck the data point.
5. Degree Location is the field degree location where the measurements are being taken (ex. 0, 30, 60, etc)
6. Profilometer measurements recorded at the final visual inspection of the journals at 3rd lathe and prior to removal of the rotor from the lathe.

Shop Order: ______ **Serial #:** 181073326 **Drawing #:** 134E5200

Prototype: 324 **Workstation:** 6-7 **Inspector Audit:** PDD **Date:** 9-30-09

GENERATOR FIELD FORGING RELEASE FORM

SUPPLIER SERIAL NO.: 62365-07/GEU 866
GE SERIAL NO.: 181073326
PURCHASE ORDER NO.: 181073326
FORGING DRAWING NO.: 117E1716P0001 Rev. E
SDR's: V08104108

MATERIAL SPEC.: B50A375A90 Rev. D
SUPPLIER: 92151 - Buderus
HEAT NO: 78002
TRIAL ORDER: YES ______ NO __X__

RELEASE BY SOURCING QUALITY AND PRODUCTIVITY

The aforementioned Rotor has been evaluated based on the Purchase Order and specification requirements and all known written Engineering requirements. Based on this evaluation, this rotor has met all the requirements and is now released to Manufacturing for further processing. GE non-destructive tests were not completed prior to receipt of the forging unless otherwise noted. The tests to be done prior to machining include those tests not performed by the supplier, those required for audit/qualification purposes and those required because the supplier is not qualified to perform the final test.

COMPLETED PRIOR TO RECEIPT IN SCHENECTADY

APPLICABLE TESTS	COMPLETED BE GE REP. PRIOR TO SHIPMENT FROM FORGING SUPPLIER			TO BE DONE PRIOR TO MACHINING	
	Y	N	N/A	Y	N
Periphery Ultrasonic Test (P3C-AL-2214)	X				X
Ultrasonic Bore Eccentricity Test (P3C-AL-2146)	X				X
THRU BORE OR UNDERBODY BORE ONLY					
Boresonic Test (P3C-AL-2201)			X		X
Bore Visual Inspection (P3C-AL-2160)			X		X
Bore Magnetic Particle Test (P3C-AL-2120)			X		X
COLLECTOR BORE ONLY					
Boresonic Test (P3C-AL-2201)			X		X
(Boresonic test P3C-AL-2201 – ONLY AT ENGINEERING REQUEST)					
Bore Visual Inspection (P3C-AL-2160)	X				X
Bore Magnetic Particle Test (P3C-AL-2120)	X				X

SIGNATURE: ____________ DATE: January 30, 2009

RELEASED FROM QCHOLD IN COPICS: DATE December 2, 2008 INITIAL ______

RIP# S8492801MS

UNRESOLVED (OPEN) SDRs OR SUPPLIER QCRs
>>MUST BE RESOLVED PRIOR TO SHIPMENT<<

(1) SDR or QCR Number(s) None

(2) All SDRs or QCRs Described Above Attached: Yes _____ No _____ Not Applicable X

FILE TRANSFER STATUS

SOURCING QUALITY & PRODUCTIVITY TO GENERATOR QUALITY

SOURCING QUALITY ASSURANCE

Date Sent: ______________ Signature: ______________

Signature signifies that all Engineering tests required to be reviewed by Sourcing in Paragrapgh 4.1 of P3B-AL-3000 have been completed and meet the prescribed requirements

DISTRIBUTION: GENERATOR QUALITY-INSPECTOR
GENERATOR QUALITY
PRODUCTION CONTROL/MRP
SOURCING QUALITY ENGINEERING
STRUCTURAL MATERIALS ENGINEERING

Rev. A – March 12, 02

B50A375	GE Power Generation Engineering Materials and Process Engineering Schenectady, NY 12345	

Material Acceptance Certificate (MAC)

GE-SPEC: B50A375 Issue: D Class: A90 DATE OF REPORT: 24.10.2008

Forging: Generator Shaft
Drawing: 117E1718 Rev. E
Serial No.: 181073326
Heat No(s).: 78002
MPP No.: 92161-97097 Rev. No.: 4 Rev. Date: 12.11.1999
Melting Practice: VSD ☑ VCD ☐ VAD ☐ ESR ☐ VAR ☐ LR ☐ Other ☐

Supplier: Buderus Edelstahl GmbH
Thru Bore: ☐
Not Thru Bore: ☑

GE, PGO Purchase order: 181073326 EBW job-no.: 82365-07
Special Requirements: -

MECHANICAL PROPERTIES

Tensile Tests
(Radial Body)

	Drawing Location	T.S. (KSI)	0,02% Y.S. (KSI)	El (%)	RA (%)
Collector End (CE1)	0°	122.0	101.0	22.7	69
Collector End (CE2)	120°	121.5	100.0	22.8	70
Collector End (CE3)	240°	122.0	100.0	23.8	71
Turbine End Prolong (TE)		122.0	101.5	22.6	70

Charpy V-Notch Tests
(Collector End)
CE1+CE2+CE3

Location	RT (Ft-lbs)	Hot/Cold Temp (°F)	Hot/Cold Ft-lbs	FATT (°F)
0° & 120° & 240° "I"	108	-148	34	-38
0° & 120° & 240° "I"		-112	34	
0° & 120° & 240° "I"		-76	39	
0° & 120° & 240° "I"		-40	45	
0° & 120° & 240° "I"		-4	83	

Approved SDR(s)

V08104108
-
-
-
-
-
-

Buderus Edelstahl GmbH
35576 Wetzlar
Quality control department
Works inspector
Schäfer

AUTHORIZED SIGNATURE

i.A.

Enclosed:
FATT-determination of the positions:
CE1+CE2+CE3 (collector end)

CHEMICAL COMPOSITION

B50A375 MAC 2

GE-order no.: **181073326**

EBW-order no.: **62365-07**

	WT. PERCENT													PPM	
	C	Mn	P	S	Si	Ni	Cr	Mo	V	Sb	As	Sn	Al	O	H
HEAT ANALYSIS OR WEIGHTED AVERAGE HEAT ANALYSIS	0.23	0.30	0.004	0.001	0.26	3.66	1.72	0.41	0.13	0.0015	0.005	0.008	0.015	13	1.0
HEAT # 1	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
HEAT # 2	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
HEAT # 3	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
HEAT # 4	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
HEAT # 5	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
HEAT # 6	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
PRODUCT ANALYSIS															
TOP	0.25	0.29	0.004	0.001	0.26	3.53	1.69	0.41	0.12	0.0015	0.004	0.008	0.015	19	0.5
MID POINT	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
BOTTOM	0.25	0.30	0.003	0.001	0.26	3.56	1.69	0.39	0.12	0.0015	0.004	0.007	0.014	11	0.5

AUTHORIZED SIGNATURE

i.A.

Buderus Edelstahl GmbH
35576 Wetzlar
Quality control department
Works inspector